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Dear Colleagues,

At the University Department of Professional Studies, we offer multidisciplinary education in social and technical sciences. Our Department promotes three common values that aspiring students and future professionals should develop: sound professional knowledge base, foreign language competence and necessary IT training.

The first CIET conference was held in our Department 6 years ago. The beginning was rather modest, not fulfilling our ambitions. This is why we put a lot of effort into making each subsequent conference better and better. We were not alone in this endeavour. Our partners were by our side during this process, supporting us in every way for which I am deeply thankful.

In light of recent developments regarding global pandemic of COVID 19 we were compelled to organize our 4th CIET conference virtually. As much as we didn't like the idea of a virtual conference, postponement was not an option. This is our modest way of fighting back. We will continue with our lives, our economic activity, professional and scientific work without endangering ourselves and our loved ones.

Therefore, the proceedings you are reading contain both scientific and professional papers presented at the 4th international scientific and professional conference entitled Contemporary Issues in Economy & Technology – CIET 2020, held in May 2020 in Split. Many of these papers were written in authorship with students and professionals in the field. In doing so, we had in mind the necessity and the opportunity to connect science and profession with business entities in order to achieve synergy effects.

The University Department of Professional Studies at the University of Split, Croatia, organized this conference in collaboration with Florida Universitària in Valencia, Spain. Dear colleagues from Valencia, thank you very much for your contribution to the organization of the conference. Particularly, I would like to wish a warm welcome to our partner institutions in organising this conference: Trade Co-operative University of Moldova, ISCAP - Porto Accounting and Business School, Faculty of Management University of Primorska and Zagreb University of Applied Sciences.

The proceedings would not be possible without the time and energy devoted by the members of the organising and program committees, and reviewers. Furthermore, special gratitude is intended to the conference donor who generously supported this event. Finally, I would like to express my gratitude to all of you who have contributed with your scientific and professional papers to the publication of the proceedings and thus enriched the scientific thought and practice.

Split, June 2020

The role that universities and Higher Education institutions play in our society is paramount. Education and research are indispensable for social development, inequality lessening, and the generation of economic and human wealth. Therefore, quality education and research must be strategic targets for any university.

In addition, another goal should be to share and inform outdoors what universities and professors do and how they do it as well as what are their fields and projects of research. Sharing what we do and how we do it, collaborating with other professors and researchers, contributing with our ideas, integrating other people's ideas enrich professors, researchers and universities. As a result, we contribute to an increase in the quality of education and research and consequently, the social impact of universities is enhanced.

National and international conferences offer the possibility to share knowledge, to start or consolidate collaborations among institutions but also, among professors and researchers. Besides, involving students in those events both as attendees or even participants grants them the possibility to either become acquainted with first-hand research related to their field of study or update their knowledge, thus stimulating their intellectual curiosity to ask questions and search for responses. Working sessions, networking during coffee-breaks and meals, and social activities developed during this kind of events enable the establishment of institutional, professional and even personal links.

In sum, this is about combining experiences at an international level by creating links among culturally distinct countries and therefore, building bridges instead of creating division and separatism. This is the objective of CIET, and international conference that was created in 2014 and which has gathered together a big number of professors and researchers from different countries who have had the opportunity to meet each other, exchange knowledge and expertise, and discuss on issues of mutual interest throughout its four editions so far.

It has been a pleasure for us at Florida Universitària to collaborate this year to the fourth edition of CIET and we also wish to thank the Department of Professional Studies of the University of Split for the opportunity of holding the fifth edition of their conference, CIET 2022, in our campus. For Florida Universitària and for the teaching and research team is very important, since quality education and research together with institutional collaborations at all levels are a priority.

We are looking forward to meeting you all in Valencia.

Kind regards

Head of Higher Education at Florida Universitària

Mercedes Herrero

Editorial Welcome

It is a great pleasure to welcome you to the electronic edition of scientific and professional proceedings published from the 4th biennial international conference entitled CONTEMPORARY ISSUES IN ECONOMY & TECHNOLOGY - CIET 2020 - which was held on 29 May, 2020 in Split, Croatia.

The University Department of Professional Studies, University of Split, Croatia, together with the conference co-organizer Florida Universitària in Valencia, Spain and partners from UCCM - Trade Co-operative University of Moldova, University of Primorska - Faculty of Management in Koper, Slovenia, Zagreb University of Applied Science, Croatia and ISCAP - Superior Institute of Accountancy and Administration of Porto, Portugal, had a great privilege to have hosted such a prestigious event.

Unfortunately, due to the COVID-19 pandemic, our conference was held as a Virtual Conference. The conference provided an excellent forum for discussion by authors in the areas of finance and economy, entrepreneurship, tourism and trade, electrical engineering, information technology, mechanical engineering, as well as interdisciplinary approaches to teaching and learning.

Furthermore, a double-blind reviewed selection of presented scientific (27) and professional papers (49) in the above mentioned fields can be found in this electronic edition with assigned the ISBN number prepared by the Split University Library.

On behalf of all the members of the organising committee, I look forward to welcoming you to the pages of this electronic edition.

Editor-in-chief

Tonko Kovacevic, PhD, college professor



CIET | Split | 29 MAY

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CIET Split 2020 Track 1

Finance & Accounting

Dividend Policy of Listed Companies on the Zagreb Stock Exchange

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Abstract. Dividend policy represents a payment policy implemented by management, where management denotes (determines) the size and pattern of cash payments over time. Determinants affecting payout policy as well as the pattern of payout behaviour over time are still controversial even though the topic is dealt with in extensive scientific literature. Many theories and explanations have been developed that sought to clarify what determines dividend policy. Each of the developed theories explains the dividend policy with specific factors that form the decision of the company whether to pay the dividend or not and the amount of the dividend also. However, there is no explicit academic consensus on which theory is the most plausible and which explains the dividend policy best. Each country by its characteristics, as well as the specific characteristics of the company itself, influences (whether directly or indirectly) the company to adapt to the situation and the environment in which it functions and operates, thereby adjusting its dividend policy. Based on the aforementioned, the subject of the research is to determine which dividend theories best explain the decision regarding dividends of the listed companies on the Zagreb Stock Exchange, and what the significant determinants of the dividend decision are, as well as what affects the size of the dividend and how. The research was conducted on companies listed on the Zagreb Stock Exchange, where a static panel model was used.

Key words: dividends, dividend policy theories, Zagreb Stock Exchange, dividend payout

1. Introduction

One of the key questions when it comes to dividends is what determines the size of the paid dividends. This is a much discussed issue, primarily as companies pay large sums of money to their shareholders. One of the pioneering papers on the topic of dividend policy, the work of Merton Miller and Franco Modigliani (1961), encouraged early research about the motives and consequences of dividend policy. The basic assumptions of their theory are the absence of market imperfections such as taxes, transaction costs and information asymmetry. According to their irrelevance theory of the dividend policy, the dividend policy has no influence on the share price or on the cost of capital, that is, the value of the company will be independent of the dividend policy adopted by management. Most economists believe that conclusions of Miller and Modigliani (1961) are correct, given their assumptions about a perfect and efficient capital market. However, no one claims that their model is an accurate description of the real world. The real world has a number of factors that influence the dividend decision. All these factors imply that the dividend policy is relevant.

By the end of the 20th century, many theories and explanations had been developed that sought to clarify what determines dividend policy. According to the signaling theory, dividend changes should be accompanied by changes in the company's profitability. A dividend change should be a signal of current/future profitability that should move in the same direction as a dividend change. The originator of the theory of dividend policy and the hierarchy of capital structure is Mayers (1984). According to this theory, companies will first try to finance their investments from the realized profit, as the most low-cost source of financing for the company.

If it does not make a large enough profit, the company will be financed by borrowing and issuing new shares. If a company has higher borrowing costs, it will pay smaller dividends to avoid costly external financing. Larger companies, can more easily get to external sources of financing, so the link between the dividend and the size of the company will be positive. Jensen and Meckling (1976) developed the agency cost theory. In the context of this theory, dividends reduce cash under the manager's control, creating a need for management to turn to the capital market to obtain the necessary cash to finance planned investments. In such a situation, management is put under the control of the capital market and reduces the owner's need for supervision of management. Jensen's (1986) free cash flow theory is just another variation of agency cost theory. Free cash flow theory highlights that first time paying a dividend or increasing the dividend actually means reducing the ability of management to misuse the company money. Baker and Wurgler (2004) have developed a catering theory according to which companies pay or increase dividends in a situation where investors put premiums on shares of dividend paying companies. The firm life cycle theory is based on view that as a company matures, the ability to generate money goes beyond the ability to find profitable investment opportunities. In the end, the optimal decision is to distribute cash to shareholders in the form of a dividend.

Each of the theories developed so far explains the dividend policy with specific factors that determine whether the company will pay the dividend and the amount of the dividend if it decides to pay dividend. However, there is no explicit academic consensus on which theory is the most plausible and which best explains the dividend policy. Each country, like the company, by its specific characteristics influences (whether directly or indirectly) the company to adapt to the situation and environment in which it functions and operates.

An insight into the literature on dividend policy leads to a conclusion that there are not many papers about dividend policy in the Republic of Croatia. So the aim of this paper is to cover as many developed theories of dividend policy so far and examine which theory or theories best describe the dividend policy in the Republic of Croatia.

2. Dividend theories and literature review

Since the mid-20th century, many theories have been developed to explain how, why and what influences the dividend policy of companies. None of the developed theories has profiled itself as a theory applicable in all markets equally. The most researched theories are certainly agency cost theory and signaling theory. More recently, new theories have been developed, such as the catering dividend theory. In the further part of the paper, an effort was made to cover and explain as many theories of dividend policy as possible, by which the definition of the dividend payment decision of the companies listed on the Zagreb Stock Exchange can be explained.

2.1. Agency cost theory

Agency theory has been developed as a formalized framework for the study of conflicts of interest in companies among key company external and internal stakeholders, with the aim of developing mechanisms to resolve such conflicts. The pioneers of agency theory, Jensen and Meckling (1976), tried to show that companies do not behave according to the principle of maximization, primarily because of a conflict of interest that exists among key management entities.

Different equity suppliers (shareholders, bondholders, convertible securities holders) and different categories of company employees (management and other employees) share the business results of the company. As shareholders are companies' owners, their interests dominate (or should dominate) over the manager's activities, while other stakeholders have

less influence on the company's decisions. This disparity of influence in agency theory has been called agency relationship. In an agency relationship, one party has a dominant influence that can affect other stakeholders. One of most significant agency relationships is the relationship between shareholders and creditors.

Shareholders and creditors share the value of the cash flow generated by the company's operations. Creditors are entitled to interest and nominal value of debt. Shareholders are entitled to all value after settling their obligations to creditors.

Among the first studies to examine the relationship between shareholders and creditors (more specifically, bondholders) and to examine the response of bond investors to the announcement of a dividend change is the Handjinicolaou and Kalaya (1984) survey. They found a weak reaction of the bond's price to dividend increase and a negative reaction to a decrease in dividends. Their survey is more consistent with the information content hypothesis than with the view that shareholders extract value from creditors through dividends.

In their work, Dhillon and Johnson (1984) confirmed the agency theory. They examined the impact of large dividend changes, the dividend elimination and introduction of dividends. When they included significant dividend changes in their research, they came to the conclusion that the announcement of the introduction of dividends led to an increase in the share price by an average of 0.72%, while the price of bonds decreased by 0.70%. Increasing the dividend by more than 30% resulted in an average increase in stock prices of 1.82%, while the price of bonds decreased by an average of 0.50%.

2.2. Free cash flow theory

In his paper, Jensen (1986) stated the reason why dividends may also be desirable in the context of solving an agency problem. He developed free cash flow theory, which is actually a variant of agency theory. One of the stated assumptions of the free cash flow theory is that in a situation when faced with limited investment opportunities on the one hand and high amounts of cash on the other hand, company management is likely to misuse excess cash for its own benefit.

Jensen's (1986) research implies that dividends can be used as a means of reducing the excess cash under a manager's control, that is, shareholders benefit from dividend payments.

Lang and Litzenberger (1989) hypothesized that the impact of the dividend change is greater on the stock price for companies that are more prone to overinvest than for those companies that are prone to increase the value of the company. Lang and Litzenberger (1989) stated that their results confirm the free cash flow theory.

Agrawal and Jayaraman (1994) have come to the conclusion that companies with management high-stakes ownership have a lower dividend payout rate than companies with low-stakes ownership managers. The results of their research imply that dividends serve as a means of reducing the conflict of interest between managers and shareholders related to the use of excess free cash.

The results of the research by Jensen, Solberg and Zorn (1976), showed that dividends are less necessary as means of reducing the problem of overinvestment when debt repayment obligations require managerial discipline and/or when the management's ownership of the company is high.

2.3. Signalling theory

In a market where information symmetry reigns, all participants have the same company information. If one group of participants has superior company information than others, there is information asymmetry in the market. The assumptions underlying this theory are that dividends reduce information asymmetry by acting as a reliable signal that corporate insiders

send to shareholders. Simply put, introducing a dividend or increasing the dividend is interpreted by market as positive information, which results in an increase in the stock price. Reducing the dividend or canceling the dividend transfers negative information to the market and the stock price drops. Abruton and Turner's (1990) survey of CFOs of major U.S. companies shows that 63% of respondents consider signaling to be the first or second reason for paying a dividend.

Lintner (1956), Fama and Babiak (1968) found a link between dividends and earnings that is consistent with the hypothesis that dividend-paying companies only increase dividends when management is confident that increased payments will continue. A great deal of research has confirmed the applicability of signaling theory. Thus, the works of Petit (1972), Watts (1973), Asquith and Mullins (1983), Fuller and Goldstein (2011), Deshmukh, Fatemi and Fooladi (2008) confirmed the theory of signaling in the US markets, the research of Gurgul, Majdosz and Mestel (2006) confirmed the theory of signaling in the German market and Miletić (2011) confirmed the theory of signaling in the Republic of Croatia.

2.4. Dividend catering theory

According to the model of Baker and Wurgler (2004), investors divide companies into those who pay and who do not pay dividends. The model is based on certain assumptions, two of which are the most significant. The first, according to which, for psychological and institutional reasons, investors' demand for dividend paying stocks is unknown and varies over time. According to the second assumption, the rational behavior of managers leads to paying (serving) dividends when investors give a premium on dividend-paying stocks. That is, non-dividend companies initiate payment when shares of existing dividend-paying companies are traded at higher prices than similar non-dividend paying companies. On the contrary, companies cancel dividends when shares of existing dividend-paying companies are traded at prices lower than similar non-dividend paying companies. Consequently, stock prices of dividend paying companies relative to stock prices of non-dividend paying companies are higher in years with higher dividend demand and lower in years with lower dividend demand. Neves (2006), in her research on EU countries, which then consisted of twelve states, examined the applicability of the dividend catering theory. She concluded that investor

When all other characteristics of the companies are constant Bulan, Subramanian and Tanlu (2007) state that there is a high probability of introducing a dividend payment when the dividend premium is high. The combination of the life cycle and the dividend catering explains the timing of the initiation of company dividends. Mature companies with high profitability and low growth rates show a high degree of propensity to initiate dividend payments. The high dividend premium gives an even greater incentive to initiate dividends.

sentiment has a positive impact on dividend policy for companies with excess liquid assets.

2.5. The firm life cycle theory of dividends

The basic thought behind the firm life cycle theory of dividends is based on the idea that as the company matures, the ability to generate money goes beyond the ability to find profitable investment opportunities. In the end, the optimal decision is to distribute cash to shareholders in the form of a dividend.

A study conducted among six developed financial markets in the US, the United Kingdom, Canada, Germany, France and Japan by Denis and Osobov (2008) found that characteristics such as company size, profitability and company maturity were positively related to the propensity to pay dividends.

Bulan, Subramanian and Tanlu (2007) have documented how companies initiate dividend payments when they reach the mature stage of life. Dividend companies have higher growth

rates, are more profitable, have higher cash reserves, and have fewer investment opportunities, unlike non-dividend companies.

DeAngelo, DeAngelo, and Stulz (2006), in a survey that examined what determines the payment of a dividend, also considered the life cycle of the company or the life stages of the company. The ratio of total retained earnings to total equity (RE/TE) as well as the ratio of total retained earnings to total assets (RE/TA) was taken as a measure of the company's maturity.

The high ratio of these indicators shows that company is at a mature stage of life, characterized by stable cash flow that the company has at its disposal. The high share of retained earnings gives the company certainty in the future, and at the same time, in the absence of potential investment opportunities, the potential for dividend payment. The conclusions of their research are that there is a statistically significant correlation between the decision to pay dividends and the RE/TE and RE/TA indicators.

2.6. The company's financial structure theories

There are a number of theories explaining the impact of financial structure, that is, capital structure, on the value of a company. These theories also have implications for the dividend policy of companies. If the company has higher borrowing costs, it will pay smaller dividends to avoid more expensive external financing. Larger companies can more easily (cheaper) reach external sources of financing, so the link between dividend and company size will be positive.

3. Variable and sample description

The Thompson Reuters database was used to calculate the variables. Some variables in the survey were to be counted while some were just taken from the database.

In the research for the variable representing the dividend policy, the dividend per share (DPS) variable was taken. *DPS* variable also represents the dependent variable in the research.

Financial leverage (LEV) as a variable confirming the agency relationship between shareholders and creditors was calculated as the ratio of the total debt of the company i in year t and the value of the company i capital and reserves in year t. According to agency theory, the relationship between the DPS and LEV should be positive.

Free cash flow as a variable of theory of free cash flow was taken from the Thompson Reuters database, however the values of free cash flow can be unmatched by the heterogeneity of stock companies by their size. Therefore, the value of free cash flow was standardized in such a way that it was divided by the amount of company assets, thus obtaining a standardized free cash flow variable (*stFCF*). It is to be expected that this variable is in positive relationship with DPS.

If the manager possesses information on potential investment opportunities and increased future earnings, increasing the dividend will signal to the market positive information, and vice versa applies. The variable ratio between market and book value of company (MV/BV) presents potential investment opportunities as key determinants of signalling theory. The higher value of this variable indicates that it is a company with potentially large investment opportunities, and consequently with potentially higher profits. The relationship between the market value and the book value of a company i in the year t is defined by the following relation:

$$MV/BV = \frac{NS_{i,t} * P_{i,t}}{BV_{i,t}}$$
 (1)

Where NSi,t stands for number of shares of company i at the end of year t. Pi,t stand for price of share of company i at the end of year t. BVi,t stand for book value of companies equity. According to signalling theory, the relationship between DPS and MV/BV is positive.

The dividend premium (DP) is calculated at the year level as the difference between the natural logarithm of the weighted MB ratio (market to book value ratio) of the dividend paying and the non-dividend paying companies. The variable MB is calculated as follows:

$$MB_{i,t} = \frac{TA_{i,t} - BVE_{i,t} + MVE_{i,t}}{TA_{i,t}}$$

$$(2)$$

As the paper is oriented to companies, *MB* variable is also included in the investigation as variable by which dividend catering theory can be explained. The logic behind including an *MB* relationship for an individual company is that if the market has a positive sentiment for dividends, the market will value the dividend paying company more than the non-dividend paying company. As a consequence, dividend companies will have a higher *MB* ratio, and vice versa.

To calculate the weighted MB ratio, the book value of an individual company is used in the total book value of all companies. In the paper, the dividend premium (DP) is calculated as follows:

$$DP_{t} = \ln(\sum_{t}^{z} p_{i,t}^{+} \frac{TA_{i,t}^{+} - BVE_{i,t}^{+} + MVE_{i,t}^{+}}{TA_{i,t}^{+}})$$

$$- \ln(\sum_{t}^{z} p_{i,t}^{-} \frac{TAI_{i,t}^{-} - BVE_{i,t}^{-} + MVE_{i,t}^{-}}{TA_{i,t}^{-}})$$
(3)

The symbols from equitation 2 and 3 stands for:

 DP_t – dividend premium in the year t.

 $p_{i,t}^+$ - share of the book value of the company *i* that paid the dividend in year *t* in the total book value of all companies that paid the dividend in year *t*.

 $p_{i,t}^-$ - share of the book value of the company *i* that didn't paid the dividend in year *t* in the total book value of all companies that didn't paid the dividend in year *t*.

 $TA_{i,t}^+$ - Book value of assets (total assets) at the end of year t of company i which paid dividend in yea t.

 $TA_{i,t}^-$ - Book value of assets (total assets) at the end of year t of company i which did not paid dividend in year t.

 $BVE_{i,t}^+$ - Book value of equity at the end of year t of company i which paid dividend in year t

 $BVE_{i,t}^-$ - Book value of equity at the end of year t of company i which did not paid dividend in year t.

 $MVE_{i,t}^+$ - Market value of equity at the end of year t of company i which paid dividend in year t

 $MVE_{i,t}^-$ - Market value of equity at the end of year t of company i which paid dividend in year t

The ratio of total retained earnings to total equity (*RE/TE*) was taken as determinants that describe the maturity of the company as well as the ratio of total retained earnings to total assets (*RE/TA*). The high ratio of the above indicators shows that company is at a mature stage of life, characterized by stable cash flow that the company has at its disposal. The relationship between these variables and the dividend per share should be positive.

The size of the company, as a determinant of the theory of financial structure of the company, is represented by the book value of the total assets of the company i at the end of year t and is calculated as the natural logarithm of the company's total assets (lnTA).

The research was conducted on companies listed on the Zagreb Stock Exchange. Only companies whose shares were included in the CROBEX index in January 2020 were taken into account for empirical investigation. CROBEX is official index of Zagreb stock exchange (ZSE). When selecting shares to be included in the CROBEX index, only shares listed on regulated market that traded more than 90% of the total number of trading days in the sixmonth period preceding the audit can be taken into account.

A total of 15 companies were included in the survey and the period of research was from year 2011 to year 2018. 15 companies for period 2011-2018 could pay maximum of 120 dividends (8 years x 15 companies) but in observed period 61 dividend was paid of maximum 120 dividends.

4. Empirical Research

Descriptive statistics for all variables employed in research is provided in Table 1. Descriptive statistic is computed based on 120 observation for all variables.

 Table 1 Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
DPS	120	6.1658	9.6826	0.0000	72.6000
LEV	120	4.1259	12.2096	-2.2264	107.4468
stFCF	120	0.0174	0.0830	-0.4677	0.2471
RE/TE	120	-1.2614	8.0004	-69.2700	1.0579
RE/TA	120	0.1065	0.4081	-1.4021	0.8113
ln(TA)	120	8.0782	1.3801	6.0827	11.8388
MB	120	1.1312	0.4312	0.4327	2.9342
MV/BV	120	0.5348	0.4416	0.0364	2.4138
DP	120	-0.0212	0.1504	-0.2647	0.1411

Source: author's calculation

First step in research was to test stationarity in a panel dataset. The presence of unit root test was tested in all variables using a Levin-Lin-Chu unit-root test. The results showed that variables ln(TA) and MB were not stationary. After finding the first difference for not stationary variables, the same unit-root test was conducted again. Result showed that the first differences of variables ln(TA) (ln(TA)d) and DP (DPd) were stationary. After conducted testing for stationarity differenced variables were used in research. Table 2 presents results of conducted Levin-Lin-Chu unit-root test.

Table 2 Levin-Lin-Chu unit-root test

Variable	p-value
DPS	0.0000
LEVERAGE	0.0010
stFCF	0.0000
RE/TE	0.0000
RE/TA	0.0000
ln(TA)	0.4341
MB	0.0000
MV/BV	0.0000
DP	0.9926

Source: Authors' calculation

Next step in research was to check the problem of multicollinearity between independent variables. The matrix of Pearson correlation coefficients and was implemented to test the problem of multicollinearity. Correlation matrix for independent variables is shown with table 3. An absolute value of the Pearson coefficient higher than 0.7 indicates a strong correlation between independent variables. An absolute value of the Pearson coefficient higher than 0.7 indicates a strong correlation, which can be identified between variable LEV and variable RE/TE and between variables MB and DPd. Since this can affect the final findings of the model, the variables RE/TE and MB have been omitted form the model.

Table 3 Correlation matrix

	LEV	stFCF	RE/TE	RE/TA	ln(TA)d	MB	MV/BV	DPd
LEV	1							
stFCF	-0.2519	1						
RE/TE	-0.7807	0.0877	1					
RE/TA	-0.3866	-0.0238	0.581	1				
ln(TA)	-0.0462	-0.1197	-0.0108	0.1492	1			
MB	0.0363	0.3521	-0.0477	-0.2319	-0.0984	1		
MV/B V	0.1367	0.0278	-0.1088	0.0205	-0.056	-0.0782	1	
DPd	-0.1769	0.3658	0.14	0.25	-0.0015	0.7656	-0.0788	1

Source: Authors' calculation

For the purpose of econometric data analysis, static balanced panel data analysis was employed. Model (4) forms the basis of estimation.

$$Y_{it} = c + \sum_{k=1}^{K} \beta_k X_{it}^k + \varepsilon_{it}$$
 (4)

Where:

 Y_{it} is the dividend per share (DPS) of company i at time t, with i = 1,..., N; t = 1,..., T X_{it} are k independent variables as discussed in section 3.

Static panel with fixed effects (FE) and static panel with random effects (RE) was used in research. Hausman test showed that most appropriate model was static panel model with random effects (RE). Table 4 shows the results of the analysis.

Table 4 Parameter estimates of static panel model with random effects.

Variable	DPS		
	-0.0331		
LEV	(0.0568)		
a4ECE	-4.8036		
stFCF	(9.4186)		
DE/TA	2.0836		
RE/TA	(3.6150)		
la (TA) d	2.0185		
ln(TA)d	(4.9141)		
MXI/DXI	7.1963**		
MV/BV	(2.8579)		
DD1	11.5246**		
DPd	(5.6986)		
2000	2.8551		
cons	(2.2440)		
R2 within	0.0209		
R2 between	0.4909		
R2 overall	0.3115		
Model p-value	0.0952		
Hausman	chi = 4.94		
specification test	p value = 0.5519		

^{*, **, ***} Statistically significant at the; 10%, 5%, 1% level, respectively. Standard errors are between parentheses.

Source: authors' work

Table 4 summarizes the final results of empirical analysis. The model with random effect is statically significant (p-value is 0.0952). Table 4 shows that variables MV/BV and DPd have positive and statistically significant influence on DPS. As mentioned, variable MV/BV presents ratio of market value of company and its book value while DPd variable stands for dividend premium variable.

A statistically significant and positive relationship between the MV/BV variable and DPS confirms the signalling theory among companies on the ZSE, that is, on the capital market in the Republic of Croatia. Also, statistically significant and positive relationship between the DPd variable and DPS confirms the applicability of dividend catering theory among companies on ZSE.

5. Conclusion

Empirical research showed the applicability of dividend signaling theory and dividend catering theory in explicating what determinates the decision about dividend. Variables

MV/BV and DPd are statistically significant and have positive impact on decision about dividends.

As already stated, if the manager has information about potential investment opportunities and increased future earnings, increasing the dividend will signal to the market positive information, so is the vice versa. The MV/BV variable presents potential investment opportunities as key determinants of signaling theory. The higher value of this variable indicates that it is a company with potentially large investment opportunities, and consequently with potentially higher profits. This relationship reaffirms the foundations of Lintner and Fama and Babiak in which they found a positive link between dividends and earnings that is consistent with the hypothesis that dividend-paying and dividend-increasing companies only do so when management is confident about the company's future performance. The aforementioned link is also confirmed by the research (Miletić, 2011) that examined the applicability of signaling theory in the Republic of Croatia and which then confirmed the hypothesis about signaling theory in the Republic of Croatia.

The dividend premium also has a statistically significant and positive effect on the dependent variable, dividend per share (DPS). This relationship is consistent with the catering dividend theory according to which the rational behavior of managers leads to the payment (serving) of dividends when investors pay a premium on dividend paying stocks. That is, non-dividend paying companies initiate payment when shares of existing dividend-paying companies are traded at higher prices than similar non-dividend paying companies. On the contrary, companies terminate dividends when shares of existing dividend-paying companies are traded at prices lower than similar non-dividend paying companies. Consequently, the stock prices of dividend companies relative to stock prices of non-dividend companies are higher in years with higher dividend demand and lower in years with lower dividend demand.

In addition to the interpretation of the obtained results, it is necessary to emphasize some of the limitations of the research which are primarily reflected in the unavailability of all data that can define the determinants of dividend policy theories and a small number of companies taken in the research. Based on these restrictions, recommendations for future research are defined in the form of an increase in the sample on the basis of which the dividend policy is researched, and not only companies that enter the CROBEX stock index.

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Politika dividend kompanija na Zagrebačkoj burzi

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Sažetak. Politika dividendi predstavlja politiku isplate koju provodi menadžment, pri čemu određuje (determinira) veličinu i obrazac novčanih isplata kroz vrijeme. Determinante koje utječu na isplatu kao i obrazac ponašanja isplate kroz vrijeme, iako je navedeno tema opsežne znanstvene literature, još uvijek izaziva kontroverze. Do danas razvile su se mnoge teorije i objašnjenja koja su nastojala razjasniti što determinira politiku dividendi. Svaka od razvijenih teorija objašnjava politiku dividendi specifičnim faktorima koji determiniraju odluku hoće li kompanija isplatiti dividendu i iznos dividende. Međutim ne postoji jednoznačni akademski konsenzus o tome koja je teorija najprihvatljivija i koja najbolje objašnjava politiku dividendi. Svaka država svojim karakteristikama, kao i specifične karakteristike same kompanije utječe (bilo to izravno ili neizravno) na kompaniju da se prilagodi situaciji i okruženju u kojem funkcionira i djeluje, a time prilagodi i svoju politiku dividendi. Temeljem navedenoga u radu je postavljen predmet istraživanja, utvrditi koje dividendne teorije najbolje ekspliciraju odluku o dividendama na tržištu kapitala u Republici Hrvatskoj, odnosno koje su značajne determinante odluke o dividendi kompanija u Republici Hrvatskoj, što i kako utječe na veličinu dividende. Istraživanje je provedeno na kompanijama koje kotiraju na Zagrebačkoj burzi gdje se koristio statički panel model.

Ključne riječi: dividende, teorije politike dividende, Zagrebačka burza, isplata dividende

1. Uvod

Kada se govori o dividendama neizbježno je pitanje što određuje veličinu isplaćenih dividendi. Pitanje je to o kojem se mnogo raspravlja, prvenstveno jer kompanije isplaćuju velike novčane iznose svojim dioničarima. Jedan od prvotnih radova na temu politike dividendi, rad Mertona Millera i Franca Modigliania (1961), potaknuo je rana istraživanja vezana za motive i posljedice dividendne politike. Osnovne pretpostavke njihove teorije su ne postojanje tržišnih nesavršenosti kao što su porezi, transakcijski troškovi i informacijska asimetrija. Prema njihovoj teoriji irelevantnosti politike dividende, politika dividendi nema utjecaj na cijenu dionice niti na trošak kapitala, odnosno vrijednost kompanije biti će neovisna o politici dividende koju je menadžment usvojio. Većina ekonomista vjeruje kako su zaključci Millera i Modigliania (1961) točni, s obzirom na njihove pretpostavke o savršenom i učinkovitom tržištu kapitala. Međutim, nitko ne tvrdi da je njihov model točan opis realnog (stvarnog) svijeta. Realan, stvarni svijet, ima veliki broj faktora koji utječu na odluku o dividendi. Svi ti faktori impliciraju kako je politika dividende relevantna.

Do kraja 20. stoljeća razvile su se mnoge teorije i objašnjenja koja su nastojala razjasniti što determinira politiku dividendi. Prema teoriji signaliziranja promjena dividende trebala bi biti praćena promjenom profitabilnosti kompanije. Promjena dividende trebala bi biti signal tekuće/buduće profitabilnosti koja bi se trebala kretati u istom smjeru kao i promjena dividende. Začetnik teorije povezanosti dividendne politike i hijerarhije strukture kapitala je Mayers (1984). Prema ovoj teoriji kompanije će svoje investicije prvo pokušati financirat iz ostvarene dobiti jer to ujedno predstavlja i najjeftiniji izvor financiranja za kompaniju. Ukoliko ne ostvaruje dovoljno veliku dobit, kompanija će se financirati zaduživanjem i emisijom novih dionica. Ukoliko kompanija ima veće troškove zaduživanja isplaćivati će

manje iznose dividendi kako bi izbjegla skupo eksterno financiranje. Veće kompanije, lakše (jeftinije) mogu doći do eksternih izvora financiranja pa će veza između dividende i veličine kompanije biti pozitivna. Jensen i Meckling (1976) razvili su teoriju agencijskog troška iz kojeg se razvio agencijski problem. U kontekstu ove teorije, dividende smanjuju novčana sredstva pod menadžerovom kontrolom, stvarajući potrebu menadžmentu da se okrene tržištu kapitala u pribavljanju potrebnih novčanih sredstava za financiranje planiranih investicija. U takvoj situaciji menadžment se stavlja pod nadzor tržišta kapitala i smanjuje vlasnikovu potrebu za nadzorom menadžmenta. Jensenova (1986) teorija slobodnog novčanog toka je samo druga varijanta teorije agencijskog troška. Teorija slobodnog novčanog toka naglašava kako uvođenje dividende ili neočekivano povećanje dividende zapravo znači smanjenje mogućnosti menadžmentu za krivo korištenje novca kompanije. Baker i Wurgler (2004)razvili su teoriju dividendne uslužnosti prema kojoj kompanije isplaćuju ili povećavaju dividendu u situaciji kada investitori daju premije na dionice kompanija koje isplaćuju dividende. Teorija povezanosti dividende i životnog ciklusa kompanije temelji se na mišljenju kako kompanija sazrijeva, sposobnost generiranja novca nadilazi sposobnost pronalaženja profitabilnih investicijskih mogućnosti. Na kraju, optimalna odluka postaje distribucija gotovine dioničarima u obliku dividende.

Svaka od navedenih teorija objašnjava politiku dividendi specifičnim faktorima koji determiniraju odluku hoće li kompanija isplatiti dividendu i iznos dividende. Međutim ne postoji jednoznačni akademski konsenzus o tome koja je teorija najprihvatljivija i koja najbolje objašnjava politiku dividendi. Svaka država, kao i kompanija, svojim specifičnim karakteristikama utječe (bilo to izravno ili neizravno) na kompaniju da se prilagodi situaciji i okruženju u kojem funkcionira i djeluje. Uvidom u znanstvenu literaturu o politici dividendi može se zaključiti kako ne postoji veliki broj radova o politici dividendi u Republici Hrvatskoj. Temeljem navedenoga ovaj rad ima za cilj obuhvatiti što više dosada razvijenih teorija politike dividende i ispitati koja teorija ili teorije najbolje opisuju politiku dividende u Republici Hrvatskoj.

2. Teorije dividendne politike i pregled literature

Od sredine 20. stoljeća, razvijene su mnoge teorije kako bi se objasnilo što, kako i zašto utječe na dividendnu politiku poduzeća. Nijedna od razvijenih teorija nije se profilirala kao univerzalno primjenjiva na svim tržištima jednako. Najviše istražene teorije zasigurno su agencijska teorija i teorija signaliziranja dok se u novije vrijeme razvijaju nove teorije poput teorije dividendne uslužnosti. U daljnjem dijelu rada pokušalo se obuhvatiti što više teorija i objasniti kako pojedine teorije objašnjavaju donošenje odluke o isplati dividende kompanija koje kotiraju na Zagrebačkoj burzi.

2.1. Agencijska teorija

Agencijska teorija razvijena je kao formalizirani okvir za proučavanje sukoba interesa u poduzećima među ključnim čimbenicima, s ciljem razvijanja mehanizama za rješavanje takvih sukoba. Začetnici agencijske teorije, Jensen i Meckling (1976), pokušali su pokazati kako se poduzeća ne ponašaju prema načelu maksimalizacije, ponajprije zbog konflikta interesa koji postoji među ključnim upravljačkim subjektima.

Različiti dobavljači kapitala (dioničari, vlasnici obveznica, vlasnici konvertibilnih vrijednosnica) i različite kategorije zaposlenih u poduzeću (menadžment i ostali zaposlenici) dijele rezultate poslovanja poduzeća. Pošto su dioničari vlasnici poduzeća, njihovi interesi dominiraju (ili bi trebali dominirati) nad menadžerovim aktivnostima, dok ostali dionici imaju manji utjecaj na odluke kompanije. Ovakav disparitet utjecaja u agencijskoj teoriji nazvan je agencijski odnos. U agencijskom odnosu jedna strana ima dominirajući utjecaj kojim može

utjecati na druge dionike. Jedan od najznačajnijih agencijskih odnosa jest odnosi između dioničara i kreditora.

Dioničari i kreditori dijele vrijednost novčanog toka generiranog poslovanjem kompanije. Kreditori imaju pravo na kamate i na nominalnu vrijednost duga. Dioničari, kao rezidualni zahtjevatelji, imaju pravo na svu vrijednost nakon podmirenja obveza prema kreditorima.

Među prvim istraživanjima koje je ispitivalo odnos između dioničari i kreditora (točnije vlasnika obveznica), a da je ispitivalo reakciju investitora u obveznice na objavu promjene dividende jest istraživanje Handjinicolaoua i Kalaya (1984). Oni su našli slabu reakciju cijene obveznica na povećanje dividendi i negativnu reakciju na smanjenje dividendi. Što je prije konzistentno sa hipotezom informacijskog sadržaja nego li sa stajalištem kako dioničari putem dividendi izvlašćuju vrijednost od kreditora.

Dhillon i Johnson (1984) su u svome radu potvrdili postavke agencijske teorije. Ispitivali su utjecaj velikih promjena dividendi, ukidanja i uvođenja dividendi. Kada su u svoje istraživanje uključili značajnije promjene dividendi došli su do rezultata kako objava uvođenja dividendi vodi povećanju cijene dionica za prosječnih 0,72%, dok se cijena obveznica smanjila za 0,70%. Povećanje dividende za više od 30% rezultiralo je prosječnim povećanjem cijena dionica za 1,82%, dok se cijena obveznica smanjila za prosječnih 0,50%.

2.2. Teorija slobodnog novčanog toka

Jensen je u svome radu naveo razlog zašto dividende također mogu biti poželjne u kontekstu rješavanja agencijskog problema. On je razvio teoriju slobodnog novčanog toka koja je u stvari varijanta agencijske teorije. Jedna od navedenih pretpostavki teorije slobodnog novčanog toka jest kako će u situaciji, kada se suoči sa limitiranim investicijskim mogućnostima s jedne strane, a s druge strane sa visokim iznosima novčanih sredstava u kompaniji, menadžment kompanije vjerojatno zloupotrijebiti višak novčanih sredstava u vlastitu korist

Jensenovo istraživanje implicira kako dividende u takvim situacijama mogu koristiti kao sredstvo kojim se može smanjiti višak novčanih sredstava pod menadžerovom kontrolom, odnosno dioničari imaju korist od isplate dividendi.

Lang i Litzenberger (1989) su postavili hipotezu prema kojoj je utjecaj tržišta prilikom promjene isplate dividende na promjenu cijene dionica veći kod kompanija koje su sklonije preinvestiranju nego li kod onih kompanija koje su sklonije povećanju vrijednosti kompanije.

Agrawal i Jayaraman (1994) su došli do rezultata prema kojem kompanije sa visokim vlasničkim udjelom menadžera imaju manju stopu isplate dividende u odnosu na kompanije sa malim udjelom menadžera u vlasništvu. Rezultati njihovog istraživanja impliciraju kako dividende služe kao sredstvo kojim se smanjuje sukob interesa između menadžera i dioničara koji se odnosi na korištenje viška slobodnih novčanih sredstava.

Rezultati istraživanja Jensena, Solbera i Zorna (1976) pokazuju kako su dividende manje potrebne prilikom smanjenju problema preinvestiranja kada obveze vraćanja duga zahtijeva menadžerovu disciplinu i/ili kada je visoki udio vlasništva menadžmenta u kompaniji.

2.3. Teorija signaliziranja

Na tržištu gdje vlada informacijska simetrija, svi sudionici imaju jednake informacije o kompaniji. Ukoliko jedna grupa sudionika ima superiornije informacije o kompaniji u odnosu na druge, na tržištu postoji informacijska asimetrija. Pretpostavke na kojima se temelji ova teorija jest kako dividende smanjuju informacijsku asimetriju djelujući kao pouzdan signal koji korporacijski insajderi šalju dioničarima. Jednostavno rečeno uvođenje dividende ili povećanje dividende tržište interpretira kao pozitivnu informaciju što za posljedicu ima povećanje cijene dionice. Smanjenje dividende ili ukidanje dividende tržištu prenosi

negativnu informaciju i dolazi do pada cijene dionice. Istraživanje Abrutyna i Turnera (1990) provedeno na financijskim direktorima velikih kompanija u SAD-u pokazuje kako 63% ispitanika signaliziranje smatra prvim ili drugim razlogom za isplatu dividende.

Lintner (1956) i Fama i Babiak (1968) našli su vezu između dividendi i zarada koja je konzistentna sa hipotezom kako kompanije koje isplaćuju dividendu povećavaju dividendu jedino kada je menadžment samouvjeren kako će se povećane isplate u budućnosti i održati. Veliki broj radova potvrdio je primjenjivost teorije signaliziranja. Tako primjerice radovi Petita (1972), Wattsa (1973), Asquitha i Mullinsa (1983), Fullera i Goldsteina (2011), Deshmukha, Fatemia i Fooladia (2008) potvrđuju teoriju signaliziranja na tržištu dionica u SAD-i dok primjerice rad Gurgula, Majdosza i Mestela (2006) potvrđuje primjenjivost teorije signaliziranja na tržištu dionica u Njemačkoj, a Miletić (2011) u svome radu je potvrdio primjenjivost teorije signaliziranja na tržištu dionica u Republici Hrvatskoj.

2.4. Teorija dividendne uslužnosti

Prema modelu Bakera i Wurglera (2004), investitori dijele kompanije na one koje plaćaju i koje ne plaćaju dividende. Model se temelji na određenim pretpostavkama, među kojima su dvije najznačajnije. Prva, prema kojoj zbog psiholoških i institucionalnih razloga, potražnja investitora za dionicama koje plaćaju dividendu je nepoznata i varira kroz vrijeme. Prema drugoj pretpostavci, racionalno ponašanje menadžera vodi isplati (posluživanju) dividende kada investitori daju premiju na dionice koje isplaćuju dividende. Odnosno, kompanije koje ne isplaćuju dividende, iniciraju isplatu, kada se dionicama postojećih kompanija koje plaćaju dividende trguje po većim cijenama u odnosu na slične kompanije koje ne daju dividendu. Suprotno, kompanije ukidaju dividende kada se dionicama postojećih kompanija koje plaćaju dividende trguje po cijenama nižim u odnosu na slične kompanije koje ne daju dividendu. Posljedično, cijene dionica kompanija koje daju dividendu u odnosu na cijene dionica kompanija koje ne daju dividendu (dividendna premija), su veće u godinama sa većom potražnjom za dividendama i manje su u godinama sa manjom potražnjom za dividendama.

Neves (2006) je u svome istraživanju na državama EU koje je tada činilo dvanaest država ispitala primjenjivost teorije dividendne uslužnosti. Došla je do zaključka kako sentiment investitora ima pozitivan utjecaj na dividendnu politiku za kompanije koje imaju višak likvidne imovine.

Kada su sve ostale karakteristike kompanija konstantne Bulan, Subramanian i Tanlu (2007) navode kako postoji velika vjerojatnost uvođenja isplate dividendi kada je dividendna premija visoka. Kombinacija životnog ciklusa i usluživanja dividendi objašnjava vrijeme inicijalizacije dividendi kompanija. Zrele kompanije karakterizirane visokom profitabilnošću i malim stopama rasta pokazuju visok stupanj sklonosti iniciranju isplate dividendi. Visoka dividendna premija daje još veći povod iniciranju dividendi.

2.5. Teorija povezanosti dividende i životnog ciklusa kompanije

Osnovna misao teorije povezanosti dividende i životnog ciklusa kompanije temelji se na mišlju kako kompanija sazrijeva, sposobnost generiranja novca nadilazi sposobnost pronalaženja profitabilnih investicijskih mogućnosti. Na kraju, optimalna odluka postaje distribucija gotovine dioničarima u obliku dividende.

Istraživanje provedeno među šest razvijenih svjetskih financijskih tržišta u koje se ubrajaju SAD, Velika Britanija, Kanada, Njemačka, Francuska i Japan koje su proveli Denis i Osobov (2008) pokazalo je kako su karakteristike kao što su veličina kompanija, profitabilnost i zrelost kompanije pozitivno povezane sa sklonošću isplate dividende.

Bulan, Subramanian i Tanlu (2007) dokumentirali su kako kompanije iniciraju isplatu dividende kada dosegnu zrelu životnu fazu. Kompanije koje iniciraju dividende imale su veće

stope rasta, profitabilnije su, imaju veće novčane rezerve i imaju manje investicijske mogućnosti za razliku od kompanija koje nisu uvele dividendu.

DeAngelo, DeAngelo, i Stulz (2006) u istraživanju kojim su ispitivali što determinira isplatu dividende uzeli su u razmatranje i životni ciklus kompanije odnosno životne faze kompanije. Kao mjera zrelosti kompanije u njihovom istraživanju uzet je odnos ukupnih zadržanih zarada i ukupnog vlastitog kapitala (RE/TE) kao i odnos ukupnih zadržanih zarada i ukupne imovine (RE/TA). Visok odnos navedenih pokazatelja pokazuje kako se radi o kompaniji koja je u zreloj životno fazi, koju karakterizira stabilni novčani tok kojim kompanija raspolaže. Visok udio zadržane dobiti daje kompaniji sigurnost u daljnjem poslovanju, a ujedno u odsustvu potencijalnih investicijskih mogućnosti potencijal za isplatu dividendi. Zaključi njihovog istraživanja su kako postoji statistički značajna povezanost između odluke da se isplati dividenda i pokazatelja RE/TE i RE/TA.

2.6. Teorije financijske strukture kompanije

Postoji veliki broj teorija kojim se objašnjava utjecaj financijske strukture, odnosno kapitalne strukture na vrijednost kompanije. Te teorije imaju i implikacije i na dividendnu politiku kompanija. Ukoliko kompanija ima veće troškove zaduživanja isplaćivati će manje iznose dividendi kako bi izbjegla skuplje eksterno financiranje. Veće kompanije mogu lakše (jeftinije) doći do eksternih izvora financiranja pa će veza između dividende i veličine kompanije biti pozitivna.

3. Opis varijabli i uzorka

Za izračunavanje varijabli korištena je baza podataka Thompson Reuters. Neke varijable u istraživanju je trebalo izračunati putem podataka iz baze, do su neke samo preuzete iz baze podataka.

U istraživanju varijable koja predstavlja politiku dividendi uzeta je varijabla dividende po dionici (*DPS*). *DPS* varijabla predstavlja zavisnu varijablu u modelu putem kojeg je provedeno istraživanje.

Financijska poluga (LEV) kao varijabla kojom se potvrđuje agencijski odnos između dioničara i vjerovnika izračunat je kao omjer ukupnog duga kompanije i u godini t i vrijednosti kapitala rezervi kompanije i u godini t. Prema agencijskoj teoriji, odnos između DPS i LEV trebao bi biti pozitivan.

Slobodni novčani tok kao varijabla teorije slobodnog novčanog toka preuzeta je iz baze Thompson Reuters, međutim vrijednosti slobodnog novčanog toka mogu biti neusporedive s obzirom na heterogenost dioničkih društava prema njihovoj veličini. Zato se vrijednost slobodnog novčanog toka standardizirala (*stFCF*) na način da se podijelio sa iznosom aktive. Za očekivati je da je ova varijabla u pozitivnom odnosu s DPS-om

Ukoliko menadžer posjeduje informacije o potencijalnim investicijskim mogućnostima i povećanim budućim zaradama, povećanjem dividende signalizirati će tržištu pozitivnu informaciju, vrijedi i vice versa. Varijablom odnos tržišne i knjigovodstvene vrijednosti dioničkog društva (*MV/BV*) prikazuju se potencijalne investicijske mogućnosti kao ključne determinante teorije signaliziranja. Veća vrijednost navedene varijable ukazuje kako se radi o kompaniji s potencijalno velikim investicijskim mogućnostima, a shodno tome i s potencijalno većim zaradama. Odnos tržišne i knjigovodstvene vrijednosti dioničkog društva definirana je sljedećom relacijom:

$$MV/BV = \frac{NS_{i,t} * P_{i,t}}{BV_{i,t}}$$
 (1)

NSi,t predstavlja broj dionica kompanije i na kraju godine t. Pi,t je cijena dionice kompanije i na kraju godine t. BVi,t je knjigovodstvena vrijednost kapitala kompanije. Prema teoriji signaliziranja veza između DPS i MV/BV odnosa je pozitivna.

Dividendna premija (*DP*) izračunata je kao razlika prirodnog logaritma vaganog *MB* odnosa kompanija koje isplaćuju dividendu i kompanija koje ne isplaćuju dividendu u promatranoj godini. *MB* odnos računa se na sljedeći način:

$$MB_{i,t} = \frac{TA_{i,t} - BVE_{i,t} + MVE_{i,t}}{TA_{i,t}}$$

$$(2)$$

Kako je rad usmjeren prema kompanijama kod ispitivanja dividendne uslužnosti kao nezavisna varijabla uzet je i *MB* odnos pojedinog dioničkog društva. Logika uključivanja *MB* odnosa za pojedino dioničko društvo jest kako će tržište, ukoliko vlada pozitivan sentiment za dividendama, više vrednovati kompaniju koja isplaćuje dividendu nego li kompaniju koja je ne isplaćuje. Kao posljedica navedenom kompanije koje isplaćuju dividendu imati će veći *MB* odnos, također vrijedi i obratno.

Za računanje vaganog *MB* odnosa koristi se knjigovodstvena vrijednost pojedinog društva u ukupnoj knjigovodstvenoj vrijednosti svih društava. U radu dividendna premija (*DP*) izračunata je na putem sljedeće jednadžbe:

$$DP_{t} = \ln(\sum_{t}^{z} p_{i,t}^{+} \frac{TA_{i,t}^{+} - BVE_{i,t}^{+} + MVE_{i,t}^{+}}{TA_{i,t}^{+}})$$

$$- \ln(\sum_{t}^{z} p_{i,t}^{-} \frac{TAI_{i,t}^{-} - BVE_{i,t}^{-} + MVE_{i,t}^{-}}{TA_{i,t}^{-}})$$
(3)

Simboli iz jednadžbe 2 i 3 predstavljaju sljedeće:

 DP_t – dividendna premija u godini t.

 $p_{i,t}^+$ - udio knjigovodstvene vrijednosti dioničkog društva i koje je isplatilo dividendu u godini t u ukupnoj knjigovodstvenoj vrijednosti svih društava koje su u godini t isplatili dividendu

 $p_{i,t}^-$ - udio knjigovodstvene vrijednosti dioničkog društva i koje nije isplatilo dividendu u godini t u ukupnoj knjigovodstvenoj vrijednosti svih društava koje nisu u godini t isplatili dividendu t.

 $TA_{i,t}^+$ - knjigovodstvena vrijednost imovine (ukupne aktive) na kraju godine t dioničkog društva i koje je isplatilo dividendu u godini t.

 $TA_{i,t}^-$ - knjigovodstvena vrijednost imovine (ukupne aktive) na kraju godine t dioničkog društva i koje nije isplatilo dividendu za godinu t.

 $BVE_{i,t}^+$ - knjigovodstvena vrijednost kapitala na kraju godine t dioničkog društva i koje je isplatilo dividendu u godini t.

 $BVE_{i,t}^-$ - knjigovodstvena vrijednost kapitala na kraju godine t dioničkog društva i koje nije isplatilo dividendu u godini t.

 $MVE_{i,t}^+$ - tržišna vrijednost kapitala na kraju godine t dioničkog društva i koje je isplatilo dividendu u godini t.

 $MVE_{i,t}^-$ - tržišna vrijednost kapitala na kraju godine t dioničkog društva i koje nije isplatilo dividendu u godini t.

Za determinante koje opisuju zrelost kompanije uzet je odnos ukupnih zadržanih zarada i ukupnog vlastitog kapitala (RE/TE) kao i odnos ukupnih zadržanih zarada i ukupne imovine (RE/TA). Visok odnos navedenih pokazatelja pokazuje kako se radi o kompaniji koja je u zreloj životnoj fazi, koju karakterizira stabilni novčani tok kojim kompanija raspolaže.

Veličina kompanije kao determinanta teorije financijske strukture kompanije prikazana je knjigovodstvenom vrijednošću ukupne imovine kompanije i na kraju godine t i izračunata je kao prirodni logaritam knjigovodstvene vrijednosti kompanije (lnTA)

Istraživanje je provedeno na kompanijama koje kotiraju na Zagrebačkoj burzi. Samo su kompanije čije su dionice uključene u indeks CROBEX u siječnju 2020. uzete u obzir prilikom istraživanja. CROBEX je službeni indeks Zagrebačke burze (ZSE). Prilikom odabira koje dionice ulaze u sastav CROBEX indeksa razmatraju se samo dionice koje su izlistane na službenom tržištu i potrebno je zadovoljiti kriterij da se dionicama trgovalo više od 90% ukupnog broja trgovačkih dana u šestomjesečnom razdoblju koje je prethodilo reviziji indeksa.

Istraživanjem je bilo obuhvaćeno ukupno 15 tvrtki dok je period istraživanja od 2011. do 2018. godine. 15 kompanija je u promatranom razdoblju istraživanja moglo ukupno isplatiti 120 dividendi (8 godina x 15 kompanija). U promatranom razdoblju 61 dividenda je ukupno isplaćena od maksimalno 120 dividendi.

4. Empirijsko istraživanje

Deskriptivna statistika za sve varijable u istraživanju prikazana je Tablicom 1. Deskriptivna statistika odnosi se na ukupno 120 opservacija za svaku varijablu.

Table 1 Deskriptivna statistika

	•			•	•
Variable	Obs	Mean	Std. Dev.	Min	Max
DPS	120	6.1658	9.6826	0.0000	72.6000
LEV	120	4.1259	12.2096	-2.2264	107.4468
stFCF	120	0.0174	0.0830	-0.4677	0.2471
RE/TE	120	-1.2614	8.0004	-69.2700	1.0579
RE/TA	120	0.1065	0.4081	-1.4021	0.8113
ln(TA)	120	8.0782	1.3801	6.0827	11.8388
MB	120	1.1312	0.4312	0.4327	2.9342
MV/BV	120	0.5348	0.4416	0.0364	2.4138
DP	120	-0.0212	0.1504	-0.2647	0.1411

Izvor: Obrada autora

Prvi korak u istraživanju bio je ispitivanje stacionarnosti kod varijabli u panel modelu. Prisutnost stacionaranosti ispitivala se pomoću Levin-Lin-Chu testa. Rezultati su pokazali da varijable ln(TA) i MB nisu stacionarne. Nakon što je izračunata prva diferencija za nestacionarne varijable, ponovno je proveden isti test. Rezultat je pokazao da su nove varijable (sa prvom diferencijom) (ln (TA)d) i (DPd) stacionarne i sa njima se nastavilo istraživanje. Tablica 2 prikazuje rezultate provedenog Levin-Lin-Chu testa.

Table 2 Levin-Lin-Chu test

Variable	p-value
DPS	0.0000
LEVERAGE	0.0010
stFCF	0.0000
RE/TE	0.0000
RE/TA	0.0000
ln(TA)	0.4341
MB	0.0000
MV/BV	0.0000
DP	0.9926

Izvor: Obrada autora

Sljedeći korak u istraživanju bio je provjera problema multikolinearnosti između neovisnih varijabli. Matrica koeficijenata korelacije korištena je za ispitivanje problema multikolinearnosti i prikazana je Tablicom 3. Apsolutna vrijednost Pearsonovog koeficijenta viša od 0,7 ukazuje na jaku povezanost između neovisnih varijabli. Apsolutna vrijednost Pearsonovog koeficijenta iznad 0,7 ukazuje na jaku povezanost koja se može prepoznati između varijable LEV i varijable RE/TE i između varijabli MB i DPd. Budući da to može utjecati na konačni rezultat modela, varijable RE/TE i MB izostavljene su iz modela.

Table 3 Korelacijska matrica

	LEV	stFCF	RE/TE	RE/TA	ln(TA)d	MB	MV/BV	DPd
LEV	1							
stFCF	-0.2519	1						
RE/TE	-0.7807	0.0877	1					
RE/TA	-0.3866	-0.0238	0.581	1				
ln(TA)	-0.0462	-0.1197	-0.0108	0.1492	1			
MB	0.0363	0.3521	-0.0477	-0.2319	-0.0984	1		
MV/B V	0.1367	0.0278	-0.1088	0.0205	-0.056	-0.0782	1	
DPd	-0.1769	0.3658	0.14	0.25	-0.0015	0.7656	-0.0788	1

Izvor: Istraživanje autora

Za potrebe empirijskog istraživanja statički panel model je korišten. Statički panel model prikazan je jednadžbom (4).

$$Y_{it} = c + \sum_{k=1}^{K} \beta_k X_{it}^k + \varepsilon_{it}$$
 (4)

Gdje:

 Y_{it} predstavlja dividend po dionici (DPS) kompanije i u vremenu t, gdje i = 1,..., N; t = 1,..., T

X_{it} su k nezavisne varijable koje su objašnjene u poglavlju 3.

Statistički panel model sa fiksnim efektom (FE) i slučajnim efektom (RE) koristio se u istraživanju. Hausmanov test pokazao je kako je najprimjereniji model statički panel model sa slučajnim efektom (RE). Tablica 4 prikazuje rezultate provedenoga istraživanja.

Table 4 Rezultati istraživanja putem statičkog panela sa slučajnim efektom (RE)

Variable	DPS
LEV	-0.0331
LEV	(0.0568)
stFCF	-4.8036
SIFCF	(9.4186)
RE/TA	2.0836
KE/1A	(3.6150)
ln(TA)d	2.0185
ln(TA)d	(4.9141)
MV/BV	7.1963**
IVI V/D V	(2.8579)
DPd	11.5246**
Dru	(5.6986)
cons	2.8551
Cons	(2.2440)
R2 within	0.0209
R2 between	0.4909
R2 overall	0.3115
Model p-value	0.0952
Hausman	chi = 4.94
specification test	p value = 0.5519

^{*, **, ***} Statistički značajno na nivou od 10%, 5%, 1% redoslijedno. Standardne greške prikazane su u zagradama.

Izvor: Istraživanje autora

Tablica 4 sumira rezultate provedenoga empirijskoga istraživanja. Model sa slučajnim efektom u cjelini je statistički značajan (p-vrijednost iznosi 0.0952). Tablica 4 prikazuje kako varijable MV/BV i DPd imaju pozitivan i statistički značajan. Kako je već navedeno varijabla MV/BV prikazuje odnos tržišne i knjigovodstvene vrijednosti dioničkog društva dok varijabla DPd predstavlja dividendnu premiju.

Statistički značajna i pozitivna veza između varijable MV/BV i nezavisne varijable DPS potvrđuje primjenjivost teorije signaliziranja među kompanijama na Zagrebačkoj burzi. Također statistički značajna i pozitivna veza između varijable DPd i nezavisne varijable DPS potvrđuje teoriju dividende uslužnosti kao jednu od teorija kojom se objašnjava dividendna politika kompanija na Zagrebačkoj burzi.

5. Zaključak

Empirijsko istraživanje pokazalo je primjenjivost teorije signaliziranja i teorije dividendne uslužnosti prilikom objašnjavanja što determinira odluku vezanu za dividende. Varijable *MV/BV* i *DPd* su statistički značajne i imaju pozitivan utjecaj na odluku o dividendi.

Kao što je već navedeno, ukoliko menadžer posjeduje informaciju o potencijalnim budućim investicijskim mogućnostima i povećanim budućim zaradama, povećanjem dividende signalizirati će tržištu pozitivnu informaciju, vrijedi i obratno.

Varijablom odnos tržišne i knjigovodstvene vrijednosti dioničkog društva (*MV/BV*) prikazuju se potencijalne investicijske mogućnosti kao ključne determinante teorije signaliziranja. Veća vrijednost navedene varijable ukazuje kako se radi o kompaniji s potencijalno velikim investicijskim mogućnostima, a shodno tome i s potencijalno većim zaradama.

Ovaj odnos iznova potvrđuje temelje istraživanja Lintnera (1956) i Fame i Babiak (1968) u kojima su pronašli pozitivnu vezu između dividendi i zarade koja je u skladu s hipotezom da tvrtke koje plaćaju dividendu i kompanije koje povećavaju dividendu to rade samo kad je menadžment siguran u buduće poslovanje kompanije. Spomenutu vezu potvrđuje i istraživanje (Miletić, 2011) koje je ispitivalo primjenjivost teorije signaliziranja u Republici Hrvatskoj i koje je potom potvrdilo hipotezu o primjenjivosti teorije signaliziranja u Republici Hrvatskoj.

Dividendna premija ima isto statistički značajan i pozitivan utjecaj na zavisnu varijabli, dividendu po dionici (DPS). Ovaj odnos konzistentan je sa teorijom dividende uslužnosti prema kojoj racionalno ponašanje menadžera vodi isplati dividende kada investitori daju premiju na dionice koje daju i dividendu. Odnosno, kompanije koje ne isplaćuju dividende, iniciraju isplatu, kada se dionicama postojećih kompanija koje plaćaju dividende trguje po većim cijenama u odnosu na slične kompanije koje ne daju dividendu. Suprotno, kompanije ukidaju dividende kada se dionicama postojećih kompanija koje plaćaju dividende trguje po cijenama nižim u odnosu na slične kompanije koje ne daju dividendu. Posljedično, cijene dionica kompanija koje daju dividendu u odnosu na cijene dionica kompanija koje ne daju dividendu su veće u godinama sa većom potražnjom za dividendama i manje su u godinama sa manjom potražnjom za dividendama.

Pored interpretacije dobivenih rezultat potrebno je i naglasiti neka od ograničenja provedenog istraživanja koja se ogledaju prvenstveno u nedostupnosti svih podatka kojima se mogu definirati determinante pojedinih teorija dividendne politike i mali broj dioničkih društava uzetih u istraživanju. Temeljem navedenih ograničenja definiraju se preporuke za buduća istraživanja u vidu povećanja uzorka na temelju kojih se istražuje dividendna politika, a ne samo društva koja ulaze u dionički indeks CROBEX.

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Cash Flow Impact on Business Results

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Abstract. We often meet the question what is more important indicator for the company business, the cash flow or the business result. It is very difficult to define what is more important because the both are essential and crucial parameters of business so we need to keep track of both. Each company have tendency to generate the positive business results and operate with the positive cash flow. Also the often question is how they are related. Understanding how cash flow relates to business results and how business results relate to cash flow is very important and crucial for success and prosperity of business. A positive business result does not have to mean positive cash flow and vice versa. The aim of this paper is to make analysis between cash flow and business results. The research objective was to explore the correlation between cash flow and business results using the data of net cash flow and business results from the financial statements. The research was conducted on the 20 companies from the Croatian capital market by using static panel data analysis for the period from 2014 to 2017. The research result shows that cash flow impact the business results and that positive cash flow resulting with higher business results. So this paper implied the important but not statistically significant role of cash flow in the determination of business results.

Key words: cash flow, profitability, analysis

1. Introduction

What is more significant factor of the business, cash flow or business result? This question represents one of the most debating researching areas. Both of them are very crucial for the business, cash flow is important from the aspect of short term business conditions, while the business result is important from the aspect of long term business conditions. A firm could have a positive business results but be at the same time insolvent and could have a positive cash flow but be at the same time unprofitable. It is very difficult to give answer which parameters are more significant for business, because this depend of different business terms and conditions. Cash flow and business result are two different financial parameters but both are crucial for company business, because each company have tendency to generate the positive business results and operate with the positive cash flow. The business result should be business direction while the cash flow is a tool for achieving that direction or we can say that cash availability provides access to various opportunities from which companies can generate the profits. The role of both parameters in company business has already been investigated and confirmed as significant, so with this paper we explore the relationship between these two financial parameters. Understanding the relationship between cash flow and business results is very important and crucial for business managing. With this paper, we assumed that poor cash flow would reduce business results and strong cash flow would increase business results. We assumed this relation on the base of previous research which shows that earnings are significantly positively correlated with operating cash flow (Mahmoud, Abdulnaser, Shakiri, & Saleh, 2012). The cash flow impact on business results in this paper will be presented through theoretical framework which should explain the cash flow role in company business and through empirical research with which will explore if the net cash flow has a significant influence on the business results.

2. The cash flow role in company business

When we discuss about company crucial assets, the first impression is money. Starting from old saying "cash is king" or "cash is life blood of the business" we can conclude importance and role of cash in the company business. Also, we need to know that cash and cash flow do not represent the same concept, but they are very closely related. Cash presents company cash position at a particular moment in time, until cash flow represent resulting changes over time from cash inflows and outflows. Company business is not activities at a particular moment in time, it is periodical activities, so the companies should to manage with the cash flow rather than with the cash. Having cash on hand is critical, but cash flow indicates an ongoing ability to generate and use cash (Kokemuller, 2020). Cash management is the art and increasingly the science of managing a company's short-term resources to sustain its ongoing activities, mobilize funds and optimize liquidity (Alman-Ward & Sagner, 2003). The most important elements of cash management are:

- The efficient utilization of current assets and current liabilities of a firm throughout each phase of the business operating cycle.
- The systematic planning, monitoring and management of the company's collections, disbursements, and account balances.
- The gathering and management of information to effectively use available funds and identify risk.

Cash management is a part of treasury management, which is defined as a part of the main responsibilities of the central finance management team (Teigen, 2008). By the treasury management, companies optimize their liquidity, improve solvency and reduce the financial risks and thus ensure undisturbed activities and successful business. Implementation of a good cash management system will ensure better control of financial risks, increase the opportunity for profit, strengthen the company balance sheet, ensure increased confidence in the company and improve operational efficiency (Gallagher, 2000). On another hand bad cash management result in loss of cash discount, loss of reputation due to non-payment of obligation on due dates and insolvency, this may result in operational shut down of the company (Tuller, 2008). The role of cash flow is very significant and has profound effects on business operations, as previous researches showed that cash flow problems are the main reason for business failure. Slow or diminishing cash flow can have several profound effects on your business (Kokemuller, 2020):

- Late payments negatively affect company business' credit rating and impact company ability to get credit account privileges and loans in the future.
- Stymied Growth lead to low employee morale and looks bad to company owners or shareholders.
- Promotional Deficiency lead to reducing marketing activities to attract customers. Plus, if company start offering sales discounts to generate cash and improve situation, can effectively diminish customer perception of company brand's value. This can have very negative long-term impacts on your pricing and revenue potential.
- No Dividends can't payout dividends to owners which are unstimulated

The above implications lead us to conclude that poor cash flow decreasing the current activities, planned investments and overall growth goals of the company. On other hand the

companies with the strong cash flow have more opportunity to take a future investment and to be proactive oriented. Also the strong cash flow ensures a greater flexibility and ability of company in responding to new market and business demands. Everything related to cash flow is published through the cash flow statement which complements the balance sheet and income statement. Understanding cash inflows and cash outflows are key parts of a successful business. Cash flow statement should provide additional information's which should help the users of accounting information in predicting the future business activities. Cash flow information's are statistically significant and relevant for investors in their investment decision (Al Khadash & Al Attar, 2005). So, by using cash flow information and understanding cash flow managing put us in better position for taking successfully business decision. The effect of cash flow is real, immediate and, if mismanaged, totally unforgiving. Cash needs to be monitored, protected, controlled and put to work (Chartered Institute of Management Accountants, 2004). Above mentioned implicate conclusion that cash flow is an imperative and major challenge in every business organization because by the cash managing companies improve liquidity and ability to answer on turbulent and dynamic market conditions.

3. Methodology and data description

The aim of this study was to explore if the net cash flow has a significant influence on the business results. Research is done in statistic software STATA. For the purpose of econometric data analysis, we employed static unbalanced panel data analysis. Model (1) forms the basis of our estimation:

$$y_{it} = c + \sum_{k=1}^{k} f_{k} X_{it}^{k} + \varepsilon_{it}$$

$$\varepsilon_{it} = Z_{i} + u_{it}$$
(1)

where:

 Y_{it} is the business results of company i at time t, with i = 1, ..., N; t = 1, ..., T.

 X_{it} is net cash flow as an independent variable. ε_{it} is the disturbance with z_i being the unobserved specific effect and u_{it} being the idiosyncratic error. The presented model is a one-way error component regression model where $z_i \sim IIN(0, \sigma_z^2)$ and independent of $u_{it} \sim IIN(0, \sigma_u^2)$.

The data was taken from the Registry of Annual Financial Reports database (rgfi.fina.hr) for 20 large companies from non-financial sector by random selection. Sample period covers 2014, 2015, 2016 and 2017. From the Registry of Annual Financial Reports we collected information related to net cash flow and business results. Descriptive statistic of dependent and independent variables is shown in Table 1.

Table 1 Descriptive statistic

Variable	Obs.	Mean	Std. Dev.	Min	Max
Business results	80	31.07787	273.6833	-815.4	1921.2
Net cash flow	80	58.64588	319.8042	-1007.8	1812

Various tests were used in order to determine which static panel (pooled panel, static panel with fixed effects or static panel with random effects) would be the most appropriate for this research. An F test was applied to analyse the applicability of the panel with fixed effects compared to a pooled panel, whereas a Lagrange Multiplier test was used to analyse the applicability of panel with random effects compared to a static pool panel. Finally, the applicability between models with fixed and random effects was determined using a Hausman test. The results of this test are shown in Table 2.

Table 2 Tests for determination of which static panel would be the most appropriate

Tests	Results	p-value
Ftest	5.24	0.0000
Breusch and Pagan Lagrangian multiplier	30.44	0.0000
Hausman test	0.00	0.9920

As mentioned before, Table 2 shows the result of F test, Lagrange Multiplier and Hausman test. F test showed that static panel model with fixed effects is appropriated than pooled model. A result of a Lagrange Multiplier showed that static panel with random effects is also more appropriated than pooled panel model. After these two tests, that static model with random effects (RE) is more appropriated rather than static model with fixed effects (FE). A static model with random effects (RE) proved to be the most appropriate when analysing the effect of free cash flow on total dividend amount paid.

The empirical results model with business results as dependent variable is presented in Table 3, while their interpretation follows.

Table 3 Parameter Estimates of Static Panel Model

Random-effects G	LS regression		Number of	= 80		
Group variable: id	l		obs			
R-sq: within = 0	0.0016		Number of	= 20		
between = (0.0014				groups	
overall = 0	0.0015				Obs per group	min = 4
						avg = 4
						= 0.12
	Random effects u_i ~ Gaussian					= 0.7266
Corr (u_i, x)	$\operatorname{rr}(\mathbf{u}_i, \mathbf{x}) = 0 \text{ (assumed)}$					
Business results	Coef.	Std. Err.	z	P > z	[95% Con	f. Interval]
Net cash flow	.0339171	.0969906	0.35	0.727	156181	.2240152
_cons	29.088708	50.74507	0.57	0.566	-70.36973	128.5473
sigma_u	205.41371					
sigma_e	193.07749					
rho	.53092767 (fi	raction of varia	anc due to	o u_i)		

From the data in Table 3 [Prob > chi2 = 0.7266] it can be argued that the model as a whole isn't statistically significant. The data in Table 3 shows that the net cash flow (independent variable) positively affects the business results (dependent variable) but that effect isn't statistically significant. Net cash flow has a positive impact on business [coef. 0.0339171]. The net cash flow is positively correlated with the business results and shows if the net cash flow increased by 1,00 kn, the business results will rise for 0,034 kn.

The above result implies the positive cash flow impact on the business results, but this impact isn't statistically significant.

4. Conclusion

We often have discussion what is the main measure of company performance and who plays the main role for successful business. Nowadays business conditions and business environment highlight the cash as significant business factor. The role of cash in the business is particularly pronounced in today's business conditions when access to cash is difficult and expensive, so companies by cash managing trying to ensure adequate cash flow which has become a major business challenge. With this paper we explore if and how the cash flow impact on business results by data which were taken from the Registry of Annual Financial Reports database (rgfi.fina.hr) for 20 large companies from non-financial sector by random selection from 2014 to 2017. Based on the conducted research we found that cash flow has a positive but not statistically significant impact on the business results. These results are consistent with previous research which shows that earnings are significantly positively correlated with operating cash flow. The results show if the net cash flow increased by 1,00 kn the business results will rise for 0,034 kn. From these facts, we recommend to managers and company owners that should take care of adequate cash flow from which should ensure liquidity and solvency and thus business efficiency. These findings broaden and confirm cognitions of the role and importance of cash flow in company business. The limitations of the paper are that we took only large companies and did not include medium and small companies which have more liquidity and solvency problems, so the proposal for future research is to investigate this relationship on medium and small companies.

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The Impact of Digitalization on Croatian Listed Companies' Corporate Performance Measured with Tobin's Q

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Abstract. This paper investigates the impact of digitalization on performance of Croatian listed companies while digitalization represents higher investments in information and communication technologies (ICT). Since the sample comprises Croatian firms listed on the official market of Zagreb Stock Exchange (ZSE) Tobin's Q is employed as a performance measure. Besides independent variable on digitalization, other control variables are encompassed with the analysis. Specifically, several firm-specific and macroeconomic control variables comprise size of the company measured with both total assets and number of employees, leverage, and GDP per capita growth. Empirical research is conducted using static panel analysis on the sample of companies from different sectors that were listed on ZSE in 2014 – 2018 period. The findings of the analysis reveal two statistically significant factors determining firm's success measured with Tobin's Q. Specifically, size of the company measured with total assets negatively affects performance whereas leverage has positive impact. Moreover, there is no evidence of digitalization playing an important role in Croatian listed companies regarding their performance.

Keywords: digitalization, listed companies, performance, Tobin's Q

1. Introduction

We live in the era of digitalization that has already impacted the behaviour of customers, processing methods, management of information etc. It "has re-arranged the economics and business environments of organizations and has consequently remodeled the ways people work" (Vuori, Helander and Okkonen, 2019). Furthermore, as stated Neumeier, Wolf and Oesterl (2017) citing Bloching and Wege (2014) "digitalization is considered as the fourth wave of industrialization, which will dramatically change the business world".

Neumeier, Wolf and Oesterl (2017) emphasize that "the ability to handle the new challenges that come with digitalization will make the difference in future". Furthermore, Parviainen, Tihinen, Kääriäinen and Teppola (2017) observe digital transformation "as changes in ways of working, roles, and business offering caused by adoption of digital technologies in an organization, or in the operation environment of the organization". Legner et al. (2017) emphasize that "digital technologies complement and/or enrich existing products and services and allow building entirely new business models". Furthermore, Şerban (2017) states that digitalization needs a profound understanding, adding that investments in building the IT architecture is essential with the aim of taking advantage of the tools and services offered by digitalization.

Therefore, the goal of this paper is to explore the impact of digitalization on corporate performance. Since the sample consists of companies from different industries that are listed on the official market of the ZSE, instead of using broadly employed accounting-based

corporate performance measures, market-based measure of performance has been used instead, specifically, Tobin's Q.

Since there is no generally accepted parameter how to measure level of digitalization at the company level, the author opted for an approach to measure digitalization as the level of companies' software investments that are reflected in intangible assets of the financial statements. This is also used by Brynjolfsson, Hitt and Yang (2002) when measuring the influence of intangible assets, i.e. computer capital on market value of the firm. Moreover, Łyskawa, Kędra, Klapkiv and Klapkiv (2019) employed this approach, though, on the sample of insurance companies.

This paper adds to the literature in a way that it provides empirical evidence on influence of digitalization on corporate performance while many other studies deal with the issue from the theoretical perspective (e.g. Şerban, 2017; Neumeier, Wolf, and Oesterle, 2017). The current research encompasses all companies listed on the official market at the stock exchange in the period 2014-2018 enabling the author to use different analytical approach, i.e. to estimate corporate performance using Tobin's Q.

The remaining of the paper is structured as follows. After the introductory part that briefly introduces the relevance of the issue being investigated literature review follows. The third section describes the sample and variables being used. Empirical methodology and research is explained in the fourth part, while the fifth section concludes.

2. Literature Review

Despite the large number of papers dealing with benefits of digitalization on business activities of the companies, these papers focus on this issue mostly from the theoretical perspective. Therefore, it can be said that there is still scarce empirical evidence on effects of digitalization on corporate performance. The papers empirically testing the influence of IT investments on performance are given as follows explaining methodologies behind these studies.

Mithas, Tafti, Bardhan and Goh (2012) have analysed influence of IT investments on profitability measured with net income per employee. Moreover, the authors tested to which extent the impact of IT on performance is facilitated through cost reduction and revenue growth. The sample consists of 452 firms while the period of analysis covers 1998 – 2003 period. Independent variable is measured as IT investments per employee whereas control variables comprise operating expenses, revenue, R&D expenditure, and advertising expenditure with all of these variables being calculated per employee. Moreover, the authors employed firm size dummy variables, industry capital intensity, HHI index as a measure of concentration as well as industry average Tobin's Q. Their results reveal that IT investments per employee have statistically significant and positive impact on revenue. However, IT investments do not have statistically significant influence expenses. Additionally, IT supported revenue growth has a larger impact on profitability than IT-facilitated decrease in operating expenses. Another important finding is that IT investments have a larger impact on firm's profitability as compared to advertising and R&D expenditures.

Neumeier, Wolf and Oesterl (2017) in their paper try to relate benefits of digitalization stated in the literature and highlight the underlying value drivers. Moreover, they explain the key "value drivers of digitalization that can be used as a starting point for developing measures for

the value of digitalization". For this purpose, the authors screened 29 practice studies as well as 31 scientific articles dealing with benefits of digitalization. The identified benefits have been categorized into five groups relating to customers, business models, business processes, application systems and services as well as infrastructure. Although the authors are aware that specific measures as well as adequate processes to estimate the value of digitalization need to be determined, they identify efficiency and customer experience as core value drivers within digitalization.

Łyskawa, Kędra, Klapkiv and Klapkiv (2019) analysed digitalization in insurance companies examining the relationship between the expenses for ICT of top four European insurance groups and the results of their activities. They measured the activities of insurance companies using gross premiums, claims and expenses that obtained different values depending on the tendency of ICT investments.

Martín-Peña, Sánchez-López and Díaz-Garrido (2019) have examined influence of servitization and digitalization on firm performance using the data on 828 Spanish manufacturing firms that operated in the 2014-2017 period. The authors expressed the level of digitalization as dummy variable measured as a combination of items that reflect the use of ICTs as well as of advanced manufacturing technologies. Specifically, the use of ICTs is measured taking into account IT programming services, online sales to companies, online sales to end customers, online purchases from suppliers and possessing an Internet domain. Besides digitalization and servitization variables, control variables were encompassed including age of the company, firm size and sector dummy variables. Among other things, the authors find that digitalization positively influences performance measured with logarithmic value of total sales.

Forcadell, Aracil and Ubeda (2020) have investigated how corporate sustainability as well as digitalization impact banks' performance assuming that digitalization can tackle information asymmetries for banks resulting in positive influence on their performance. The analysis is conducted using a sample of 112 international banks that operated in 13 developed countries in the 2003-2016 period with the banks' digitalization being measured on the basis for its cost reduction. Specifically, the authors estimated translog cost function with two output variables including investments and total loans while both employee and non-interest operating expenses were employed as inputs. Furthermore, debt over equity ratio served as control variable. In this paper the technological gap is determined as the distance to the stochastic meta-frontier while the variation of technological gap defined banks' digitalization efforts. Banks' market and accounting performance based on four performance measures is also controlled for bank size, restructuring processes, solvency risk, ROA, the annual loans growth rate, non-interesting expenses as well as the evolution of monetary policies, economic growth and the share of mobile phone subscriptions. The findings reveal, among others, that digitalization negatively affects performance measured with price-to-book ratio and annual equity return whereas its influence on efficiency ratio as well as ROA is insignificant.

3. Sample and Variables Description

With the aim of investigating how digitalization affects performance of Croatian listed companies a set of firm-specific as well as macroeconomic variable were employed in the analysis.

First of all, since the sample consists of listed companies the author has chosen Tobin's Q, market-based performance measure instead of widely employed accounting-based performance measures including return on assets and return on equity. Specifically, a proxy for Tobin's Q

(**TOBIN_Q**), determined as the sum of market value of shares and book value of debt to total value of assets has been used. Moreover, market value of shares has been determined as the product of share price and the number of shares listed. The following equation has been used:

$$Tobin's Q = \frac{\text{market value of shares + book value of debt}}{\text{book value of assets}}$$
(1)

This approach has also been employed in papers by e.g. Demsetz and Villalonga (2001), Cheung and Wei (2006), Cheng (2008), Ghazali (2010), Coles, Lemmon and Meschke (2012), Marinova, Plantenga and Remery (2016) to name a few, all dealing with samples consisting of listed companies.

Digitalization (In_digital) is independent variable reflecting higher investments in information and communication technologies (ICT). Having in mind that financial reports lack the exact data on ICT, the author has used a proxy of the balance sheet items "other intangible assets" or "concessions, patents, licences, trademarks, software and other rights" which mostly relates to software the companies use. This approach has been also used by e.g. Brynjolfsson, Hitt and Yang (2002) and Łyskawa, Kędra, Klapkiv and Klapkiv (2019). However, as stated by Łyskawa, Kędra, Klapkiv and Klapkiv (2019) "this type of asset includes a wider list of nonmonetary assets, such as trademarks, trade dress, video, and audiovisual materials, marketing rights and so on. In the notes of financial statements, ...the company could show the value of software: separately acquired and internally developed." However, this is rarely the case. For the purpose of this analysis logarithmic values were used to avoid skewness towards large values. Furthermore, positive effect of digitalization on performance is expected.

For the purpose of this research size of the company has been employed as a control variable which is measured using both total assets (**In_size**) and the number of employees (**In_emp**). Specifically, logarithmic value of total assets was employed in the analysis. Variable size computed as logarithmic value of total assets has been extensively used in empirical research as a potential determinant of company's performance measured with Tobin's Q (e.g. Carter, Simkins and Simpson, 2003; Pathan and Faff, 2013). Furthermore, while investigating the effect of company size on performance using the sample of 200 firms that were listed at Istanbul Stock Exchange (ISE) in the 2008-2011 period, Doğan (2013) has used assets, sales as well as the number of employees as indicators of size. The influence of the size variable on the performance, regardless of the fact whether it is measured on the basis of total assets or number of employees, is ambiguous. The common perception is that, as noted by Lee (2009), "...larger firms tend to be more profitable than their smaller counterparts, either due to efficiency gains or higher market power." On the other hand, Hardwick, Adams and Zou (2011) note that "...once a firm becomes too large, the effect of size inflects possibly because of the increasing complexity of management...".

Leverage variable (**leverage**) is employed in the analysis to find out how the use of external sources of financing affects performance. It is calculated as follows:

The expected effect of this variable on corporate performance is also unclear. Firstly, Jensen (1986) notes that "as leverage increases, the usual agency costs of debt rise, including bankruptcy costs." Therefore, negative influence if this variable is expected. This is also found

by Doğan (2013) and Ilyukhin (2015). On the contrary, there is also a rationale supporting the positive impact of leverage on performance. Specifically, agency cost hypothesis by Jensen and Meckling (1976) predicts that increased leverage is linked with enhanced efficiency. Moreover, Hutchinson (1995) states that "financial leverage has a positive effect on the firm's return on equity provided that the earnings power of the firm's assets exceeds the average interest cost of debt to the firm."

GDP per capita growth (**GDP_pc_growth**) is encompassed by the research to capture for the influence of macroeconomic environment. It reflects economic activity as well as level of economic development. If the macroeconomic setting deteriorates, this may cause disruptions in performance of the firms, therefore, positive influence of this variable is expected.

The data for firm-specific variables employed in the analysis were obtained from companies' annual reports retrieved from ZSE web-pages. Specifically, for the purpose of calculating dependent variable Tobin's Q, data on share price as well as on the number of shares being listed were taken from ZSE web pages. Moreover, macroeconomic variables, i.e. GDP per capita growth were taken from World Bank.

Furthermore, the analysis is based on firm year observations. The author's primary intent was to include in the sample all companies listed in the official market of the ZSE in the period 2014 – 2018. E.g. in 2018 there were 22 companies listed. However, after adjusting for the firms that were not listed for at least three successive years the final sample is unbalanced consisting of 74 companies in five-year period.

It is worth mentioning that the official market is part of the regulated market of the ZSE together with prime and regular market. These three segments differ with regard to the requirements that have to be met by the issuer, especially in relation to transparency. The companies encompassed by the analysis belong to different sectors.

4. Empirical Research

Descriptive statistics for both dependent and independent variables covered by the analysis are presented with Table 1. Descriptive statistics are calculated on the basis of 74 observations for all variables.

Table 1 Descriptive Statistics

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Variable	Observations	Mean	Standard Deviation	Min	Max
Tobin's Q	74	20.58327	98.5722	0.5243176	661.4677
ln_digital	74	15.57594	2.404816	11.36576	20.89771
ln_size	74	20.83981	1.743866	14.2115	23.77694
leverage	74	1212.589	6139.782	0.0007866	44204.32
ln_emp	74	6.42287	1.237603	3.871201	9.005774
GDP_pc_growth	74	3.177311	1.45846	0.304	4.385

Source: author's calculation

Further step in this study was to test the presence of multicollinearity between independent variables. For this purpose the matrix of Pearson correlation coefficients was employed.

Table 2 Correlation matrix

	In_digital	In_size	leverage	In_emp	GDP_pc_growth

In_digital	1.0000				
In_size	0.5254	1.0000			
leverage	-0.1043	-0,6644	1.0000		
In_emp	-0.5432	0,4414	-0,0148	1.0000	
GDP_pc_growth	0.0422	-0,0860	0,1232	-0,0383	1.0000

Source: author's calculation

Correlation coefficients matrix for independent variables is given in Table 2.

Absolute values of the Pearson coefficients higher than 0.7 indicate a strong correlation between independent variables. As presented in Table 2 there is no problem with multicollinearity between independent variables.

Furthermore, static panel data analysis was employed with the aim of conducting econometric data analysis. For this purpose model (3) has been estimated.

$$Y_{it} = c + \sum_{k=1}^{K} \beta_k X_{it}^k + \varepsilon_{it}$$
(3)

 $\varepsilon_{it} = Z_i + U_{it}$,

where:

 Y_{it} is the firm's performance measured with Tobin's Q of the company i at time t, with i = 1,..., N; t = 1,..., T

X_{it} are k independent variables as described above.

 ε_{it} is the disturbance with z_i being the unobserved firm-specific effect and u_{it} being the idiosyncratic error. The model showed above is a one-way error component regression model where $z_i \sim IIN(0, \sigma_z^2)$ and independent of $u_{it} \sim IIN(0, \sigma_u^2)$.

Static panel model with fixed effects (FE) as well as with random effects (RE) were used in the analysis. However, Hausman test indicated that most suitable was the one with fixed effects. The findings of the analysis are presented with Table 3.

Table 3 Parameter estimates of static panel model with fixed effects

Variable	Tobin's Q
In digital	-1.726244
ln_digital	(0.194)
ln_size	-16.8875*
III_SIZE	(0.000)
lavaraga	0.0128438*
leverage	(0.000)
ln omn	-1.672386
ln_emp	(0.590)
CDD no growth	0.2720726
GDP_pc_growth	(0.295)
cons	393.6935*
cons	(0.000)
R2 within	0.9933
R2 between	0.7953
R2 overall	0.9330

F value	3.10
r value	p value=0.001
Housman tast	$chi^2 = 18.29$
Hausman test	p value = 0.011

^{*} Statistically significant at the; 1% level. Standard errors are between parentheses. *Source*: author's calculation

Table 3 presented above shows the coefficient of determination (Adjusted R2) of 0.9330 suggesting that the variables in the model explain 93.30% of the variability of performance, while the remaining 6.70% of performance variance should be explained by other variables that are not encompassed by the research.

Table 3 also shows that size and leverage have statistically significant effect on performance. Specifically, size of the firm measured on the basis of total assets negatively affects performance whereas leverage is exhibiting statistically significant and positive influence on Tobin's Q. However, digitalization does not determine corporate performance of Croatian listed firms. Similarly, insignificant influence of digitalization on performance is found by Forcadell, Aracil and Ubeda (2020) in the models where bank's performance has been measured with efficiency ratio and ROA.

The grounds for such relation between variables firm size and Tobin's Q could be found in the alternative theories of the firm, that, as stated by Pervan and Visic (2012), "suggest that large firms come under the control of managers pursuing self-interested goals and therefore profit maximization as the firm's objective function may be replaced by managerial utility maximization function."

Statistically significant and positive influence of leverage on corporate performance is found by Drmac, Pervan and Pavic Kramaric (2017) who analysed gender diversity on supervisory boards of Croatian listed firms in 2016. In order to explain such a relationship the aforementioned authors cited Kartikasari and Merianti (2016) who studied the influence of leverage and firm size on profitability of public manufacturers in Indonesia stating that managing the debt efficiently may lead to an increase of profitability. Moreover, the sample covered by this analysis encompass listed firms which, due to their reputation, size and negotiating powers, could get sources of financing at a lower cost. This was also stated by Drmac, Pervan and Pavic Kramaric (2017). It is also worth mentioning Margaritis and Psillaki (2010) who found positive relationship between leverage and efficiency.

5. Conclusion

Given the fact that the issue of digitalization has almost become an indispensable segment of the business activities of each company, this paper has tried to provide evidence in favour of digitalization in terms of enhancing the performance of the company.

For this purpose the analysis is conducted on the sample of Croatian firms listed on the official market of ZSE in the 2014 - 2018 period using a set of firm-specific and macroeconomic variables while performance has been measured using Tobin's Q, i.e. market-based measure of performance. Employing static panel analysis, the results reveal that, contrary to the expectations, digitalization does not play significant role in defining companies' performance.

This could be explained by Forcadell, Aracil and Ubeda (2020) who state that "digitalization strategies developed as a mere reaction to a fierce competitive environment are unable in improve performance" suggesting that it should be combined with sustainable strategies. However, size of the company calculated on the basis of total assets negatively whereas leverage positively affects performance.

The author is aware of the limitations of the study arising primarily from not having precise data on companies' investments in ICT. Some directions for future research might include more company-specific variables as well as other performance measures in order to compare obtained results.

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The Impact of Key Audit Matters on Cost of Debt

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Abstract. As part of the International Auditing Standards amendments, made by the International Auditing and Assurance Standards Board (IAASB) in 2015, key audit matters were implemented in order to provide users of independent auditor's report with additional information which highlight accounting items highly susceptible to management's judgment. Among the potential users of new information, the most prominent are lenders and shareholders, since they provide companies with resources necessary for smooth organization of their business activities. In this regard, the greater informativeness of the new independent auditor's report may affect the decision-making process conducted by aforementioned company's stakeholders. Their perception of financial position, financial performance and stability of the cash flows determines investment decisions, as well as the cost at which the funds will be lent. Focus of this paper was on the lenders' decisions, i. e. relationship between key audit matters and the cost of debt. Research sample consists of nonfinancial public limited companies that were listed on the Zagreb Stock Exchange. Content analysis was applied to collect information regarding key audit matters contained in audit reports while financial data was gathered from disclosed annual financial statements. Model has been tested using the multivariate method of ordinary least squares regression and the results of research have provided evidence that there is no statistically significant effect of number of key audit matters on cost of debt.

Key words: Cost of Debt, Independent Auditor's Report, Interest Rates, Key Audit Matters

1. Introduction

Recent accounting scandals prompted audit regulators' actions necessary for improving audit quality¹ by implementing the "idea of extended audit reporting as a way to increase the information content in the report and to reduce the information asymmetry between auditors and users" (Bedard et al., 2014, Cordos and Fulopa, 2015, in Pinto and Morais, 2019, p. 2) which contributes to the further "decline of trust in audits" (Sirois, Bedard and Bera, 2018, p. 1). New reporting model for auditors is developed after years of criticism directed on insufficient communicative value provided by the pass-fail model² for audit reports (Church, Davis and McCracken, 2008, in Pinto and Morais, 2019) due to their highly standardized content (Bedard, Gonthier-Besacier and Schatt, 2014, u Ferreira and Morais, 2019).

As part of the International Auditing Standards amendments, made by the International Auditing and Assurance Standards Board in 2015, key audit matters were implemented in order to provide users of independent auditor's report with additional information which highlight accounting items highly susceptible to management's judgment. Revised International Standard on Auditing 701 – Communicating Key Audit Matters in Independent

¹ Audit quality is considered as "the core of the audit market" – "the audit mission has no value if the public has no confidence in it" (Maijoor and Vanstraelen, 2012, in Cordos and Fulop, 2014, p. 936).

² Study conducted by Christensen, Neuman and Rice (2019, p. 1) has provided "evidence that binary signals in audit reports are unable to fully communicate underlying risks that are inherently continuous in nature".

Auditor's Report "requires the auditor to disclose in the audit report, based on the professional judgment, the most significant risks of the company identified during the audit and how they addressed those risks" (Gambetta et al., 2019, p. 32).

When this research was initiated, it took into account "the call for more research on key audit matters disclosures" (Bedard et al., 2016, in Velte, 2018, p. 1), remarks that "recent empirical key audit matters research on debtholders reactions is not valid and of low quantity unlike research on investors" and that "it is most useful to analyze the link between key audit matters disclosure and debtholders' reactions using archival data", as well as researchers' encouragement "to include debtholders in future designs", given that they are "key corporate stakeholders, especially in small and medium-sized entities" (Velte and Issa, 2019, p. 332) and the fact that "most of the included studies analyze the impact of key audit matters disclosure on investor reactions in a US-American setting" (Velte and Issa, 2019, p. 323).

This research contributes to the literature because it is first to analyze the effect of key audit matters on cost of debt. Among the potential users of new information, the most prominent are lenders and shareholders³, since they provide companies with resources necessary for smooth organization of their business activities. In this regard, the greater informativeness of the new independent auditor's report may affect the decision-making process conducted by aforementioned company's stakeholders. Their perception of financial position, financial performance and stability of the cash flows determines investment decisions, as well as the cost at which the funds will be lent.

The paper is organized as follows – after introductory remarks in chapter 1, chapter 2 integrates previous researches on key audit matters in literature review, chapter 3 provides the research design – presents data and gives insight in methodology used for research, chapter 4 shows results of performed research, and chapter 5 concludes the paper by providing final remarks.

2. Literature review and hypotheses development

In this chapter, the literature on number of key audit matters, their determinants and their relationship with loan financing decisions, i. e. the price of debt, will be examined. Briefly, there are notions on desireable number of key audit matters to be included in independent auditor's report, factors that can be influental in determining the number of key audit matters, and the impact that key audit matters could have on bank directors and corporate loan officers. The latter question was addressed by experiments and questionnaires to examine the perception of mentioned physical persons and have yielded mixed results.

Quantity and nature of key audit matters which should be included in independent auditor's report is not regulated and it is a matter of auditor's professional judgment (Tušek and Ježovita, 2018; Pinto and Morais, 2019), who should "prioritize what is to be communicated within the key audit matters section" (Iwanowicz and Iwanowicz, 2019, p. 3). Despite the fact that key audit matters have been introduced in order to improve informativeness of auditor's reports, their excessive inclusion could be counterproductive in terms of causing information overload (Pinto and Morais, 2019). There is no optimal number of key audit matters to be included in auditor's report since companies' characteristics are heterogenous and require individual approach. Regulating bodies have recommended including two to seven key audit matters as advisable range (Tiron-Tudor, Cordos and Fulop, 2018).

³ Velte and Issa (2019, p. 323) have identified "five major streams of empirical research that analyze the impact of key audit matters disclosure on stakeholders' reactions: (1) shareholders (e. g. investors' perceptions of auditors' responsibility and litigation, value relevance and investors' decisions), (2) debtholders (e. g. loan contracting terms), (3) external auditors (e. g. audit processes and audit fees), (4) boards of directors (e. g. earnings management), and (5) other stakeholders (e. g. informational value for suppliers and customers).

Ferreira and Morais (2019, p. 2) took into account that number of key audit matters in auditor's report may be influenced by the relationship between the auditees and the auditors, thus they state that "the disclosure of key audit matters in the auditor's report is influenced by the consequences perceived by the auditor in the economic trade-off between the probability of being exposed to litigation and the loss of reputation, on one hand, and the expected cost of losing a client, on the other".

Besides the negotiations between the auditees and the auditors, Lin et al. (2020, p. 2) highlight that "the number of key audit matters as a measure of a firm's risk can be influenced by directors and supervisors also through their business decisions". They perceive the key audit matters as "measure of the quality of corporate governance and a firm's exposure to risk" (Lin et al., 2020, p. 2) – "the more items that are identified as key audit matters in the audit report, the more uncertain the auditing of a firm's fair value estimates will be and the more imprecise the disclosures in the financial statements will be, indicating an increase in a firm's financial or operating risk" (Lin et al., 2020, p. 6).

Ferreira and Morais (2019, p. 1) had tried to "identify the number of key audit matters disclosed by Brazilian companies and analyze the main factors associated with their disclosure". Their results have shown "a positive relationship between the number of key audit matters disclosed and both the auditor being a Big Four and the complexity of the audited company", while "the auditor's fees and auditor's opinion being modified show a negative relationship with the number of key audit matters".

The aim of research conducted by Pinto and Morais (2019, p. 1) were "to determine the factors that influence the number of key audit matters that auditors disclose in the main European countries under the new regulation". They have founded, contrary to their expectations, "a positive association between the audit fee and the number of key audit matters disclosed" and stated that "as audit fees can be related to higher client risk, it could indicate litigation risk dominates any auditor–client dependence".

Boolaky and Quick (2016, p. 158) have investigated "the impact of expanded audit reports, namely information on the assurance level, materiality levels and key audit matters, on bank director perceptions of the quality of the financial statements, the audit and the audit report, as well as on their credit approval decisions". Their results show that "the communication of key audit matters has no significant influence at all ... and their findings do not support the disclosure of key audit matters ... because it does not affect the perceptions and decisions of bank directors" (Boolaky and Quick, 2016, p. 168).

Trpeska, Atanasovski and Lazarevska (2017) conducted a research by distributing questionnaires with closed-ended format questions to corporate loan officers and heads of corporate loan departments. They stated that "lenders rely on information from the standard audit report, and gave equal importance weight to all types of auditor's opinion" and that "lenders value most information on key audit matters, existence of material uncertainty and auditor's judgement for the going concern and auditor's procedures related to risk of fraud in the financial statements" (Trpeska, Atanasovski and Lazarevska, 2017, p. 457).

Sirois, Bedard and Bera (2018, p. 26) have got results "consistent with Boolaky and Quick (2016) who, in an experimental setting, fail to find that key audit matters influence bankers' likelihood to approve a loan" and stated that "the lack of significant effect on the loan decisions could be the result of their experimental design" (Sirois, Bedard and Bera, 2018, p. 27).

Velte and Issa (2019, p. 332) provided a comprehensive literature review and stated that "in contrast to shareholders, they had identified only three studies on debtholders (Boolaky and Quick, 2016; Porump et al., 2018; Trpeska et al., 2017), which have mixed results".

According to the researches analysed in lietrature review, following hypothesis was established:

There is a negative effect of the number of key audit matters on the cost of debt.

3. Research design

3.1. Sample and methodology

Research sample consists of public limited companies that were listed on the Croatian capital market – Zagreb Stock Exchange. Relevant data from annual financial statements and information from audit reports regarding key audit matters have been collected for 79 listed nonfinancial companies for the financial years 2017 and 2018.

Content analysis was applied with the aim of determining the number of key audit matters reported in auditor's statements. Research was conducted using statistical analysis which included correlational statistics, as well as estimating ordinary least squares regression model which was used to determine the effect of the number of key audit matters on the cost of debt.

3.2. Model specification

Company's average interest rate on debt was utilized in the cost of debt analysis which was "estimated by dividing the reported interest expense by the average of the beginning and ending debt levels" (Minnis, 2011, p. 471). Model was formulated by adding key audit matters variable, which was calculated as "the number of disclosed key audit matters at fiscal year-end divided by the average number of sample key audit matters" (Pinto and Morais, 2019, p. 8), into model similar to one that Minnis (2011) applied. Several control variables that he used were incorporated in model – he classified them in two categories – "financial statement performance variables typically used by lenders in assessing borrowers" and other firm characteristic controls for examining the relationship between their test variable and cost of debt (Minnis, 2011, p. 473):

$$IR_{i,t+1} = \beta 0 + \beta_1 * KAM_{i,t} + \beta 2 * IC_{i,t} + \beta 3 * CR_{i,t} + \beta 4 * PPE_{i,t} + \beta 5 * LEV_{i,t} + u_{i,t}.$$

where, IR is "reported interest expense by the average of the beginning and ending debt levels" (Minnis, 2011, p. 471), KAM is the "number of disclosed key audit matters in auditor's report divided by the average number key audit matters of research sample" (Pinto and Morais, 2019, p. 8), IC is "earnings before interest, taxes, and depreciation (EBITDA) divided by interest expense as a measure of the firm's ability to service the debt from its operations", CR is "defined as current assets divided by current liabilities, and measures the level of firm resources to service obligations that will occur over the next year", PPE is "defined as net property, plant, and equipment divided by total assets, and is the extent of tangible assets in place that could be liquidated to repay outstanding debts in the event of default", and LEV is calculated "as total liabilities divided by total assets" (Minnis, 2011, p. 473).

4. Empirical results

4.1. Correlation

Correlation analysis was performed to determine the relationship between the dependent variable and test variable. Since the correlation coefficient is 0.14, it indicates that the direction of correlation coefficient is positive but extremely weak. Results of analysis indicate that there is no statistically significant relationship between interest rate variable and number of key audit matters at the significance level of 5 percent.

4.2. Regression analysis

Model has been tested using the multivariate method of ordinary least squares regression.

 Table 1 Regression model

Independent variable	В	Standard error	Significance
KAM	0,07	0,03	0,46
EBITDA	- 0,05	0,01	0,64
CR	0,66	0,01	0,01
PPE	- 0,03	0,09	0,74
LEV	0,03	0,08	0,79

As it is evident from the model equation in chapter 3. 2., all independent variables are lagged variables from one year before the year that was used for calculating cost of debt. Therefore, IR was calculated using data for financial year 2018 (t + 1), while KAM, EBITDA, CR, PPE and LEV were calculated using data for financial year 2017 (t). It was assumed that key audit matters which had been disclosed in previous year had influenced cost of debt in the following year.

With regard to research hypothesis, it can be stated that there is no statistically significant effect of number of key audit matters on cost of debt at the threshold for statistical significance of 5 percent. Contrary to expectations, research hypothesis is rejected.

5. Conclusion

Among the potential users of new information provided by the expanded independent auditor's report, the most prominent are lenders since they provide companies with resources necessary for organization of their business activities. Thus, their greater informativeness may affect the decision-making process conducted by aforementioned company's stakeholders because of additional information which can be incorporated in it as a part of credit risk assessment.

Negative impact of number of issues emphasized in key audit matters section of independent auditor's report on cost of debt was assumed. Results of research provide evidence that there is no statistically significant effect of number of key audit matters on interest rate variable. Consequentially, established research hypothesis was rejected. This could imply that debtholders do not incorporate information contained in key audit matters section in their decision-making process.

This research was conducted as an answer on a lack of research on key audit matters regarding debtholders' actions emphasized by some authors in this field. Scientific contribution of this paper is analysis of key audit matters effect on cost of debt which company must pay to the debtholder, which wasn't addressed by other authors. Also, there was a lack of key audit matters researches in area of Continental Europe.

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Utjecaj ključnih revizijskih pitanja na trošak zaduživanja putem zajma

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Sažetak. U sklopu izmjena Međunarodnih revizijskih standarda, koje je 2015 izvršio Međunarodni odbor za standarde revidiranja i izražavanja uvjerenja (International Auditing and Assurance Standards Board, IAASB), predviđena je i implementacija ključnih revizijskih pitanja s ciljem opskrbljivanja korisnika revizijskih izvještaja dodatnim informacijama kako bi se istaknule stavke financijskih izvještaja koje su značajnije izložene prosudbama od strane menadžmenta. Među potencijalnim korisnicima novog skupa informacija najviše se ističu zajmodavci i dioničari, o kojima trgovačka društva u najvećoj mjeri ovise s obzirom na to da im osiguravaju sredstva nužna za nesmetano organiziranje poslovnih aktivnosti. U tom pogledu, veća informativnost izvješća neovisnog revizora može utjecati na proces donošenja odluka od strane spomenutih dionika društva. O njihovoj percepciji financijskog položaja, financijske uspješnosti i stabilnosti novčanih tokova trgovačkog društva ovise investicijske odluke, ali i trošak po kojem će se pozajmljivati novčana sredstva. Fokus ovog rada je na odlukama koje donose zajmodavci, tj. na odnosu između ključnih revizijskih pitanja i troškova zaduživanja putem zajma. Istraživački uzorak čine nefinancijska dionička društva koja su kotirala na Zagrebačkoj burzi. Analiza sadržaja primijenjena je za prikupljanje informacija o ključnim revizijskim pitanjima sadržanim u izvješćima neovisnog revizora, dok su financijski podaci pribavljeni korištenjem objavljenih godišnjih financijskih izvještaja. Testiranje modela provedeno je s pomoću multivarijatne regresijske metode najmanjih kvadrata, a rezultati istraživanja upućuju na to da nema statistički značajnog utjecaja broja ključnih revizijskih pitanja na troškove zaduživanja putem zajma.

Ključne riječi: trošak zaduživanja putem zajma, izvješće neovisnog revizora, kamatne stope, ključna revizijska pitanja

1. Uvod

Nedavni računovodstveni skandali bili su poticaj regulatornim tijelima za provođenje poboljšanja kvalitete revizije¹ primjenom "koncepta proširenog revizorskog izvještavanja kao načina povećanja informativnosti izvješća i smanjenja asimetrije informacija između revizora i korisnika izvješća" (Bedard i sur., 2014, Cordos i Fulopa, 2015, u Pinto i Morais, 2019, str. 2) koja doprinosi daljnjem "opadanju povjerenja u reviziju" (Sirois, Bedard i Bera, 2018, str. 1). Novi model revizorskog izvještavanja razvijen je nakon višegodišnjih kritika usmjerenih na nedovoljnu komunikacijsku vrijednost koju pruža binarni model² izvješća neovisnog revizora (Church, Davis i McCracken, 2008, u Pinto i Morais, 2019) zbog njegovog visoko standardiziranog sadržaja (Bedard, Gonthier-Besacier i Schatt, 2014, u Ferreira i Morais, 2019).

¹ Kvaliteta revizije smatra se "jezgrom revizorskog tržišta" - "revizija nema vrijednost ako nije popraćena povjerenjem javnosti" (Maijoor i Vanstraelen, 2012, u Cordos i Fulop, 2014., str. 936).

² Prema istraživanju kojeg su proveli Christensen, Neuman i Rice (2019, str. 1) "binarni signali u revizorskim izvješćima ne mogu u potpunosti priopćiti temeljne rizike koji su po svojoj naravi kontinuirani".

Kao dio izmjena i dopuna Međunarodnih revizijskih standarda koje je Odbor za međunarodne standarde revidiranja i izražavanja uvjerenja donio 2015, ključna revizijska pitanja implementirana su kako bi se korisnicima izvješća neovisnog revizora pružilo dodatne podatke putem kojih se stavlja naglasak na računovodstvene stavke izrazito podložne menadžerskoj prosudbi. Revidirani Međunarodni revizijski standard 701 – Priopćavanje ključnih revizijskih pitanja u izvješću neovisnog revizora "zahtijeva da revizor u izvješću neovisnog revizora objavi, koristeći profesionalnu prosudbu, najznačajnije rizike poslovanja društva koji su identificirani tijekom revizije i način postupanja s njima" (Gambetta i sur., 2019, str. 32).

Kada je započeto ovo istraživanje, u obzir su uzeti "poticaji za daljnja istraživanja o ključnim revizijskim pitanjima" (Bedard i sur., 2016, u Velte, 2018, str. 1), opažanja da "nedavna empirijska istraživanja odnosa ključnih revizijskih pitanja i reakcija zajmodavaca nisu valjana i da su rijetka za razliku od istraživanja o investitorima" te da je "najkorisnije analizirati povezanost ključnih revizijskih pitanja i reakcija zajmodavaca koristeći arhivske podatke", poticaji istraživača "da zajmodavce uključe u budući dizajn istraživanja", s obzirom na to da su oni "ključni korporativni dionici, posebice u malim i srednjim kompanijama" (Velte i Issa, 2019, str. 332), kao i činjenica da "većina istraživanja analizira utjecaj ključnih revizijskih pitanja na reakcije investitora u američkom okruženju" (Velte i Issa, 2019, str. 323).

Ovo istraživanje doprinosi literaturi jer je prvo koje analizira utjecaj ključnih revizijskih pitanja na trošak zaduživanja putem zajma. Među potencijalnim korisnicima novih informacija najviše se ističu zajmodavci i dioničari³, s obzirom na to da društvima osiguravaju resurse nužne za nesmetano provođenje poslovnih aktivnosti. S tim u vezi, veća informativnost novog izvješća neovisnog revizora može utjecati na postupak donošenja odluka spomenutih dionika. Njihova percepcija financijskog položaja, financijske uspješnosti i stabilnosti novčanih tokova određuje investicijske odluke, kao i trošak po kojem će se sredstva pozajmiti.

Rad je organiziran na sljedeći način – nakon uvodnih napomena sadržanih u poglavlju 1, poglavlje 2 u pregledu literature objedinjuje prethodna istraživanja o ključnim revizijskim pitanjima, poglavlje 3 pruža uvid u dizajn istraživanja – uzorak i metodologiju korištenu u istraživanju, poglavlje 4 prikazuje rezultate provedenog istraživanja, dok je u završnom poglavlju 5 zaključak rada.

2. Pregled literature i oblikovanje hipoteze

U ovom poglavlju analizirat će se istraživanja koja su za predmet imala broj ključnih revizijskih pitanja, njihovi čimbenici i njihov odnos s odlukama o financiranju putem zajma. Ukratko, postoje istraživanja o broju ključnih revizijskih pitanja koja bi trebalo uključiti u izvješće neovisnog revizora, faktorima koji mogu utjecati na određivanje broja ključnih revizijskih pitanja i utjecaju kojeg ključna revizijska pitanja mogu imati na direktore banaka i kreditne službenike. Glede posljednjeg pitanja provodili su se eksperimenti i popunjavali upitnici kako bi se ispitala percepcija spomenutih fizičkih osoba, a analiza tih podataka dala je mješovite rezultate.

Količina i vrsta ključnih revizijskih pitanja koja bi trebalo uključiti u izvješće neovisnog revizora nisu regulirane te su u domeni profesionalne prosudbe revizora (Tušek i Ježovita, 2018; Pinto i Morais, 2019), koji bi trebao "odrediti prioritete glede pitanja koja će se

³ Velte i Issa (2019, str. 323) identificirali su "pet glavnih smjerova empirijskog istraživanja u kojima se analizira utjecaj objavljivanja ključnih revizijskih pitanja na reakcije dionika: (1) dioničara (npr. percepcija investitora o odgovornosti revizora), (2) zajmodavaca (npr. uvjeti ugovora o zajmu), (3) eksternih revizora (npr. revizijski procesi i revizijske naknade), (4) upravnih odbora (npr. manipulacije financijskim rezultatom) i (5) ostalih dionika (npr. informacijska vrijednost za dobavljače i kupce).

priopćiti u odjeljku o ključnim revizijskim pitanjima" (Iwanowicz i Iwanowicz, 2019, str. 3). Unatoč činjenici da su ključna revizijska pitanja uvedena kako bi se poboljšala informativnost izvješća neovisnog revizora, njihovo prekomjerno uključivanje moglo bi biti kontraproduktivno u smislu prevelikog opterećenja informacijama (Pinto i Morais, 2019). Ne postoji optimalan broj ključnih revizijskih pitanja koja bi trebalo uključiti u izvješće neovisnog revizora, s obzirom na raznolikost karakteristika društava i potrebu individualnog pristupa. Regulatorna tijela preporučuju uključivanje dva do sedam ključnih revizijskih pitanja (Tiron-Tudor, Cordos i Fulop, 2018).

Ferreira i Morais (2019, str. 2) uzeli su u obzir da na broj ključnih revizijskih pitanja u izvješću neovisnog revizora može utjecati odnos između revidiranog subjekta i revizora, pa stoga navode da "na objavljivanje ključnih revizijskih pitanja u izvješću neovisnog revizora utječu percipirane posljedice kompromisa između vjerojatnosti da će revizor biti izložen parničnom postupku i gubitku ugleda s jedne strane, i očekivanih troškova gubitka klijenta s druge strane".

Osim pregovora između revidiranog subjekta i revizora, Lin i sur. (2020, str. 2) ističu da "na broj ključnih revizijskih pitanja kao mjere rizika društva mogu utjecati direktori društva, također kroz vlastite poslovne odluke". Ključna revizijska pitanja smatraju "mjerom kvalitete korporativnog upravljanja i izloženosti društva riziku" (Lin i sur., 2020, str. 2) - "što je više stavki koje su u izvješću neovisnog revizora identificirane kao ključna revizijska pitanja, neizvjesnija će biti revizija procjena fer vrijednosti, dok će objave u financijskim izvještajima biti nepreciznije i upućivati na povećanje financijskog ili poslovnog rizika društva" (Lin i sur., 2020, str. 6).

Ferreira i Morais (2019, str. 1) pokušali su "identificirati broj ključnih revizijskih pitanja objavljenih od strane brazilskih društava i analizirati temeljne čimbenike povezane s njihovim objavljivanjem". Njihovi rezultati pokazali su "pozitivan odnos između broja objavljenih ključnih revizijskih pitanja i pripadnosti revizora Velikoj četvorci sa složenošću revidiranog društva", dok "revizijske naknade i modifikacija revizorskog mišljenja pokazuju negativan odnos s brojem ključnih revizijskih pitanja".

Cilj istraživanja koje su proveli Pinto i Morais (2019, str. 1) odnosio se na "utvrđivanje čimbenika koji utječu na broj ključnih revizijskih pitanja koja revizori objavljuju u glavnim europskim zemljama sukladno novoj regulaciji". Utvrdili su, suprotno njihovim očekivanjima, "pozitivnu povezanost revizijskih naknada i broja objavljenih ključnih revizijskih pitanja" te konstatirali kako je "s obzirom na to da revizijske naknade mogu upućivati na veći rizik klijenta, moguće da rizik parničnog postupka dominira u odnosu revizor – klijent".

Boolaky i Quick (2016, str. 158) istraživali su "utjecaj proširenih izvještaja neovisnog revizora, odnosno informacija o razini uvjerenja, razinama značajnosti i ključnim revizijskim pitanjima na percepciju direktora banke o kvaliteti financijskih izvještaja, reviziji i izvješću neovisnog revizora, kao i o njihovim odlukama o odobrenju kredita". Njihovi rezultati pokazali su kako "komunikacija ključnih revizijskih pitanja uopće nema značajan utjecaj ... te njihovi rezultati ne podržavaju objavljivanje ključnih revizijskih pitanja ... koja ne utječu na percepciju i odluke direktora banaka" (Boolaky i Quick, 2016, str. 168).

Trpeska, Atanasovski i Lazarevska (2017) proveli su istraživanje distribuirajući upitnike sastavljene od pitanja zatvorenog tipa službenicima za korporativne kredite i šefovima odjela za odobravanje korporativnih zajmova. Naveli su da se "zajmodavci oslanjaju na informacije iz standardnog izvješća neovisnog revizora dajući jednaku važnost svim vrstama revizorskog mišljenja" te da "zajmodavci najviše vrednuju informacije o ključnim revizijskim pitanjima, postojanju materijalne nesigurnosti i revizorovoj prosudbi o vremenskoj neograničenosti poslovanja i revizorskim postupcima koji su povezani s rizikom prijevare u financijskim izvještajima" (Trpeska, Atanasovski i Lazarevska, 2017, str. 457).

Sirois, Bedard i Bera (2018, str. 26) dobili su rezultate "identične onima koje su dobili Boolaky i Quick (2016) koji, u eksperimentalnom okruženju, nisu uspjeli utvrditi da ključna revizijska pitanja utječu na vjerojatnost odobravanja zajmova od strane bankara" te konstatirali da "bi nedostatak značajnog utjecaja na odluke o pozajmljivanju mogao biti rezultat njihovog eksperimentalnog dizajna" (Sirois, Bedard i Bera, 2018, str. 27).

Velte i Issa (2019., str. 332) napravili su opsežan pregled literature i izjavili da su "za razliku od onih s dioničarima, identificirali samo tri istraživanja s zajmodavcima (Boolaky i Quick, 2016; Porump i sur., 2018; Trpeska i sur., 2017) te da imaju mješovite rezultate".

Sukladno istraživanjima analiziranim u pregledu literature, utvrđena je sljedeća hipoteza:

Postoji negativan utjecaj broja ključnih revizijskih pitanja na trošak zaduživanja putem zajma.

3. Dizajn istraživanja

3.1. Uzorak i metodologija

Uzorak čine trgovačka društva koja kotiraju na hrvatskom tržištu kapitala – Zagrebačkoj burzi. Relevantni podaci iz godišnjih financijskih izvještaja i informacije iz izvješća neovisnih revizora o ključnim revizijskim pitanjima prikupljeni su za 79 nefinancijskih društava u financijskim godinama 2017. i 2018.

Analiza sadržaja primijenjena je s ciljem utvrđivanja broja ključnih revizijskih pitanja koja su objavljena u izvještajima neovisnih revizora. Istraživanje je provedeno korištenjem statističke analize koja je uključivala korelacijsku analizu, kao i procjenu regresijskog modela metodom najmanjih kvadrata koji je korišten za određivanje utjecaja broja ključnih pitanja revizije na trošak zaduživanja putem zajma.

3.2. Specifikacija modela

Prosječna kamatna stopa na zajmove korištena je u analizi troška zaduživanja putem zajma te je "izračunata stavljajući u odnos prijavljene rashode od kamata i prosječne vrijednosti zajma s početka i kraja razdoblja" (Minnis, 2011, str. 471). Model je oblikovan dodavanjem varijable ključnih revizijskih pitanja, koja je izračunata kao "broj objavljenih ključnih revizijskih pitanja na kraju poslovne godine podijeljen s prosječnim brojem ključnih revizijskih pitanja u uzorku" (Pinto i Morais, 2019, str. 8), u strukturu modela sličnu onoj koju je primijenio Minnis (2011). Uključeno je i nekoliko kontrolnih varijabli koje je spomenuti autor koristio – razvrstao ih je u dvije kategorije – "varijable financijske uspješnosti koje zajmodavci obično koriste prilikom procjene zajmoprimaca" i druge varijable glede karakteristika društava, koje su koristili za ispitivanje odnosa između njihove testne varijable i troška zaduživanja putem zajma (Minnis, 2011, str. 473):

$$IR_{i,t+1} = \beta 0 + \beta_1 * KAM_{i,t} + \beta 2 * IC_{i,t} + \beta 3 * CR_{i,t} + \beta 4 * PPE_{i,t} + \beta 5 * LEV_{i,t} + u_{i,t}.$$

gdje je IR "kamatni rashod podijeljen s prosječnom vrijednosti zajma na početku i kraju razdoblja" (Minnis, 2011, str. 471), KAM "broj objavljenih ključnih revizijskih pitanja u izvješću neovisnog revizora podijeljen s prosječnim brojem ključnih revizijskih pitanja u istraživačkom uzorku" (Pinto i Morais, 2019, str. 8), IC "financijski rezultat prije kamata, poreza i amortizacije (EBITDA) podijeljen s kamatama kao mjerilom sposobnosti društva da pomiruje zajam iz vlastitog poslovanja", CR "omjer kratkotrajne imovine i kratkoročnih obveza koji mjeri razinu sredstava društva raspoloživih za podmirenje obveza koje će se pojaviti tijekom sljedeće godine", PPE "iznos neto imovine, postrojenja i opreme podijeljen s ukupnom imovinom, koji predstavlja materijalnu imovinu raspoloživu za prodaju s ciljem otplate obveza u slučaju financijskih poteškoća", a LEV "ukupne obveze podijeljene s ukupnom imovinom" (Minnis, 2011, str. 473).

4. Empirijski rezultati

4.1. Korelacija

Provedena je korelacijska analiza kako bi se utvrdio odnos između zavisne i testne varijable. Budući da koeficijent korelacije iznosi 0.14, smjer koeficijenta korelacije je pozitivan, ali izuzetno slab. Rezultati analize pokazuju da ne postoji statistički značajan odnos između varijable kamatnih stopa i broja ključnih revizijskih pitanja pri razini značajnosti od 5 %.

4.2. Regresijska analiza

Model je testiran s pomoću multivarijatne regresijske metode najmanjih kvadrata.

 Table 1
 Regresijski model

Nezavisna varijabla	β	Standardna greška	Značajnost
KAM	0,07	0,03	0,46
EBITDA	- 0,05	0,01	0,64
CR	0,66	0,01	0,01
PPE	- 0,03	0,09	0,74
LEV	0,03	0,08	0,79

Iz jednadžbe modela prikazane u poglavlju 3. 2. razvidno je da su sve neovisne varijable analizirane s vremenskim odmakom od jedne godine unatrag u odnosu na godinu koja je korištena za izračun troškova zaduživanja putem zajma. Stoga je IR izračunat korištenjem podataka za 2018. (t + 1), dok su KAM, EBITDA, CR, PPE i LEV izračunati korištenjem podataka za 2017. (t). Pretpostavka je da su ključna revizijska pitanja koja su objavljena u prethodnoj godini utjecala na troškove zaduživanja putem zajma u sljedećoj godini.

S obzirom na istraživačku hipotezu, može se ustvrditi kako ne postoji statistički značajan utjecaj broja ključnih revizijskih pitanja na trošak zaduživanja putem zajma pri razini značajnosti od 5 %. Suprotno očekivanjima, istraživačka hipoteza se odbacuje.

5. Zaključak

Među potencijalnim korisnicima novih informacija koje pruža prošireno izvješće neovisnog revizora najistaknutiji su zajmodavci s obzirom na to da društvima osiguravaju resurse nužne za organizaciju poslovnih aktivnosti. Stoga, njihova veća informativnost može utjecati na proces donošenja odluka spomenutih dionika društva zbog dodatnih informacija koje se u njega mogu uključiti kao dio procjene kreditnog rizika.

Inicijalno je pretpostavljen negativan utjecaj broja ključnih revizijskih pitanja u sklopu izvješća neovisnog revizora na trošak zaduživanja putem zajma. Rezultati istraživanja dokazuju kako ne postoji statistički značajan utjecaj broja ključnih revizijskih pitanja na varijablu troška kamata. Slijedom toga, postavljena istraživačka hipoteza je odbačena. Ovo može upućivati na to da zajmodavci ne uzimaju u obzir informacije sadržane u ključnim revizijskim pitanjima prilikom donošenja odluka.

Ovo istraživanje provedeno je kao odgovor na nedostatak istraživanja o ključnim revizijskim pitanjima glede postupanja zajmodavaca, kojeg su istaknuli neki autori iz ovog područja. Znanstveni doprinos ovog rada izražen je kroz analizu utjecaja ključnih revizijskih pitanja na trošak zaduživanja putem zajma kojeg društvo mora podmiriti zajmodavcu, koji nije istraživan od strane drugih autora. Također, postoji i nedostatak istraživanja ključnih revizijskih pitanja na području kontinentalne Europe.

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Dimensionless Characteristic of the Interest Rate

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Abstract. This paper presents the interest rate as quantity with no dimension. This is opposite to a widespread perception among economists that a dimension of interest rate is 1/time. This perception is so widely spread that it is a part of the economic theory. That theory has a problem with dimensional analysis but this is not discussed here. The paper presents a new form of formulas for value of a capital during a time interval when a change of the capital is calculated using both a simple and a compound interest calculation. Those formulas do not have a problem with dimensional analysis and they are dimensionally homogeneous, that means they are independent of the size of the base units. So, they are the correct mathematical model for the value of the capital that changes over time interval using simple and compound interest calculation. This paper shows that some fundamental quantities in economic theory can be considered in a different way that is consistent with the dimensional analysis.

Key words: interest rate, dimensional analysis in economics, simple interest, compound interest, equivalency of interest rates, econophysics

1. Introduction

It is well known that economic theory has problem with dimensional analysis. There are formulas that are not dimensionally homogeneous. Let see what Barett has written in the conclusion in his work (Barett II, William, 2004., page 99):

".... economists have failed to emulate physicists and engineers in one essential aspect of their work: the consistent and correct use of dimensions. This is an abuse of mathematical/scientific methods. Such abuse invalidates the results of mathematical and statistical methods applied to the development and application of economic theory. it is a continuing problem and one found in the leading mainstream journals (and textbooks). Because young minds are formed by such materials, future generations of economists are being brought along in a faulty tradition. And, unless and until this changes, and economists consistently and correctly use dimensions in economics, if such is possible, mathematical economics, and its empirical alter ego, econometrics, will continue to be academic games and "rigorous" pseudosciences. ... What is certain, however, is that mathematics cannot possibly be a valid means unless and until it is used properly. Among other things, that means that dimensions must be used consistently and correctly."

The goal of this work is not to analyse and discuss this huge problem, but to rise a question about a dimension of a basic and, in economy, so important quantity as the interest rate is. It seems, there is a problem in definition of interest rate and, consequently, in its dimension.

A capital accumulation over time will be called *capitalization*. The capitalization is called *simple capitalization* if capital is accumulated using simple interest calculation. If capital is accumulated using compound interest calculation, we are talking about *compound capitalization*.

2. About dimensions

Here, we are using a notation for dimensions as they are in De Jong (1967.). It's well-known that each quantity in physics has a dimension. For example, a distance has dimension [L], a time [T], a velocity $[LT^{-1}]$ (i.e. [L/T] and so on. A simple definition of dimension is that it is a set of all quantities that can be compared, added or subtracted. The sum and difference of the two (or more) quantities is also element of the same dimension.

For a quantity that is element of some dimension it is used to say that this quantity has this dimension. Numbers are dimensionless, or it is used to say that they have dimension [1]. A percentage is a number and has dimension [1].

For example, any rectangle has two quantities, a length a and a width b, and both have the same dimension [L]. The circumference of this rectangle 0 = 2(a+b) has also the dimension [L]. The surface of this rectangle $P = a \cdot b$ has a dimension $[L^2]$. So, we can write [L+L] = [L], [L-L] = [L], but $[L\cdot L] = [L^2]$. The ratio (i.e. a percentage) between the length and the width k = a/b is a number and has dimension [L/L] = [1].

The above simple definition of dimension implies that in a meaningful expression only quantities of the same dimension can be added and subtracted. If this is not the case, the question is whether the expression is not meaningful or the dimension of some quantities is not appropriate. If an equation (i.e. a formula) or an inequality has the same dimension on its both side it is dimensionally homogeneous. In the economic theory there are formulas that are not dimensionally homogeneous, so above mention question arises.

The mathematical theory of algebraic operations with dimensions is called dimensional analysis. For more about the dimensional analysis see: Alvarez Texocotitla (2019) and Sonin (2001).

3. The Interest rate

The interest rate is a key component of financial mathematics and economic models. It is a measure of time value of money. But still, its definition is not quite unique. The most economists define the interest rate as a growth rate, i.e. change of unit of the capital per unit of time. For example, in De Jong, 1967. (page.15), the interest rate is "the sum of money per annum that must be paid by the borrower for every unit of money borrowed". See also Estola (2017) and Stanić (2001). A dimension of so defined interest rate is [T^{-1}]. In Cvitanić, Jakša, & Zapatero, Fernando (2004) interest rate is define as relative return (percentage of return). On the page 4 there is written "The difference between the bond price the creditor pays to the debtor and the nominal value is called interest. The interest as a percentage of the total value is called interest rate.". (The total value, in that quote, means the bond price.) A dimension of so defined interest rate is [1], i.e. the interest rate is dimensionless.

An interest is calculated on a capital over some time interval of a length **d**. An interest is a capital too. Only productive capital produces interest. In the case of simple capitalization, the interest is not productive, while in the case of compound capitalization it is productive. Generally, each capital can have both, its productive and unproductive portion. Here, the interest rate is defined as the change in total capital, over some time interval of a length **d**, relative to its productive part. It is a percentage of a change in value of total capital over some period of time with respect to the value of productive part of that capital at beginning of that period of time.

This definition is fundamentally different from definition that defines the interest rate as the rate of growth, i.e. the average velocity of change of one unit of the capital over an unit of time interval. Here, the interest rate i is a change of one unit of the productive capital over the time interval of a length d, and it is a function of a time interval's length, i.e. i = i(d).

We do not assume the character of the functional relationship between *i* and *d*. It depends on the capitalization itself. Jones, in his book (Jong, 1967., p.80) assume that "the rate of interest is the reciprocal of time", what, as he wrote "is well-known idea". But, this idea has hidden assumption, it assumes that the simple capitalization is considered.

Let a capital C (0) be given at time t = 0. Let it be capitalized for $t \ge 0$. Let's consider an accumulation of the capital C over a time interval [t, t+d]. The difference between C(t+d) and C(t) is an interest accrued over that time interval. This interest per one unit of the productive capital $C_p(t)$ is our interest rate $i_t(d)$, i.e.

$$i_t(d) = \frac{C(t+d) - C(t)}{C_p(t)} \ . \tag{1}$$

In case of the simple capitalization $C_p(t) = C(0)$, and in the case of compound capitalization $C_p(t) = C(t)$. Let us denote the dimension of capital by [M], as it is done in De Jong (1967). Then, it is obvious that dimension of so define interest rate is [(M-M)/M] = [M/M] = [1], i.e. interest rate is dimensionless.

The interest rate, defines in (1), is a percentage, an interest per the capital at beginning of the time interval of a length d. We assume that the interest rate does not depend on time t. So furthermore, instead of $i_t(d)$, we are using i(d).

For some natural number n (n, as number, is dimensionless), we are considering an accumulation of a capital over some time interval [0,nd]. Then we have well known formulas for calculation of a value of the capital in the time point nd:

$$C_n = C_0 (1 + n \cdot i(d)), \tag{2}$$

and

$$C_n = C_0(1+i(d))^n$$
 (3)

First formula (2), is used in a case of a simple, but second one (3) in a case of a compound capitalization. The both formulas are dimensionally homogeneous. It would not be true if the interest had dimension $[T^{-1}]$. Obviously, there is some problem with the definition of interest rate in (Jong, 1967., p.79). In a case of simple interest, Jong (1967) wrote that a dimension of "number of unit of time" (that is n here) is $[T^{-1}]$, but later (page 81) he wrote that a dimension of "unit of time" is also $[T^{-1}]$. This is a contradiction. A problem is that a dimension of number of units of time is not $[T^{-1}]$ but [1], as is a dimension of number n in this work.

Let's change C_n and C_0 in the formulas (2) and (3) with C(nd) and C(0). Let's t = nd, i.e. $n = \frac{t}{d}$, then (2) and (3) can be written as:

$$C(t) = C(0) \left[1 + \left(\frac{i(d)}{d} \right) t \right], \tag{4}$$

and

$$C(t) = C(0) \left(\left[1 + i(d) \right]^{\frac{1}{d}} \right)^{t}. \tag{5}$$

Note that the functions C(t) in (4) and (5) are defined for every positive real number. They are continuous function of real variable, so they are extension of the discrete function C_n in (2) and (3) where a variable is whole natural numbers. There is no reason do not take them as functions for continuous simple and compound capitalization.

An expression in parentheses in (4) is an interest rate over one unit of time interval i(1) that is equivalent to i(d) in the case of simple capitalization, i.e.

$$i(1) = \frac{i(d)}{d}. (6)$$

An expression in parentheses in (5) is 1 plus an interest rate over one unit of time interval i(1) that is equivalent to i(d) in the case of compound capitalization, i.e.

$$i(1) = [1 + i(d)]^{\frac{1}{d}} - 1$$
. (7)

The interest rates $i(d_1)$ and $i(d_2)$ are mutually equivalent if, for every time point t, they give a same C(t). It is easy to see that i(1) and i(d) are mutually equivalent. Now, in the case of simple capitalization, we have next relation between the mutually equivalent interest rate:

$$\frac{i(d_2)}{d_2} = \frac{i(d_1)}{d_1} \,. \tag{8}$$

In the case of compound capitalization, relation between the mutually equivalent interest rate is:

$$[1+i(d_2)]^{\frac{1}{d_2}} = [1+i(d_1)]^{\frac{1}{d_1}}.$$
(9)

Therefore, the expression in parentheses in (4) can be replaced by either side of equation (8) and the expression in parentheses in (5) can be replaced by any side of equation (9). Regardless of chosen side C(t) in (4) and (5) retains the same value.

The formulas (4) and (5) are dimensionally homogeneous and compatible with (2) and (3), so there is no reason not to use them. However, there are some advantages. A work with interest rates become simply an easy. There is no need for an awkward way to specified, for example, monthly interest rate using yearly interest rate that is no equivalent with it in the case compound capitalization. Very often, we can see something like "12% yearly interest rate compound monthly", meaning which is simple "1% monthly interest rate". This 12% is called a nominal yearly interest rate. In the case of the compound capitalization yearly equivalent of "1% monthly interest rate" is not 12%, but 12,682503%. This is called an effective yearly interest rate. In this example the effective yearly interest rate is more than 5% higher than nominal yearly interest rate.

Why could not we simply say "1% monthly interest rate", and use $\left(\left[1+i\left(\frac{1}{12}\right)\right]^{12}\right)$ in (5)? There is a good reason to do so.

Formulas (4) and (5) will automatically calculate and apply equivalent interest rate for a unit of time. In the example above it is one year. There is no need to play with all of these stuff as

an effective and a nominal interest rate, and a proportional (relative) and so called a conform interest rate as we can find in every theory of financial mathematics.

4. Conclusion

The interest rate that is defined here is proper and dimensionless. By using it, a new form of formulas for the simple and the compound capitalization were presented. They are proper, dimensionally homogeneous and gave same results as traditional formulas for natural numbers, but also can be used for any real number, i.e. they are proper model for the continuous capitalization. However, the formulas presented here are deprived of clumsy ways of expressing an interest rate for a time interval that is less than a time unit (usually one year), as it is usually in economic theory and practice. They are simple and clear to use. This work shows that some fundamental quantities in economic theory can be viewed in a different way that is consistent with the requirements of dimensional analysis.

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CIET Split 2020 Track 2

Tourism, Trade and Entrepreneurship

Importance of E-customs in International Trade

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E-Customs, within its jurisdiction, performs business activities by using Abstract. information technology. In order to create an efficient and modern environment for customs service, the aim of e-customs is complete replacement of paper customs procedures with electronic ones. E-customs operations, through a facilitated international trade exchange of goods process, enables security improvement of the European Union external borders. Direct results of the e-customs functionality are: effective customs control organization, free flow and information exchange, faster customs goods clearance, industry-specific administration, effective activities against organized crime and terrorism, EU's fiscal interests protection, European cultural heritage protection, goods security and quality in the international trade, better human health and the environment protection. As a part of Croatia's preparations for the accession to the European Union, the Customs Administration has accepted the electronic commerce challenges in the customs procedures through customs developing and improving process. Intensive preparations have implemented new systems that support the paperless customs procedures and electronic communication of all customs procedure participants that is, communication between customs and entrepreneurs through the G2B service has been developed. In this paper will be presented a specific area of Customs Administration activity through the development of a functional, integrated, centralized, secure, interoperable, available 24/7 information system. Effective implementation of business processes facilitates customs clearance and reduces paperwork and costs for both the customs service and entrepreneurs ensuring: international trade facilitation, improved market protection and financial interests, and the society security in general.

Keywords: e-customs, Authorised Economic Operator (AEO), Centralised clearance (CC), Government-to-Business (G2B)

1. Introduction

Fiscal and security role of the Customs Administration is achieved by applying a unique legal system of the European Union and national provisions in the field of customs.

In addition to the supervisory system core activities in preventing, combating and detecting all forms of illegal activity, particular attention was paid to the intensive integration concept of cooperation and partnerships with reliable economic operators, the efficient and economical customs procedures creation and the formalities simplification. By reducing customs formalities, educating the business sector and the modernization of its own resources, it is contributed to the national economy's better business environment ie relieving the administrative steps (Izvješće, 2018).

The visualization of e-customs as seen in Figure 1 shows customs service operation concept and electronic support to the economy.

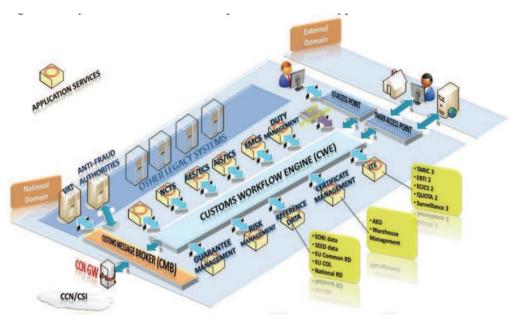


Figure 1 E-customs workflow

Erceg, A. (2013). The new computerized transit system and e-customs influence on savings in transit time and costs. Poslovna logistika u suvremenom menadžmentu, 143-152.

An integral part of the Customs Administration activities is the Information System upgrading with the new functionalities of existing applications and the new applications development and launching.

In order to limit the burden on the economy Customs Administration has determined measures through a number of consultations with entrepreneurs concerning certain reports and records elimination and simplification and also enabling electronic submissions, which will ultimately lead to entrepreneurs' cost administration reduction (Izvješće, 2018). In order to increase the European Union customs services operation efficiency and the services quality, improvement will be carried out by analysing, monitoring and adapting business processes to the economy needs. Customs Administration specific area activity is a functional integrated, centralized, secure and interoperable, available 24/7 information system for business processes efficient implementation. Contribution to customs procedures efficiency increasing is access to all current information system data in real time and ensuring smooth data flow, by which improves and accelerates customs clearance, reduced administration, costs for both the customs service and entrepreneurs. All mentioned facilitates trade, market and financial interest protection and the society safety. The goals achievement stated was through the system digitization by using the project management method and the quality assurance system (Poslovna, 2020). Based on analyses and administrative burden measurement which arise from customs regulations, measures are taken to relieve the economy and to strike a balance between controls and trade facilitation.

Encouraging customs facilitation institutes, public discussions with interested economic operators, and economic operator's involvement in proposing and adopting regulations process, contribute to the development of the Customs Administration's partnerships with economic operators which implies continuous cooperation and communication.

At the same time with development of IT system to facilitate business operations, customs service increase efficiency by establishing standardized and harmonized interfaces for entrepreneurs in accordance with EU rules and legislation, as well as national regulations, will ensure the reduction of different access to IT system for entrepreneurs (Poslovna, 2020).

Providing a unified, modern and easy access to customs system information facilitates trade for domestic entrepreneurs while increasing their international trade competitiveness (Godišnji, 2020).

The aim of paper is analysis and presentation of e-customs importance as a vital part of the global logistics system based on e-customs key institutes such as the Authorized Economic Operator,

Centralized Clearance and Government-to-Business. Given that so far, in scientific and professional literature, there has not been such approach, not only on the issue of general customs domain, but also on particular e-customs directions, the main contribution of this paper is to educate the wider community and institutions with relevant customs tools. Customs due to its credibility, normative and statistical components represent an institution where the customs functionality and operability with economic operators indicates reached joint work level and quality in digital environment.

2. Term of e-customs

Due to global technological development which led to organizational changes in government, it was also necessary to create new ways of interacting with the economic sector. The use of new information and communication technologies has enabled the development of e-government and environment creation for multiple benefits. It manifested by higher level of service delivery to citizens, more effective communication with the economic sector and faster exchange of information and data (Benazić, 2014). Additional support in the digital environment and to efficient customs management is also the ability of the customs service to access other civil service information systems (Hajnić, 2017) as well as the information systems of all other entities managing specific areas where international transport and trade activities are carried out (Smokvina, 2017). On 5 December 2003 EU Council adopted resolution on the simple paperless environment creation for customs and trade that launched the e-customs creating process, ie, a coherent and interoperable electronic customs system for the EU. Based on automated risk analysis systems customs controls have provided a framework for unique access points by which entrepreneurs can submit electronic customs declarations to the single interface, regardless of whether the customs procedure is carried out in another member state and when more than one member state is involved in customs operations (Ured, 2013).

Task processing, advanced information and innumerable electronic capabilities and simplifications not only position but also define e-customs as shown in Figure 2.

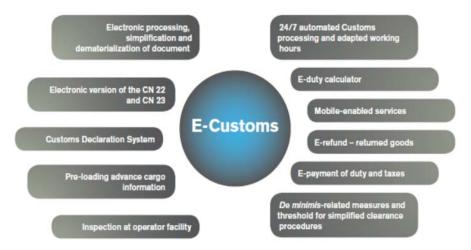


Figure 2 The e-customs environment and the space-time work activities freedom

Facilitating e-commerce, Retrieved February 02, 2020, from https://mag.wcoomd.org/magazine/wco-news-78/facilitating-e-commerce/

E-customs is a system that uses electronic technologies to perform electronic commerce and data exchange between the customs service and the economy. Further development of e-customs enables effective customs control and in a global environment faster goods exchange (Plazibat & Grgurica, 2019). For the Republic of Croatia, as part of other preparations and activities, a successful connection to IT systems and the applications use created under EU legislation in customs procedures was necessary for the accession to the European Union, and at the same time confirming the Customs Administration capacity (Zlopaša, 2019). The Croatian Customs Service

and the created e-customs system set an example for all other institutions in the entry process and adjustment to the European Union (Smokvina, 2017).

Due to communication via the Internet, customs became an electronic service to the economy (Hajnić, 2015), and due to the work of Croatian customs within the Union customs services, and in a globalized environment, it generated a change from classical practices into a proactive control system (Demirovic & Mataga, 2019). The Customs Administration also adopted: *Rules for the electronic data exchange system use and the electronic commerce services provision of the Ministry of Finance, Customs Administration (e-Customs)*. Customs Administrations (e-customs) rules regulate basic principles of electronic data exchange and electronic commerce services, and the obligations of electronic data exchange system users (G2B, 2020). Applying electronic commerce with the Customs Administration implies: customs procedure implementation by using the Customs Administration web application in an electronic environment with electronic data exchange and the electronic signature use.

Basic technical, technological and procedural conditions for using e-commerce services with the Customs Administration are also regulated (Pravila, 2013).

2.1. Effects of e-customs

Accelerated trade and traffic trends generated customs operations harmonization and simplification. New social global relations development pointed out the customs service importance as a quality and always accessible service to the economy (Horvat, 2011). As it can be seen in Figure 3, e-Customs allows simpler customs procedures, allowing better market presence to all parties involved.

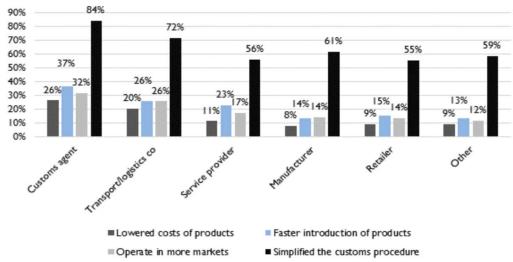


Figure 3 E-customs benefits for all import-export procedures participants Europska komisija. (2015). Evaluation of the electronic customs implementation in the EU. Annexes to the final report, 21 January 2015.

The e-customs basics of the classic customs procedures reengineering are: offering to the economy a wide range of e-customs services, and within the European Union, communicating standardization with any customs administration. This development process has allowed easier import-export-transit procedures, less administrative costs and saving time during customs clearance, also technical assistance and undisturbed information flow between customs and economy (Tomašević, 2014). With the help of modern information and communication technology, and through its efficient and secure goods exchange activities, e-customs has contributed to the changing role of customs in international trade. An automated risk analysis has been set up as the basis for e-customs, which has enormous benefits when doing import, export, transit and customs warehouses operations procedures (Erceg, 2013). With the operation procedures acceleration and cost reduction, the e-customs basic features are 24 hours, 365 days a year availability, and personalization, which is manifested in the fact that any entrepreneur's attention can be directed due to the availability and the target routing information (Horvat, 2011).

An implementation solution that ensures the customs regulations and the customs basic role, and the customs revenues collection while supporting legal trade, various forms of legally established simplifications and effective customs clearances through customs service productivity maximization is a basic e-customs guideline. Meeting such operations requirements is possible with the latest information and communication technologies use, risk management modern methods and operations monitoring systems (Tomašević, 2011). The European Commission has launched the e-customs project by information and communication technology usage for several reasons. The primary objective was to replace the paper-based process with an electronic one, in order to create an efficient and modern customs environment, which would directly affect financial resources saving and entrepreneurs time, increasing business competitiveness and improving the EU's main strategic growth targets (Erceg, 2014). Electronic customs operations goal is additional value creation by information technology usage when performing business activities (e-Carina, 2019). The e-customs application has not only brought changes in the Customs Administration's information system, but also in a number of other work areas. Operations procedures changes have accelerated the goods flow, and the risk analysis system improvement has enabled targeted and effective controls. E-customs and customs procedure changes enabled changes of all parties involved in international trade, from IT system adaptation to both responsibility and benefits assuming in dealing with e-customs (Horvat, 2011). Reported examples of companies which invested in IT resources in order to connect with the customs program interface, and to interact with the e-customs environment, saved and repaid the amounts already in the first year of operation due to reduced administrative costs. Therefore, the e-customs benefits can be categorized as cost effective and costs downsizing. (Europska, 2015). E-customs offers a number of benefits for both customs authorities and the overall business environment. According to World Bank estimations e-customs brings also financial savings because each day of delay in customs duties brings losses of 1% in international trade (Popa, Belu, Paraschiv & Marinoiu, 2015). Figure 4 explains how e-customs, through it accessibility and uniformity, generates mutual communication between the customs and the economy.

In connection with the e-customs evaluation, not just in the EU but also in the rest of the world, proposed recommendations are further resources investing to create good practice based on the e-customs diversity possibilities with professional assistance and activities provided by World Customs Organization (WCO) and the Partnership and Customs Academic Research and Development (PICARD) (Granqvist, Hintsa & Männistö, 2010).

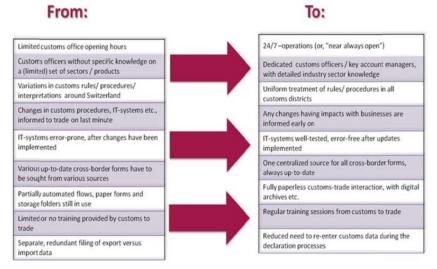


Figure 4 Guidelines interaction of e-customs and economic operators

Granqvist, M., Hintsa, J., & Männistö, T. (2010). E-customs Study: Private Sector Views on Potential Benefits of Further Electronic Customs Developments in Switzerland. Retrieved January 19, 2020, from https://www.researchgate.net/publication/282849877_e-Customs_Study_-

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3. Government-to-Business (G2B)

Trough approach and power in the economy's interaction with the customs service it make it easier to access all the customs system possibilities offered, as illustrated in Figure 5.



Figure 5 Possibility and functionality of the customs interface. Produkcija, Retrieved February 02, 2020, from https://e-carina.carina.hr/

The Customs Administration, in order to facilitate the e-commerce application, has created a two-way data service exchange between the server and the service user. Based on e-customs, a G2B service model was developed for electronic data exchange with entrepreneurs. G2B is an integral part of the Customs Administration Information System Common Infrastructure (ZIISCU) with the primary purpose of the Customs Information System interoperability maintaining with business sector applications. With the secured channels used between companies authorized persons and the Customs Administration on electronic procedure possibility and messages on further actions, the system operates on the principle of EDI-electronic document exchange (Horvat, 2018). G2B services increasing use is manifested in the fact that during 2018, there were 709 G2B service users in the Republic of Croatia production environment who communicate in customs procedures with the Customs Administration and have technical and business support from the Helpdesk Customs Administration. The Customs Information System continuously improves new functionalities of existing applications for test and production environment, which includes upgrading G2B services.

Entrepreneurs' can access G2B registered services to centrally served Customs Decision applications, in which both the representation module and the freight forwarding in customs procedures have been developed. Also, a G2B client adaptation was conducted to make additional transparency for entrepreneurs when submitting reports (Izvješće, 2018).

3.1. Authorised Economic Operator (AEO)

One of the most important partnership marks of the customs service and the economy is expanding and promoting the authorized economic status (AEO) in e-commerce as a tool for the effective implementation of the legislative framework (WCO, 2019).

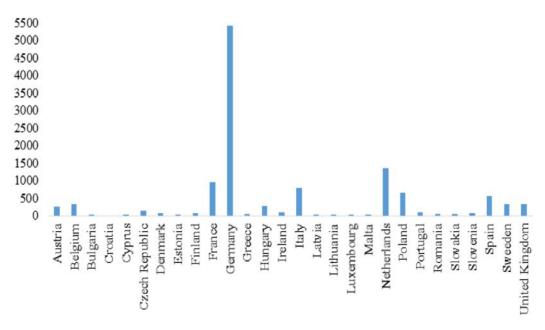


Figure 6 AEO approval numbers in the European Union.

Popa, I., Belu, M.G., Paraschiv D.M., & Marinoiu A.M. (2015). Best practices in customs procedures. Amfiteatru Economic, 17 (40), 1095-1107.

AEO economic operator can be defined as an entity whose economic activity implicate customs legislation and is considered reliable in the context of its customs procedures and is therefore entitled to certain benefits throughout the EU (Europska, 2014). The AEO status granting basic conditions and criteria are: condition that the entrepreneur has no serious or repeated customs breach in the last three years; condition that there is no conviction for serious offenses related to economic activities; and condition of high level control of his own activities and records enabling customs checks, financial solvency, and practical experience in customs matters. The benefit that the authorized economic operator has from AEO status is that it is recognized in all EU member states. Customs EU legislation defining the status of AEOs implies simpler implementation of customs simplifications, fewer physical and documentary controls, an control advantage with other economic operators, and the choice of control location (Uputa, 2018). Economic operators active involvement in adopting and monitoring regulations procedures within customs service competence is the basis for Customs Administration work planning, through instruments of cooperation and partnership creation between the customs and the economy, with an especially important area of AEO status (Godišnji, 2020). In order to facilitate the business for entrepreneurs', activities are underway to increase the AEO authorizations number, and the basic indicator will be an increase in the number of AEO approvals (Godišnji, 2020). Promoting the customs simplification institute use or Authorized Economic Operator (AEO) status is a Customs Administration contribution to the business sector as facilitating the most favourable operating conditions (Izvješće, 2018). The AEO status application process since October 2019 has been improved and made possible through the e-AEO portal as the G2B system an integral part. With the further partnership development, part of the updating data responsibility is evenly transferred from customs officer to the entrepreneur (Mazzi, 2019).

4. Centralised clearance (CC)

The operation guidelines precise presentation, technology used and the EU customs services coordination is given through centralized customs clearance, as can be seen in Figure 7.

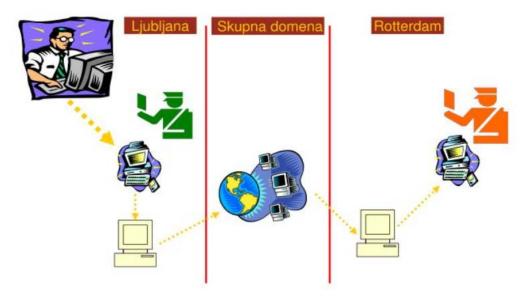


Figure 7 Presentation of the customs offices communication in centralized customs clearance

Centralizirano carinjenje, Retrieved February 02, 2020, from https://www.slideserve.com/maalik/eori-centralizirano-carinjenje

One of the most important innovations made in the new Union Customs Code, which came into force on 1 May 2016, is the centralized customs clearance procedure, namely the possibility of separating the place where the declaration was submitted from the place where the goods were physically submitted (Novi, 2020). This enables, for example: a Munich entrepreneur to file a declaration at the Munich Customs Office for goods that have been submitted for customs clearance at, for example the Split Customs Office. All clearance operations are carried out electronically in the central customs system for customs decisions (Pisačić Krstičević & Galić, 2018), and the customs office to which the declaration is submitted and the customs office to which the goods are submitted exchange all the necessary information regarding the declaration and goods verification (Uputa, 2016). The centralized clearance procedure may be used for import and export procedures, customs warehousing and economic effects under customs custody. It is of great benefit to entrepreneurs who carry out their business activities throughout the Union, as it brings cost savings while maximizing the transport resources and storage infrastructure use (Pisačić Krstičević & Galić, 2018). Centralized authorization significantly changes the business because it enables the centralization and integration of accounting, logistics and distribution functions for economic operators in one place, thus making the customs service a company's important partner (Zocche, 2017).

5. Conclusion

The Customs Administration specific area activity and scope is a functional integrated, centralized, secure and interoperable, available 24 hours a day, information system for efficient implementation of business processes between customs and the economic sector. The e-customs was launched in order to create an efficient and modern customs environment that would allow easier import-export-transit procedures, less administrative costs and saving time during customs clearance and technical assistance and unhindered flow of information between customs and economy. Changes in customs operations have enabled greater efficiency of all international trade participants, and e-customs is the customs service contribution to providing the most favourable business conditions to economic sector.

E-customs foundations are based on the created and continuous development of the G2B system, which enables communication with entrepreneurs'. This allows for entrepreneurs' business activity in the entire territory of the Union trough technology use and EU customs services coordination by centralized clearance. The e-customs ultimate goal is to operate with as many entrepreneurs' who obtained the Authorized Entity or Trusted Partner status, all in the context of their customs-related procedures, thereby gaining the right to certain benefits in customs treatment across the EU.

9. Literature

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Implementing Smart Specialization in the Republic of Moldova: Progress and Next Actions

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Abstract. Research, development and innovation are recognized as key elements of economic growth, efficient use of resources, regional development and societal progress. Smart specialization has become one of the important concepts of economic transformation based on innovation. It is widely supported by EU policies due to its impact. Compared to the European countries with experience in implementing smart specialization strategies (S3), the Republic of Moldova is just at the initial stage in this area. Aiming at integration into the European community, our country is open for a new approach to RDI in order to stimulate economic and social development.

The paper analyses the importance of implementing S3 in the Republic Moldova, the positioning of Moldovan research and innovation in international rankings, the main pillars of the S3 concept, the results obtained in developing the smart specialization strategy in Moldova at the first stages of this process, including mapping of the economic, innovative and scientific potential; identification of the preliminary priority areas for smart specialization with potential for economic development (energy, ICT, agriculture and food processing, biomedicine and biopharmaceuticals), as well as the identification of the main niches of smart specialization for these areas through the first entrepreneurial discovery process (EDP) organized in Moldova. The EDP results (SWOT analysis, vision, development goals) are presented in detail for agriculture and food processing, which are a priority due to the agricultural profile of our country. Also, the actions to be followed for the successful development and implementation of S3 in our country are emphasized.

Key words: smart specialization, entrepreneurial discovery process, innovation, economic development

1. Introduction

Sustainable economic development and sustainable growth are increasingly dependent on the innovation and transformation capability of the economies, including the regional ones, in order to adapt to an ever-changing and increasingly competitive environment. In such conditions, much greater efforts are required to create systems able to stimulate innovation, research and development, as well as the spirit of innovative entrepreneurial development. The European Union has taken many steps to achieve this goal, with particular emphasis on smart specialization (S3). This concept has been embedded and has become a key element of the European Union's Cohesion Policy, being an effective instrument for implementing the European strategy for smart and sustainable growth favorable to inclusion.

Developing and implementing the smart specialization strategy (S3) has become especially important for the Republic of Moldova, in the context of its aspirations for European integration, and because the smart specialization concept supports the reorientation of RDI policies towards those research activities that contribute to economic transformation.

The opportunity to develop such a strategy for our country was mentioned in the Report of the team of foreign experts who evaluated the research and innovation system of the Republic of

Moldova [6]. One of the recommendations of this report calls for better integration of research and innovation policy in the overall economic policy strategy; improvement of the interaction between research and innovation strategies, but also enhancement of priorities through increased stakeholder involvement. At the same time, experts have recommended urgent reviewing of the framework conditions for innovation by implementing a coherent set of measures aimed at creating and stimulating a favorable environment for the involvement of companies in research and innovation activities.

2. Moldovan research and innovation in international rankings

An eloquent argument, in favor of the need to implement the smart specialization concept in our country, is the position of the Republic of Moldova in international rankings. In conformity with the data of the World Intellectual Property Organization, according to the Global Innovation Index [10], our country ranked 48th among 126 countries monitored in 2018. At the same time, according to other studies, to the Global Competitiveness Report [9], the Republic of Moldova ranked 88 among 140 countries in the world ranking 2018, according to the Global Competitiveness Index. In recent years, our country has been classified as an economy based on the exploitation of production factors, being at the first stage of development of an economy based on innovation. In 2018, according to the World Bank data [12], in the ranking of countries according to their innovation capacity, Moldova positioned on the last place and ranked last in Central and Eastern Europe.

Some more detailed information on the indicators making up the competitiveness index of the Republic of Moldova, according to the Global Competitiveness Report 2018, is presented in (Table 1).

Table 1 Ranking of main Moldovan competitiveness indicators [9]

Indicators	Rank/out of 140		
Pillar 1: Institutions	84		
Property rights	116		
Intellectual property protection	102		
Pillar 6: Skills	73		
Ease of finding skilled employees	135		
Pillar 7: Product market	70		
Competition in services	82		
Pillar 10: Market size	126		
Gross domestic product	127		
Pillar 11: Business dynamism	69		
Growth of innovative companies	129		
Companies embracing disruptive ideas	91		
Pillar 12: Innovation capability	105		
State of cluster development	136		
Multi-stakeholder collaboration	117		
International co-inventions, applications/million pop.	79		
Patent applications, applications/million pop.	81		
Quality of research institutions	106		

As can be seen from the table, there is a direct relationship between innovation capability, employees' skills, business dynamism and economic performance (expressed in GDP). Ranking 105th (out of 140 countries included in the ranking) in terms of innovation capability and 129th in terms of growth of innovative companies, the Republic of Moldova ranked 127th according to one of the most relevant macroeconomic indicators - GDP (Gross Domestic Product). In this regard,

actions are needed to stimulate and streamline research and innovation activity and to transform it into a catalyst for economic growth.

3. Analysis of innovation activity of Moldovan enterprises

Since any innovation acquires value when implemented in practice, it is of interest to analyze the innovative activities of Moldovan companies. According to the data of the National Bureau of Statistics for 2017-2018 (The results of the innovation activity of enterprises in the Republic of Moldova, 2019)¹ "the number of innovative enterprises amounted to 605 companies in the republic, which represented 18% of the total number of innovative companies involved in research (decreasing by 10% compared to 2015-2016). Out of the total number of innovative companies, 40.3% of them accomplished several types of innovations simultaneously (product, process, method of organization and marketing), 19.7% of them obtained product and/or process innovations, and 40% of companies performed innovations in the field of methods of organization and/or marketing (Table 2).

Table 2 The structure of innovative enterprises by types of activity, 2017-2018

percent

		of which:		
	Innovative companies - total	Companies that have accomplished several types of innovations	Product and/or process innovative companies	Organizationa l and/or marketing innovative companies
Total	100.0	40.3	19.7	40.0
Industry - total	52.4	23.1	11.9	17.4
Mining industry	1.0	0.2	0.7	0.2
Manufacturing industry	48.1	22.3	9.4	16.4
Production and supply of electricity and heat, gas, hot water and air conditioning	1.2	0.3	0.7	0.2
Water distribution; sanitation, waste management, decontamination activities	2.1	0.3	1.2	0.7
Services - total	47.6	17.2	7.8	22.6
Wholesale	22.3	8.9	2.3	11.1
Transport and storage	10.6	2.5	3.1	5.0
Information and communication	8.4	3.8	1.2	3.5
Financial and insurance activities	2.5	0.7	0.3	1.5
Professional, scientific and technical activities	3.8	1.3	0.8	1.7

Of the total number of innovative companies, 52.4% were active in the field of industry (48% of which in the manufacturing industry), and 47.6% were active in services (22% of which in wholesale, 11% in transport and storage, and 8% in information and communications).

In 2017-2018, in the framework of cooperation activity on product and process innovation, 29% of the innovative companies mentioned suppliers of equipment, materials, components or software as cooperation partners, 21% - other companies, 24% - customers or buyers, and 6% - universities and research institutions [11]. This situation denotes a weak collaboration

¹ The analysis of the innovation activity of companies was included in the official national statistics for the first time in 2018.

between the academic environment (universities, research institutes) and the business environment, as well as a decrease in the effectiveness of research conducted by educational and research institutions (Figure 1).

Analysis of the structure of innovative enterprises by the size of companies shows that the dominant share (62.5%) belongs to enterprises with a small number of employees (10-49 persons). This fact confirms that small enterprises are more flexible and more responsive to innovations.

At the same time, analysis of the activity of product and process innovation by the development mode (Figure 2) shows that most companies innovate products (66%) and processes (51%) independently, and on the basis of cooperation with other companies - respectively 16% and 21%.

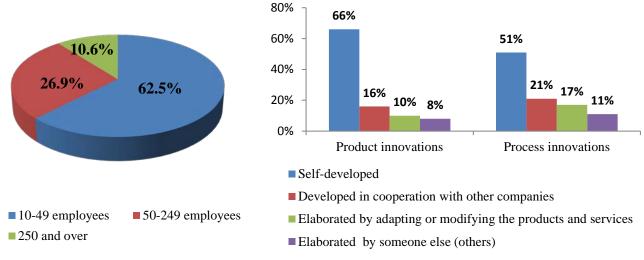


Figure 1 Structure of innovative companies by size, in 2017-2018

Figure 2 Product and process innovations by development mode, in 2017-2018

As for the costs of innovation, 22.4% of expenses in 2017-2018 belonged to those related to research and development with their own forces, 65.3% represented purchases of machinery, equipment, software, 2.6% - acquisition of research and development results from other companies, 1.0% - acquisition of external knowledge, and 8.8% - other innovative activities.

From the foregoing, we can conclude that the development level of R&D and the performance of the sector have a direct impact on economic growth. Countries investing in research, innovation and development and pursuing consistent policies in this area have recorded significant economic and social changes, and progress in the development of the entire ecosystem. If we report on investments in R&D, the innovations registered in the economic development, then this relationship is obvious.

According to policy documents, the target objective of the Republic of Moldova was to achieve 1% of GDP allocated to research and development; in fact this indicator has varied around 0.3% in recent years, while in some countries it attested major values (Austria – 3.16%, Germany – 3.02%, Finland – 2.76%, Poland – 1.03%, Lithuania – 0.88%, Bulgaria – 0.75%, Romania – 0.5% of GDP, the average in the EU member states was 2.07% of GDP in 2017 [8]. At the same time, according to the World Bank data, GDP per capita amounted to 3189 USD in the Republic of Moldova in 2018, this index being almost four times lower than in Romania (12301 USD per capita), 4.8 times lower than in Poland, 6 times smaller than in Lithuania, and 15.7 times lower than in Finland. The average for the countries of the European Union was 36531.7 USD per capita in 2018.

3. Status of the implementation of Smart Specialization Concept in Moldova

Since 2016, a series of actions has been launched and carried out in the Republic of Moldova to raise public awareness of the concept and importance of smart specialization, the impact of smart specialization strategies on the economic growth and efficient use of resources, as well as on regional development.

The first step in developing the smart specialization strategy is the analysis of the national/regional context and potential for innovation [3]. In this regard, with the support of the international experts of the EU Joint Research Center and the local expert group (part of which is the author of the present paper), the mapping and identification of the regional potential of the Republic of Moldova (economic, research and innovation) was carried out in order to identify the strengths and potential for business innovation and research for the purpose of identification of smart specialization priorities. The results were published by JRC in the work "Mapping for Smart Specialization in Transition Countries: Moldova [5].

Following these studies, subsequently, SIRIS Academic (consulting company designing and implementing strategy and policy solutions for higher education, research and innovation), with the support of the Joint Research Center, has carried out the characteristic of the preliminary priority areas for smart specialization in Moldova, the report being published in the reference source [1]. The experts structured the priorities in terms of their importance (top, intermediate, slightly significant) and depending on their orientation (scientifically or technologically oriented or balanced) and identified among the main specific (thematic) areas at the level of the preliminary priorities the following: Agriculture and food processing; ICT; Energy; Health, biomedicine and pharmaceuticals; Chemical industries, materials and nanotechnology; Production technology and heavy machinery; Electrical and electronic technologies; Environmental industries, services and sciences.

The next step in developing a smart development strategy is the *process of entrepreneurial discovery (EDP)*, the purpose of which is to identify the niches of smart specialization, specific to each region. This is a very important exercise for our country towards transition from fragmented priorities and objectives to the priorities of economic transformation, based on the efficient use of the innovation potential and investments.

EDP is considered to be the defining element of smart specialization and represents an inclusive, interactive, bottom-up process, in which stakeholders of the Quadriple Helix participate (business, academia and HEIs, authorities, civil society). Once established, the structures and methods of the entrepreneurial discovery process can contribute to shape any type of policy in a country or region.

Recognizing the importance of EDP, the Ministry of Education, Culture and Research (which, after structural reforms in the field of research in the Republic of Moldova in recent years, has been vested with the powers and responsibilities in the field of research policy) has taken over the coordination of actions in implementing the concept of smart specialization. In 2018, a national team was set up (the author of the present paper is one of its members) to promote the concept of smart specialization in our country and to conduct EDP exercises.

Following the actions taken in the context of the development of S3 in the Republic of Moldova (mapping of the economic, innovation and scientific potential, identification of the preliminary priorities for smart specialization), in June 2019, under the auspices of the Ministry of Education, Culture and Research, with the support of JRC and the Information Society Development Institute of Moldova, the first four workshops on entrepreneurial discovery were organized at national level [4], in the first four areas highlighted by experts: *energy, information and communication technology, agriculture and food processing, biomedicine and biopharmaceuticals* (the author of this paper was trained as facilitator in two workshops). The workshops helped to identify and validate the sub-areas with potential for smart specialization (Table 3).

Table 3 Potential areas of smart specialization in the Republic of Moldova identified within EDP

Areas	Potential areas of smart specialization			
Energy	 Energy efficient technologies 			
	 Alternative energy sources 			
	Heating solutions			
ICT	 Micro/nanomaterials and electronic engineering 			
	Interoperability, open data and e-Infrastructures			
	Software engineering, Mobile apps, cloud computing			
Agriculture and food	 Advanced biotechnologies for agriculture 			
processing	 Sustainable agriculture 			
	Value-added food products			
Biomedicine&	Biomedicine			
Biopharmaceuticals	Biopharmaceuticals			
_	 Bioinformatics&ehealth 			

Source: EDP results, Ministry of Education, Culture and Research [7]

The workshops involved all stakeholders according to Quadruple Helix (representatives of public authorities, universities, research institutes, private sector and civil society). These workshops were attended by 189 people, including *energy* - 41, ITC - 44, *agriculture and food processing* - 56, *biomedicine and biopharmaceuticals* - 48 people.

The first EDP workshops focused on 2 aspects:

- performing SWOT analysis of the identified sub-areas and the priority area as a whole,
- developing visions for the identified sub-areas and then a common vision for the future of the ICT priority area as a whole.

The agri-food sector is a priority for all the regions of Moldova and it also has been identified by the Investment Agency of the Republic of Moldova as one of the main economic sectors contributing to the economic development of Moldova.

Further, we will refer to EDP actions and results in agriculture and food processing [2].

In the framework of *agriculture and food processing* EDP the participants provided the SWOT analysis of the agri-food sector. The results are presented in Table 4.

Table 4 SWOT analysis of the agri-food sector of Moldova

Strengths	Weaknesses
• Scientific capabilities – specialized	Weak connection between research,
fundamental and applied research	production and state authorities;
institutes;	Exaggerated dependence on non-renewable
• Rich soils and favorable weather	and imported energy sources;
conditions;	Dispersed activity of system elements,
• Vast and diverse genetic pool of	fragmentation between production and
agricultural crops and breeding animals;	processing, poor orientation towards the
 Experience and traditions in growing 	technological process of high added value
crops and raising animals;	products in the value chain;
Integrated plant and animal protection	Excessive fragmentation of agricultural
system;	land;
• A significant private sector in the field;	Soil degradation due to incorrect
• Innovative potential, indigenous raw	management;
materials and agricultural products	Lack of motivation policies for highly
processing infrastructure.	qualified staff;

	 Lack of internationally accredited laboratories for soil quality, seed and products certification; Low innovation absorption capacity of companies; Lack of testing units for functional products developed in industrial quantities; Developed functional products are not capitalized by the private sector; Poor funding (lack of state investment) and insufficiency of modern equipment.
Weaknesses	Threats
• Opportunities brought by the Deep and Comprehensive Free Trade Agreement	Brain drain and aging of the labor force;Unfair competition, uncontrolled import,
within the EU Association Agreement;	monopolization;
Collaboration among countries /	Social-economic instability, danger of
international collaborative partnerships,	embargoes;
regional and international investment	• Limited and expensive energy sources;
funds;	• Decrease of drinking water volume;
Open access to international markets;	Natural hazards.
Advanced degree of mobility and	
openness of science;	
High demand for organic products;	
Appropriate policies in the field of	
product processing and export.	

Among the main *objectives* to achieve this vision the following were identified:

- establishing an efficient communication platform between research and business, creating clusters of research, implementation and production stakeholders;
- adopting the concept of intensive agriculture based on a completely closed cycle of energy and nutrients (rational crop rotations, conservative soil cultivation systems, rational soil fertilizer systems, etc.);
- increasing the share of land on which precise and ecological agriculture is carried out and increasing the share of organic production up to 5-10%;
- stimulating agricultural producers through monitoring of ecosystem services provided by farmers;
- use of virus-free / certified seeds and seedlings;
- capitalizing on innovative potential and technological endowment;
- improving the legislation in this area and the tools for its implementation;

 Table 5 Main development factors per sub-areas

Agricultural biotechnologies and horticulture	Field crops	Animal husbandry and veterinary medicine	Food processing
• Scientific capabilities – specialized fundamental research institutes	 Rich soils Human scientific potential Insufficient highly 	 Favorable conditions for animal breeding Available genetic pool (breeding animals) Innovative potential for animal breeding and 	 Domestic raw materials Migration of the labor force Lack of testing units for products in

- Diagnosis of harmful organisms (integrated plant protection)
- Poor funding (lack of state investment)
- Insufficiency of modern equipment
- Collaborative relations among countries / international collaborative partnerships
- Regional and international investment funds
- Unfair competition, uncontrolled import, monopolization
- Social-economic instability

- qualified staff (lack of motivation)
- Promoting a sustainable and resilient organic agricultural system
- Diminishing human scientific potential
- Limited and expensive energy sources

- production processing
- Lack of internationally accredited laboratories for product certification
- Deficient system / underdeveloped organization of the zootechnical sector (lack of breeding segment, etc.) / System fragmentation
- Insufficiency of qualified specialists (qualified staff)
- Low innovation absorption capacity of companies
- Opportunities brought by the Deep and Comprehensive Free Trade Agreement within the EU Association Agreement
- Appropriate policies in the field of product processing and export
- Migration of labor force / promoting the migration of labor force
- Natural hazards
- Internal and external unfair competition

- industrial quantities
- Developed functional products are not capitalized by the private sector
- Scientific potential
- Aging workforce
- Open access to international markets
- Poor orientation towards the technological process of high added value products in the value chain
- State and international programs (donors) for funding and subsidizing producers
- High demand for organic products
- Application of IT for product processing
- Decrease of drinking water volume
- Natural hazards
- training and development of qualified staff, introduction of continuing education programs for professionals;
- implementing advanced and/or intensive (complex flow) technologies for the processing of organic raw materials;
- providing stable niches on international markets for processed food;
- implementing innovations in the processing technological flow;
- establishing testing units for new technologies and product quality in industrial quantities;
- certifying the conformity of agricultural production with national and European standards, creating internationally accredited laboratories for certification of products;
- funding and implementation of partnership projects;
- supporting small and medium-sized enterprises.

The discussions in the framework of the first EDP workshop confirmed the importance of the agri-food sector as a priority area of the Smart Specialization Strategy of the Republic of Moldova. The participants of the workshop emphasized the importance of such exercises not only for the identification of the vision and objectives based on innovative potential in the field, but also for establishing a communication and cooperation platform between different stakeholders.

At the same time, this EDP exercise identified some shortcomings, such as the lack of a database of the most relevant representatives of the agri-food sector, the low interest of the stakeholders in participating in the EDP, extremely limited knowledge about the concept of smart specialization and its advantages, and the predominance of the traditional approach to research and innovation activity, focused mainly on sectoral research to the detriment of joint research.

The process of entrepreneurial discovery will continue. It is necessary to involve actors related to relevant fields (through participation in EDR or their questioning), who can contribute with their knowledge, vision and experience to identify the most promising areas of smart specialization. Therefore, the next stages of the EDP should include intersectoral workshops (involving representatives of other priority areas identified during the mapping process). As part of the agri-food workshop it was found that this area has close ties with the ICT sector and biomedicine. In this regard, niches of cross-sectoral smart specialization could be identified.

The results of the entrepreneurial discovery process play a decisive role in the design of smart specialization strategy, as it allows verifying and identifying priority areas of smart specialization based on the consensus among all stakeholders.

The next stage of implementation of the S3 concept in Moldova will focus on the *policy mix*, the development of smart specialization strategy (at national or regional level), the providing of sectoral and regional policies with S3 priorities, the selection of an appropriate set of tools to achieve the set objectives. Thus, the development/updating of the national research and innovation policies should ensure the synchronization with the country's national development program, with the sectoral strategies and the EU framework programs for research and innovation.

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Application of Digital Marketing Tools in the Music Industry

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Abstract. This article seeks to answer the question what kind of digital marketing tools are available today to musicians, producers, record labels and consumers. Which of the digital marketing tools should be used and for what purpose. A review of relevant literature and current research on the topic is given. Exploratory, qualitative research based on five consumer focus groups was conducted. The goal was to find out how consumers listen to music today and what kind of digital marketing tools they use for that purpose. Results of the study implicate that consumers use different digital tools, but the most popular ones are YouTube and Instagram. They use YouTube to access musical content, mostly for free, and they use Instagram to follow their favourite musicians and bands. They use mobile phones and USB stick to store the music as they listen to music on the go.

Key words: digital marketing, music industry, streaming platforms, social media

1. Introduction

The music industry has undergone a huge change with the arrival of new technologies. The dematerialization of music happened almost overnight. CD era was replaced by digital era and new players appeared on the scene. Not only digitalization happened, but consumer's habits have changed too. The way people listen to music is not the same. Especially new generations, they consume music on the go, while they drive, run, walk or travel. Many predicted the collapse of the music industry we once knew. And it really did collapse because it was no longer the same. But it did not disappear, it survived. Like any change in evolution, you have to adopt in order to survive, so did the music industry.

Revenues as a result of digitalization are in constant growth all around the world. "Continued strong growth to more than 60 million paid subscriptions drove the U.S. music industry to its fourth consecutive year of double digit growth. Total 2019 revenues of \$11.1 billion were up 13% versus \$9.8 billion the prior year. Streaming made up nearly 80% of total revenues as the music industry has transformed to a digital-first business."

"Revenues for authors of music, from digital sources, in Europe have jumped as much as 29% to €1.6 billion, thanks to the accelerating global expansion of music services as well as video-on-demand (SVOD) subscription services. In the last 5 years, digital revenue for authors has almost tripled, accounting for 17% of total fees, compared to 7.5% in 2014."²

¹ Revenue report from RIAA (Recording Industry Association of America, Retrived March 25, 2020, from https://www.riaa.com/reports/riaa-releases-2019-year-end-music-industry-revenue-report/

² Web page of ZAMP, Retrived March 25, 2020, from https://www.zamp.hr/clanak/pregled/2202/naknade-od-autorskih-prava-u-svijetu-2018-dosegle-rekordnih-97-milijardi

In this article we try to answer the question what kind of digital marketing tools are available today to musicians, producers, record labels and consumers. Which of the digital marketing tools are most often used and for what purpose. Through empirical research we try to find out how consumers listen to music today and which streaming platforms and social media they most frequently use. Academic research literature concerning digital marketing tools in music industry is very poor, so with this article we try to contribute to the existing literature and give valuable insights for the management in the music industry.

2. Digital marketing tools applied in music industry

2.1. Literature review

Digital disruption and movement toward digital technologies and the emergence of the Internet with its capacity to support file sharing dramatically changed the ways in which users engage with music. The digital innovations of the 21st Century have shaped not only how record labels sell their artists, but also how fans experience these artists. So record labels have had to change their strategies in order to engage audiences in a streaming and social media-dominated industry. Web 2.0, opened a whole new perspective for music fans who are now able to create and share their own content resulting in less influence by music companies (Daniel, 2019).

There are not so many scientific or professional papers regarding different digital marketing tools in the music industry. Most of them analyze the use of social media marketing tools in the music industry. For example, Brown et al. (2019) in their research investigated the nature, purpose and degree of social media tweets and posts on Twitter and Facebook before, during and after four music festivals. O'Donoghues (2019) found that fans are searching for two things from their favorite artists, engagement and experience. Holt (2011) investigates the role of video and his importance in music industry. Salo et al. (2013) in their research address the question of why consumers use social media especially in relation to music consumption and how music industry companies could improve their social media efforts.

Negus (2018) examines how musicians have found themselves redefined as content providers rather than creative producers and writes about historical change from recorded music as product to content. Daniel (2019, 160) in his article analyses the impact of the CD as a cultural artefact, and its representation as "one of the major contributors to the current period of digital disruption in music and society, as well as consider its position as potentially the last physical music album artefact to enter the market." Salo (2019) in his thesis gives detail introspective on how independent musicians can sell and promote their music through digital platforms.

2.2. Conceptual framework

In this article we use term digital marketing tools in music industry for all digital platforms that use Internet and are used to distribute, stream or promote music. Digital distribution platforms are intermediaries between artists and streaming platforms and deal with contracts, licencing rights, copyrights and etc. Digital streaming platforms share music online free and/or with a monthly payment fees. Digital promotional platforms are social networks and other internet platforms that are used for promotional purposes. Each of them will be explained in more detail in the sections below.

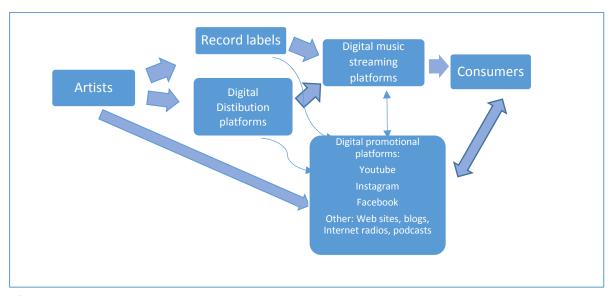


Figure 1 Conceptual framework

Source: author

2.3. Digital music distribution platforms

Traditional way of distributing music is to use the service of record labels and all marketing machinery behind. But if you are new, unknown artist it is very small chance that you will sign up a contract with some major record label company. You can still distribute your music using digital distribution platforms that will connect you to major streaming platforms and also do different analytics, marketing, bookkeeping, and other additional services for you. Most of them offer cover song licensing, but with different pricing and renewability options (Salo, 2019). In the table below are listed some of the most popular music distribution platforms like CDBaby, Distrokid, Soundrop and TuneCore.

Table 1 Digital music distribution platforms

Music distribution platform	Founded in	Reach	Tools available
CDBaby	1998	150+digital distribution partners incl. Spotify, Deezer and iTunes.	Cover song licensing, songwriter splits, physical formats and merch etc.
Distrokid	2013	150+ digital distribution partners incl. Spotify, Deezer and iTunes.	Cover song licensing, col-laborator splits, unlimited backups, embedded lyrics, artist page services etc.
Soundrop	2011	Spotify, Deezer, iTunes, Apple Music, Amazon Mu-sic, Google Play, YouTube Music and Pandora.	Cover song licensing, col-laborator splits, monthly income statements (PDF) etc.
TuneCore	2005	150+ digital distribution partners incl. Spotify, Deezer and iTunes.	Cover song licensing, songwriter splits, physical formats etc.

Source: Salo (2019, p 23)

2.4. Digital music streaming platforms

Streaming platforms are used by consumers as a tool for searching, streaming and/or downloading desired music. Instead of buying a CD, consumers go on Internet and search for the music. Most popular streaming platforms are Youtube Music, Spotify, Deezer, Google Play Music and Apple Music. All of them offer free limited streaming service with ads and if you want to download songs for listening offline, and without ads, you have to pay monthly fee of around 10 \$. Some of them offer additional services like music videos, podcasts and radio

options and these are the main differences between them. Most of them are available on all devices (smartphones, tablets, desktop computers, laptops) and are compatible with Android and iOS operating systems. However, YouTube Music Premium charges extra for downloads through the iOS App Store because of a surcharge from Apple. They all offer family accounts, and student accounts at discount prices. You can create your own playlists from the millions of songs offered to suit your specific musical preferences. ³

Streaming platforms that are often used and have the largest number of subscribers are YouTube Music, Spotify and Apple Music. Although they all share some similarities there are certain features that differentiate each service from one another.



Figure 2 Music streaming platforms

Source: made by author (Retrived March 21, 2020, from https://www.deezer.com/en/offers; https://www.spotify.com/us/; https://www.deezer.com/en/offers; https://www.deezer.com/en/offers; https://www.deezer.com/en/offers; https://www.apole.com/music/; https://www.apple.com/apple-music/)

³ Apple Music web page, Retrived March 21, 2020, from https://www.apple.com/apple-music/
Deezer web page, Retrived March 21, 2020, from https://www.deezer.com/en/offers
Google Play Music web page, Retrived March 21, 2020, from https://play.google.com/music/
Spotify web page, Retrived March 21, 2020, from https://www.spotify.com/us/
YouTube Music web page, Retrived March 21, 2020, from https://www.spotify.com/us/

YouTube Music offers all kinds of material from artistes such as live performances, remixes, covers, music videos and even user-uploaded content. So, if you enjoy watching videos of your favorite artists YouTube Music is good solution. The best part about YouTube Music is that there is no limit to the amount of music and video data you can download.

Spotify invests heavily in user-generated content and podcasts that cannot be found on other platforms, so you are having access to exclusive material. Spotify is also known for its algorithms that recommends daily, weekly or thematic playlists based on your listening habits and the region you're from. Spotify also features a social element in its app so you can share your music with your friends. You can see what your friends are listening to and share songs with them or on your Instagram stories. The cons to using Spotify is its offline download limit. Compared to Apple Music and YouTube Music, offline downloads on Spotify are limited to 10,000 songs per device at up to 5 devices. That means you're able to download only up to 50,000 songs over 5 devices. YouTube Music has unlimited downloads and Apple Music allows you to download 100,000 songs. The advantage to using Apple products with Apple Music would be their seamless functionality and inside their unique ecosystem. Apple Music is also compatible with Sonos smart speakers. You can stream radio stations live through the app feature that both YouTube Music and Spotify do not have.⁴

2.5. Digital music promotional platforms

Salo et al. (2019) in their study identified common motives for using social media in the music industry: a *sense of affinity, reinforcement of social identity* of both the individual and group, *participation* in the form of user-generated content, *two-way interaction* between the members of the group and *access to content* which is an extremely important consumer motive for using social media in the music business.

Most popular digital platforms for promoting music online like Facebook, YouTube, Instagram, Twitter and others are listed and explained in more detail in the table below.

Table 2 Digital music promotional platforms

Social media platform	Founded in	Active users per month January 2019 (in millions)	Marketing tools available	Purpose	
Facebook	2004	2 271	Targeted ad post campaigns video ads	Joining artist fan pages, posting comments and questions to community, participating events (Salo et al. 2013.)	
Instagram	2010	1 000	Targeted ad post campaignsvideo ads	Searching information about artist personal life, news about new releases, new videos, concerts, fan pages, current stories and IGTV	
Twitter	2006	326	Promoted tweetsaccountstrends	Vocational information source, reading tweets of registered friends, WOM (Word of mouth). Not so popular outside USA and UK. (adopted from Salo et al., 2013.)	
YouTube	2005	1 900	Targeted video adscontent clips	Viewing content (music videos, live performances, artists' backstage material, playing songs), searching content not found elsewhere, downloading content, creating playlists, browsing recommendations, sharing links. (Salo et al. 2013.)	

⁴ Dollars and Sense, Retrieved March 12, 2020, from https://dollarsandsense.sg/youtube-music-premium-vs-spotify-premium-vs-apple-music-sporeans-choose-music-subscription-needs/

Others (web pages, blogs and forums, Internet radio stations, podcasts)		 Web (PPC/Display advertising) Guest blogging/influencer s Shows 	Searching artist information, buying tickets, reading news, downloading music, viewing friends' playlists, listening to music, showsetc.
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Source: author (from www.YouTube.com, www.Instagram.com, www.Twitter.com, www.Facebook.com, Retrieved March 21, 2020, and Salo et al. (2013))

Other platforms such as Google Plus, Myspace and WeChat have had great active user numbers but have other problems that exclude them from being sufficient marketing platforms for an independent musician to target the general music consuming public (Salo, 2019). Musicians also need to be careful in choosing the right social media to promote their music, because spreading out on too many platforms can seriously reduce one's ability to conduct effective marketing campaigns.

Brown et al. (2019), in their study of music festivals, found that Twitter was used most for promotional and organizational purposes prior to the festival, but once the festival had started photographs and videos were dominant, indicating that the Facebook, Instagram and YouTube platforms then became integral to actual experiences and activities. They suggest that the 'development of links together with hashtags reflect the forming of the festival community Social media and chat forums were the main platforms for creating relationships and communicating with others about the festival and was suggested to influence participants' social identity'. But in the end they also emphasize that although social media have improved the artist-to-fan relationship, it is not necessarily substitute for the music experience. Music fans, they conclude, 'yearn for physical experiences on festivals and concerts of their favorite artists that create lasting memories' Brown et al. (2019, p 23).

YouTube has, in very short period, become pivotal for streaming and downloading songs and images, for identifying audiences and for building a 'fan base' (Wasko & Erickson, 2009, in Holt, 2011). The distribution, presentation and communication about music have become more visual, and video is playing an important role in creating more audiovisual communication (Holt, 2011). He argues that video is not only a promotional tool but also a powerful medium for sharing social sentiments and styles of visual and bodily expression that are closely linked with music.

In the middle of 2017 by YouTube's parent company Google together with RBB Economics did a research about *Value of YouTube to the music industry*. They used online surveys with 1,500 listeners, tracked 5,000 songs in 4 European countries over 3 years and analyzed data on YouTube streams. The findings were very positive about YouTube and stated that it allowed a diversity of music to reach listeners, mostly by older and by less well known artists, it also helped listeners discover new artists. As a promotional medium YouTube increased streams and downloads on other paid services and contributed to longer 'song life cycles'. Ultimately, RBB reported that YouTube 'provides substantial direct revenues to the music industry, amounting to 1 billion \$ in 2016' (RBB, 2017, Paper 5, p17, in Negus, 2019, p16).

But there is also another side of the story where musicians, publishers and labels complained that they should be receiving greater financial payments in addition to promotion and publicity on platforms like Youtube and Spotify. Such platforms are generating income from the advertising that intervenes in the content. 'Musician's worth and hence their income will come from how they attract advertising. This is a stark contrast to the musician's and the recording industry's assumptions about music being measured according to sales and rights that recognize the individual creations of musicians.,' (Negus, 2019, p14)

Consumer's most often prefer playlists of music defined by genre and activity (walking, workout, chill, party, road trips) rather than specific album of performers or bands. Most of the

social media users are casual listener's which are usually distracted by skipping commercials and navigating through different content placed on Internet where music is often decontextualized and irrelevant. For the digital conglomerates music is 'content' that attracts subscriptions and 'traffic' and is used as customer engagement tool. So we can see the evident contrast between the social media's definition of music as content and the musician-as-artist's belief in their music as a means of expression and a point of public identification (Negus, 2019).

3. Methodology

In our empirical research we used exploratory, qualitative research method. The main objective of the empirical research was to find out how consumers listen to music today and what kind of digital marketing tools they use for that purpose. Five student focus groups were administered in January 2020. Focus groups consisted of mostly postgraduate students of University of Professional Studies in Split, Croatia. The detailed structure of the focus groups is given in the table below. The goal was to find out how consumers listen to music today and what kind of digital marketing tools they use for that purpose. Final sample consisted of 34 respondents aged from 21 to 30.

Table 3 Structure of the focus groups

	1. focus group	2. focus group	3. focus group	4. focus group	5. focus group
Duration	40 min.	50 min.	45 min.	45 min.	35 min.
Number of participants	6	6	7	7	8
Year of study	1 st postgraduate	1 st postgraduate	1 st postgraduate	1 st postgraduate	2 nd year
Age range	21 - 29	21 - 27	22 - 28	21 -30	20 - 27
Employed / Unemployed	5 / 1	4/2	3 / 4	3/4	4 / 4

Source: author

4. Results of empirical study

All respondents listen to local and foreign music, with domestic music prevailing. Most of the respondents usually listen to music in cars when traveling to work, in public areas such as coffee bars and while getting ready for a night out. None of the respondents use CDs or LPs for listening to music, and the last CD they bought six years ago. They use mobile phones for listening to music. Most of the respondents don't buy music online because they consider it expensive, and it is available free of charge via the pirate Internet services so they think they don't need to pay for it. Only some of them (4 respondents) listen and buy music on line using online streaming services, mostly Youtube music, Spotify or Deezer. Some of them are willing to pay smaller amounts of money (maximum 50 kunas for album) for legal downloads of their favourite albums. More than half of the respondents store music content on a mobile device, sometimes connecting to radios, while half of the respondents store it on the usb memory they use on a radio device in cars. All respondents use Facebook and Instagram social networks, but mostly follow the Instagram social network when following famous musicians and bands. Also, more than half of respondents use Facebook groups as a source of information for attending a concert.

Thus we can say that every respondent use social networks when informing about music content, in which they search and try music using the Internet service mostly Youtube, while in the acquisition of music content they use pirated services like Youtube converter or Mp3 downloads. When monitoring musicians and bands, the respondents mostly use the Instagram social network. Some of them also use Instagram TV (IGTV) and Googl Play Music for listening to their favourite bands. Accordingly, social groups play an essential role in presenting

and promoting music content, musicians and bands, and significantly influence the selection of musical events to attend in the observed population.

The results of the research must be taken with caution because of the small sample size of the respondents, mostly students of the Department of Professional Studies. These conclusions therefore cannot be generalized. However, they can still serve as a basis for future research on these topics. It would be especially interesting to conduct quantitative research on a larger sample of respondents to identify differences in the way of listening to music between different age groups. In addition, it would be also interesting to explore the views and experiences of Croatian musicians on the use of digital technologies in the music industry.

5. Conclusion

The development of Internet technology has made it possible to use various digital marketing tools for both well-known and lesser-known musicians who have been given the opportunity to gain access to a wider audience without spending a fortune on promotional and distributional activities. Consumers gain access to information and music they wanted, they are also participating in the form of user-generated content and two-way interaction between the members of the group, sharing, posting and commenting. They are much closer to their favorite musicians and bands than ever before while watching their personal photos on Instagram their daily stories, touring videos and concerts.

The main objective of the empirical study was to find out how consumers listen to music today and what kind of digital marketing tools they use for that purpose. Through our literature review and empirical research we found out that YouTube is the most popular digital platform for streaming and downloading music among students. Instagram is also widely used in finding information about musicians and sharing photos, videos and comments. Facebook is no longer popular as it used to be, especially among young audience, and is usually used for updates about upcoming events and WOM group sharing information. Most of the respondents download music for free using pirate services or free apps and then store music on their mobile devices or USB sticks so that they can listen to music while driving, running, preparing for a night out or traveling. Some of them are willing to pay for their favorite album or create their own playlists, more as a one-time payment and less as a monthly fee. Most of them are casual listeners who don't identify with the music/band they listen, rather they see music as a content which is more of a background noise for their daily activities and web scrolling daily routines. Therefore, we ask ourselves what about artistic value of recording music today, what about music as a means of expression and a point of public identification. And what are we going to leave to our children as musical legacy LP, CD, playlist or just a link?

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Social Media as a Channel for Boosting Female Entrepreneurship in Retailing

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Abstract. The level of female participation among Croatian entrepreneurs has been growing steadily. The highest percentage of female-owned companies is evident in the retailing and service industry. Although there are many support systems available for Croatian women to start businesses today, they are still lagging behind their male colleagues. This paper focuses on social media as the fastest-growing global cultural phenomenon in strengthening the participation of women in business as entrepreneurs. Within the context of entrepreneurship among women, this article addresses the main characteristics of female entrepreneurship, such as motivations, personal characteristics, problems, expectations, etc. Moreover, social media as an innovative way of how entrepreneurs carry out their day-to-day activities is discussed. As the main goal of this paper is to answer the research question (RQ): How social media supports female entrepreneurship activities in Croatia, a two-phase research study was conducted. The research methodology consists of a qualitative and quantitative approach. The qualitative approach consists of four face-to-face interviews, where successful Croatian female entrepreneurs explain the positive aspects of their business, obstacles that they were faced with, as well as the benefits they have had using innovations in retailing (especially social networks, innovations, etc.). The quantitative approach includes a study of a sample of 62 female entrepreneurs – owners of companies operating in retailing. The results point out that social media has been recognized by female entrepreneurs as the best channel to market their products/services as well as to interact and network.

Keywords: social media, women, female, entrepreneurship, retailing

1. Introduction

The topic of women in entrepreneurship has been largely neglected even though for many years the Croatian female population has been recognised as an important part of Croatian economic development. A possible explanation for this situation lies in the existence of the so-called glass ceiling in Croatia, the concept that was first introduced in 1984, in the column *Corporate Women* in the *Wall Street Journal*. It is a metaphor for an impenetrable and invisible barrier preventing women from moving beyond middle management into senior management executive positions (Park, 2012).

According to the Mastercard Index of Women Entrepreneurs (2019), high rates of women business ownership (WBO) ranging between 30% to 35% are found in North America (United States, 35.1%) and Asia Pacific (New Zealand, 31.8%). WBO rates are also quite high across most European markets such as: Portugal (30.2%), Spain (29.9%) and Hungary (28.4%). According to the same source, women business ownership of between 20-25% is present in Latin America (Colombia and Costa Rica), MiddleEast&Africa (South Africa), Asia Pacific (Indonesia and Thailand), and Europe (Denmark, Ireland, and Czech Republic). Finally, economies with very low WBO rates (between 10 to 20%) are Saudi Arabia (WBO 1.6%),

Egypt (4.1%), Bangladesh (4.4%), due to poor progress in women's advancement as business leaders and professionals, lack of access to financial services and products, and lower quality of governance. In Croatia, women make up over half of Croatia's population yet represent less than a quarter of its entrepreneurs (FINA, 2019). The figures show women own and operate about 21.9 percent of the 112,084 enterprises in Croatia, compared to the 51.4 percent owned by men.

The majority (56 percent) of female entrepreneurs have set up shop within the service industry. The rest are mostly concentrated in the education, health and welfare sectors. However, we have to point out the high percentage of female entrepreneurs who generated the highest level of revenue (11.5 bil. EUR) in the trade sector (Berndt, 2018).

There has been a significant amount of research interest in the topics of various aspects of women's entrepreneurship (e.g. Brodman and Berazneva, 2007; Carrington, 2006; Grundey and Sarvutytė, 2007; Manolova, Brush, and Edelman, 2008; Madill, Riding, and Haines, 2006; Ramadani, Gërguri, Dana, and Tašaminova, 2013; Tominc and Rebernik, 2004). They have helped to shed some light on women as entrepreneurs: their motivations, personal characteristics, problems, expectations, types of firms owned by women, etc. Gulevičiūtė and Baubonienė (2015, p. 133) found motivations of women in developed countries differ to those of women in developing countries. Women start businesses in developed countries, women start businesses due to necessity.

Many authors note that the glass ceiling is still evident in various industries worldwide as women have to put more effort into building their careers and proving their expertise and knowledge compared to men. There is a very interesting statement (Campbell, 2002) that powerful women have one more barrier on top which is related to their successful position, on the one hand, and the traditional male hierarchical structure (through informal meetings that men have outside of the office) on the other hand. Thus, today's networks are becoming more virtual, providing business based on innovative concepts such as sharing, collaboration and co-creation opens up new opportunities for female entrepreneurs (Antes and Schuelke, 2011).

Within the context of challenges facing women in entrepreneurship, this article addresses social media as the fastest-growing global cultural phenomenon in strengthening the participation of women in business as entrepreneurs. The main purpose of this article is to find out whether social media presents an effective tool for enhancing female entrepreneur development and to answer the research question (RQ): *How social media supports female entrepreneurship activities in Croatia*.

The paper is organized as follows. After the introduction, a brief description of Croatian women's entrepreneurship and a literature review on social media, as a powerful strategic tool for female entrepreneurship, are given. Then a discussion about the research methodology and results of the two-phase research study (using a qualitative and quantitative approach) are presented. Finally, conclusive remarks including the limitations of the study and directions for future research are highlighted.

2. Women's entrepreneurship in Croatia

The Croatian female population plays an important role in Croatian economic activity, particularly in the sector of small and medium-sized companies. According to the Croatian Bureau of Statistics (2018), women have the largest share (52,2%) in the active working population. Enterprises with female business owners make up 22% of the total number of business entities. Despite the increasing engagement of women in entrepreneurial activities within the last decade and the National program of promoting gender equality, statistical reports indicate the existence of discrimination against women in Croatian society. For example,

average female wages and opportunities for career development are mostly lower than men's largely due to the conflicts between careers and maternity. The former Croatian President Grabar Kitarović (Deloitte Hrvatska, 2019) points out that there is a difference in female wages compared to men's and that on average it amounts to 12%. Various projects on enhancing female entrepreneurs have been initiated on the national and regional level, such as the Fostering women's entrepreneurship project within the Operational programme of fostering small and medium-sized entrepreneurship by the Government of the Republic of Croatia; activities of the European Bank for Reconstruction and Development supporting the economic empowerment and improving the equality of opportunities for women; the EntrepreneurSHEp Croatia project conducted by the Croatian Chamber of Economy, Tera Technopolis Osijek, Technological park Varaždin – TPV and the University College of Economics, as well as Entrepreneurship and Management "Nikola Subic Zrinski" Zagreb, etc.

In order to boost access to business networks, the European Commission supports several networks helping women become entrepreneurs and run successful businesses (EIGE, 2016, p. 6): the European Network to Promote Women's Entrepreneurship (WES); the European Network of Female Entrepreneurship Ambassadors; the European Network of Mentors for Women Entrepreneurs. However, the full potential of women's entrepreneurship remains untapped.

According to the UN Economic Commission for Europe (UNECE, 2012), female-headed companies are the most dynamic market segment in many UNECE member countries creating new jobs and contributing to economic growth. Many studies find differences in business characteristics and performance between men and women as work-life balance and family care responsibilities have a greater influence on entrepreneurship activities by women, particularly if they have dependent children. Women more often start business ventures out of necessity, while men do it more often because of perceived opportunities (Singer, Šarlija, Pfeifer, and Oberman Peterka, 2018, p. 101). They demonstrate patience, curiosity, openness to new technologies, learning and knowledge (Oberman Peterka, Koprivnjak and Zvijerac, 2016). In Croatian society, the labor market policy has still reflected the traditional male breadwinner model due to significant socio-cultural barriers, traditional dominant values and the lack of

model due to significant socio-cultural barriers, traditional dominant values and the lack of support activities (child and dependent care responsibilities) for women's entrepreneurship. The strategy of Women Entrepreneurship Development in the Republic of Croatia 2014-2020 (The Ministry of Economy, Entrepreneurship and Crafts of the Republic of Croatia, p. 5-6) points out three groups of obstacles that are slowing down female entrepreneurship:

- structural obstacles the results of cultural heritage, absence of political willingness for consistent implementation of a political-regulatory framework, and infrastructural insufficiency to support family life, such as educational choices of women (which reduce the possibility for women to start business ventures in technology-intensive activities);
- economic obstacles the results of difficulties in accessing financing and insufficient numbers of business connections (non-networking);
- "soft" obstacles the results of the lack of access to the networks of entrepreneurs (male or female), the lack of training and educational programs and schooling for technology-intensive ventures.

Many authors (Avelini Holjevac and Galičić, 2005; Miošić Lisjak and Ćurlin, 2002; Muhek, 2007; Oberman Peterka, Koprivnjak and Zvijerac, 2016; Sesvečan, 2008) investigate women's entrepreneurial status in the domestic market and point out major obstacles encountered by women in establishing a business in Croatia. Studies (Avelini Holjevac, 2005; Perkov, 2002) suggest that, in the case of the unemployment economic trends in Croatia, women form a category most affected by the loss of work and long-term unemployment. Women are thus

trying to escape unemployment by starting up a business. Other researchers deal with the economic and social position of women in Croatian society by comparing it with the European labor markets (Esim, 2003; Kerovec, 2005; Mildrag Šmid, 2005; Valdevit, 2003, Zirdum and Cvitanović, 2017).

According to Eurostat statistics (2020) across all Member States, the employment rate for men (78%) was higher than that of women (67%). Among EU Member States, Sweden had the highest employment rate for women (80%) in 2018, whereas Croatia (60%), Greece (49%) and Italy (53%) reported the lowest rates.

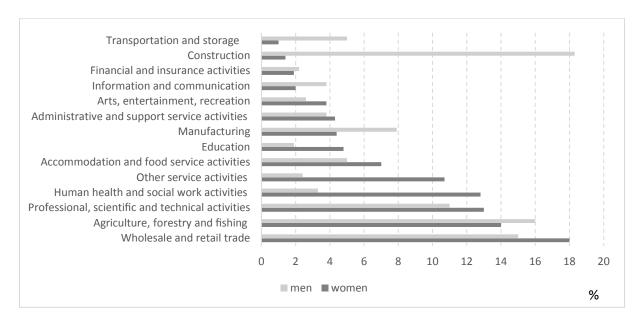


Figure 1 Distribution of self-employment by industry (OECD, 2016)

Figure 1 shows that wholesale and retail trade is the most innovative, fast-growing sector with more self-employment opportunities for female entrepreneurs. Accordingly, the National Retail Federation (Berndt, 2018) considers female entrepreneurs as drivers of changes in retailing as new retail business owners (defined as those that have owned their business for three years or less) are 61 percent female. Those facts were the main drivers to include retailing in the investigation concerning women entrepreneurship.

3. Literature review of social media and female entrepreneurship in retailing

As the literature (Oberman Peterka, Koprivnjak, Zvijerac, 2016) shows that the majority of incentives in female entrepreneurship are aimed at encouraging self-employment and creation of small businesses, proactively using social networks to advertise goods and services and making use of mobile technology have proven to be beneficial for female entrepreneurship development (Ukpere, Slabbert, Ukpere, 2014).

Social media offers a set of computer-mediated tools that allow creating, sharing, or exchanging information, career interests, ideas, and pictures/videos in virtual communities and networks (Cesaroni, Demartini, Paoloni, 2017, p. 317). As balancing professional and private life and accessing financial resources are among the main obstacles for female entrepreneurs (Ministry of Entrepreneurship and Crafts, 2014), social media has been regarded as an essential tool towards enhancing their business. Social media encourages the creation of new businesses run by women due to its flexibility, low investment and operating costs involved in a social media

start-up (Hossain, Fairuz Rahman, 2018), and due to its ability to provide a balance between their private life responsibilities and work commitments (Emslie and Hunt, 2009). Low barriers for using social media allows women who started small businesses to use the advantages of social media, such as the ease of collaborating, allowing people to easily meet, gather information, and stay in touch with others at a very low cost (Mukolwe and Korir, 2016, p. 249) in the same way as large corporates do, without the need for extensive resources. Providing networking, social media increases customer and supplier contacts, and reveals where resources and funding are available, promotes innovation, and helps in the cultivation of strategic partnerships (Zontanos and Anderson, 2004).

As Chache (2015) argues, social media platforms can revolutionize communication among individuals and businesses by increasing their networking circle. Therefore, many businesses have turned to social networks as a worthwhile communication tool (Mukolwe and Korir, 2016). In retailing, social media plays an important role in influencing customer shopping decisions (Ramanathan, Subramanian, Parrott, 2017) as customers strongly rely on product and retail outlet reviews on social media more than sales promotions. Research suggests that social media has become an important influencer of consumer behavior (Constantinides and Fountain, 2008) and, retailers have to get and stay in touch with their markets, learning about the needs and opinions of their customers as well as interacting with them (Baird and Parasnis, 2011). Burby, Atchison and Sterne (2007) point out that social media allows easy communication with many customers in a short amount of time, and enables companies to increase customer loyalty, while at the same time is getting feedback from customers and valuable data from their opinion (Drury, 2008; Friedman and Friedman, 2008).

Despite the evidence that social media has given rise to a new breed of female entrepreneurs and also augmented existing businesses to develop, interact and service their customers (Fischer and Reuber, 2010), only a few authors have explored the influence of social media on female entrepreneurs (Cesaroni et al., 2017; Merza, 2019; Mukolwe and Korir, 2016; Tran, 2014). Additionally, there is no academic evidence on how social media has accelerated female entrepreneurship in retailing.

4. Methodology

Different techniques were used in this study: qualitative and quantitative data were integrated in order to reveal whether social media supports female entrepreneurship activities in Croatia. The qualitative approach consists of four face-to-face interviews, while the quantitative approach includes a study of a sample of 62 female entrepreneurs – owners of companies operating in retailing.

Explorative Survey among Female Entrepreneurs

Relying on the data from the Best Female Entrepreneur in Croatia award organized by Women in Adria (a network gathering female entrepreneurs and businesswomen) (https://www.total-croatia-news.com/tag/women-in-adria/), with the help of a university student, four face-to-face interviews with successful Croatian female entrepreneurs in August 2019 were conducted. The interviews consisted of questions about the positive aspects of their business, obstacles that they were faced with, and their opinions about technological innovations especially social networks, etc.

Quantitative Study

The quantitative approach contained a survey of a sample of female entrepreneurs - owners of companies operating in the retailing sector on the Croatian market. In order to reach the target

sample, we used data from the Croatian Women Entrepreneurs Association members list "WECroatia" (in September 2019). A particularly useful snowball sampling technique was also used because the population is hard-to-reach (Atkinson and Flint, 2001). Accordingly, the sampled respondents are then asked to help identify other respondents to sample and this process continues until enough samples are collected (Dusek, Yurova and Ruppel, 2015). In total, 62 respondents participated in the research (Table 1 summarizes the profile of the sample).

Research Instrument

The questionnaires were created on Google survey and sent online through social media, like Facebook. In the first part of the survey, participants were asked specific types of questions to obtain general information regarding the demographics and customer profiles. As can be seen from Table 1, this study focused on the "basic" dimensions that portray an entrepreneurs' profile, namely the size of their company, the core business of the company, the years of its existence on the market, demographic characteristics of respondents (age, level of education, marital status, number of children under 18 years old), average working hours, average working days during the week, etc. with the percentages that indicate a satisfactory level. In the second part of the questionnaire, characteristics that female entrepreneurs possess such as motives, and problems that they face in conducting business were investigated. The questions were adopted from the studies of Gupta, Turban, Wasti, and Sikdar (2009), Kepler and Shane (2007), Kephart and Schumacher (2005). The third part of the questionnaire consisted of questions on the role that social media played for women starting and continuing the business. The questions were adopted from the studies of Merza (2019), Hossain and Fairuz Rahman (2018), and Ramanathan, Subramanian and Parrott (2017). We point out that the questions in the second and third parts of the questionnaire were created in the form of statements with a five-point Likert scale ranging from 1= strongly disagree to 5= strongly agree.

Data Analysis

The collected data were analyzed using SPSS. Besides descriptive statistics calculations, testing the reliability with Cronbach's Alpha coefficient was conducted. Before using items for further analysis, reliability testing was conducted. Cronbach's Alpha coefficient was chosen as an adequate test of internal reliability. It assumes that each indicator (items in Table 2) contributes equally to the overall variance observed. For all the constructs, except *problems in conducting business*, the coefficients alphas exceeded the recommended standard of 0.7 that has been suggested by Nunnally (1978), DeVellis (2003) and Malhotra (2007). As for *problems in conducting business*, the alpha value is 0.65 and it raises suspicion about the robustness of the measure to capture the intended construct.

5. Results and Discussion

Qualitative Study

Four different types of retail businesses were represented by the female entrepreneurs interviewed: catering, electronic equipment, flower shops, and fashion. One of them has a long tradition in business (more than 20 years), but the other owners are newly established companies operating less than 10 years on the Croatian market. All the respondents have a university degree, but they are not working in the industry they specialized in during their college. Additionally, all of them have families and balanced family life. As the main motives for starting the business, they point out the possibility to fulfill market needs through their own firm with a higher level of success and a desire to be independent. As the main problems in conducting their business, they mentioned a lack of time, and a need to prove their managerial abilities. All of them consider social media platforms as a strategic tool that enables them to

share marketing information, execute sales, and gain marketing knowledge. The respondents share information about their products and post photos of the product offerings. Potential consumers can contact them and place orders. Among the popular and widely used social networking sites, such as Facebook, LinkedIn, Instagram, Twitter, Skype, WhatsApp, Viber, WordPress, YouTube, etc., they use Instagram which provides them a customer base of some 8.000-20.000 followers.

Quantitative Study

As Table 1 shows, a large majority of the sample belongs to the 36-45 age group (40.3 percent) suggesting that mature women are those who are interested in doing business. Furthermore, half of the sample (50.0 percent) held only a high school diploma. 87.1 percent of the respondents are married and in most cases (38.7 percent of the respondents) they have three or more children. However, a relatively large percentage of the respondents (33.9 percent) have got one child. The analysis of income levels suggested that the respondents had personal income above the average Croatian level. On the other side, there are some indicators that entrepreneurship requires a lot of personal female involvement because a large majority of the respondents (46.8 percent) work 8-10 hours a day and 6 days a week (62.9 percent of the respondents).

 Table 1 Characteristics of the Sample

Item	Frequency	Percent
Age		
less than 26	1	1,6
26-35	21	33,9
36-45	25	40,3
46-55	11	17,7
more than 55	4	6,5
n		
Education	21	50.0
high school	31	50,0
secondary/High	13	21,0
College/University	18	29,0
Marital status		
Married Married	54	87,1
single	5	8,1
divorced	3	4,8
divorced	3	4,0
Number of children (less than 18yrs)		
without children	1	1,6
1	21	33,9
2	16	25,8
3 and more	24	38,7
		,
Income level		
less than EUR900	11	17,7
EUR901-1700	13	21,0
EUR1701-2650	13	21,0
EUR2651-3550	10	16,1
more than EUR3551	15	24,2
No. of working hours per day		
less than 5 hours	2	3,2
5-8 hours	13	21,0
8-10 hours	29	46,8
more than 10hours	18	29,0

No. of working days per week 5 days 6 days 7 days	18 39 5	29,0 62,9 8,1
Size of the company (number of employees) less than 10 11-50 51-250	55 5 2	88,7 8,1 3,2
Retail sector Accessories Kitchen furniture Fashion clothes Food Cosmetics Services Shoes	32 4 21 1 2 1	51,6 6,5 33,9 1,6 3,2 1,6 1,6
Years of existence on the market more than 20 19-10 less than 10	18 15 29	29,0 24,2 46,8

As can be seen in Table 1, Croatian female entrepreneurs are mostly the owners of small companies (88.7 percent of the sample is comprised of companies with less than 10 employees). Considering the retail subsector in which they operate, 51.6 percent of the sample presents accessories retailing and 33.9 percent of the sample are fashion clothes retailing. Considering the years of existence on the market, the largest percentage of the sample (46.8 percent) are newly established companies operating less than 10 years on the Croatian market.

Table 2 Descriptive statistics for different aspects of female involvement in business

Item	Frequency	Percent
Characteristics of the female entrepreneur		
Always ready to accept a business risk	4.18	0.878
Knowing how to manage the career	4.15	0.721
Full of self-confidence	4.39	0.737
Giving advice to fellow-workers	4.29	0.797
Accepting useful advice of fellow-workers	4.55	0.563
Always ready to accept new tasks	4.49	0.622
Family support	4.66	0.676
More customer-focused than male managers	4.07	0.946
Pushing herself to have an adequate role in society	2.67	1.217
Good organizer and coordinator	4.24	0.670
The ability to recognize very fast which activities are priorities, and which are not	4.39	0.732
Enjoy working with the goal of attaining business success	4.10	0.926
Reasons and motives for starting a business		
Impossibility to harmonize family and career at previous work	2.14	1.246
Possibility to fulfill market needs through own firm with a higher level of success	3.94	1.089
Not adequately evaluated and honored business efforts at previous work	3.02	1.620
Decision to start with own career after kids grew	2.29	1.449
Possibility to harmonize business with family	3.77	1.134
Desire to be independent	3.83	1.201
Enough experience to start own firm	3.95	1.083
Possibility to control their own lives and to be own boss	4.27	0.924

Problems in conducting own business		
Forming a quality management team	3.00	1.176
Problems with quality working labour	3.19	1.371
Profit is not as high as expected	3.28	1.136
Product prices of the firm are higher and less competitive compared to other firms'	2.24	1.129
prices at the market		
Limited business freedom	2.68	1.265
Larger costs than expected	2.92	1.029

Table 2 displays the descriptive statistics for female entrepreneurs involvement in the business. The results reveal that while starting a retailing business in Croatia female entrepreneurs relied mostly on family support (average score = 4,66). Croatian female entrepreneurs accept useful advice of their fellow-workers (average score = 4,55) and they are always ready to accept new tasks (average score = 4,49). They are full of self-confidence (average score = 4,39), and able to recognize which activities are priority and which are not very quickly (average score = 4,39). Moreover, the descriptive statistics (Table 2) confirm that women's motivations for starting a business were remarkably similar across countries (Greene, Hart, Gatewood, Brush, and Carter, 2003). The findings of this research support the study of Machado, Gazola, Dos Santos Fabricio, and Anez (2016), because among the reasons and motives for starting a business (Table 2), the mean score for "ability to take control over their own lives and to be own boss" is the highest one (average score = 4,27).

Several studies point out the work-family balance as the motivation for business initiation. The findings of this study also confirm the importance of flexibility to handle family responsibilities as a possible motive for female entrepreneurship. However, similar to the findings of Machado et al. (2016), the mean score for the possibility to balance family life and career is not among the top five reasons for starting a business.

As shown by the mean scores in Table 2, three main problems faced by Croatian female entrepreneurs were (1) low level of expected profit (average score = 3,28); (2) problems with quality working labour (average score = 3,19) and (3) problems with forming a quality management team (average score = 3,00). However, their values, measured on the five-point scale show that the respondents are indecisive regarding problems they are facing within conducting business.

Table 3 Descriptive statistics for the role of social media in female involvement in business

Item	Frequency	Percent
The use of social media resulted in more customers	4.48	0.721
It is easier to expand the business through social media	4,60	0,527
Social media enables feedback from customers to help improve business	4,26	0,854
Social media provides a multi-channel strategy	3.79	0.977
Social media helps to interact effectively with users	4.24	0.670
Social media sites are trustworthy in handling my information	4.10	0.926

Regarding the social media platforms that female entrepreneurs use for conducting business, 75 percent of the respondents use Instagram, 22 percent of them use Facebook, and 3 percent of the respondents use LinkedIn. They point out a decrease in the popularity of Facebook due to changes in Facebook policies, such as taxation or charging for services. As can be seen in Table 3, in general, the respondents agree about the importance of social media for their business. However, they did not agree with the results of Beninger et al. (2016) that without social media they would likely not have been able to effectively start and run their business. The respondents

have recognized the benefits that social media has for female entrepreneurs to increase their visibility in society, as well as gather and spread information cost-effectively related to their business.

6. Conclusion

According to the literature review, despite various projects and programs for the support of female entrepreneurship in the Republic of Croatia, by entrepreneurial activity, Croatia is still significantly a "male" country. Female entrepreneurial activities are more likely to be found in the retail sector than in any other business sector. Led by the motivation to take control of their own lives and to be own boss, women established mostly small companies in the retail sector. In doing business they face the problems of a low level of expected profit, quality working labour and forming a quality management team. They understand the importance, benefits, and challenges of social media for their business. They think that social media makes a big change in the life of women, facilitate their ways to be more creative in their business activities and share their knowledge with other women. The fact is that when it comes to social media, technology is helping businesses with no regard for demographic characteristics. But in 37 out of the 95 countries, women value social media higher than men (Guta, 2019). This paper offers valuable insights into the knowledge about female entrepreneurs and their usage of social media in Croatia.

This study also has some potential limitations. Firstly, a limitation of the study lies in its relatively small sample size. This was mainly attributable to the reluctance of female entrepreneurs to participate in the study and the resources available for the study. Therefore, the findings of this research should not be generalized across the entire female Croatian entrepreneur sector. Also, more independent variables related to the role of social media could be included due to the complexity of that topic. Finally, such a survey should be conducted in different time periods and the results should be compared. More empirical work needs to be carried out before establishing a generalisation about the findings of this work.

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Family Entrepreneurship and the Issue of Transfer of Ownership in Family Businesses

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Abstract

Family entrepreneurship is a specific form of entrepreneurship as it merges both business and family interests. The balance between these two subsystems is crucial for the sustainability and development of family businesses. The issue which is crucial for the continuity, growth and development of family businesses is the transfer of business ownership. Considering the fact that one half of the employed population in the Republic of Croatia work in family businesses, and that an entire generation of company founders is nearing the end of their working life, the issues related to the successful transfer of business ownership and business management to the next generation is becoming an important economic question. In the Republic of Croatia there is no official definition of a family business, nor is there a definition of a family business in the current legislation regulating business entities. According to the available scientific literature, the aforementioned issues have not been sufficiently researched. This paper shall outline the main characteristics of family entrepreneurship, provide the definition of family entrepreneurship, and examine some of the most important characteristics of family entrepreneurship in the Republic of Croatia. Additionally, this paper shall provide an insight into the complexity of the issue of transfer of business ownership and family business management, as well as guidelines for a successful transfer of a family business to new generations.

Keywords: family entrepreneurship, sustainable family business, transfer of ownership, family business management.

1. Introduction

Family businesses are an important segment of any economy, especially in the countries which have a long tradition of entrepreneurship and private property. The balance between interests and objectives is crucial for the success of a family business. If the said balance is not achieved, both the business and the family might be compromised. A lack of balance between family and business goals can be viewed from two perspectives: as an imbalance characterized by the emphasis on business objectives at the expense of family ones, or as an imbalance characterized by the emphasis on family objectives at the expense of business ones (Kružić and Bulog, 2012).

The largest number of family businesses are micro, small and medium-sized enterprises which are facing the highest level of risk of unsuccessful transfer of business operations and

ownership to the next generation. Family businesses are specific, and their advantages are the focus on long-term development, a strong dedication of the family members to the business operations, a more homogeneous organizational culture and a strong motivation for success. On the other hand, some of the greatest disadvantages are nepotism and conflicts within the family, while the most complex problem family businesses need to overcome is the issue of ownership transfer and company management.

Those family businesses which are able to identify potential challenges in a timely manner and consult experts from different fields have greater chances of successfully transferring their business operations and ownership. To ensure the continuity of family businesses is to ensure the continuity of employment and continuous contribution to the economic growth.

The complexity of this issue was recognized by the European Commission back in 1994 because a considerable number of family businesses has unsuccessfully tackled the said process, which had a negative impact on owners, employees, creditors and the environment in which the company operates. For more than twenty years the European Commission has been monitoring the quality of national business transfers in the EU member states, providing recommendations for improving the support system for the development and sustainability of family businesses.

The complexity of the issue of transfer is even more pronounced in the Republic of Croatia.

The role of small and medium enterprises in the Croatian economy has been indisputable and stable for years: in 2018. small and medium enterprises remain the largest employer in Croatia (72,2%), have the largest share in the total number of enterprises (99,7%), significantly contribute to total income (58%) and export activities of the country (53%). (CEPOR, 2019).

Considering the fact that the largest number of family businesses are micro, small and medium-sized enterprises, that one half of the employed population in the Republic of Croatia work in family businesses, and that an entire generation of company founders is nearing the end of their working life, the issues related to the successful transfer of business ownership and business management to the next generation is becoming an important economic question.

Croatia is in the phase of the first wave of the business transfer process. An important characteristic of enterprises in the hands of 55 plus generation is that majority of them are established in 1990s (76%) and that their owners are also their founders in as much as 92% of cases without personal experience of participation in the business transfer process. A significant proportion of owners who are thinking about the future of enterprise plan the transfer to family members (children) and there is only small proportion of those who are thinking about other options, sale of the enterprise, transfer of the management role to employees or external managers (CEPOR, 2015).

The transition of ownership and management of a family business must not jeopardize the continuity of successful business operations because it also compromises employment and economy of a given region, due to the fact that family businesses are largely the motor of the regional economic development.

According to the available scientific literature, the aforementioned issues have not been sufficiently researched. The complexity of the issue of transfer of business ownership and family business management in Croatia is last time researched in 2015. in Business Transfer Barometar survey conducted by CEPOR. There is a gap of four years in which this potential economic problem is not seriously researched and it is necessary to make guidelines for a successful transfer of family business to a new generation.

2. What is family business?

Family firm research has come far but has a long way to go.

There is a growing awareness among public policymakers of family firm's role in creating new jobs, incubating new businesses, and promoting economic development of local communities (Astrachan, Zahra and Sharma, 2003; Heck and Stafford, 2001).

According to the Beckhard and Dyer (1983a) and (1983b) family owned business is a firm, that is, both family owned and managed. Continuing with this view on ownership. Beckhard and Dyer (1983a) define the family owned business as business in which two or more extended family members influence the direction of the business through exercise of kinship ties, management roles, or ownership rights. Beckhard and Dyer (1983b) define a family business as the system that includes the business, the family, the founder, and such linking organizations as the board of directors. An analysis of the literature suggests three principal ways in which to consider the plethora of definitions: content, purpose, and form. To be functional, a definition of family business must be unambiguous and transparent in such a way that it can be quantified. Good example is Lea's (1998) definition: family business is a business is a family business when it is an enterprise growing out of the family's needs, built on the family's abilities, worked by its hands and minds, and guided by its moral and spiritual values; when it is sustained by the family's commitment, and passed down to its sons and daughters as a legacy as precious as the family's name.

Researchers in the field of family business agree that succession is the most important issue that most family firms face. Theorists like Ward (1987), Handler (1989) and Lansberg (1988) also agree that the continuity of businesses from one generation to the next depends highly on succession planning. The statistics confirm that succession is typically a problematic issue. But enterprise can be viewed only as a family business when a transfer to the next generation is intended. It could be argued that the level of experiences gained from the succession process is greatest during the shift from first to second generations. During the first generation of ownership, many new rituals are installed and only 30 percent of the family firms survive the transition to second generation and only 10 percent make it to the third generation (Beckhard and Dyer,1983a and 1983b). As shown in Figure 1, family business experience of succession is regarded as involving an exponential continuum.

The average life of the founder of the firm is twenty four years, which is also the average life tenure of the founder in the firm (Beckhard and Dyer, 1983a). Many have argued that the responsibility of providing for succession lies with the founder or owner (Danco,1982; Schein,1983). Others have focused on the experience of the next generation (Barnes,1988; Friedman,1991) and the relationship with their parent (Dumas,1990; Handler,1990).

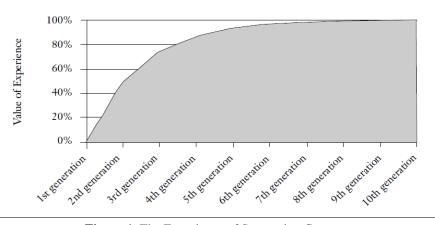


Figure 1. The Experience of Succession Curve

Source: Astrachan, J. H., Klein, S. B. and Smyrnios, K. X. (2002). The F-PEC Scale of Family Influence: A Proposal for Solving the Family Business Definition Problem1. Family Business Review, Vol. 15(1), 45-58.

Is it family business sustainable?

It is generally recognized that family firms have received scant attention in the mainstream management literature, particularly with respect to the development of theories of the firm. According to research Danes et al. (2008) central tenets of sustainable family business theoretical model include:

- (a) Family is a rational social system (Stafford et al., 1999);
- (b) Family business sustainability is a function of both business success and family functionality (Danes et al. 2008);
- (c) Resource and interpersonal processes differ during times of stability and change (Danes, 2006);
- (d) Family and business interact by exchanging resources across their boundaries (Danes et al., 2007);
- (e) Owning families rationally manage the family and business jointly to optimize achievement of their objectives (Paul et al., 2003);
- (f) Family or business can be destroyed if the boundaries are too diffuse (Stafford et al., 1999);
- (g) Conflicts arise when there is a mismatch between demands and resources (Danes, 2006) and (h) a positive symbiosis between family, business, and community is productive for both the firm and the community (Niehm et al., 2007).

During times of disruption, managers must reconstruct processes to ensure sustainability (Danes et al., 2005; Fitzgerald et al., 2001; Winter et al., 2004). Look more in the Figure 2.

Figure 2. is a visual summary of the changes. The greatest changes are: (1) inclusion of family and business structure, (2) separation of resources and constraints, (3) greater detail about outputs, (4) a distinction between short-term viability and long-term sustainability, and (5) clarification of how the theory applies to ethnic-family businesses and their cultural contexts (Danes et al., 2005).

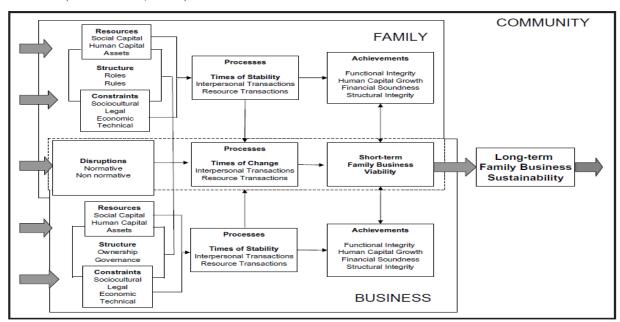


Figure 2. Sustainable family business theoretical model

Source: Danes, S.M., Lee, J., Stafford, K. and Heck, R.K.Z. (2008). The effects of ethnicity, families and culture on entrepreneurial experience: an extension of sustainable family business theory. Journal of Developmental Entrepreneurship, Vol. 13(03), 229-268.

In Figure 2. we can see that recognizes family business achievements are evaluated multidimensionally. Objective financial success measures have been the primary concern of most business and economic theories. However, other non-financial indicators such as congruity between business and family and meeting goals also are important assessments of success (Danes et al., 2008).

The importance of business transfer

Apart from starting and expanding a business, business transfer is the third critical point in the development of family businesses. Family businesses are an important segment of any economy: small enterprises (more than 95% of which are family-owned) are the backbone of Europe's economy – they are the main source of employment and initiators of numerous business ideas. They are the main promoters of innovations, employment, adaptability and competitiveness, as well as social and local integration in Europe (Kružić and Bulog, 2012). Only 30% of family businesses survive the transfer of business operations to the second generation; 13% of them successfully transition the business to the third generation, while only 3% have a longer life span (*CEPOR* – SME Policy Centre, 2015).

The European Union documents dealing with the importance of the issue of business transfer of small and medium-sized enterprises indicate that there are 450.000 businesses in the European Union with approximately two million employees that undergo the business transfer process each year. These documents also estimate that in about 150.000 companies the issue of business transfer is not addressed in an adequate manner, which potentially compromises around 600.000 jobs (*CEPOR* – SME Policy Centre 2015).

The complexity of business transfer stems from the fact that the transfer issue has its legal, organisational, financial, tax-related and psychological aspects and that it requires many years of careful and timely preparation. If it is not carried out in an adequate manner, business transfer can potentially jeopardize the company's market position and its survival regardless of its previous competitiveness and good reputation.

An untimely preparation for business transfer causes interruption of business activities of a company, the loss of its market position and job loss, as well as a failure to make profit from the labour and resources that the owner has invested in the development of the company.

A research conducted by Business Transfer Barometer Croatia (2015) identified 16.500 limited liability companies in Croatia whose majority owners are over 55 years of age and which, according to the EU criteria, belong to the group of small and medium-sized enterprises whose owners should start conducting the transfer. The said 16.500 companies account for 31% of the total number of registered limited liability companies, constituting 16,1% of the total number of people employed in limited liability companies and earning 18,9% of the total income generated by all limited liability companies in Croatia.

Legal aspects of succession of family businesses in Croatia

The private sector initiative was introduced into the Croatian legal system in 1989 by means of the Companies Act. The Corporations Act entered into force in early 1995, offering a modern approach to the regulation of company operations. A vast majority of companies were established during that period; however, legal issues related to the generational change in family businesses eventually arose. Business transfer and ownership succession in family-owned businesses is not only an economic, but a complex legal issue, and the most important question is whether the younger generations should be involved only in the management structure of a family business or given full ownership of the company, or whether both options should be considered.

In order to make the best possible decision, it is necessary to understand the difference between ownership and management of a company. Pursuant to the Companies Act, a single person can be the founder, a member and a shareholder in a company. In practice, the majority of active companies were founded by a single natural person who is also the company's owner. It is also common for the natural person who is the founder and the member of a company to be the only board member as well, i.e. the CEO who actually manages the company.

It is important to emphasize that company members are free to use their business share in any way they want in the event of ownership transfer. The Companies Act stipulates that business shares can be transferred and inherited. The business share transfer typically occurs during the shareholder's lifetime; however, according to the Companies Act, it needs to be based on a contract concluded in the form of a notarial deed or a private document certified by a notary public.

The company owner should also decide how to protect his or her private assets and ensure regular income from a smooth-running family business. One of the potential solutions is to conclude a lifelong support contract or support until death contract with one's successors.

Family business owners need to consider the possibility of their sudden death or severe illness, in which case they will most likely draft a last will and testament which will specify who (an in which manner) shall inherit the company in the event of owner's death, thus reducing the possibility of business shares being inherited by those successors who, for various reasons, should not become a part of the company's ownership structure.

In practice, owners of family business often have several children, some of which are not interested in working or building their careers in the family business. In order to preserve the balance between business and private interests it is necessary to take measures to divide the property evenly among all successors. In this case, the valuation of the family business should be carried ut by professionals, including the valuation of assets, human resources, market position, business performance, patents, trademarks, the company's location, etc. In order to ensure a fair division of property among successors, the owner of the family business can conclude an agreement on transfer and division of property with his or her successors during his or her lifetime, whereby the content of the said agreement needs to be agreed upon by all the children and the spouse.

It is important to emphasize that there is a difference between whether the business share is transferred onto the successors as a chargeable or a costless legal transaction. A successor's own property includes only the property acquired during marriage by inheritance, donation and similar, whereas the property which the spouses have earned during their marriage or which derives from the previously-mentioned property is their joint marital property.

If conflicts caused by the generational shift escalate to such a level that it becomes impossible to reach an agreement, one of the remaining options is the mediation process. Mediation is a voluntary, confidential and extra-judicial process which is facilitated by an officially registered mediator. Any conflicts and disputes are resolved by means of dialogue and negotiation. Even though mediation in case of family businesses disputes is rather common around the world, in Croatia it is still in its infancy and the mediation process is facilitated by the Croatian Chamber of Commerce, Croatian Chamber of Trades and Crafts, Croatian Mediation Association, Croatian Employers' Association and Croatian Insurance Bureau.

3. Research findings

The data presented in this paper are the result of the analysis of secondary sources of data published mainly in reports from institutions that are, through their mission, responsible for,

or monitor the state and development of transfer of business ownership and family business management.

According to the available scientific literature, the aforementioned issues have not been sufficiently researched. There is a gap of four years from 2015-2019. in which this potential economic problem is not seriously researched and it is necessary to make guidelines for a successful transfer of family business to a new generation.

This research describes activities carried out in 2015 and 2019 by institutions responsible for improving the quality of successful transfer of family business to a new generation the environment in which small and medium enterprises in Croatia operate.

In 2015, the SME Policy Centre (*CEPOR*) conducted a research called Business Transfer Barometer Croatia with the purpose of raising awareness of the issue of ownership transfer in family businesses in Croatia, due to the fact that the said process will have happened for the first time in Croatia. More than 200 respondents from Croatia, all of whom were majority owners of small and medium-sized enterprises aged 55 and over, participated in the Business Transfer Barometer research in 2015.

The sample consisted of limited liability companies with at least one employee and a minimum annual income of 100.000 Kuna. According to the Business Transfer Barometer research (2015), the largest number of companies which need to start preparing for business transfer is based in Istria county (34,9%), Karlovac county (34,7%), Primorje-Gorski Kotar county (33,5%) and Međimurje county (32,8%). Furthermore, among the companies whose owners are about to undertake or have already undertaken the process of business transfer (age group 55 and over), there are 26% of businesses whose majority owners are women and 74% of businesses whose majority owners are men. In terms of age, 47% of owners belong to the 55-60 age group, while 53% of them are 61 and over. As many as 92% entrepreneurs who belong to the 55+ age group are both owners and founders of companies who have no personal experience with the process of business transfer or takeover from the previous generation. Apart from the ownership role, in 88% of the cases their role in the company is also managerial. Although 97% of the owners have children, most of them do not involve their family members in the company's business operations. Only 38% of the owners have a family member who, apart from themselves, participates in the company's ownership or management structure, which according to the EU definition classifies them as family businesses. In 60% of the cases the family member involved in the company's business operations or management is the owner's child, while in 52% of the cases it is the spouse.

Considering the significance of family businesses for Croatian economy and the economy of the European Union in general, which has been recognized by the European Parliament Resolution of 8 September 2015 on family businesses in Europe, it is critical to ensure a successful first generational business transfer in Croatia.

According to the Business Transfer Barometer (2015), as many as one fourth of entrepreneurs aged 55 and over do not consider changing their role in the company for the following ten years. With regard to the owners' awareness of the change in roles in managerial and ownership functions, a group which is particularly at risk are the owners who do not consider changing their future role in the company. Within the category of owners between the ages of 55 and 59, 40,9% of entrepreneurs belong to the high-risk group, while within the category of owners aged 60 or over, 27,7% of owners belong to the high-risk group. Looking at all entrepreneurs who belong to the 55+ age group in total, 32% of owners belong to the high-risk group.

It has been estimated that more than 5.300 companies belong to the high-risk group due to their untimely business transfer, which potentially jeopardizes more than 57.000 jobs

(*CEPOR* – SME Policy Centre, 2015). Those who are thinking about transferring their businesses (65% of owners) believe that their companies will continue to operate; only 6% believe that their companies will end up being sold, while 17% believe that their companies will cease to operate. In the European Union, 40% of companies end up being sold once their owners have retired (*CEPOR* – SME Policy Centre, 2015).

Furthermore, according to surveys conducted in the European Union, only 15-35% of businesses are transferred to family members, continuing to operate as family businesses (Final Report, CSES 2013). In Croatia, as much as 60% of owners expect that their companies will be managed by one of their family members. Two thirds of owners already have an idea of who will take their place once they retire, which in 73% of the cases is one of their children who, in the majority of cases, is already employed in the company (Alpeza, M., Grubišić N. and Mikrut, M., 2015).

In European Union, the need to raise awareness of a timely business transfer is continuously emphasized and encouraged because business owners often underestimate the time required to carry out the transfer. In Croatia, 22% of entrepreneurs underestimate the time required for a successful business transfer, believing that a successful implementation of the said process does not require more than a year (Alpeza, M., Grubišić N. and Mikrut, M., 2015).

The biggest challenge in the business transfer and ownership succession process for the members of the 55+ age group is balancing family and business interests, transferring knowledge onto the person who is about to assume the role of the company's CEO, and finding the right person for the position of the company's CEO. Additionally, members of the 55+ age group also believe that they will need support and assistance in the process of transfer, especially when it comes to technical aspects of business transfer and to business valuation.

The attitudes of the generation of successors of family businesses in Central and Eastern Europe have been examined by the global PwC survey (PwC with Global NextGen Survey, 2019). Currently, 53% of them are actively involved in the operations of their respective companies, which is lower than the global average of 70%, but the level of their involvement is increasing and should reach 76% in the future. 47% of the respondents expect to assume the role of the company's CEO by 2025, while 33% of them expect to be majority stakeholders.

Almost 90% of the respondents believe they can create added value by applying their digital knowledge and skills, thus helping their companies to develop their digital strategy. They believe digital technology is crucial for the success of their companies, while 30% of the respondents are afraid that their family business is lagging behind its competitors in this area (PwC with Global NextGen Survey, 2019). The changing needs of customers are perceived as the main cause of disruption by 26% of the respondents. They are also concerned about the influence of constantly changing technologies (22%) and about their market competitors (19%). Interestingly enough, the generation of family business owners in Central and Eastern Europe perceive themselves as "transformers" responsible for steering their companies towards digital revolution and for meeting their customers' changing needs (68% of the respondents, in comparison with the global average of 48%). This percentage is considerably higher than among their counterparts on the global level. Seen that a considerable number of respondents come from the industrial and manufacturing sector, it is not surprising that the generation of successors in Central and Eastern Europe identifies the Internet (82%), robotics (57%) and artificial intelligence (54%) as the most important technologies for the future of their companies. The members of the new generation of owners in Central and Eastern Europe claim that they have already had a chance to manage projects aimed at introducing changes in the family business (37%), while 23% of them state that their opinion is not taken into account in the decision-making process in their family businesses. Nonetheless, 27% of them believe they need to prove themselves before they are in the position to express their ideas about changes (PwC with Global NextGen Survey, 2019).

4. Conclusion

Family businesses are the most common form of business organization and management around the globe; they are the main source of innovations and employment and they significantly contribute to the development of national economies. What makes family businesses specific is the involvement of family members in business operations, which is why it can be difficult to achieve balance between family interests and business interests. A particular problem is the transfer of business ownership and management to the next generation. Although an integral part of the life cycle of a business, it is a fundamental problem because the manner in which this issue is addressed has a direct impact on sustainability and development of the family business. Transfer of ownership is a complex issue full of challenges and it needs to be examined from the legal, financial, organizational and psychological aspect.

Unless the entire process is successfully implemented, economic stability of an entire region might be compromised, since family businesses mainly operate on a local scale. The transfer process itself can last up to several years, and the challenges related to that process have been recognized by the European Union.

The issue of transfer is still not sufficiently recognized in the Republic of Croatia, which could potentially jeopardize numerous jobs. The problem is further exacerbated by the fact that the majority of owners and founders of family businesses belong to the generation which is close to retirement, and the Republic of Croatia is about to face the generational transition for the first time although the majority of owners have no personal experience with the transition of businesses from the previous generation. Due to a lack of an official definition and statistical monitoring of family businesses in the Republic of Croatia, it is not possible to objectively assess their impact on Croatian economy. Family businesses are not limited to only one type of companies. They can be established as both partnerships and capital companies. Business shares are crucial elements on which the change in the ownership structure of family businesses is based, due to the fact that business shares can be transferred and inherited. Business Transfer Barometer Croatia research, conducted in 2015 by CEPOR – SME Policy Centre, identified the significance of this issue in the Republic of Croatia. According to the available information, that was the last research into the said topic in the Republic of Croatia. Having examined the available literature, the authors have concluded that there is a lack of scientific papers dealing with the topic of family businesses in the Republic of Croatia.

Furthermore, particularly important for the development of the domain that this paper focuses on is to raise the awareness of the fact that succession of family businesses is only one of available options; others include transfer of ownership to non-family managers or employees, selling the business to persons outside the company, merger and acquisition. It is recommended to learn from countries with a long tradition of entrepreneurship and to look into the good practice examples. In order to facilitate and successfully carry out the said transfer, it is necessary to consider the favourable financial instruments for those who are buying a company from its retiring owner, especially if they are employees of the said company. In the Republic of Croatia there are very few examples of transfers which can be classified as good practice, which is why it is necessary to organize trainings and promote the practice of buying a family business as a manner of starting one's entrepreneurial career, as

well as entrepreneurial networking, support from state institutions and activation of on-line platforms that connect business buyers and sellers.

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Needs and Opportunities the Implementation of the Quality System at Enterprises of the Republic of Moldova

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Abstract: The article is aimed to describe the approaches to the problems of studying quality management systems, their development; also the lists of the quality indicators are presented to be studied and selected when creating quality management systems for a particular enterprise. This article also describes the sequence of stages of development and implementation of a quality system in small enterprises.

Keywords: quality, quality control.

1. Introduction

The quality management system that ensures high quality of production and competitiveness of products is successful in many companies in industrialized countries. Product competitiveness is a characteristic of a product (service), reflecting its difference from a competitor's product, both in terms of the degree of compliance with a particular need and in the cost of meeting it, i.e. This is the ability of goods to meet the requirements of the market and the demands of customers. Quality management depends on the success of competitive products in the market, since pricing and quality policies are the main factors driving consumer demand. Competitiveness is also influenced by fashion, advertising, the image of the enterprise, the market situation and other factors.

Quality represents a multidimensional concept; to ensure it, it requires the combination of the creative potential and practical experience of many specialists. The problem of quality improvement can be solved only with the joint efforts of the government, managers and members of the labor collectives of the enterprises. Consumers play an important role in solving this problem, they dictate their requirements and requests to the producers of goods and services. This process led to a serious re-segmentation of the market, for which the foreign manufacturers are in favor, because of their higher-quality products, which indicates a tougher competition of producers. It should be noted that foreign companies have sufficient experience in competitive struggle, as well as all the necessary resources for this (financial, technical and human), but Moldovan manufacturers are far behind them.

The material constituent - the quality of goods and services, has an important influence on the quality of lifestyle. It is a strategic issue, on the resolution of which the economical stability of our country depends on. The process of enhancing the quality, that includes the activity of many industries, designer groups and services, is needed not only to profit from the sale of goods and services, but, most importantly, for the whole society and its interests.

Domestic enterprises' most important task is to ensure the production of high quality products through highly efficient processes.

2. Literature Overview

Quality has different interpretations in literature.

Quality is a definition of an object (object, phenomenon, process) that characterizes it as a given object, possessing a combination of its inherent properties and belonging to the class of objects of the same type (Gladilina, I.P., Kolesnik, V.V. 2015).

Quality is meant as a holistic, integral characteristic of an object (the unity of its properties) in the system of its connections and relations with other objects.

Quality represents a set of characteristic properties, shapes, appearances and conditions of use (Semenov, V.L. 2011). All of these characteristics endow the goods to meet the standard of quality. The mentioned elements define the requirements for the quality of the product, which are specifically embodied at any stage of the project, in the product specification, in the design documentation, in the technical specifications. Other important aspects are: providing the quality of raw materials, constructive dimensions, etc.

The term of quality has been recurrently discussed by the scientific community and practitioners. As a result of its impact, a conceptual vision of quality has emerged as one of the fundamental categories that determine the lifestyle, social and economic basis for the successful development of man and society.

The basic elements of the suitability of the goods, determined by the technical characteristics of the product, are called the quality of design. Improving the quality of the design increases the cost of the product.

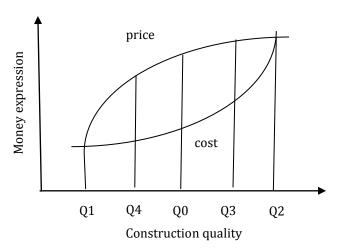


Figure 1 Dependence of the product quality on its price and cost

The dependence of the quality of the product from its price and cost is presented in Figure 1 (Lapushin, R., 2019). The part of the graph, situated between the production cost and product price curves, limited by their Q1 and Q2 intersection points, reflects the profitability, which is the basis for existence of the enterprise. The point Q0, which fixes the most distant curves, corresponds to the quality of the structure, ensuring maximum profit. The market, in the presence of competing products, provides the company with a choice between different versions of production strategy and tactics. The company can focus on the quality in the Q3 design, aiming at the production of high-class products, sacrificing an insignificant share of their own profits, while targeting a mass production, regardless of low profits, or decide to accept the low quality of the Q4 design at lower cost. So, it all depends on the management's decision.

In an enterprise, management operates in a cycle: planning - organizing (implementation) - control (including the quality control of product designs) - managerial decision - managerial action. Quality management in an enterprise is one of the links in the described managerial cycle.

In other words, the managerial cycle, which belongs to the group of preliminary control and analysis of product designs, is the basis for quality management.

3. The evolution of quality management systems

In the history of the development of quality management systems, motivation, training and partnerships, one can distinguish five periods that justify the need for quality improvement.

The first phase corresponds to the initial stages of the systematic approach. When the first system emerged – Taylor system (in 1905), it established the requirements for the quality of products (details) as tolerance zones. It was afterwards tuned to the lower and upper limits of the tolerance zones, which are passable and impassable gages, in order to provide a successful application of the Taylor system. This resulted in the introduction of the first quality specialists called inspectors (controllers).

The motivation system provided penalties for defects and spoilage, as well as dismissal. The training system was limited to professional education and training on how to work with the measuring and control equipment. Relationships with suppliers and customers were built on the basis of contracts that included the requirements established in the technical conditions (TC), the fulfillment of which was checked during acceptance control (input and output).

All the above-mentioned features of the Taylor system evolved it the quality management system for each individual product.

The second phase. The Taylor system gave a great quality management mechanism for each product (details, build-up), but in order to produce something, it means that you need to have processes. And soon it became evident that there is needed to manage those processes.

Quality systems have become more complex as they incorporate services using statistical methods. The quality tasks, solved by designers, technologists and workers, became complicated, because they had to understand what variations and variability are, and also know what methods can be used to reduce them. This resulted in a new specialization - the quality engineer, who should analyze the quality and defects of products, build control charts, etc. In general, the focus from inspection and detection of defects was shifted to their prevention, by identifying the causes of defects and their elimination, based on the study of processes and their management. Given how processes have become more fine-tuned and how certain regulation and control cards are analyzed it has made employee motivation more complex. The training in statistical methods of analysis, regulation and control were added to most professional educations. The supplier-consumer relationship became more complex, and standard tables on statistical acceptance control began to play a large role in them.

The third phase. In the 50s of the last century, the concept of total (universal) quality control, TQC, was introduced. Its author was an American scientist - A. Feigenbaum. TQC systems were developed in Japan with more emphasis on the use of statistical methods and the involvement of staff in the work of quality circles. The Japanese themselves have long emphasized that they use the TQSC approach, where S is Statistical (statistical).

At this phase, documented quality systems appeared, establishing responsibility and authority, as well as interaction in the field of quality at the level of the entire management of the enterprise, and not just specialists of quality services.

Motivation systems began to shift towards the human factor. Material incentives decreased, while moral ones increased. The main factors for a high quality of work are teamwork, recognition of achievements by colleagues and board of management, the concern of the company about the future of the employees, their insurance and support for their families.

The supplier - consumer relationship systems were now also reliant on third party certifications. Furthermore, the quality requirements in contracts have become more serious and the guarantees of their fulfillment have become more crucial.

The fourth phase. In 70'-80's of the last century, the transition from total quality control to total quality management (TQM) began. The main scarcity in this phase was the lack of new methodological developments that could help quickly reorganize enterprises. The development

of the system of total quality management (TQM) was used to solve this. At this time, a series of new international standards for quality systems emerged, as an example, the ISO 9000 standards. They had a significant impact on management and quality assurance. The uniqueness of TQM lies in the fact that it focuses not only on the quality of the products produced, but also on the quality of all the processes carried out in the organization (Hellman, Pasi, Liu, Yang, 2013).

The TQM system is an integrated system, focused on continuous quality improvement, minimization of production costs and delivery on time. The basic philosophy of TQM is based on the principle that there is no limit for improvement. In relation to quality, the target setting is in effect - striving for zero defects, for costs - zero overhead costs, for deliveries - just in time. At the same time, it is realized that it is impossible to reach these limits, but we must constantly strive towards this and not stop at the results achieved. This philosophy has a special term - "continuous quality improvement".

One of the key peculiarities of the system is the use of collective forms and methods of searching, analyzing and solving problems, the constant participation in improving the quality of the whole team.

In TQM, the human role and the role of the staff training increases significantly. Training becomes total and continuous, accompanying workers throughout all their labor activity. The forms of training are changing significantly, becoming more and more active. So, workshops, special tests, computer courses, etc. are used. Learning becomes part of the motivation of employees.

A well-trained person feels more confident in the team, is capable of playing the role of a leader, and has advantages in his field of work. Special techniques are elaborated and used to develop the creative abilities of workers.

The fifth phase. In the 90's, the influence of society on enterprises intensified, and enterprises began to increasingly take into account the interests of the society. This led to the emergence of ISO 14000 standards, which set requirements for management systems in terms of environmental protection and product safety.

Certification of the quality systems to conform with the ISO 14000 standard is no less popular than the ISO 9000 standards. The influence of the human component on quality has significantly increased. The implementation of the ISO 14000 and ISO 9000 standards, as well as self-assessment methods based on European quality award models, is the main achievement of the stage characterized by the fifth phase.

Thus, it can be argued that quality management in an enterprise is a type of management activity that provides the design, manufacture and sale of goods with a fairly high degree of utility, safety and satisfaction of consumer needs.

4. Features of the application of ISO standards in small enterprises of Moldova

With the implementation of international quality standard systems, a universal comparison measure has emerged that allows us to assess which suppliers meet the minimum requirements and which do not.

It is usually considered that the ISO 9000 standards are applicable to all enterprises, regardless of their size, organizational form, affiliation to the industry, or service sector (Gassin, 2003). If, for large and medium-sized, export-oriented enterprises, voluntary certification is a predetermined procedural action, then small enterprises will weigh the costs and benefits of implementing a quality management system.

In Moldova, enterprises are divided into micro, small, medium and large, based on the number of personnel and sales revenue. Micro enterprises include companies with no more than nine annual employees on average and an annual income from sales of up to 3 million Lei. Small enterprises have an average of 10 to 50 annual employees and an annual income from sales of up to 25 million Lei (Law of the RM, 2016).

The most common misconception of small business managers is the relationship between quality, competitiveness, and enterprise management. Entrepreneurs are convinced that the main objective in business is to make a profit, thus increasing sales. Therefore, it would not be necessary to be concerned about the quality of the products if they are marketable and competitive. Such assumptions can cause problems: small businesses experience the short-term effect of a high profit-margin at the expense of producing a lesser quality product. Such a strategy is risky, as competitors are offering similar, higher-quality products. It is important to consumers that products suit their needs, and they are indifferent to the size of the organization from which the products were manufactured. The consumer demand for purchasing safe and quality products requires developing quality assurance measures.

A characteristic of small businesses, in addition to their size, is their strong hesitation towards standardization. The decision to introduce product certification for small enterprises, in our opinion, may be influenced by several internal and external factors.

External considerations:

- Markets continue to demonstrate their need for certified-only products, manufacturing, and services, regardless of the size of the supplier. It appears that over time, certification will be mandatory. Small businesses are characterized by mobility when entering the market due to their competitive advantages efficient response to demand, risk diversification, and management efficiency.
- The state policy aims to improve the competitiveness of domestic goods when Moldova joins the WTO. Competitive products that meet quality standards and other parameters can reach any market. In order for goods from Moldova to meet the requirements of other markets, it is necessary to apply global technical regulations in the Republic. Unfortunately, the transition in Moldova from the former mandatory standards to international technical regulations is still difficult due to the lack of funding resources.
- Improving the enterprise's public image, is an advantage when participating in competitions and tenders. To be certified as a small business that meets international technical regulations in Moldova is still quite rare.
- Domestic and foreign financial institutions see certification as risk mitigation for lending and investing. A small enterprise, often not possessing its own working capital, works on borrowed funds and depends on credit organizations more than medium and large enterprises. Here, the certificate can act as a goodwill for the company. Internal considerations:
- The successful implementation of quality management standards ensures the creation of a systematic gradual increase in business performance. In a small enterprise, growth can be sharp due to the increased visibility of business processes that need reengineering, leading to potential rapid and dramatic improvement.
- Thanks to the detailed procedures, a clear separation of increased participant responsibility in certified processes would be carried out. The disadvantage of a small enterprise is that the staff usually have a wide range of duties, many of which are often unregulated. The quality management system is focused on the identification of self-starting employees, on one hand, and their effective rotation, on the other, allowing duplicate tasks between employees to be eliminated. As a result, the overall manageability of the organization increases.
- According to statistics, introducing quality management systems reduces the rejection rate. The standard requirement is the implementation of phased quality control at all stages of the product's development life cycle. In some cases, a small enterprise is able to implement total quality control without significant costs for its implementation.
- The use of market research is a way to gain insight on what consumers are looking for in a particular product. Here, focusing not on the desire to sell what the company can produce, but rather the desire to sell what the customer needs, can lead to a breakthrough in market share. For Moldovan enterprises, ISO certification is important to improve the quality of their work, as they are striving to reduce spoilage, unnecessary costs, and downtime. ISO certification is not only applicable to commercial companies, but also to administrative institutions, hospitals and educational institutions.

ISO certification becomes more important when all or most business partners in one enterprise have introduced such a system, especially when this enterprise seeks to gain access to a new market or market share, which is more demanding than its current market(s).

In the Republic of Moldova, there is a quality infrastructure, which includes various bodies in the field of regulation of product quality control (Mini guide, 2018). The body responsible for Management Systems Certification (OCCM), accredited by the National Accreditation Body of Moldova (MOLDAC), provides the following services (Gidirimsky, L., 2019):

- management system certification, including information and planning sessions, document examination, auditing and tracking the nonconformities;
- training and seminars, in order to assure the quality of the management system's implementation;
- conducting the preliminary activities to the audit, in order to determine the level of preparation of company for evaluation;
- conducting the audits by second and third parties according to regulatory standards, other that mentioned before;
 - identifying process improvements, during risk assessment and observation visits.

5. Characteristics of indicators and stages of assessing the technical level of product quality

To control the product's quality and its improvement, it is necessary to assess the product's qualimetry. Evaluating a product's quality level is necessary to develop actions to control said product's quality assurance system.

The creation of assessment process contains the following: the quality indicators should be chosen for consideration, the methods under which they should be assessed, and by what margin of error should their values be determined, what resources will be needed for this, how to process and present the assessment's results.

The following indicators are used to group and identify said indicators underpinning the assessment process (Table 1).

Table 1 Product quality indicators

Technical indicators	Organizational indicators	Economic indicators
Price-agnostic competitive indicators		Price-reflecting competitive indicators
1. Reliability 2. Durability 3. Maintainability 4. Storage 5. Ergonomic features 6. Aesthetics 7. Technological indicators 8. Transportability 9. Standardization 10. Unification 11. Brevet-legal indicators 12. The environmental indicators 13. Safety indicators	1. Management Responsibility and Competence 2. Responsibility and qualification of workers 3. The level of organization of services responsible for the quality of manufactured products 4. Terms of delivery 5. Terms and Conditions of Warranty	1. The cost of manufacturers to create products of this quality. 2. Buyer's costs for the purchase and costs associated with the consumption of products for the entire period of its service 3. Post-warranty service costs 4. Training

Reliability indicators. Reliability is the property of a product (object) to preserve in time, within the established limits, the values of all parameters that are characterizing the ability to perform the required functions in specified modes and conditions of use, maintenance, repairs, storage

and transportation. Reliability is the property of an object to continuously maintain a state of serviceability for some time or some work.

Durability is the product's ability to maintain a state of serviceability until the onset of a limiting state, during the time the system of maintenance and repair is available.

Maintainability is the property of the product, consisting in its ability to prevent and detect the causes of failures, damage, to maintain and restore working condition through maintenance and repairs.

Storage is the product's shelf-life to maintain the values of reliability, durability and maintainability indicators during and after storage or transportation.

Ergonomic features characterize convenience and comfort of consumption (operation) of the product at the stages of the functional process in the "man-product-environment of use" system. Aesthetic indicators characterize the product's physical appearance as it relates to the integrity of its composition and the perfection of production performance. The evaluation of aesthetic indicators for products is carried out by an expert commission. The criterion for aesthetic evaluation is taken as a ranked (reference) series of products of a similar class and purpose, compiled by experts on the basis of basic samples.

Technological indicators characterize the properties of products, determining the optimal distribution of costs, materials, labor and time during the technological preparation of production, manufacture and operation of products.

Transportability indicators characterize the adaptability of products for transportation without using or consuming them. The most complete transportability is estimated by the cost indicators, which allow simultaneously to take into account material and labor costs, qualifications and the number of people involved in transportation works.

The standardization and unification indicators characterize the usage of products with standard, unified and original parts, as well as the level of unification with other products.

Brevet-legal indicators characterize the level of technical solutions' update, used in products for their brevet advocacy. Brevet-legal indicators represent a substantial factor in determining a product's competitiveness.

The environmental indicators characterize the level of harmful effects on the environment, which could emerge during the operation or use of the product.

Safety indicators characterize product features ensuring the safety of the person (attendants) with operation or consumption of products, installation, maintenance, repair, storage, transportation, etc.

Economic indicators characterize the cost of development, manufacturing, operation or consumption of products.

After the assessment, the production is referred to one of three levels:

Ø surpasses the world level;

Ø conforms to the world level;

Ø inferior to the world level.

The assessment results used throughout the development of new, upgraded products: the requirements for reference and regulatory documentation of a product; the decisions on the manufacturing process of a product; the need for the replacement or removal of older products; drafting proposals for export and import.

The small size of the enterprise, according to the authors, contributes to the implementation of effective organizational transformations required for the integration of the TQM. The following steps for implementing TQM in small enterprises are proposed:

1) The preparatory phase. The manager must create the prerequisites for the implementation of work methodologies required by the TQM. To do this, he creates a working group to develop documentation of the quality system. "Quality Policy" may be one of the documents. This document reflects the goals of building TQM, highlighting the processes that need to be controlled, as well as criteria for assessing their quality. The manager must then notify the employees of the decision to implement TQM.

- 2) The implementation of TQM should be considered as a complex and lengthy project (for a period of up to one and a half to two years). Therefore, the working group must carry out a number of tasks:
- A. Draw up a TQM implementation program, which should include: a description of the implementation stages; list of those responsible for each phase of the project, TQM implementation budget, procedure and indicators for assessing TQM implementation.
- B. Describe existing and develop new business processes that will be required in accordance with ISO. The scope of TQM should be determined. The best approach is to choose the main activity of the company and begin building the TQM for the main processes of production of goods and services.
- C. Develop regulations, documentation, and procedures to ensure the operation of the quality management system. The basis for them is usually an existing set of documents at the enterprise.

Once done, the project lead should familiarize the employees with regulatory documents on the quality system.

- 3) Obtaining a certificate. In order to certify TQM, you must apply to the certification body. The specialists or representatives of the certification body conduct an examination of the enterprise's quality system and, if it gains positive results from the audit, issue the enterprise a product quality certificate.
- 4) An Internal audit staff member of the enterprise should identify and then correct all the inconsistencies between the company processes, the work of employees and regulatory documents.

According to the authors, the complexity of the quality problem requires an integrated approach to the organization of the quality service in an enterprise. In this approach, it is advisable to include not only the party that carries out the quality control, but also other parties in the organization involved in the quality assurance and analysis field, as well as quality advancements and development.

6. Conclusions

The quality management is the management of processes that identify various discrepancies in products, in manufacturing or in the quality system and the elimination of these inconsistencies, as well as the reasons that caused these inconsistencies.

The experience coming from countries that have well developed market economies shows that quality is the main tool that allows you to: optimally spend all types of resources; reduce production costs and increase productivity, thereby contributing to the success of the entire organization; comply with all the requirements for the products; implement consumer needs into products; ensure mutual understanding and interaction throughout the chain, from the manufacturer to the consumer of products; continuously improve the processes of manufacturing, maintenance and management; ensure satisfaction of both producers and consumers.

An effective method of improving quality management in Moldovan enterprises is to follow the ISO standards. Their main goal is to ensure the quality of products required by the customer, and prove them that the enterprises are capable of following these standards. Alongside the fact that the government of the Republic of Moldova has created a quality framework, the executives in the small enterprises should take the matter of improving the quality of their products more seriously. Managers must work on changing the attitude and the commitment of their employees to the concept of TQM.

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Analysis of Personal Consumption in Croatia

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Abstract. Personal consumption is the most important component of aggregate demand, accounting for over half of its value. Through its influence on investment, savings and (un)employment, personal consumption has important multiplicative effects on GDP. The paper analyses historical movement as well as the structure of personal consumption in Croatia in comparison to other CEE countries as well as EU28 during the last two decades, including most recent 2008 crisis. Results indicate a tight relationship between GDP and personal consumption movement, explaining a decline in personal consumption during economic crisis. Households and NPISHs final consumption expenditure, as % of GDP, declined during crisis and, as a result, in 2018 per capita personal consumption still did not reach the 2008 pre-crisis value. Per capita personal consumption values in Croatia are comparable to its CEE counterparts, namely Poland, Hungary and Slovakia who also have comparable per capita GDP values. However, it should be noted that personal consumption in Croatia, as in other CEE countries, is mainly driven by bank loans and, simultaneously, aimed at imported goods. This type of personal consumption is not sustainable in the long run. Policy implications would indicate stimulating permanent income, as oppose to current, by stabilising GDP growth and employment possibilities.

Key words: personal consumption, household personal consumption by purpose, Croatia, CEE

1. Introduction

Personal consumption is a measure of national consumer spending indicating how much money citizens of a particular country spend on goods and services over a certain period of time. Indicating the national product/wealth employed directly to meet the needs of its population, personal consumption presents the most important part of gross domestic product (GDP) often considered as one of the most important indicators of economic development and the standard of living (Osei Bonsu, Muzindutsi, 2017). It has also been the crucial driver of aggregate demand as well as the real economic growth in most European post-transition economies (Dumičić et al., 2013). The share of personal consumption in GDP accounts for well over 50% indicating its importance (Jurčić, Čeh Časni, 2017).

Analysis of personal consumption in this paper implies the analysis of the trend of personal consumption values and its relative share within GDP as well as household budget allocations for various categories of personal consumption. The paper also includes comparative analysis in regard to other Central East European (CEE) countries, post transition members of the European Union (EU), which represent comparable economic systems. Therefore, the aim of the paper is to theoretically identify the importance of personal consumption

The paper is organized as follows: after explaining the importance of personal consumption in section 2, theoretical background as well as literature review are given in sections 3 and 4. Section 5 gives an overview of the data used in this paper followed by personal consumption and GDP analysis in Croatia and CEE countries (section 6). Finally, after analysing the structure of household personal consumption in section 7, concluding remarks are given in section 8.

2. The importance of personal consumption

The level of consumption usually reflects the standard of living while its size and structure depend on many factors, namely: economic development of the society, economic system, size and distribution of disposable income, natural resources and the possibilities for its exploitation, investment, population structure, economic exchange with foreign countries, the habits and preferences of consumers as well as many other factors (Jurčić, Čeh Časni, 2017). Consumption is a very complex social and economic phenomenon. Although primarily referred to as an economic phenomenon, other sciences including sociology, political sciences, demography etc. also analyse consumption often overestimating its psychological, political and/or demographical aspect (Dobša et al., 2011).

The importance of personal consumption is also related to its multiplicative effects on the overall economy. Consumer preferences are as equally important. Income can be either spent or saved, depending on the marginal propensity to consume (MPC) vs. marginal propensity to save (MPS). Consumer preferences also determine their consumption structure or which products need to be produced. If consumers prefer imported goods to those domestically produced this puts out a great challenge for policy makers. Customer preferences also signal which intermediate inputs need to be employed depending on the structure of their consumption, implying that a change in the consumption structure (or composition, or pattern) of households will cause changes in the GDP level and employment across occupations (Chen, 2015).

At a high level of economic development, the share of personal consumption is maintained at around 60% of GDP, while the value of personal consumption per capita grows significantly (Denona Bogović, 2002). The share of personal consumption in the distribution of each country's GDP amounts to more than 50%, and when it comes to the distribution of total world production, personal consumption accounts for more than 60%.

As stated earlier, the value and structure of personal consumption determine economic growth, GDP levels, production structure, standard of living and the quality of life. At different stages of economic development, the structure of personal consumption changes. Along with economic development of the country, the share of existential goods consumption declines (food and beverages, housing, clothing). At the same time MPC declines as the share of income households save starts to increase. This is why personal consumption analysis and research is extremely important. It allows us to understand its current state (including level and structure) as well as to predict its future movement (aggregate as well as per capita) and structure. This enables the employment of appropriate policy measures in order to steer personal consumption in the desired direction.

Personal consumption also largely determines other two basic macroeconomic aggregates: imports and government tax revenues. Its importance is especially pronounced in economic systems where value added tax (VAT) is the basic form of indirect taxes, as is the case in Croatia. In Croatia, VAT, customs and excise duties, which mainly depend on the movement of personal consumption, account for more than 50% of central government revenues (Lovrinčević, Mikulić, 2003).

3. Theoretical background

No single theoretical model fully explains consumption of the population. Among the models analysing population consumption factors, the following four are most represented: disposable income, prices of goods and services (that the consumer are willing to buy), consumer preferences, and the assumption that the consumer seeks to maximize consumer satisfaction, or maximize marginal utility (Jurčić, Čeh Časni, 2017). All of them sought to

explain the movement, or the causes of movement of consumption, covering its most proportion.

Consumption function, a key macroeconomic consumption concept, was first introduced by Keynes in 1936 in "The General Theory of Employment, Interest and Money". His consumption theory is popularly named Keynesian consumption theory or the **Absolute Income Hypothesis** (**AIH**). The idea was to create a mathematical relationship between disposable income and consumer spending on aggregate levels. According to AIH, personal consumption is a function of (current) income:

$$C = \alpha + \beta(Y-T) \tag{1}$$

where C represents consumption, Y is the income and T are taxes, therefore Y-T represents disposable income. α is autonomous consumption and β is the marginal propensity to consume (MPC). Disposable income can be used for consumption or savings. So 1- β represents marginal propensity to save (MPS). As MPS increases, MPC decreases, and vice versa. β value ranges from 0 to 1 with its value moving towards 1 as disposable income increases. Keynes excluded other possible determinants of consumption on grounds that they could not be covered qualitatively (Lovrinčević, 2000). For instance, he thought that short term interest rate effect on consumption was relatively unimportant and secondary (Čibarić, 2010).

Throughout the 20th century, statistical data quality increased and time series were prolonged. This enabled AIH theory testing and critiques of Keynes theory started to emerge. The research indicated that sometimes consumption increases even if disposable income does not (and vice versa!) which was impossible to explain using AIH (Ferber, 1953). This led the way to the development of modern theories stressing out the importance of wealth as a key determinant of consumption, as oppose to income.

Relative Income Hypothesis (RIH) was introduced by James Duesenberry in 1949 as an attempt to rationalize and explain the consumption data series as well as to reconcile contradictory elements of the AIH theory. His theory introduced consumer behaviour as well as consumer satisfaction maximization stating that consumer spending is related to the ratio of consumer income in relation to other consumer's incomes. In other words, the part of the income consumer spends depends on his percentile position within the income distribution. Additionally, Duesenberry stated that current consumption level is also influenced by previous consumption levels for it is difficult for households to promptly change previously attained consumption levels. Trying to maximize their living standard, Duesenberry indicates that consumers make consumption choices referring not only to their present income but also to their past income peak. Unlike AIH, RIH states that MPC decreases as income increases, and vice versa, which explained why in recession times decreases of consumption were not as underlined as decreases of income.

In an attempt to better understand consumer behaviour, RIH was soon to be replaced by **Permanent Income Hypothesis (PIH)** introduced by Milton Friedman (1957). The theory explains consumer intent to keep their consumption level rather stable over time, not fluctuating with income. Friedman believes that consumers make their consumer choices based on their long term income or a lifetime wealth, referred to as permanent income. So consumption depends on permanent income and permanent income does not depend on current income. MPC can therefore fluctuate under the influence of a number of factors; interest rate, consumer preferences, uncertainty etc. Permanent income is therefore defined as an expected long-term average income and is the primary consumption factor.

Finally, the **Life-Cycle Hypothesis (LCH)**, proposed by Modigliani and Brumberg (1954) is also based on consumer utility function where utility is derived as the function of aggregate lifetime consumption. By observing that consumers tend to save up during earlier working

stages of their lives in order to spend their saving as they retire, the authors concluded that consumers plan their consumption (and savings) over their entire life cycle with the key assumption being that consumers choose to maintain stable lifestyles. The latter indicates consumption levels to be rather similar in different life stages.

Finally, some policy implications can be drawn. According to PIH and LCH, countercyclical fiscal policy aimed at increasing current income, will not affect consumption level. Temporary income changes only result in temporary effects. The only fiscal measures that can be efficient in stimulating consumption (and GDP growth fuelled by consumption growth) are those who can boost permanent income, therefore, it is important for consumers to maintain and increase not only their disposable income but overall wealth. This is only possible by stimulating national production and employment and stabilizing long term real economic growth.

4. Literature review

After presenting the overall importance of personal consumption it comes as no surprise that personal consumption behaviour in Croatia has been a matter of interest to a number of researchers.

Denona Bogović (2002) analysed long-term characteristics of personal consumption in Croatia comparing them to personal consumption development in selected transition and developed countries. Her results indicate that a higher relative share of personal consumption in GDP accompanied by low per capita GDP indicates a lower level of economic development. Along with economic development, the share of personal consumption in GDP decreases, as well as MPC, with per capita consumption increasing. Finally, at a high level of economic development, the share of personal consumption in GDP stabilises while per capita consumption increases significantly.

Lovrinčević and Mikulić (2003) modelled personal consumption in Croatia (1970-2002) with Error Correction Model (ECM), using yearly household consumption and disposable income data as well as bank loan ratio in total consumption. They estimated average MPC for Croatia at 0,935 (or MPS being 0,065) and highlighted high consumption variations (calculated as standard deviations – SD) throughout the analysed period. Moreover, their results indicate the importance of bank loans in determining consumption.

Using multiple regression analysis Dumičić, Čeh Časni and Palić (2011) analysed short run determinants of personal consumption in Croatia (2002:Q1-2010:Q4). The results implied that wages and interest rates on housing loans play the most important part in determining personal consumption. In addition, their results revealed that total loans to households and housing price are also important, but to a lesser degree compared to wages and interest rates on housing loans. In a follow up study, same authors (Dumičić, Čeh Časni, Palić, 2013) employed an ECM in order to investigate shot term and long term behaviour of personal consumption in Croatia (2002:Q1-2010:Q4). Their results indicate that income (approximated by net real wage), house price and total credits to households play an important role in determining personal consumption. ECM estimates also suggested significant lagged house price values posing as an argument in favour of house price persistence.

Tica and Rosan (2014) used Johansen cointegration technique to test LCH in Croatia. Their variables included disposable income and aggregate net wages as proxies for income effect and CROBEX, hedonist housing index, net financial wealth and net savings of private sector as proxies of wealth effect. The authors concluded there was statistical evidence in favour of both income and wealth effect with former estimates being more robust than the latter.

Following the Engle-Granger cointegration and Johansen cointegration approaches, Bilas and Bošnjak (2015) found evidence of debt-financed consumption in Croatia (1996-2012). The

authors found empirical evidence for statistically significant, long-run and short-run levels of banking loans to private individuals' growth rate having an effect on the personal consumption growth rate in Croatia. Given the low competitiveness of the domestic economy, the research results raise questions regarding the sustainability of a banking business in Croatia which is mainly oriented toward lending to private individuals.

Jurčić and Čeh Časni (2017) analysed characteristics of personal consumption in Croatia in comparison to selected EU countries indicating the contribution of personal consumption to GDP in most recent post crisis recovery. The recovery of personal consumption was mainly a result of an increase in disposable income, increased foreign tourist consumption and low oil prices.

Finally, if other post transition CEE countries are taken under consideration, a few more papers are worth noting. Ciarlone (2012) used panel analysis to assess the impact of real and financial wealth on private consumption in 16 Asian and CEE countries (1995:Q1-2011:Q2). The results indicate that both real and financial wealth positively influence private consumption in the long run. Ciarlone (2012) also states the fact that real wealth effect on private consumption is more pronounced in developing economies in comparison to developed ones, while the opposite stands in developed countries, indicating the importance of financial wealth influence on personal consumption in the latter.

Using Vector Error Correction Model (VECM) Šonje et al. (2012) analyzed the relationship between housing wealth and personal consumption in: Bulgaria, Croatia, Estonia and the Czech Republic (1997:Q1-2010:Q1). Their analysis found evidence supporting the housing wealth effect in all four countries. The strength of the housing wealth effect is comparable to those of developed countries'.

In order to test the PIH, Čeh Časni (2014) estimated the impact of changes in the housing wealth effect on personal consumption using pooled mean group estimator of dynamic heterogeneous panel data on a sample of CEE economies, namely Bulgaria, Croatia, the Czech Republic, Estonia, Lithuania and Slovenia (1997:Q1-2012:Q3). The main result of the analysis is the statistically significant long-run and short-run housing wealth effect in the analyzed economies, with the latter being less pronounced than the former.

Finally, Radulescu et al. (2019) employed panel methodology to study growth effects of consumption and investment in CEE countries (2004-2017). Their results indicate a contribution of personal consumption to GDP growth in CEE region stating that long term real growth stimulated by consumption is not an option for CEE countries. It seems that significant public spending (for wages and social protection) boosted personal consumption with consumption being oriented on imports as oppose to domestic goods and services. This in turn increased international debt and economies couldn't generate significant employment effects. Government spending oriented on social protection and wages did not increase labour productivity. Moreover, savings rate in CEE is much lower than in developed countries with significant decrease of interest rates not stimulating savings. Both consumption and investment in CEE are based on bank borrowing posing a burden for the economies. This type of real growth is not sustainable in the long term.

5. Data

GDP and personal consumption quarterly data (by expenditure approach) as well as Household Budget Survey used in this paper were provided by Croatian Bureau of Statistics (CBS). Final consumption expenditure comprises of households and NPISH expenditure and government expenditure, marked in standard aggregate demand models with C (Consumption) and G (Government) respectively. Non-profit institutions serving households, abbreviated as NPISH, make up an institutional sector in the context of national accounts

consisting of non-profit institutions which are not mainly financed and controlled by government and which provide goods or services to households for free or at prices that are not economically significant. Examples include churches and religious societies, sports and other clubs, trade unions and political parties (Eurostat, Statistics Explained, 2020). For the purpose of this analysis we focus on real households and NPISH consumption (in 2015 prices, in millions HRK). For international comparisons we use World Bank as well Eurostat data.

The structure of personal consumption of households is expressed using 12 basic consumption categories by purpose (according to Classification of Individual Consumption by Purpose - COICOP). The classification of personal consumption by purpose classifies expenses into 12 basic groups: food and non-alcoholic beverages, alcoholic beverages and tobacco, clothing and footwear, housing and energy consumption (includes expenditures for rent, utilities, electricity, water, gas, home repairs, products and services for regular maintenance of the dwelling and the amount of imputed rent), furniture, home furnishings and regular maintenance, health, transport, communications, recreation and culture, education, restaurants and hotels, and other goods and services (CBS, 2019). The share of these groups in the personal consumption forms the structure of personal consumption.

6. Personal consumption and GDP

Figure 1 shows the trends of real GDP and real personal consumption in Croatia (2000-2019) indicating their close co-movement. It is also evident that personal consumption, as theoretically expected, makes up a large part of GDP, round 60% on average, largely explaining their close co-movement.

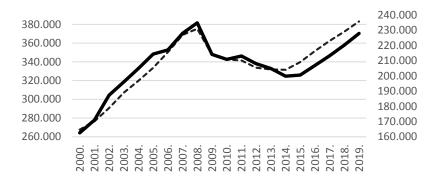


Figure 1: GDP (dashed line, left axes) and final consumption expenditure - households and NPISH (full line, right axes), in constant prices, reference year 2015, in millions HRK

From the beginning of the millennia (even earlier on) GDP and personal consumption increased substantially. The particularly strong growth of personal consumption as early as 1997 can be explained by the end of the war and the recovery of consumption, as well as by the opening of markets enabling strong consumption growth mainly from imports (partly due to the inadequate structure of domestic supply). Extensive supply of banking loans to consumers, due to the opening of the economy and the change in consumer preferences, were primarily used for purchases of imported durable consumer goods (Nestić et al., 2001). With the occurrence of the crisis in 2008, both GDP and personal consumption declined sharply. Their recovery started at the end of 2010, but then the crisis deepened until the end of 2014. It is important to note that GDP started to increase much earlier than personal consumption did. Personal consumption reacted to the exit from the crisis four quarters later (at the end of 2015) still not reaching its pre-crisis level in 2019, as oppose to GDP. A growing trend in personal consumption (from 2015 onwards) reflected the effects of continued employment

and wage growth and household lending growth with a further increase in the consumer confidence index (HNB, Makroekonomska kretanja i prognoze, 2019).

The long lasting crisis in Croatia resulted in GDP levels returning to their pre-crisis level after a decade, in 2018. The economy is now facing yet another global crisis, boosted by the global COVID-19 pandemic. This is why it is important to compare how well the Croatian economy did during the crisis compared to our CEE counterparts (the Baltic states are excluded from the analysis).

An economic crisis implies a decline in GDP accompanied by an increase in unemployment, an increase in illiquidity, a decrease in investment activities, falling property prices, etc. Due to the decrease in disposable income, there is also a decrease in real household consumption (Buterin et al., 2019). An unforeseen economic crisis strongly influences consumer behaviour influencing their spending decisions. An economic crisis has an impact on personal consumption, especially over a longer period, because consumers do not experience a crisis momentarily. Consumers change their habits over time and this transition towards new consumption levels and patterns is slow and smooth, as stated earlier on by consumption theories. Crises periods induce consumers to rationalise their spending and savings decisions, to spend less and save more.

Comparing data (please see Figure 2 and Figure 3) on GDP and personal consumption in Croatia to other CEE countries it is obvious that no other CEE country experienced such profound and longlasting crisis reflecting both on GDP and personal consumption levels.

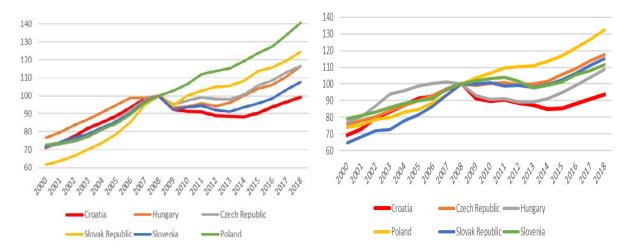


Figure 2: World Bank, World Development Indicators, GDP (constant 2010 USD, indexed, 2008=100)

Figure 3: World Development Indicators, Households and NPISHs Final consumption expenditure (constant 2010 USD, indexed, 2008=100

As a result, Croatia is the only country where personal consumption (in 2019) still hasn't returned to its pre-crisis level. The beginning of a new, COVID-19 pandemic induced, crisis in 2020 means that personal consumption in Croatia will not be reaching it's 2008 level for quite some time now. Even Hungary, who experienced severe fiscal challenges uppon the beginning of the crisis, did better than Croatia. The best example, by far, is the case of Poland, the only CEE country that experienced almost no negative consequences from the 2008 crisis. Another analysis worth noting is the comparison of per capita household consumption (Figure 4) as well as the consumption to GDP ratio (Figure 5). Figure 4 presents per capita

consumption data for Croatia, Czech Republic, Hungary, Poland, Slovak Republic and

Slovenia (2000-2018). Slovenia has had the highest levels of per capita consumption throughout the whole period with Czech and Slovak Republic reaching Slovenian per capita consumption from 2000 at the end of the analysed period (two decades later). Poland, who exhibited the best macroeconomic performance, as well as consumption growth, had the lowest per capita consumption at the beginning of the analysed period. Its per capita consumption almost doubled till 2018 but was still far from Slovenian per capita consumption levels, as were other CEE countries. As far as Croatia is concerned, it is obvious that Croatian citizens experienced the most pronounced drop in per capita consumption from 2008 onwards. This is why at the end of the analysed period only Hungary had lower per capita consumption than Croatia.

As for the percentage share of consumption in GDP (Figure 5), it is evident that the share of consumption in GDP in Croatia first increased from the beginning of the crisis, and then decreased. The reason for this is the pronounced drop in GDP while household consumption adjusts much slowly to GDP variations. It is also important to note that, other than Poland who also had rather low per capita consumption, Croatia has the highest share of consumption in GDP. This indicates that real economic growth is dependent on personal consumption slightly more than in other CEE countries (with the exception of Slovenia). All observations fit theoretical background and the conclusions of Denona Bogović (2002).

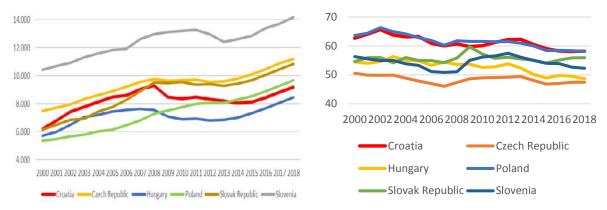


Figure 4: World Development Indicators, Households and NPISHs Final consumption expenditure per capita (constant 2010 US\$)

Figure 5: World Development Indicators, Households and NPISHs Final consumption expenditure as % of GDP

Since 2013 private consumption increase, in CEE as well as in EU28, has been related to positive movements of household income and wealth. As for Croatia, consumption growth was notably stimulated by banking loans to households up until 2008 (primarily housing loans). According to Croatian National Bank data (CNB, 2020), after 2008 household indebtness remained stable and even decreased from 2015 to 2018 (despite a substantial drop in bank loan interest rates) indicating that the recovery of personal consumption after the crisis was not primarily a result of household indebtness.

7. The structure of household personal consumption

A number of studies focusing on aggregate personal consumption neglect the structure of consumption assuming that the structure does not change or that it changes very slowly. However, studies have shown that the share of consumption on various goods and services changes systematically along with income change (Deaton, Muellbauer, 1980). Foellmi and Zweimüller (2005) also stated that many important economic problems (such as the inequality

and growth interdependence) need to be rethought once the structure of consumption is taken into account.

Figure 6 indicates household expenditure by consumption purpose (COICOP, % share of total) in Croatia in 2009 and 2017, and EU28 (in 2018). Comparing the data for Croatia (2009 to 2017), it is evident that the share of household consumption on food and beverages has decreased while the share of consumption on transport has increased. Housing and energy consumption costs have also increased in share. Transport category includes expenditures on purchase of vehicles and spare parts, expenditures on vehicle repairs, purchase of fuels and expenditures on public transport. The consumption of durable goods (namely vehicles) varies substantially over the business cycle (ECB, 2018). Purchases of new vehicles in Croatia were reduced by over 60% from 2008 to 2013. The recovery started in 2013 but the number of 1st registrations still did not reach 2008 levels by 2018. The structure of purchases was also changed with imported second hand vehicles making up more than 50% of 1st registrations in 2019 (Lolić Čipčić, 2020). The increase of consumption share in this category is mainly a consequence of an increase of expenditures on vehicle repairs and fuels.

Comparing Croatia to EU28, it is noticeable that food and beverages take up almost 30% of total consumption in Croatia while the average share in EU28 is barely 12%. On the other hand, the most important consumption category in the EU28, as is typical for developed EU countries, is housing and energy consumption accounting for almost 25% of total household consumption. This consumption share is far less in Croatia. It is important to note that the data for EU28 was retrieved from Eurostat and for Croatia from CBS, with expenditure data for this group not including imputed rent for Croatia (as oppose to EU28). Imputed rent expresses the assumed amount of the rent that a household that lives in its own dwelling would have paid if it had rented the same type of dwelling for its needs (CBS, 2019). At the same time in EU28 (in 2016) a majority of people are owners of their dwellings (69.3%). Croatia has the 3rd highest share of the population owning their dwelling (90.1%), possibly violating the comparison of data.

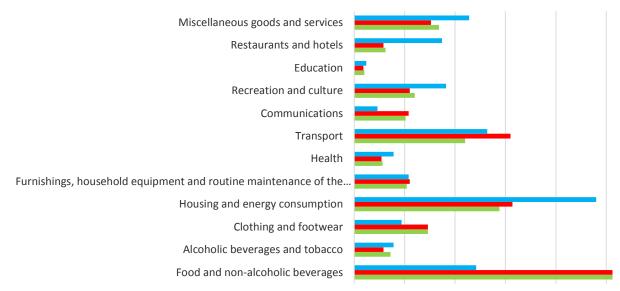


Figure 6: Eurostat, Household expenditure by consumption purpose – COICOP, % share of total and Croatian Bureau of Statistics (2019). The Household Budget Survey, Basic characteristics of household consumption in 2017

Finally, another look at Figure 6 indicates a larger share of consumption on recreation and culture as well as on restaurants and hotels in EU28, as oppose to Croatia. This is a consequence of lower per capita consumption in Croatia, leaving less space for these types of activities.

A closer look at the structure of household consumption revealed that still a great deal of household income is used to consume existential goods and services, primarily food and beverages, indicating rather low per capita consumption in Croatia in comparison to EU28 average.

8. Conclusion

The paper analysed personal consumption in Croatia in terms of its value and structure over the past two decades in comparison to other CEE countries and the EU. After indicating the importance of personal consumption in the economy, a brief theoretical background was given, followed by a literature review of papers who researched personal consumption, its structure, value and drivers in Croatia and other CEE countries.

Our analysis revealed a that the crisis started in 2008 resulted in a great drop in personal consumption as well as GDP, unlike in any other CEE country. This is why by 2019 personal consumption still hadn't reached its pre-crisis level. This is also the reason why per capita personal consumption in Croatia, decreased and started increasing as late as 2015, much later than in other CEE countries. The structure of household consumption also reveals the prevailing importance of consumption on food and beverages indicating there is still much room for improvement i.e. economic development that would lead to a diminishing share of existential goods and services in final household consumption.

As for the drivers of consumption, despite almost non-existent time series on household disposable income and wealth, there are studies that tried to measure the income and wealth effect in Croatia as well as personal consumption drivers. Private consumption in Croatia and other CEE countries is, on average, based on bank loans to private citizens. This potentially endangers economic stability in this region. Additionally, growth rates from the past five years could not be supported in the long run (even without COVID-19 pandemic crisis) for they generate high indebtedness burden.

Finally, presented theories and research results indicate that people make consumption choices based on their permanent income (which is not a statistical category) and not their current income so all fiscal measures aimed and stimulating consumption will not have any effect in the long run. Households and individuals aim to maintain (and increase) their current level of consumption by adjusting their expectations about the future based on how much they think they will be earning in the foreseeable future. This explains why, in the long run, the only sound basis for an increase in personal (per capita) consumption is healthy economic growth based on aggregate demand towards domestic production and healthy exports. Research also supports the need for institutional reforms because political and economic institutional factors, such as corruption perception index, play a key role in impacting both per capita GDP and unemployment rate. In order to steer personal consumption in the desired way, policy measures need to be aimed at fighting corruption and reforming and stimulating labour productivity in the public sector. Apart from that, policy measures should be aimed at empowering domestic small and medium enterprises and aiming domestic demand towards their goods and services.

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Health Tourism in the Republic of Croatia: State of Play and Oppurtunities for Improvement

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Abstract. Health tourism is a special type of tourism and is considered the fastest growing form of tourism globally with growth rates of up to 20 percent annually. Since tourism presents the largest share of Croatia's GDP, it is important to adapt to the trends in the demanding tourism market, as Croatia's competitiveness and its overall development depend on it. For this reason, it is necessary to develop new and existing tourism products and services, thus enhancing Croatia's competitivenessHealth tourism is aimed at increasing the quality of life and improving the health status of guests who visit certain destinations due to the specificity of climate, environmental, nutritional and social factors. Although Croatia has all the prerequisites for the development of health tourism, such as the abundance of resources of coastal, island, lowland and mountainous, price competitiveness, a long tradition of health resorts, quality medical staff, tourist attractions of the destination, proximity to major eminent markets and good road connectivity, the development of this type of tourism is not significant. The analysis will explore the opportunities and perspective for the health tourism development in the Republic of Croatia, taking into account available resources using different sources of funding. Taking into account that health tourism is a growing industry in the European Union, examples of good practice from selected Member States will also be presented.

Key words: health tourism, source of funding, wellness tourism, medical tourism

1. Introduction

Health tourism is a complex tourism product that presents a large number of specialized travel facilities and services motivated by the need to promote health and improve quality of life. The Tourism Development Strategy of the Republic of Croatia until 2020, as well as the National Health Development Strategy of Croatia 2012-2020, but also European Commission documents recognize three forms of health tourism: wellness, treatment center and medical tourism. Croatia has 222 sites with favorable potential conditions for the development of health tourism, of which only 10% are in exploitation within 18 organized health centers.

Spa tourism in Croatia is the oldest and still very significant segment of health tourism. The spa centers are almost all located in the Continental Croatia and represent a respectable tourist offer and a great resource potential for the development of continental tourism. Good examples of such developments can be seen in some neighboring countries whose standards have generally not yet been reached by Croatia. Croatia has a respectable tradition of thalassotherapy centers on the Adriatic coast and wellness centers have been developing competitively in the regional environment over the past ten years. In addition, in recent years the number of specialized private healthcare institutions has been increasing, which forms the basis for the development of medical tourism. Health tourism is also recognized as one of the key tourism drivers in the Croatian Tourism Development Strategy until 2020, and one of the measures of the National Program - Health Tourism Development Action Plan.

Although health tourism is recognized as a significant development potential in the Tourism Development Strategy 2020, 'Sun and Sea' is still a dominant tourism product in Croatia, and also the main cause of the pronounced seasonality of Croatian tourism (according to the Croatian Bureau of Statistics in 2019, occupancy rates of permanent beds ranged between 75% and 98% in the summer months, while the other months presents a large decline shown in the table 3). Nowadays, the sun and the sea are not enough motives to meet the new demands of the customers and increase the competitiveness of Croatian tourism, so it needs to be combined with other tourism products.

According to the results of the Travel and Tourism Competitiveness Report 2019, Croatia is ranked 27th in the world, therefore Croatia improved its ranking by five places compared to last year's results. There is a noticeable lag in comparison to other tourist developed countries of the Mediterranean, such as France, Spain and Italy.

Given the trend of population aging, but also the growing orientation towards 'healthy living' and health prevention, it is expected that health tourism will be one of the main motives for travel in the future. In this sense, specific success factors for health tourism products relate to the quality of specialized health centers / institutions, the quality of the accompanying tourist offer and the development of the overall destination. Current data from the European Commission's 2019 survey indicate that there were 19% of the population over the age of 65 in Europe in 2015, and their share is projected to increase to 32% in 2060, or about 1/3 of the population. Furthermore, the development of a well-being society with a growing middle class that has sufficient income and free time for health-motivated travel is another reason for the potential expansion of health tourism.

According to aforementioned, the research problem is focused on the underdeveloped health tourism sector in the Republic of Croatia and a significant lag behind the surrounding countries.

The goal of this research therefore is to define the state of play of health tourism in Croatia. The analysis will show the possibilities of development of health tourism in the Republic of Croatia using available sources of financing from EU funds. Furthermore, the development of health tourism in the European Union will be explored and good practices will be presented. This is followed by a description of the current situation, synthesis of information, recommendations of the necessary development guidelines and conclusion remarks.

2. Literature review

Health tourism is a combination of medical and tourism services. It is a combination of health treatments, hotel and other services in a tourist destination. The concept of medical tourism has evolved a step further than the classic concept of health tourism, spas and SPA centers, whose roots extend far into the past. The term "medical tourism" represents a wide range of sophisticated and high quality medical services (Favis-Villafuerte, 2009).

According to the calculations based on research by the European Commission, the total size of the European market for health tourism is equal to 56 million domestic arrivals and 5.1 million international arrivals (from all over the world), for a total of 61.1 million arrivals. The total market of health tourism makes up for 4.3 per cent of all the EU arrivals, 5.8 per cent of the domestic ones and 1,1 per cent of international arrivals (European Commission, 2018). Similar estimates are based on Deloitte's report on medical tourism, quantifying the number of people traveling abroad for healthcare between 30 and 50 million each year (Keckley and Underwood, 2008). It has been growing at 12-15 percent annually, according to research from PwC. At the EU level, the turnover generated by health tourism is around 2 billion Euro, and could further grow (Directive 2011/24/EU of the European Parliament and of the Council, 2011). Health-tourism revenues total approximately €47 billion, which represents 4.6% of all tourism revenues and 0.33% of the EU28 GDP.

At the global level, health tourism is an industry with an annual growth of 3.9 per cent annually and worth 513 billion dollars (Carrera and Bridges, 2006).

According to the latest Global Wellness Tourism Economy (2018), wellness tourism grew from a \$563 billion market in 2015 to \$639 billion in 2017, or 6.5% annually, more than twice as fast as tourism overall (3.2%). It's forecast to grow even faster through 2022 (7.5% yearly), to reach \$919 billion.

Although it is difficult accurately estimate the total size, the health toursim has grown substantially in the past decades as citizens of the EU travel from richer countries like the United Kingdom, Sweden, Germany, Netherlands, and Ireland to seek affordable healthcare in other countries, primarily in Eastern Europe.

Table 1. The most popular health tourism services in Europe

Medical tourist	n	Wellness	
- Cosmetic surgery	25% - 34%	Most popular traditional programs:	
- Dentistry	30% - 50%	- Body treatments	
- Orthopedic surgery	7%	- Sports and fitness	
- Obesity treatments	7%	- Saunas	
- IVF treatments	3% - 6%	- Yoga and meditation	
- Ophthalmic surgery	3%	- Nutrition and detox	
		Popular 'next generation' programs:	
		- Holistic 'body-mind-spirit' programs	
		- Healthy Eating, Personal Learning Programs	
		growth, quality of life, etc.)	
		- Physical challenge (eg triathlon, cross-fit, etc.)	

Source: Mintel, Health and Wellness Tourism in Europe, 2014

Wellness demand is defined by a system of values in which care for health, maintenance of physical and mental capacity, learning about advancement and lifestyle change are extremely important. Factors affecting the decision to travel to another country for treatment most often include significantly lower costs of surgery, long waiting lists in the domicile country, and the risk of poor quality medical services or lack of quality healthcare institutions in the domicile country.

According to available data, three leading receptive destinations in the world are Malaysia, the US and Thailand, while Europe's leading destination is Poland. An interesting example of medical fourism is South Africa, a well-known world destination for medical tourism which is specialized in the so-called "medical safari". In this special form of tourism, the use of medical services is combined with safari (Puri and Singh, 2010).

The seasonality of health tourism differs from general tourism and tends to be less pronounced. Health tourism actually helps counter average seasonality in tourism as a whole. The share of health tourists arriving from outside the EU amounts to an estimated 6%.

Tomas Health Tourism 2018 Survey - Attitudes and Consumption of Health Tourism Users in Croatia provides data on tourism demand for health tourism in Croatia for three major demand segments: wellness, health and medical. The study which included 1,331 respondents from seven countries, stated that the most important motive for using wellness services was relaxation or (79%), followed by stress relief (27%). Every tenth user of wellness services on the trip uses wellness facilities or goes for massages and at the place of permanent residence. The spa segment is motivated primarily by physical therapy services (44%) and rehabilitation (28%), while dental interventions are the dominant motive for travel in medical tourism (56%).

Furthermore, the Institute for Tourism conducted a survey of the perception and opportunity of Croatia as a health tourism destination. In total, 24 interviews were conducted, 12 of which were with agencies in foreign markets and 12 with domestic agencies and providers of health

and tourism services. In analyzing the results of the aforementioned research, Croatia is generally recognizable and positively perceived holiday destination in the observed markets except in the United Kingdom. Based on the aforementioned research, Croatia has not been recognized as a favorable destination for health tourism in the United Kingdom based on surveys of individuals and agencies that do not have sufficient information about this form of tourism and its development in Croatia. In Italy, Croatia is a coutry famous for dental tourism. Recent Ipsos survey, conducted on a sample of more than 18,000 respondents from 24 countries around the world, says that approximately 18% of respondents would consider using a medical service (including dental care) outside their own country if it were financially more affordable. If we put the percentages in question with the total population of the countries surveyed, we reach a theoretical potential of hundreds of millions. However, if we look at the results of the study in question, we can conclude in principle that the hypothetical demand for medical services outside one's own country is significantly higher in the countries of "emerging economies", ie less pronounced in "traditional" economies.

3. Research Methodology

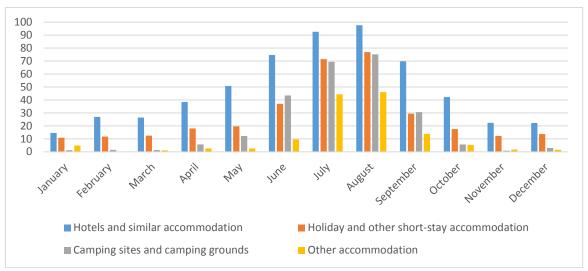
The research methodology is based on desk research, which mainly consisted the collection and analysis of available data and secondary sources of data collected from national strategic documents and European Commission documents. Various methods were used, including as follows: regulatory, statistics, economic analysis; induction and deduction, instruments and methods of economic research, such as statistical and economic comparison.

This paper will explore the possibilities for the development of health tourism in Croatia as well as the possibilities of financing projects from the EU funds: European Regional Development Fund, Cohesion Fund, European Social Fund, Agricultural Fund for Rural Development, European Fund for Strategic Investments.

4. Health tourism in Croatia – state of play

The Republic of Croatia owns numerous preconditions that are crucial in the development of health tourism. The favorable climate, good geographical location, high quality of professional staff and low cost of medical intervention make it a very interesting destination for the rest of the world. High potential for development have a dental, orthopedics, physiotherapy and thalassotherapy especially after Croatia's accession to the European Union thus allowing foreign tourists / patients to reimburse their costs from their insurance company. A lot of potential investments are focused on development in the area of continental Croatia, which could thus ensure a longer and more fulfilling season. Croatia is surrounded by very strong competitors, including neighboring Slovenia, Hungary and Austria, which have also made significant investments in this sector over the past twenty years. Moreover, medical tourism is becoming a focus of investments in CEE countries, such as Poland, Czech Republic, Romania, Bulgaria, but also in Turkey.

Economic and political instability at the global level and in the European Union, new conditions of the international environment as well as the dynamic changes in consumer demands in the global tourism market indicate the need to modernize the current model of tourism development in Croatia, which primarily refers to over-concentration on summer resort and a high degree of seasonality. Croatia belongs to countries that attract more visitors to the features of its natural area and rich cultural and historical heritage than to the quality, availability and diversity of newly created tourist attractions, as shown in the table below.



Source: Author's research based on Croatian Bureau of Statistics, 2020

Croatia is a typical example of a mature tourist destination dominated by a single product ('sun and sea') with high seasonality, which is characteristic of the Mediterranean and Adriatic countries. While other Mediterranean and Central European tourist destinations began to restructure in the mid-1980s in line with changes in tourist behavior, Croatia entered a period of breakup of the former state that lasted from 10 to 15 years, which greatly slowed down the processes of modernizing Croatian tourism. There are too few reasons (products and services) for traveling and staying in Croatia outside the summer season, due to lack of entrepreneurial interest and due to development and business barriers and insufficiently managed processes by the public sector.

The health tourism offer in Croatia is a complex set of wellness, spa and medical tourism providers in the private and public sectors. Almost the overall wellness offer, smaller number of spas and a significant part of the medical tourism offer is predominantly privately owned, representing a market-oriented, mostly vital small and medium-sized enterprise. Special hospitals, spas and large hospital systems are part of the public health system and are focused on the beneficiaries of the State Health Insurance Institute. They possess most of the natural healing waters such as thermal waters and naphthalene. According to their size and expertise, they are key factors in the credibility and recognition of Croatia's health tourism offer.

The health tourism offer consists of a wellness offer with over 80 hotels of higher categories and spas that include accommodation services. The most prominent is Terme Tuhelj, Terme Jezerčica, Sv. Martin and Lesce. About 60 wellness centers are located on the Adriatic, while the spa is located in the northern part of Croatia. Spas are often combined through cooperation with medical institutions, for example Terme Sv. Martin and the Lumbalis Spine Center, where Salt Room, Halotherapy and many other spine remedies are offered.

The total contribution of Croatias`Travel & Tourism to GDP in 2019, was 24.9% of GDP and it is forecasted to rise by 31.7% of GDP in 2028. This is a significantly larger share of GDP when compared to other European countries. At the same time, in 2017, Travel & Tourism directly supported 326,3 jobs (23,3% of total employment) and it is expected to fall down to 323,9 jobs in 2029 (WTTC 2019).

The Tourism Development Strategy of the Republic of Croatia until 2020 (OG 55/2013) positions spa tourism as a major factor in Croatia's health and tourism offer, with the assumption of ensuring differentiation of spa destinations and a significant improvement in their quality. Health tourism is also seen as an interdisciplinary area in the National Strategy for the Development of Health in Croatia 2012-2020. (OG 116/2012). In order to further develop health tourism, the Institute for Health Services in Tourism (OG 116/2014) was established

within the Ministry of Health in 2014 as an organizational unit competent for performing professional tasks related to health, medical and wellness tourism and in general for health services in tourism.

Table 3 Health tourism providers in Croatia

FOOD AND RESTA	URANT FACILITIES	HEALTH INSTITUTION				
Wellness offer	Natur	al spas	Clinias / Hasnitals			
(hotels, spa)	Spas	Special hospitals	Clinics / Hospitals			
Hotels:	– Topusko spa	 Varaždinske Toplice 	Public health institutes:			
- About 80 hotels with	- Top Terme, Topusko	 Stubičke Toplice 	 Clinical hospital 			
wellness facilities	 Bizovačke Toplice 	 Krapinske Toplice 	centers (5)			
Spa (with	– Veli Lošinj	 Daruvarske Toplice 	– Clinical hospital (3)			
accommodation):	 Istarske Toplice 	– Lipik	– Clinics (5)			
– Terme Tuhelj		- Naftalan, Ivanić Grad	– General hospitals (20)			
 Terme Jezerčica 		- Thalassotherapia,	– Polyclinic			
- Terme Sveti Martin		Opatija	Private Health			
– Toplice Lešće		- Thalassotherapia,	institutes:			
		Crikvenica	- About 800 subjects;			
		– Kalos, Vela Luka	Larger:			
		– Biokovka, Makarska	– SH Sv. Katarina			
			– SH Akromion			
			- SH Dr. Nemec			
			- MagdalenA Clinic			
			– Medico Clinic			

Source: Action Plan for Health Tourism Development

The largest part of the hotel's wellness offer (approximately 60 wellness centers) is located in the Adriatic. Their offer typically includes facilities such as massages, beauty treatments, saunas, pools and fitness. Swimming pools at hotel wellness centers on the Adriatic are mostly filled with seawater. Offering a variety of wellness packages that combine wellness center services with diet regime, exercise, aromatherapy or similar offer is very common.

The spa tourism offer includes medical rehabilitation based on the use of natural healing factors and is based on the facilities and services of special hospitals and a small number of spas. Most special hospitals and spas are located in the continental part of the country and they use thermal springs and mineral oils (naphthalene) in their treatments, while a smaller number of them located on the Adriatic coast focus on the use of medicinal mud, sea, air and climate as healing factors. Regardless of their location and differences in the use of natural resources, special hospitals are specialized in all kinds of rehabilitation (such as cardiovascular, respiratory, neurological, orthopedic, locomotor and / or dermatological diseases).

Medical tourism in Croatia is related to the offer of a growing number of specialized private healthcare institutions. These are mainly medium and small-sized clinics specializing mainly in dentistry, plastic surgery and dermatology, IVF, ophthalmology, orthopedics, physical medicine and / or rehabilitation, although there are also few larger private polyclinics with a broader range of activities (eg Medico, Rijeka) and specialized clinics (eg Magdalena Clinic for Cardiovascular Diseases) and special hospitals (eg Dr. Nemec, Akromion, St. Catherine).

The current market position of medical tourism in Croatia is determined primarily by the individual efforts of private clinics to break through the market, affordable prices for internationally acceptable quality in several areas of medical expertise, and the credibility of staff and equipment. At the Croatian level, the supply of medical tourism is still sporadic, insufficiently diversified, relatively unorganized and poorly recognized. Therefore, Croatia is not yet an internationally recognized destination for medical tourism.

However, the Health Tourism Sector of the Ministry of Health has identified development investment projects of health institutions called "Health Tourism Investment Program".

The catalog of health tourism projects is intended for potential investors and stakeholders of health tourism in order to provide information on investment opportunities in projects of special hospitals for medical rehabilitation and spas. Although all spas and special hospitals make significant efforts to adapt their offer to the needs of the health and tourism market, the standard of quality of accommodation and accompanying hospitality and recreational facilities generally does not meet the expectations of international tourist demand. The offer of special hospitals and spas in Croatia is not competitive in today's extremely demanding health and tourism market, despite the efforts of several institutions. The current scenario can only be improved by increased investment in the modernization, in particular, of the accommodation facilities offered by most Croatian specialty hospitals and spas. Significant new investments are needed in the reconstruction of the existing accommodation offer, but also in the construction of new health facilities and new hotel facilities.

5. Opportunities for improvement using different sources of funding

This chapter will present available source of EU funding with emphasis on the tourism sector. Furthermore, it will provide project examples under the current multi-annual financial framework and outline EU funds that can be used by potential beneficiaries in the health tourism sector.

Table 4 Available source of funding from EU funds 2014-2020

Fund EU FUNDS European Fund for Regional Development	Total budget for Croatia (in billion EUR)	Small and medium enterprises, research centers, local and regional authorities, schools, corporations, training centers, government, universities, associations	Support for small and medium-sized enterprises, innovation and research, digital agenda, low-carbon
Cohesion Fund	3,011	Public authorities (opportunities for the business sector are opened through participation in public procurement procedures for the delivery of goods and services, and the carrying out of works such as various studies, construction works and the like)	Infrastructure projects, environment
European Social Fund	Public administration, businesses, NGI		Promoting employment and supporting labour mobility, promoting social inclusion and combating poverty, investing in education, skills and lifelong learning, enhancing institutional capacity and an efficient public administration
European Agricultural Fund for Rural Development	2,383	Agricultural beneficiaries, agricultural organizations, associations and trade unions, environmental associations, organizations providing services in community culture, including the media, women's associations, farmers, foresters and young people	Promoting social inclusion, poverty reduction and rural economic development, fostering knowledge transfer and innovation in agriculture, forestry and rural areas

INVESTMENT PLAN FOR EUROPE										
European Fund for Strategic Investments	over 500,000	EFSI is directed at financing projects with higher risk levels than projects eligible for financing in common business transactions. Projects valued at over 50 million euros are eligible for direct EIB financing with EFSI gurantees, whereas SME and MidCap projects valued at up to 50 million euros are financed through financial intermediaries operating in the Member State concerned under EIB's Infrastructure and Innovation Window (IIW) and Window for Small and Medium Enterprises (SMEW).	Investment into high risk profile projects in the areas of research, innovation, energy, transport and social infrastructure, education and science, and with extenuation of EFSI these areas were extended to include agriculture, fisheries, forestry, as well as climaterelated measures.							

Source: Author's research

With the accession of the Republic of Croatia to the European Union, numerous opportunities have been opened for investments projects from EU funds. In the multiannual financial framework 2014-2020, the Republic of Croatia received more than EUR 10 billion at its disposal to finance development projects, including projects in health tourism. The Member State is obliged to adopt Operational Programs which need to be approved by the European Commission. In order to be aligible to use EU funds, Member State shall determine the priorities for investing sources of funding in accordance with the needs and strategic development plans. Croatia is currently in the process of negotiating for the next multiannual financial framerwork 2021-2027, so it is necessary to have sound quality negotiations with the EU Commission and wisely set goals and priorities for investing new funds for the next seven-year period. Health tourism projects can be financed from all the above mentioned funds (Table 4), so it is necessary for the government to recognize the importance of this sector and already include strategic projects in operational programs, which must subsequently be approved by the European Commission in order to be eligible for grants and financial instruments.

In order to gain clearer insight into the type of projects that can be financed from individual funds, examples of funded projects in Croatia and EU Member States will be presented below.

Examples of project funded by the ERDF:

Krimml Waterfalls Used for Health Tourism Development (Austria)

In 2006, the University of Salzburg established a science laboratory near the Krimml Falls to study the highly concentrated water-producing aerosol when it hits the ground. This natural aerosol has been shown to have good effects in people suffering from asthma or allergies: a daily walk near the waterfalls lessens the symptoms and the positive effects last for several months. Together with other local features (low pollution, low levels of fungal spores and short flowering season) make this part of the national park an ideal place for healing.

Eleven local hotels were required to implement renovation/adaptation measures in order to become eligible for certified anti-allergy rooms offer. Collaboration with a regional hospital has also been developed in order to help hotels provide access to medical services. The promotional campaign was aimed at people with allergies and guests with high health awareness. The idea then spread to the local lumber and construction industry. The leading lumber company joined the initiative and began collaborating with the university institute in making antiallergic wood products (from furniture to houses). The project received the 2012 RegioStars Award and is an example of how the traditional sector can be innovative in the rural area with the help of scientific partners. Local hotels have benefited (the number of overnight stays increased from 60.000 in 2008 to 78.000 in 2010). EU contribution: EUR 125.000 - EU funding level: 25%.

Examples of project funded by the CF:

Slowacki Route project improves road network between Gdańsk airport and sea port

Over 10 km of road was constructed or widened to provide a direct route through the city, which relieves pressure on smaller roads and the S6 bypass around Gdańsk. To further increase capacity, the project constructed a 1.34 km tunnel under the Vistula River, previously crossed only by ferry. Other project works make roads safer for pedestrians, improve public transport connections and make surrounding neighbourhoods more attractive (Open Data Portal for the European Structural Investments Funds, 2020). This had a positive effect on tourism development in the area.

Examples of project funded by the ESF:

Improvement of the Dental Medicine study program in accordance with the Croatian Qualifications Framework at the University of Zagreb, School of Dental Medicine

The project improved and harmonized the dental medicine study program with programs in the EU by developing a professional practice program that is demonstrated by learning outcomes in accordance with the CROQF. During the project, 80 students conducted internships in 40 collaborative dental offices and continue to practice regularly after the project is completed. The internship program developed by this project enabled students to gain the necessary clinical experience before graduation and then, they were able to begin independent work immediately after graduation.

Examples of project funded by the EAFRD:

Dental care for residents in isolated rural communities

An enterprise from a rural area in northern Finland has been awarded support from the EAFRD in order to set up new commercial healthcare activities in isolated rural communities, highlighting the potential of mobile units for easier accessibility. The main beneficiary group is the elderly who need dental care but others from the local communities. The project also helps the younger generations maintain their oral health. A complete range of oral hygiene services is provided.

Examples of project funded by the EFSI:

Loan to improve the energy efficiency of hotels and tourist complexes

In November 2015, the EIB decided to grant a EUR 500 million credit to Caisse des Dépôts and its user, Société pour le logement intermédiaire (SLI), to finance programs for the construction of affordable rental apartments. SLI use this line of credit for 5 years to finance loans for up to 25 years. The goal is to build 13.000 affordable rental apartments by 2019 in areas where there is a shortage. SLI will finance smaller-scale projects (less than EUR 50 million) for new homes that fall under the 'near zero energy building' category. Energy savings will help homeowners repay loans.

Companies in Île-de-France have also received EFSI funding (EUR 100 million for SEM Energies Posit'If) for the renewal of the energy efficiency of private accommodation. They will finance the insulation of buildings and windows, as well as the renewal of heat production and distribution systems in buildings, ventilation systems and electrical appliances that are part of common spaces (lights, pumps, etc.). The use of renewable energy sources (eg biomass or solar collectors) may also be included in the works.

Gathering more small projects regionally or nationally can also be an option for outdated hotels and tourist complexes that are not energy efficient. EU contribution: EUR 500 million (approved in February 2016) - EU funding level: 33%.

6. Discusion

The research was based on analysis of the health tourism development in Croatia. The number of overnight stays during the year is shown in the Chapter 4, which indicates the seasonality of the tourist offer which is still based on the offer of "Sun and Sea" instead of a high quality variety of offers which includes a combination of different forms of tourism with emphasis on specific forms of tourism including health tourism.

The tourism sector in Croatia is extremely important for the development of the overall economy (as shown by the percentage of tourism in GDP, which amounted to as much as 24.9% of GDP in 2019), so it is important to adopt quality strategic plans that will generate revenue throughout the year. The conducted research has shown that significant problem is the high degree of seasonality (shown in the graph in Chapter 4), so it is necessary to focus on the fast-growing forms of high-income tourism, namely health tourism. The development of health tourism reduces the seasonality of tourism, which gives an additional incentive to the development of this special type.

Health tourism actually helps counter the average seasonality in tourism as a whole. This research outlines the Croatia's advantages in order to become a significant tourist destination in the field of health tourism as well as the obstacles that have not yet been eliminated. Many EU Member States have recognized the potential of health tourism and are generating significant revenues, such as Poland and the Czech Republic. In case of Croatia, it is necessary to adopt a clear strategic plan at the national level and set guidelines for the development of health tourism which would help to reduce the impact of seasonality and make wise use of available sources of funding in order to become eligible to compete at EU and global level.

Furthermore, the precondition for the development of health tourism lies in the development and modernization of new and existing facilities. The current situation of health tourism in the Republic of Croatia (which is presented in Chapter 4) shows that Croatian thermal spas / special hospitals are outdated both in terms of functionality of facilities and equipment and in terms of offering health programs intended for the tourism market. In addition to the modernization and construction of diagnostic and therapeutic centers, it is necessary to raise the quality of accommodation facilities (equalization with higher category hotel standards), build a number of entertainment facilities ('water fun' parks, sports facilities, leisure facilities and similar), construction of new accommodation (hotel) facilities related to the existing thermal / thalasso spas and special hospitals (while ensuring access to natural healing factors) and build a number of completely new health-tourist centers. Best international practices need to be explored in their design and implementation.

This paper explores development opportunities using available EU funding sources. The Republic of Croatia has published a catalog of potential investments in health tourism, which is presented in Chapter 4. However, significant efforts to achieve the plan have not been realized. Investments in health tourism are extremely high, so EU funds can be a key driver in order to develope this form of tourism. Croatia is currently in negotiations with the EU Commission for the next multiannual financial framework 2021-2027, so it is crucial to include health tourism projects in operational programs so that strategic projects could receive direct funding in the future. In addition to EU funds, the European Fund for Strategic Investments (EFSI) provides a significant source of financing for high value projects. The European Fund for Strategic Investments focuses on financing projects that have a higher risk than the projects eligible for lending in the ordinary business. Direct financing is only possible for projects exceeding €50 million, while projects of small and medium-sized enterprises and mid-cap companies totaling up to €50 million are considered through intermediaries through the EFSI window for SMEs.

Croatia's accession to the EU has opened up numerous project financing opportunities. In order to exploit the full potential, it is essential that key stakeholders (in this case, government, ministries, health organizations, cluster associations, non-profit organizations and other stakeholders in the health tourism sector) advocate for the development of health tourism to reduce the impact of seasonality. It is essential to include projects in the health tourism catalog in the key strategic documents in order to be eligible for funding for the next programming period.

7. Conclusion

The current market position of health tourism in Croatia is determined primarily by the individual efforts of private clinics in breaking into the market, affordable prices for acceptable quality in several areas of medical expertise and the credibility of staff and equipment. The supply of health tourism in Croatia is still sporadic, insufficiently diversified, relatively unorganized and poorly recognized. There is no quality clustering organization on a production-specialist basis, nor on the vertical integration and integration of different stakeholders into a complete destination value chain. This should be added to the lack of systematic national promotion as well as the absence of a strong sales network of incoming agencies and specialized facilitators. Therefore, Croatia is not yet an internationally recognized destination for medical tourism.

Additional research on this topic would include analysis on quality of operational programs for the use of EU funds for the future financial period 2021-2027, with an emphasis on the listing of health tourism projects, especially those in the catalog of health projects recognized as strategic projects for the development of this specific branch of tourism.

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Analysis of Consumers' Intentions for Online Shopping

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Abstract. Online shopping is a form of e-commerce that allows buyers to directly buy products and services from online sellers through web browsers. More and more companies are choosing to launch an online store when selling their products or services, as it brings many benefits for both the seller and the buyer. In recent years we can see the trend of the increasing use of online shopping for the purchase of different products and services. Shopping online has many advantages, but also some disadvantages. According to past experience, older people are less likely to shop online because they are less skilled and experienced in the field of technology and are more afraid of misuse of payment cards. The survey confirmed that customers older than 50 years, show more concern about the potential abuse of their personal data or credit cards in online shopping than the younger ones. However, there are no significant differences in online purchase intentions between the two age groups.

Key words: internet, online shopping, age, purchase intentions, trust

1. Introduction

In recent years we could see a trend of increasing use of online shopping for purchases of various products and services (clothing, footwear, fashion accessories, technology, books, tickets, travel, etc.). The company in question is concerned with identifying the causes of aging, mitigating its effects and preventing it. The company so far carried out personal and telephone sales and has been considering the introduction of an online store for a long time. According to their estimates, younger generations (up to the age of 50) are more likely to make online purchases, while older generations (over the age of 50) are somewhat more restrained towards this type of shopping.

Shopping online has many benefits because it is quick, easy, shoppers can shop anytime, anywhere, and an online retailer can reach a much wider segment of shoppers. However, there are some downsides to online shopping - product buyers are unable to test it, they are concerned about the possibility of returning the product, and many people are distrusted and concerned about privacy and possible abuse. Pawlowska, Nielek, & Wierzbicki (2019) simulation suggests that the effectiveness of e-commerce platform recommender systems in improving quality of elderly consumers choices is low for population of agents with strong cognitive deficits.

2. Theory review

The first online store was created in 1994 and was introduced by Pizza Hut, the first to allow customers to order pizza online. In 1995, two of the most famous online stores appeared online - Amazon and eBay. Since then, there has been a rapid development, which lasted until 2000, when the stock markets breakdown of the Dot-Com companies followed. The Dot-Com bubble burst has been triggered by excessive investments of billions of dollars in telecommunications fibre optic cables.

Excessive investments have led to almost zero costs of transmitting votes, data and images. This revolution took people-to-people connectivity to a whole new level - at one time more people could connect with people from many different places in more different ways than ever before (Friedman 2005).

The collapse removed most of unprofitable traders from the market, and those who remained organized the business with more serious consideration. Over the years, many online stores have established themselves on the market, and online commerce became a serious service, with millions of euros being turned up every year.

Web search engine is a software system designed to perform three basic tasks: they constantly search the web and process the content found, store a word index (such as words on your page) and information about the site where they were found, and allow users to search through this index with a different combination of words, which then tries to return the results that are relevant (Netron 2010).

2.1 Factors affecting purchase

Trust and satisfaction are the decisive factors for a successful business relationship between the company and clients in e-commerce. Trust plays a key role in all forms of business involving cash transactions. Customer satisfaction is directly related to their intention to buy, their intention to repurchase and the word of mouth. Customer satisfaction is a measure of how well a product or service provided by a business meets the customer's expectations. We can expect a more satisfied customer to buy and repurchase and promote the business to other potential buyers (Goh et al. 2013).

The intention to buy online reflects the buyer's plan to buy at a specific time, using the cart in the current online session. The intention to buy in a given session leads to an increased frequency of items being added to the cart; the shopping cart system increases the customer's convenience and thus encourages him/her to buy more products (Close and Kukar-Kinney 2010). The intention to buy online is also influenced by the trust, usability, enjoyment of the purchase and the quality of the website. Different levels of website quality showed an influence on the intention to buy online, while providing the same product information, which indicates that the quality of the website independently influences customer perception (Seo et al. 2012).

Online shopping brings value to customers, but it can also deprive them of certain sources of value. Today's shoppers use multiple shopping channels, and in some cases prefer traditional shopping to online shopping (Perea et al. 2004). WorldPay (Patel 2014) conducted a survey of the reasons why people leave the shopping cart, among the most common reasons were: I became aware of the unexpected costs, just looking, elsewhere I found a better price.

The process of online marketing is not expensive, it delivers instant international reach, offers great and fast feedback, and reaches millions of people for whom the world wide web is the centre of all communication (El-Gohary 2013).

Some are shopping online because they do not have access to certain stores or products in their area, some would like to get home delivered items, and some simply prefer to shop. One

of the benefits of online shopping is that the user can find a large number of products and compare them. When he / she selects a particular product, he or she can search for it from other sellers in the search engine or search for user reviews of that product (Nichols 2014).

Thulasimani (2012) points out that all online stores are available twenty-four hours a day, allowing users to access the online store at home, at school, in cafes or even at work; online shopping reduces the time and cost that shoppers would spend to go to the store; customers can choose the product based on the images, prices and sizes available online; this reduces the time they spend deciding which product to buy, and they can be assured if the product can also be purchased directly from the store.

According to Heinemann and Schwarzl (2010), there are also some disadvantages for the online seller:

- High technical complexity is the result of underestimating the need to build a specific IT infrastructure. The introduction of technological systems usually requires high initial inputs.
- -Due to the high initial investment, the return on invested capital is slow. Also, building a customer base requires effort, which means that revenue is generated by a time lag.
- Due to the spatial and temporal infinity of the web, there is a competition with sellers from other sectors. Sellers who did not sell a particular product before can now sell it without much effort.
- Some shoppers use traditional stores to get product information, which they then search online for a lower price. Through smart contact management, we can connect customers to the store. Channel switching is in favour of multi-channel solutions.
- Online sellers cannot avoid being dependent on Google. There are no more vendors to go without the traffic generated by Google. Companies whose online business model was built on Google visitor traffic have become dependent on it.

2.2 Traps of online shopping

In Slovenia, the most popular form of payment remains the one on delivery, in which the buyer pays the postman upon receipt of the package. Although most online stores also offer other forms of payment (via prepay, via PayPal), are customers reluctant to disclose their payment card information for the fear of abuse. International online sellers mostly require payment by pro forma invoice or via PayPal, and more and more national sellers are embracing this practice. In this way, the seller protects against the buyer not taking the ordered package and thus causing unnecessary costs to the seller.

Chen and Barnes (2007) argue that a perceived level of security and privacy is a key factor affecting a customer's initial confidence in an online business. It is recommended to reduce the perceived risk of customers and thus increase the perception of confidence. Businesses should focus on clearly stating their arrangements and security and privacy policies, including third-party site evaluation, and providing delivery and payment services through strategic logistics partners.

Fraudsters are inventing new ways of cheating. The message is e.g. attached as a malicious file that downloads additional code from the web server and executes it. The information stealer virus on the system searches for all stored passwords in browsers, email clients, FTP clients, instant messaging programs, etc., and sends the data to the attacker (SI-CERT 2020).

According to the Statistical Office of the Republic of Slovenia (SORS 2015a), internet users in the age range 16-74 years were most restricted or even discouraged in their online use in transferring personal information to online social or professional networks, use of banking services, software transfer, music, video or other data files, communicating with public

institutions through the Internet and accessing the Internet through mobile devices with wireless mobile connection outside the home.

Payment cards are very vulnerable, both when shopping online and elsewhere. Anyone who manages our card can copy the card number and expiration date and attempt to make unauthorized payments (Parsons and Oja 2014). Thieves can hack into the vendor's computer where order information is stored. Hackers can intercept payment card numbers with misuse of software designed to legally monitor network traffic (ibid.).

2.3 The effect of age on the online purchase decision

Older consumers often have more time and income available compared to many younger groups. Each generation grew up with a certain technology and devices that made a significant difference to their daily lives. Learning new technologies depends on the individual and his / her ability to move to the next generation level. Kim, Nam, & Kim (2019) highlighted the important role of trust generating value in the context of selling websites.

Despite the challenges that older people face when using modern technology, once they become Internet users, it often becomes an important part of their daily lives. A survey of US Internet users (Pew Research Center 2014) found that as many as 79% of Internet users over the age of 50 access the Internet daily or almost daily, and 8% three to five times a week. These older Internet users have a strong positive attitude to the benefits that online information brings to their privacy. As many as 79% of older Internet users are of the opinion that people with no Internet access miss a lot of useful information (ibid.).

According to the Statistical Office of the Republic of Slovenia (SORS 2015b), 78% of households had Internet access in the first quarter of 2015 in Slovenia. Compared to the previous year, the share of households that also used mobile broadband using a mobile phone to access the Internet increased from 34% to 52%. However, 22% of people between the ages of 16 and 74 have never used the Internet. Most of them are persons aged 65-74 (65%), followed by 55-64 years old (47%) and 45-54 years old (21%) (SORS 2015b).

While in 2019, 89% of households had Internet access, 56% of them bought an item over Internet in the last year (SORS 2020). Among 65-74-year-olds are more than half (51%) of those who have never used the Internet, among 55-64-year-olds 35%, among 45-55-year-olds 10%, and among 35-44-year-olds 3% (SORS 2019).

According to Eurostat (2015), online shopping in the European Union is significantly less widespread among the older population than among the younger population. This difference between age groups is largely due to the fact that older people make less use of the Internet for any purpose. Among Internet users aged 16-74, the share of those who shop online reached 53%. According to Eurostat (2020), in the EU28, 45% of elderly over 65s use the Internet at least once a week.

3. Survey

The primary purpose of the study is to determine if older customers of a company that sells nutritional supplements to alleviate the effects of aging are willing to shop online and what factors most affect their purchase intentions.

Nielsen's Global Online Store Survey warns against neglecting the older generation, as it accounts for as much as 40% of potential customers online, but reaching the older segment is far more complicated than reaching the younger generation (Nielsen 2014). As one might expect, the higher the age, the lower the intention to shop online. Globally, respondents who are members of Generation X (ages 35-49) represent 28% of those willing to shop online, and members of the "baby boom" generation (ages 50-64) represent about 10%; those over 65

represent barely 2%, and those under 20 represent about 7% (ibid.). The research will determine whether this also applies to potential customers of the company in question.

Hypothesis 1: The intent of online shopping is higher for company's customers under 50 than for customers over 50.

A survey by GfK in March 2014, covering 1,000 U.S. respondents, found that there were obvious differences between generations regarding online privacy concerns; people age 50 or older are more protective of their online activities than younger people (GfK 2014). Among those who eschew all online services, the majority are those over the age of 50; 66% of people over 50 believe that the government should do more to protect the confidentiality of information (ibid.). Generations Y and Z (ages 19 to 34) are somewhat more satisfied with the government's current role in data protection, although their level of concern remains high (ibid.). The survey will determine if there are any obvious differences between the customers of the business in question regarding their online privacy concerns.

Hypothesis 2: Customers of the company over 50 are more concerned about the misuse of their personal information or credit cards than online shopping.

3.1 Research methods

We adopted an online survey method, using a casual sample. Questionnaire has been pilot tested with 20 random respondents and later sent to 532 email addresses from company's customer base. The demographic question divides the respondents into two age groups (younger and older). The survey questionnaire consists of ten questions, three of which are closed-ended questions, one semi-open-ended question, two questions about the frequency of online activity. In the last question respondents express the degree of agreement with the stated claims with a Likert-level scale. To test the hypotheses, we processed the data in the SPSS program with a T-test. The results are presented with tables and graphs.

3.2 Analysis and survey interpretation

Questionnaire has been returned by 78 company's customers, of whom 30 were 50 years of age or less and 48 were more than 50 years old. There were no respondents that never used the Internet, as the survey was emailed. Thus, those who do not use the Internet have dropped out of the survey.

However, more younger users (40.00%) use the Internet on a daily basis than older people (22.91%). The respondents over 50 use the Internet most often to read the news and search for information (47.92%), while those aged 50 or less use it to communicate with other people and social networks (40.00%). Internet users over the age of 50 most often buy clothing and footwear (10.42%), and travel online (8.30%), while younger people buy mostly clothing and footwear (46.67%) in addition to travel (23.33%). In both age groups, most of respondents are willing to pay between €21 and €50 for a single online purchase.

The question of the importance of the factors that drive individuals to buy online has revealed that the most important incentive for both age groups is the ability to find the lowest price. Among the respondents aged 50 years or less, as many as 80% rated this factor as very important and more than 70% among those aged 50 and over (Figure 1). For the younger ones is also very important the increase of the variety of products and brands, as well as easier access to product information, while elderly are also more comfortable in not having to leave their homes, as well as the cost savings of running the store.

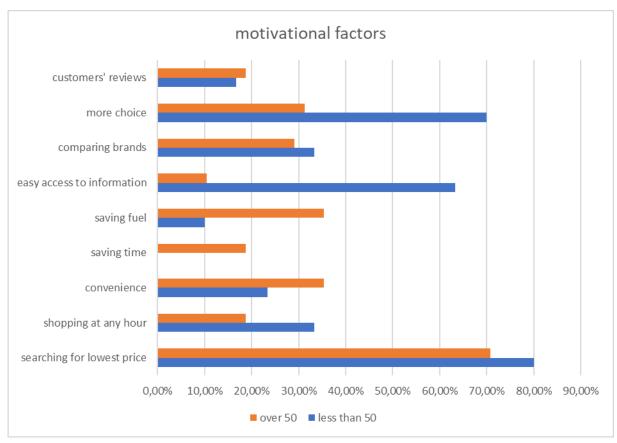


Figure 1 The most important factors that encourage individuals to buy online by age group

When testing the hypotheses, we used the t-test for independent samples, as we wanted to check the differences between the two independent groups in the normal distribution of data. Statistically significant differences were examined between the two variables (company customers 50 years of age or older and younger than 50 years). With hypothesis H1, we checked the intention to buy online. Values on the scale varied from 1 to 5 in the claims (where a value of 1 means that they completely disagree with the statement and have no intention to buy, and a value of 5 means that they completely agree with the statement and their intention to buy is very high).

Table 1 Hypothesis H1, Descriptive Statistics

		N	Mean	SD	Std. error mean
I have a positive attitude towards	Less than 50y	30	3.87	1.008	.184
shopping online.	More than 50y	48	3.19	.982	.142
I will probably buy some product online	Less than 50y	30	3.40	1.037	.189
in the next three months.	More than 50y	48	2.94	1.156	.167
In the next six months, I intend to buy	Less than 50y	30	2.83	.986	.180
personal care and health products online	More than 50y	48	2.67	.907	.131
I think I will be buying more products	Less than 50y	30	4.30	1.022	.187
online over the next year than in the previous year.	More than 50y	48	3.77	1.276	.184

Using the Leven test, we found that the variability was the same in both populations. The assumption of variance equality is fulfilled, since the p-value is higher than 0.05.

Table 2 Hypothesis H1, independent samples t-test

		for eq	en's test equality t-test for equality of means ariances							
		F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. error	95% interval	confidence
						taneu)	uniterence	difference	lower	upper
I have a positive attitude towards buying online.	Equal variances assumed	001	.971	2.942	76	.004	.679	.231	.219	1.139
	Equal variances not assumed			2.924	60.472	.005	.679	.232	.215	1.144
I will probably buy some product online in the next three	Equal variances assumed	089	.766	1.787	76	.078	.463	.259	053	.978
months.	Equal variances not assumed			1.832	66.702	.071	.463	.252	041	.966
For the next six months, I intend to	Equal variances assumed	024	.878	.764	76	.447	.167	.218	268	.601
buy personal care and health products online.	Equal variances not assumed			.749	57.832	.457	.167	.223	279	.612
I think I will be buying more products online over the next	Equal variances assumed	3.473	.066	1.918	76	.059	.529	.276	020	1.079
year than in the previous year.	Equal variances not assumed			2.018	71.268	.047	.529	.262	.006	1.052

Using the Leven test, we found that the variability was the same in both populations. The assumption of variance equality is fulfilled, since the p-value is higher than 0.05. Table 2 shows whether there are statistically significant differences between the age groups regarding the aforementioned claims. As we can see, the differences are only characteristic of the first claim. With this assertion, the p-value is lower than 0.05. However, this is a condition for saying that there are differences in the averages between the age groups. However, there are no significant differences with the other three claims, so we reject hypothesis H1. Therefore, we have found that there are no significant differences in the intent to buy online between business customers 50 years of age and under and over 50.

Table 3 Hypothesis H2, Descriptive Statistics

		N	Mean	SD	Std. error mean
The possibility of errors in cash transactions online	Less than 50y	30	4.27	.740	.135
	More than 50y	48	4.48	.714	.103
Fear of identity theft	Less than 50y	30	4.23	.626	.114
	More than 50y	48	4.54	.582	.084
Fear of losing privacy	Less than 50y	30	4.47	.681	.124
	More than 50y	48	4.52	.714	.103
I believe that online stores are trustworthy.	Less than 50y	30	3.60	.894	.163
	More than 50y	48	2.75	.863	.125
I feel safe when providing personal information and	Less than 50y	30	3.60	.770	.141
transactions with online stores.	More than 50y	48	2.69	.903	.130

Hypothesis H2 examined the concerns about misuse of personal information and payment cards by both age groups. We included in the analysis the claims about the importance of customer concerns regarding online shopping in relation to age group differences. We wanted to know if older and younger respondents chose different values on a scale of 1 to 5 (where a value of 1 means that a single factor is irrelevant to them and they have no concerns about

data misuse, and a value of 5 means that it is very important to them and their concern about data misuse is very high).

Table 4 Hypothesis H2, independent samples t-test

		Leven's test for equality of t-test for equality of n						of means	means		
		varian									
		F	Sig	t	df	Sig. (2-tailed)	2- Mean difference	Std. error differenc	95% confidence interval		
								е	lower	upper	
The possibility of errors in cash transactions online	Equal variances assumed	.006	937	1.261	76	.211	213	.169	.548	.123	
dunsactions on the	Equal variances not assumed			1.251	60.065	.216	213	.170	.552	.127	
Fear of identity theft	Equal variances assumed	.137	713	2.211	76	.030	308	.139	.586	031	
	Equal variances not assumed			2.174	58.289	.034	308	.142	.592	024	
Fear of losing privacy	Equal variances assumed	.036	849	.332	76	.741	054	.163	.380	.271	
	Equal variances not assumed			.335	63.908	.739	054	.162	.377	.269	
I believe that online stores are trustworthy.	Equal variances assumed	.186	668	.173	76	.000	.850	.204	.444	1.256	
dustworthy.	Equal variances not assumed			.139	60.023	.000	.850	.205	.439	1.261	
I feel safe when providing personal	Equal variances assumed	.365	246	.588	76	.000	.913	.199	.516	1.309	
information and transactions with online stores.	Equal variances not assumed			.760	68.866	.000	.913	.192	.530	1.295	

Using the Leven test, we found that the variability was the same in both populations. The table shows that four of the five differences are significant (the p-value is higher than 0.05), so hypothesis H2 can be confirmed. We have found, therefore, that customers over 50 are more concerned about the misuse of their personal information or payment cards than online shopping.

By rejecting the H1 hypothesis, we found that the intention to buy online was the same for both age groups, so we thought that launching an online store at the company would be reasonable. However, since the confirmation of the H2 hypothesis, we have found that customers over the age of 50 are more afraid of potential misuse of personal information and payment cards, and the company needs to pay a lot of attention to building trust with customers.

4. Conclusion

Online shopping is becoming more popular and widespread in different age groups. More and more companies are choosing to sell their products or services online, as this brings them many benefits that make them easier to operate and reduce costs. Online shopping has many benefits for shoppers who have a wider selection of products and sellers online, the ability to find the lowest price, online shopping is fast, convenient and easy. However, online sellers should also be aware of the reservations customers have about online shopping. Some, especially older customers, do not master computer skills. Many fear that the product ordered

might not meet their expectations, the difficulty of returning the product, and the possible misuse of personal information and payment cards.

We wondered if there were any significant differences in online shopping between customers of the company aged under 50 and over 50. Based on this, we wanted to find out if it would make sense to introduce an online store in a company that, by nature, has the majority of customers over 50. A survey among customers of the company found that there were no significant differences between age groups in purchasing intent. Customers over the age of 50 are also planning to shop more online in the future and have a positive attitude towards online shopping.

However, it turns out that older customers are more afraid of misusing personal information and payment cards than younger ones. According to the research findings, it would be reasonable to set up an online store in the company in question, but a great deal of attention should be paid to establishing trust among customers. The company must ensure the highest level of security during the purchasing process and clearly inform the customers about the business conditions. We think it would be best to choose pay-per-view payment methods, as this does not require customers to provide payment card information and therefore feel more secure. The company can also offer customers the option of paying by pro-forma invoice and giving them a certain discount. Regular buyers may eventually gain more trust in the seller and make it easier to decide on a prepayment as they complete more orders.

The research findings are generally useful in deciding whether to launch an online store in companies with customers over 50 years of age. A limitation of the survey is that it only included internet users, while those who did not use the internet dropped out of the survey. In recent years, we can also see an increase in the number of internet users and those who shop online among the older population. The older population thus represents an important segment and challenge for online marketers in the future. Younger people are more likely to make online purchases and are more experienced, so it is important to focus on older potential buyers and bring them closer and simplify the online purchase process. It is important for sellers to be aware of the importance of gaining the trust and affection of the older age group to shop online, as this brings mutual satisfaction. By doing fair business and providing quality online sales, salespeople will increase their sales even among the older population. When older shoppers get rid of fear, they will recognize the many benefits of online shopping that can make their everyday life easier.

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Rethinking Digital Transformation Strategy: Why Should Leaders Rather Focus on Employee Engagement?

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Abstract. No company today escapes digital transformation any longer. Digital transformation is the key enabler for additional internal efficiency, as well as new external opportunities. It is not just about turning existing processes into their digital versions, but rethinking current operations and giving sense to employees why things should be done differently, especially in cases where companies have been successful even prior to digital transformation. We begin this paper with a literature review showing that employee engagement and internal communication highly contribute and foster successful digital transformation. Therefore, organizational leaders must know that digital transformation strategy and transformation of employees are strongly interlinked. Answering the question how organizations can successfully intertwine these two transformations is far less understood in literature, meaning that valuable insights are gained through case studies. The qualitative research presented in this paper shows the case of an international tobacco company in the largest transformation in its history. As its result the paper proposes a systematic 9-step approach to tackle digital transformation that is intended to help companies to redefine their internal communications roadmap and lead them successfully in engaging employees. The contribution of this paper is threefold. The paper extends existing theory, both, on digital transformation and employee engagement. Secondly, this paper will help to better understand internal communications underlying digital transformation and thirdly, this paper could help businesses to understand that companies must interlink employee and digital transformation. Identifying conditions that engage employees fills an important gap in understanding the transformation process and finds new interesting areas for future research.

Key words: Digital transformation strategy, employee engagement, internal communications.

1. Digital transformation strategy

Digital transformation refers to changes associated with the application of digital technology in all aspects of human society (Stolterman & Fors, 2004). Digital Transformation is fundamentally rethinking organization's processes, services and roles from a technology-enabled perspective (Parvianen et al., 2017), known as the ability to turn existing products or services into digital variants, and thus offer advantages over tangible product (Gassmann, Frankenberger & Csik, 2014, Henriette, Mondher & Boughzala, 2015). It is seen as one of the major global trends of change caused to implement digital products, processes or businesses in organizations. Digital transformation is a journey, and a journey needs a map, a clear roadmap driven by a digital strategy (Gobble, 2018, p. 66). It has emerged not just as a business phenomenon, but also as important topic in the strategic context (Bharadwaj et al., 2013; Piccinini et al., 2015), as well as for researches outside of the academic world (Fitzgerald et al., 2014; Westerman et al., 2011). We can say that digital transformation "encompasses the profound changes taking place in society and industries through the use of

digital technologies" (Agarwal et al., 2010, Majchrzak et al., 2016). At the organizational level, it has been argued that firms must find ways to innovate with these technologies by devising "strategies that embrace the implications of digital transformation and drive better operational performance" (Hess et al., 2016, p. 123). Companies all around the globe and the majority of industries have at least tried to digitize their businesses in order to exploit what digital transformation of production, processes or supply chain might bring them. As a result of such an intention entire business models can be reshaped (Downes & Nunes, 2013). Based on the Westerman research (2014) conducted in 50 global companies and 157 executives concluded that the best companies combine digital activity with strong leadership, managers having a clear vision of how they want to transform and constantly redefining the way they work in the new digital era. According to Berman (2012, p. 16) companies leading in digital transformation focus on two complementary activities: reshaping customer value propositions and transforming their operations using digital technologies for greater customer interaction and collaboration based on capabilities they have built to support both. The key reason according to Gale and Aarons, why so many organizations struggle in digital transformation is that they add digital technology without transforming their thinking and without connecting employees, processes, insights to become truly digital inside and out (2018, p. 31).

2. Employee engagement

In order to become truly digital inside and out, organization leaders must rethink the human dimension of digital transformation. This is where engaging employees comes into play. When referring to the term engagement in an everyday context the meaning may be related to dedication, enthusiasm, focus on relevant or commitment. According to the Engaging for Success study (MacLeod & Clarke, 2009) over 50 different definitions of employee engagement have been identified only in frames of their UK based research. There is a clear lack of a single, universally agreed definition of employee engagement. Engagement at the workplace can be considered a desirable condition for employees as well as for the organization they work for. Work engagement refers to the relationship of the employee with their work, whereas employee engagement may also include the relationship with the organization (Truss et al, 2014, p. 15). Employee contribution becomes a critical business issue because in trying to produce more output with less employee input, companies have no choice but to try to engage not only the body, but also the mind and the soul of every employee (Ulrich, 1997, p. 125) especially in times of changes caused by digital transformation. Historically seen has the term engagement firstly been used in the Gallup organizations in the 1990s. The so-called Q12 tool is based on survey results Gallup conducted since 1988 on around 100.000 employees and their workplace perception. The results were later on summarized by Buckingham and Coffman in 1999 in their book First, break all the rules. Along with the 2000s different changes in importance of workplace perception took place as the result of trends in century shift companies. Those changes require a substantial psychological adaptation and involvement from the part of employees. In other words, more than ever employees need psychological capabilities in order to thrive and to make organizations survive (Truss et al., 2014, p. 15). The interest for engagement from consulting firms, academics as well as the business has grown exponentially through the years based on the raised awareness of growing importance of human capital on one hand and power of psychological involvement of employees.

When talking about the psychological part of employee engagement definitions, according to Kahn (1990) there are three psychological needs meeting and resulting into employee engagement: meaningfulness (i.e. the feeling receiving feedback for the work or results), psychological safety (i.e. the feeling of complete openness and no fear of expressing taught

and opinions) and availability (i.e. the belief of being able to contribute to the workplace in an emotional and physical way). According to Bledlow et al. (2011) their affective shift model is pointing out the dynamic nature of work engagement. Based on their theory work engagement is influenced by both positive and negative affect. In other words, employee engagement is based on the shift of turning negative affects into positive as a consequence of the motivation and need to do so. Based on Saks (2006) employees have the need to give back to their respective companies through engagement. Also, when engaged employees feel they have strong support from their organizations or supervisors it is more likely to expect their commitment (Alfes, Shantz, Truss & Soane, 2013). And commitment is crucial in changing times of digital transformation.

3. Case study

As previously mentioned in this paper, the relationship between digital transformation and transformation of people is strongly interlinked and answers the question "Why?", yet at the same time far less is known about the "How?" and at this point valuable learnings are coming from case study insights. The organization we have studied in this papers case study is Philip Morris International (PMI), the leading international tobacco company engaged in manufacturing and sales of cigarettes, smoke-free products and associated electronic devices and accessories and other nicotine-containing products. It is the world's most successful cigarette company with products sold in over 180 markets worldwide.

3.1 Research context

Regardless of already being successful, PMI's leaders chose to change dramatically with the aim to ultimately replace cigarettes with smoke-free products to the benefit of adults who would otherwise continue to smoke, society, the company and its shareholders. By doing so PMI has also started a transformation of the whole tobacco industry. PMI is now building a future on a new category of smoke-free products that, while still not risk-free, are claimed to be a better choice than continuing to smoke. Through multidisciplinary capabilities in product development, state-of-the-art facilities and scientific substantiation, PMI aims to ensure that its smoke-free products meet adult consumer preferences and rigorous regulatory requirementsⁱ. Such a huge transformation strategy change of a very successful global company in a profitable industry has encouraged us to challenge the quality and ways of employee engagement as main research area of this paper and find the answer to our main research question: How can organizations successfully intertwine digital transformation and transformation of people? It is important for us to point out that the scope of this research paper is not in any way connected to smoking or nicotine products. Beyond that we have chosen the case of an industry which has been unchanged and very traditional for decades, it's employees have been working the same ways throughout history and for the first time such a company has decided to change everything facing huge challenges when it comes to employees like lack of sense making, lack of willingness to change, lack of competencies needed for the new business model, threat of resignations and many other.

3.2 Data collection

This paper builds on a field study conducted in a single organization during 2017-2019. Data were gathered from multiple sources. Data for the case study was collected using following techniques: (1) written and electronic documentation (2) deep semi structured interviews and (3) formal and informal observations. We relied on written and electronic documentation as the main source of data, with observation and interviews as important supplementary sources. We collected 33 documents explaining PMI's digital transformation top down during 2017-

2019 from first announcements towards employees until launches and afterwards. These documents took following forms: (1) external press releases, (2) externally published annual reports, (3) public web site, (4) internal web site (intranet), (5) internal announcements, (6) internal strategic documentation, (7) internal presentations, (8) internal guidelines, (9) internal leadership blogs (10) internal webcasts and (11) internal meeting minutes. We have executed narrative analysis of interviews with the management board and employees. The 20 semi structured interviews were lasting around 30 minutes with most interviews being standardized, while specific customization was done related to business unit, employee's hierarchy, years in the company. The applied sampling logic moved from purposeful to theoretical (Locke, 2001). Firstly we interviewed employees who could provide rich and insightful information on their engagement in the companies' transformation. Later, we selected our employees on the basis of specific research interests covering dimensions identified during analysis of gathered data. All in order to deeper understand the specifics of their transformation journey. Interviews included questions related to understanding digital transformation, understanding the role of individuals in the transformation process, perception of level of knowledge about the transformation, involvement, commitment, feelings and engagement. Finally, we engaged in observation of employees social interactions in order to gather insightful data into cultural dimensions of transformation, personal and interpersonal commitment to change and contribute towards change. 25 observed events included transformation dialogue sessions, employee trainings, internal meetings and internal conferences as well as informal conversations.

3.3 Data analysis

As we collected data we analysed it in parallel according to methods of naturalistic inquiry (Lincoln & Guba, 1985). We used open coding (Strauss & Corbin, 1990) wherever possible or simple descriptive phrase in lack of coding and began the analysis by grouping data into categories. In the next step we searched for relationships between those categories which led to assembling them into higher-order topics. In the final step we gathered topics into nine dimensions as key findings of our paper.

4. Key findings

PMI needed to transform the business model and built its digital transformation strategy on three transformation pillars (Figure 1): (1) product transformation, (2) external (society, regulatory) transformation and (3) internal transformation. The focus of this paper will be on the third pillar, internal transformation, related to employees. The main enablers are people, culture and ways of working. The importance is strategically set on people – not just in terms of employees, but also the commitment to close the skill gap to enable transformation. The scope therefore is to challenge diversity and an overlap of the "old = winning culture" and the "new = transformation".

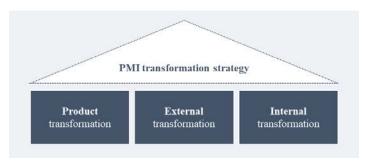


Figure 1 Philip Morris International Transformation pillars adopted to PMI data.

There are three proposed steps large companies in Digital transformation should follow based on research of Eden et al. (2019) for transforming their workforce in times of digital transformation: (1) Establishing the culture in order to enable successful workforce transformation, (2) building relevant transformation competence and (3) managing transformation tensions across organizational levels. Adopting the above-mentioned and based on research findings this paper aims to list down (Figure 2) key steps guiding a successful transformation of employees, while each steps findings will be explained in this paper.

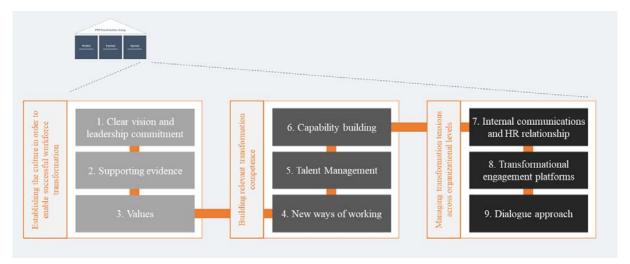


Figure 2 9-step approach in 3rd PMI Transformation pillar. Source: Based on research findings adopted to Eden et al. (2019).

4.1 Clear vision and leadership commitment

According to Kane at al. their 2015 report of a study sponsored by MIT Sloan Management Review and Deloitte reviled that more than 80 percent of digitally maturing companies had clear, coherent digital strategies, while just 15 percent of those at the early stages did. Based on findings in the Philip Morris case it is to conclude that the vision is clearly stated by companies' senior management, at the same time their commitment is present. PMI stated its clear vision as "designing a smoke-free future" and is now building its future on smoke-free products. As said by PMI CEO, André Calantzopoulos, company's resources are continuously being shifted towards achieving this vision: 92% of investment in research and development and 60% of global commercial expenditure were dedicated to smoke free products in 2018ⁱⁱ. According to Gale and Aarons (2018) there is no transformation without leadership and leaders play the most significant and changing role. According to Gale and Aarons (2018, p. 35) the key responsibility of leaders is to become agile and to find out what the skills and ideas are in order to empower employees to think, design and act digitally. In the case of PMI, the clarity of vision, goals and leadership commitment is not challengeable and fully understood by each and every employee.

4.2 Supporting evidence

When a successful company decides to dramatically change then it is inevitable that employees will ask themselves why. The reason behind is the health aspect of the products and PMI made it its focus to provide supporting evidence to its employees to make them understand the reasons. Besides that PMI stated a common-sense approach to public health as an important part of the transformation strategy in general. Within it, PMI defined two

important steps: first to invent less harmful alternatives to cigarettes and second to make them appealing to smokers in terms of taste and sensory experience. As a result, a significant public-health benefit can be achieved only when a large number of these smokers switch from cigarettes to better productsⁱⁱⁱ. In case of PMI huge efforts have been made in building a science platform which is the basis of all product-related decision making in the company. Explaining the science behind the new product category still seems to be more focused on the first two pillars rather than internal stakeholders. The reason might be caused by local leaders and communicators to be careful about communicating science related topics further, rather focusing on a few key takeaways employees should know (exception are employees working in R&D), while deepening of the science-related knowledge lies in ambition and effort on individual levels.

4.3 Values

Business change itself also required internal change in culture and redefining the values. Due to this, PMI introduced the so-called "new cultural energies", all being equally important across all functions and departments. Consumer at the core - in everything that is done, consumer comes first, no matter who the consumer at a specific moment and within specific function is. Forward leaning - meaning employees act ahead of events, are comfortable with uncertainty and therefore learn from mistakes. *Inclusive* – meaning that employees learn from each other, challenge each other, but also respect and expect disagreements. Space to deliver – simply said, giving people what they need to get the job done and then get out of their way. Disruptive innovators - being curious and looking outward. Additionally, "leadership energies" were introduced as well and are included in employees' measurement of performance, which highlights the importance of those energies as part of company values. Employees are graded on each of this energies, by the level they include them in their every day job and behaviour. They describe what is expected from every individual in terms of behaviour to drive the culture change in the company. Those energies include putting consumer at the core, being disruptive innovators, embrace forward leaning, being people activators and meaning creators.

Internal transformation through introducing these energies is intended to evolve the organization into one that masters digital, lean and agile skills, displaying the culture and leadership mindsets and behaviours needed to transform successfully. Both, cultural and leadership energies are well communicated and their application on every single workplace is challenged trough workshops and specific sessions, their importance is raised as being part of performance evaluation of employees as well as basis for future recruitment. Field of improvement is seen in focusing on the less understandable values in terms of how they can be translated to every employee, since at this point most of the focus seems to be on Consumer at the core. Additional challenges related to certain energies is that they might not be equally applicable and visible across different departments, meaning it might take more time for some employees to better understand how to use some of them in their every day jobs.

4.4 New ways of working

Along with transformation, the way things are done and assessed has changed in PMI. Based on Lean Enterprise and Design Thinking PMI has developed its own methodology of how a certain number of internal project should be approached – *Fast Forward*. At PMI *Fast Forward* became the new way of working and basis for PMI project management. It is a customer-centric framework that leverages rapid iteration and experimentation to turn customer problems into successful business solutions. It is composed of principles and tools

providing common language, skill set and way of thinking. It includes digital, lean start up, agile, lean manufacturing, collective and authentic leadership, and the unit of progress is validated learning. One of the main principles is to base decisions and answer questions (assumptions and hypothesis) using data (validated learnings) from research and experiments. The new way of working is applicable in situations where PMI is facing unknown customer problem and unknown solutions, therefore objective methodology is key in order to find data driven solutions beyond personal opinions. The rollout of the methodology at PMI has been made in stages: developing trainers, setting up a global team, developing local builders and catalyst teams. That way a group of trained employees have been equipped with deep knowledge, while the rest of the organization will learn by doing guided by. *Fast Forward* teams added to their basic level of knowledge.

And to mention it as well, PMI is in parallel working on the refreshment on portfolio of tools to change the way employees work. New digital tools will help to connect, collaborate, and co-create with colleagues more easily on daily tasks and to have a secured digital environment – a fully digital workplace. The biggest challenges identified are going back to old methods since perception of a group of employees is that new methodologies are time-consuming, buyin among all employees and challenging psychological safety since the new way of working should be based on insights and quality of ideas and not decision making based on hierarchy, but employees are not feeling psychologically safe to contribute to ideation.

4.5 Talent management

PMI strategy in digital transformation relies on: (1) Enabling transformation - finding the right talent to enable the business to grow RRP, (2) Continuous improvements – creation and deployment of new tools, technologies and analytics to improve customer experience, (3) Closing the skill gap - filling critical roles with the right people, and (4) Operational excellence - using data driven insights and analytics to improve operational excellence. In terms of closing the skill gap PMI primarily refers to for example the fact that since 2008 over USD 6 billion were invested in research, development and employing more than 400 worldclass scientists, engineers and technicians. Additionally with the digital transformation PMI came across the need of acquiring new skills in the areas of digital, customer care, CRM, business intelligence^{iv}. Having this in mind, the PMI Talent Acquisition team is facing the challenge of keeping the focus on PMI strategy to "be the employer of choice for our global workforce and work tirelessly to attract the best talent", using new digital platforms in order to offer better candidate experience and working on personal skills in order to identify new profiles which have not been common in the past. At the same time, creating an inclusive and diverse workplace is seen crucial, since PMI believes this should be key to turn their vision of a smoke-free future into reality. The stakeholder management in recruitment seems to be very challenging, since often the organization is not ready to define what expertize they are looking for, therefor acquiring new talent and managing satisfaction of existing talent is not easy.

4.6 Capability building

A few times have capabilities been mentioned in this paper so far. Mostly in terms of building internal capabilities needed to support PMI's transformation. At the same time the acquisition of new talent closing the identified skills gap has been crucial. On the global level PMI has introduced a new online learning platform offering content in areas of fundamental trainings about transformation, new ways of working and methodology, consumer centricity and workplace skills all with the aim to enable employees to learn when suits them best. PMI relies on the strength of its internal trainers, working by doing and functional and technical trainings executed locally and as per need. The end goal seems to be creating a "learning

culture" where employees should have access to learning platforms any time, use opportunities to learn and share learnings by connecting with others. This step is showing great field of improvement and area for future development.

4.7 Internal communications and HR relationship

According to Cowan (2014, p. 8) the triangle of internal communications, employee engagement and HR needs to be effective across the organization, appealing to both the professional and personal aspects of individual employees. In other words, the importance of a consistent flow of relevant information top down can contribute to improving one's workplace to a place of belonging to a higher cause, meaning important contributor to company goals and vision. While internal communications of the 20th century where focused on communicating about what organizations do, it is the role of internal communicators of the 21st century to add the why and trigger positive attitudes, excitement, feeling of belonging and engagement. On top of transmitting the message, in the 21st century company communicators are expected to understand behaviour, trigger interest, raise engagement and support dialogue.

In order to facilitate the process and make change as effective and as easy as possible to understand, in some local PMI organizations, a special team with recognizable branding was formed in order to introduce the transformation to the organization. Am team was established and made of employees from various departments, but was led from internal communications and human resources side. In the first stages the aim was to have a single point of contact for all transformation related topics and in the mid-term the team is kept for maintaining the communication channels and facilitating regular communication between employees and management. On the global level PMI has put accent on celebrating success of different markets, yet the local teams are left to ideate, create and execute projects as outcome of the HR & Internal Communications relationship. The explanation is in nonexistence of best practice to be applicable in all markets, yet field of improvement is identified in the global approach.

4.8 Transformational engagement platforms

MacLeod and Clarke (2009) differentiate two levels of engagement: transactional and transformational. Transactional engagement is identified in situations where a survey is conducted in order to detect the current situation and next step activities, while those activities, as its consequence, are executed and all with the aim to improve engagement. Activities are seen as set of transactions separated from business strategy, rather a one-time project. Transformational engagement on the other side integrates employee behaviour and contribution as relevant part of the business strategy, therefor employee engagement insight is conducted on a regular basis and culture is seen as a natural part of business. Most companies are in the middle between two approaches. Transformational engagement approach requires management involvement, a high level of trust, a strength based approach, shared responsibility and employee involvement as well as managers with capabilities and skills to engage others.

In order to activate and encourage internal transformation in PMI, different platforms have been designed for employees to speak up and engage. Moreover, those platforms are intended to share best practices and experiences among employees from different markets, but also to encourage inspiration throughout the organization, all over the world. A few executed examples are Transformation teams in local markets consisting of early adopter employees and being given the task to create engagement platforms, events, pass it on sessions to engage

all other employees to join and feel as part of the transformation. This step of employee engagement has been identified as extremely important hence in PMI not all employees have the opportunity to work on the new product and feel left out. The goal of engagement platforms seems to be finding ways of showing each employee that every workplace plays a significant role in PMI's transformation.

"Sometimes I feel like only a few elite-employees are invited to work on the new category." Employee (PMZ03)

"Being part of a pass it on session gave me the chance to see what others are doing in this times of transformation. Now I see the bigger picture and understand that even my role is part of it."

Employee (PMZ04)

"Before the pass it on session I was sure that my level of knowledge about our new category is not questionable. But once I was in the position to pass on my knowledge I became aware of the fact that I still have so many open questions, that I am not sure about the quality of my communication."

Employee (PMZ08)

Lately there have been many research papers claiming a positive relations between the average level of employee and business success. The most significant to mention is a summarizing meta-analysis covering 8,000 business units of 36 companies which revealed that levels of engagement are positively related to indicators of their performance, such as customer satisfaction and loyalty, profitability, productivity, turnover and safety (Harter et al., 2002). Most of those empirical studies are based on cases provided by consultancy firms, unpublished data and may require deeper analysis and investigation, however evidence exists and suggests that employee and work engagement might be increasing business results. Based on research of available theories and papers it can be concluded that definitions of Employee Engagement come back to one's approach, but can be summarized to employee behaviours and needs to be dedicated to the role and committed to the company. Employee Engagement can be measured using valid questionnaires (UWES), but when it comes to measuring impact to business results, Employee Engagement cannot be narrowed down and focused for measurement, since in its broader definition organizational commitment could be lost. In terms of future empirical research goals of researchers might be translating engagement into separate behaviours which then can influence separate business goals and be measured. Same can be transferred to PMI, since there is according to internal survey results proven that the impact of engagement platforms is significant, yet no connection to results exists.

4.9 Dialogue approach

Cowan emphasizes the importance of talking and sharing as "essentially the building blocks of a dialogue that creates new insights and understanding, which should be part of the objective of engaging dialogue", further on it is pointed out that dialogue allows view of both sides and helps to "refine our understanding or grasp of alternative points of view or the perceptions of our own points" hence, dialogue being the "opportunity for encounter" (2015, p. 124).

Surveys have always been regularly conducted among PMI employees, not only to measure the level of satisfaction, but also their understanding and company expectations. As the consequence of new values, new ways of working, new organizational changes, the focus of most of the surveys has been changed. All the results are promised to be shared with employees as well as directions and next steps to respond to identified pain points. Great importance is put on feedback, not only from employees' side, but also management. As

already mentioned in the example from local organization, regular dialogue sessions are organized to facilitate open two-way communication between employees and management and each session is organized based on the input and questions from the previous one.

"I have been within this company for over 10 years now and this is the first time we have been invited to such kind of open round. I think it is just great."

Employee (PMZ09)

"I am still not sure if our organization is ready to talk openly. I know people have concerns, but they are not used to raise it in front of everyone."

Employee (PMZ11)

"Those sessions only tackle the nice topics. What about the negative?" Employee (PMZ19)

At the same time PMI has significantly spent more time in designing surveys tackling all topics related to its transformation, where also after each announcement or newsfeed information globally shared employees are invited to share opinions, concerns, ideas and questions. Employees have stated their satisfaction about being asked, but also turned out to be overwhelmed and confused due to numerous surveys, overlapping topics and not always clear communication of results. At this stage it is not clear where the level of psychological safety of PMI employees is. It is for sure to be concluded, that in the following years the company has to invest a lot of efforts in that area.

5. Discussion and contribution

According to Truss (2010) employee engagement is "about creating opportunities for employees to connect with their colleagues, managers and wider organization". It is also about creating an environment where employees are motivated to want to connect with their work and really care about doing a good job. It is a concept that places flexibility, change and continuous improvement at the heart of what it means to be an employee and an employer in a 21st century workplace. Another definition of engagement is "positive attitude held by the employee towards the organization and its values. An engaged employee is aware of the business context, and works with colleagues to improve performance within the job for the benefit of the organization. The organization must work to develop and nurture engagement, which requires a two-way relationship between employee and employer" (Robinson et al, 2004). The last two decades have shown a significant transition from satisfied employees to engaged employees (Avery et al, 2007, Buckingham & Coffman, 1999) who are often identified as the force behind organizational growth and success.

Trends and impacts from digital transformation change the environment where companies operate. Digital transformation is not just about turning existing processes into their digital versions, but rethinking current operations and giving sense to why things in the organization should be done differently, especially in the case of a successful company, even prior to digital transformation. Digital transformation is the key enabler for additional internal efficiency in organizations, as well as offering new external opportunities like new products or opening up to new groups of customers. At the same time disruptive changes in the operating environment and the impact cased towards employees can cause unknown situations, less of sense or accumulated dissatisfaction of the existing workforce. All of these challenges can be translated into success by keeping the momentum and relying on leadership, values, internal communication and processes. Each company's experience is different, therefore case studies are seen as valuable insights into the yet not so known. Based

on synthesis of existing literature and previous research findings, this paper explains a systematic approach to tackle digital transformation that will help companies to define a roadmap to lead them through successful transformation of their workforce and putting employee engagement on the highest level.

In this paper, the phenomenon of digital transformation has been discussed in the context of a tobacco industry case study and based on insights the model for employee engagement is explained. We began this article with the question: How can organizations successfully intertwine digital transformation and transformation of people? In response to this and based on previous research and in depth literature review as well as case study insights gained from studying a global industry leader in its biggest transformation we have proposed a 9-step approach cascading from vision about digital transformation to full employee engagement. The contribution of this article is threefold. The article extends existing theory both on digital transformation and employee engagement. Secondly, this paper will help to better understand the role of leaders involvement in all processes related to people underlying digital transformation based on case study learnings from a disruptive innovator and thirdly, this paper is to help businesses understand that companies must interlink employee and digital transformation. Additionally, area for further research we see in further analysis of the relationship interlinking the 9 steps presented in this paper.

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Abstract. In the modern economy, the training of professional skills and competitive specialists is an imperative of major importance. In order to achieve the aims of education, adjusting the teaching methods to the specific of the educational approach, represents an important task of the teachers. Stimulating learning and personal development, fostering the exchange of ideas, experiences and knowledge, ensures active participation, promotes interaction, leading to active learning with obvious results. At present, it is opted to modernize the didactic approach by using modern methods that can contribute to increasing the efficiency of the lesson. By contributing to the teaching and learning of knowledge, to fixing, consolidating and evaluating them, the modern methods determine the students to carefully follow, with increased interest and curiosity, to use their imagination and creativity, request their personal effort of thought, etc. Creating and maintaining an appropriate learning environment, in which students participate with enthusiasm, is a real challenge for each teacher. Therefore, the presentation of modern, interactive methods used in the teaching-learning process is a real necessity. In this context, the authors of the article analyze and highlight the educational requirements in the preparation of a specialist who corresponds to the current labor market standards, highlighting the active-participatory methods that contribute to the improvement of the quality of the instructive-educational process and the aspects of effective value in using these methods, integration appropriate in the didactic project.

Key words: skills, education, interactive methods, modern education

1. Introduction

At present, the needs of the society in training the specialists are oriented towards quality, performance and competence. In this context, teachers from higher education institutions have to act as promoters of change, innovation and modernization. Fulfilling these social and professional requirements in various, types of teaching-learning activities constitute the areas of strategies, methods and techniques applied by teachers in order to train competitive specialists on the labor market. This approach has an impact on the curriculum, courses' contents and upon the degree of courses' interactivity.

The approach of modern education focuses on the students' needs, while the teacher has the responsibility to facilitate the competence-based educational process, using a varied methodology, being efficiently managed in time and space. By adjusting the classical way of teaching, along with using some effective, teaching strategies, methods and techniques,

learning will be achieved by building skills and competencies according to the current labor market's requirements. (Gutu, 2013)

The aim of this paper is to analyze the active-participatory methods, their role in developing students' critical thinking, exposing students' opinions in a survey, about applying, using these methods and their roles in their professional training. In this context, we consider that the formation of some interactive-creative learning skills must be built and consolidated in time, in order to have a more efficient formative effect, materialized in the development of high intellectual skills.

So, the major objective is to equip the students with learning methods ("learning to learn"), thus preventing the passive accumulation of knowledge and ensuring an active education. Starting from the idea that the active education is achieved with the help of participatory-innovative methods, it is necessary to use as little as possible those activities that limit the stirring-up and expansion of the use of modern, active methods that develop the thinking, the ability to investigate, etc.

The active-participatory methods are those that subject the students to a maximum effort, deducted from the tight correlation between thinking and action, intellectual activity and practical experiences.

The success in the professional training of students will depend on the way the teacher combines the classical, traditional methods with the active-participatory methods, using practical, technical methods and examples. The applied methods will favor research, discovery or innovation, thus we will form and develop competencies, attitudes and behaviors, which will successfully respond to the challenges of the subsequent professional experience of the students.

Nowadays, it is becoming more and more obvious that in higher education institutions (both in teaching and learning) the emphasis is placed on heuristic, problem-based strategies that have resources on involving the students in the successful realization of a priority formative education. In the vision of modern didactics, these strategies represent a fundamental methodological principle, with an extremely important role on student-centered activities in the teaching-learning process. (Bontaş, 2007)

So, let us start with the analysis of the "training process" dimension. We will inevitably present the forms, the traditional methods used nowadays in Higher education establishments, which are meant to effectively organize the teaching process. And we will also describe to what extent the teaching-learning methods are implemented in the studying process: lectures, seminars, case studies, project learning, etc., made during the studying subjects, oral presentations of the students, individual studies.

We will highlight the active-participatory methods that contribute to improving the quality of the educational process and the efficient aspects in using these methods, the proper integration in teaching project, which resulted from some students' opinions about this process. We believe that the successful combination of these ways of learning will contribute to the formation of an efficient educational process based on goals' design and the skills' training of the students.

The university course, as the main form of organizing the training activity in higher education institutions, is methodologically achieved through lecture's strategy, which can be conceived and improved in different ways: demonstrative, problem-based; based on experiment, on the documentary study; on deductive, analogical, creative dialogue, etc. (Cristea, 2015)

According to the followed purpose, there exist: introduction course, current thematic course, synthesis course.

According to the theory-practice ratio, there exist: theoretical course, practical-applied course, sandwich course (modular-interactive).

According to methods' paradigm, there are distinguished the following courses: classical lecture, lecture-debate, lecture-conference, problem-based lecture. (Pintilie, 2006)

The functions of the lecture are: informative, encouraging, formative, orienting, educational and axiological.

Like the university course, **the seminar** is the main form of organizing the teaching process in Higher Institutions. The main purpose of the seminar is deepening, systematization of knowledge, skills' formation, especially the applied ones, formation of integrative attitudes.

More recently, the participatory "valences" of classical methods are sought today. It is current to diversify them through the application procedures, so that the students are placed in active learning situations.

Currently, the educational process is determined by the principles of active involvement, of focusing the activities on the student. To achieve this goal it is necessary to use active methods: discovery learning, problem learning, cooperative learning, case study, simulation, role-play, brainstorming, heuristic conversation, presentation, debate, development and implementation of projects, etc. (Joită, 1999)

As a result, using efficiently the active, modern methods contributes to the achievement of studying goals, which are the results obtained in terms of students' skills.

2. Approaches to modern education regarding the integration of active-participatory methods in the teaching and learning process in modern Higher Education Institutions

A special role in the training all types of competencies belongs to the problem-based one, which is one of the essential coordinates of modernizing the education at all stages and at all levels, stimulating the creativity of teachers and learners.

In developing this idea comes the author of the article "Pedagogy" C. Cucos, who mentions that the specifics of this problem is that the teacher does not present the knowledge which has already been elaborated, he gives up presenting the information as a product and focuses on knowledge as a process, reveals the subjects of the didactic process as the "embryology of truths", placing the students in the research and discovery situation. (Cucos, 1996)

It should be mentioned that in modern didactics the inquiring exceeds the status of didactic method and acquires a much more complex status – the didactic orientation, the fundamental methodological principle, the didactic technique, the educational direction, the didactic strategy, so, we, authors, support this idea, that is why we have also approached it. The problem-based education in Higher Education Institutions can be done at different levels:

- a) The problem-based presentation of the subject;
- b) The creation of a problem-situation and its solution by the students together with the teacher;
- c) The creation of a problem-situation and its solution by the students independently;
- d) The notification and solution of the problem by the student.

All these levels of the problem-based education can be practiced while organizing all forms of the didactic activities in a university: the university course, university seminar, practical activities, scientific research activity (Repida, 2010, p 102).

But, based on the above-mentioned, it is necessary for the university staff (teachers) to possess and, especially, to practice all these levels, not to be limited to the first two and make the student feel that he is the master of his own learning.

So, problem-based teaching is the set of steps taken by the teacher in order to organize and manage the problem-based learning activity of the students.

Problem-based learning is a way of active and interactive participation of students at the teaching process, which consists in designing and performing independent searching activities (individually or in groups) of the solution to a contradictory problem.

We can conclude that problem-based learning is an efficient means of achieving student-centered education, when he, himself, through his actions, contributes to his own development.

The teacher is the one who will decide what topics and questions will be exposed through the problem-based lecture. However, selecting the studying topics for problem-based studying is not so simple. In any case, the teacher must know the students, in terms of the reached cultural level, individual potential, interests and skills, expectations and desires, adaptation and integration, personality traits (knowledge of psycho-individual peculiarities and age), learning style, previous experiences etc. (Repida, 2010)

In our opinion, as a result of many years of experience, in order to form all types of skills: **general** (instrumental, interpersonal, systemic) and **specific** (knowledge and understanding, application of knowledge in practice, analytical and predictive skills, communication skills, learning skills) in university education, we consider to be efficient the use of heuristic strategies (problem-based) in the teaching-learning process in both Cycle I – Bachelor and in Cycle II – Master, at all specialties (economic, legal, etc.).

Through these strategies, the students learn the science as a process, participate at their own trainings and development as a specialist in the chosen field and as a personality (Lapuşin, Livitchi, 2011).

Today, the educational process is determined by the principles of active involvement, of focusing the activities on the student. To achieve this goal, it is necessary to use the interactive methods: learning by discovery, inquiring learning, cooperative learning, case study, simulation, role-play, brainstorming, heuristic conversation, presentation, debate, projects' development and implementation, etc. (Cabac, et al., 2012)

The efficient use of interactive methods will obviously contribute to achieving the goals of studies, to the results obtained in terms of students' skills.

In the literature, there are various opinions on this subject. One thing, known to all remains certain: self-dedication, experience, creativity, intuition, the application of these methods day by day, demonstrates their effectiveness, the opportunity and the need for implementation based on the specifics of the specialty.

In the above-mentioned context, we believe in the successful conduct of a teaching activity, lesson, organized either face-to-face or online, using active-participatory, interactive training methods a lot depends on the clear and concise formulation of the topic or problem to be solved. Respectively, there can be successfully used several information tools, such as:

- Electronic presentations;
- Interactive whiteboard;
- The educational software SMART Notebook, MOODLE Platform, etc.

The informational technologies are used for collecting, storing, organizing, processing, presenting and communicating the information. Their use as content elements and teaching aids helps to improve the quality of higher education. Thus, it will be possible to develop skills for creating, processing, obtaining, systematizing, retrieving information, creativity, structural thinking ability and teamwork skills.

The diversity of methods and teaching means used in student-centered teaching and learning responds to a fundamental need for variation, differentiation, customization of teaching, while broadening and considerably accumulating the teaching experience by the teacher and learning experience by students, offering the possibility of multiple and appropriate action strategies. (Dumitriu, 2011)

It is also certain that the aims of the studies cannot be achieved through traditional strategies, methods and techniques. The reality requires the use of interactive methods focused on heuristic, algorithmic actions, learning through cooperation and collaboration, research.

The interactive-teaching-learning-assessment methods are an important support of formative education, presenting itself as an effective means of facilitating the assimilation of knowledge at the cognitive level, forming skills- at the application level, cultivating attitudes and skills – at the integrator-complex, creative level. (Cartaleanu, et al., 2008)

As we have mentioned, unlike the traditional ones, the interactive, active-participatory methods focus on the student, who becomes the subject responsible for the made options and choices. The interactive methods contribute, mainly, to transforming the student into a learning subject, removing him from the sphere of passivity, from the comfort zone, from the position of a simple information consumer.

3. Application of active-participatory methods in the teaching-learning process in order to achieve the curricular didactic approach in Higher Education Institutions

Nowadays the requirements for modernizing, improving and efficientising the teaching methodology are part of the University Curriculum, indicating the directions of increasing the active character of teaching methods, by applying some methods with a pronounced formative character. It is also important the aspect of capitalizing the new educational technologies (e-learning), in transmitting and overlapping the inquiring of each learning method and technique, thus managing to make a significant contribution to the development of the student's full potential (Musteață, Liviţchi, 2014). In such a way, the student does not remain a simple actor or participant in the teaching process, but becomes his own trainer.

So, analyzing the aims and types of theoretical and practical activities, from the wide range of teaching methods existing in the literature, below, we will present those interactive methods and techniques which are used in our teaching and which we consider effective in the teaching-learning process at university level, not only we, the teachers, but also the students, this being confirmed by the surveys carried out regarding the quality of the course.

While providing educational, research and other services, our University promotes the implementation and development of the Quality Management System based on the new ISO 9001: 2015 standard. In this context, there was elaborated and administrated an Assessment Questionnaire for the Course Quality, according to the procedure - Customer Satisfaction Assessment. There have been interviewed 78 students from the faculties of law and business and administration, part—time studies, from the Cycle I-license.

Each semester during the two examination sessions, the students are involved in the quality assessment process, on several dimensions. In this article, we will analyze the students' answers in the questionnaires on the size of the *Training Process*. The respondents expressed their opinions on the teaching-learning methodology, to what extent the active-participatory methods were used in the study program made during the studying subjects, but also their opinions on the effectiveness of these techniques, their contribution to building skills and developing the competences.

The case study is a method of direct exploration that stimulates thinking and creativity, making the students analyze and compare situations, seek and develop solutions to real

problems. This method offers the possibility to freely express the opinion, but also to choose the optimal solution after debating the cases.

The specifics of the method consists in the tendency to approach learning to real life, starting from the idea that, where there is a similarity between the learning situation and the life situation, learning becomes much more effective.

The case study is applied in teaching different topics at any university subject (real or humanitarian profile) and allows not only to focus the thinking on a particular problem, but also its in-depth analysis. It is important that students not only select the case in the field of professional training, but also try to independently develop the case that will be proposed for solving. The presentation of the case can be done through posters, collages, photographs, images, drawings, paintings that represent the case in different phases, watching documentaries, etc.

The case can be investigated by: the entire academic group, in a small group, by each student individually, by different students who deal with the study of different cases (Iucu, 2008). The rules of unfolding the method take into account in particular the chosen "case". Thus, for a situation to be considered and analyzed as a representative "case" of a field, it must meet the following conditions:

- * to be authentic and significant in relation to the mentioned objectives, including the essential;
- * to have educational value in relation to professional, scientific and ethical competencies;
- * to have an exciting character, motivating the participants to solve it, corresponding to their training and interests;
- * to request the active participation of all students in obtaining solutions, assuming the responsibility of solving the case.

While applying the case study method, there should be followed six steps and namely:

- Stage 1: Presentation of the general framework in which the event took place and of the given case: the teacher will firstly choose a "case" from the researched field and the proposed objectives, which will highlight the general-valid aspects; the case it will be analyzed and tested firstly in a small group, then it will be proposed to the participants for analysis; the presentation must be as clear, precise and complete as possible;
- Stage 2: Notifying the peculiarities of the case at the same time with the understanding of the need to solve it by the participants: there takes place the understanding of unclear aspects; there are asked detailed questions by the participants; additional information is requested on how to resolve the case (bibliographic sources);
- Stage 3: Individual study of the proposed case: informing the participants; finding and writing the solutions by the participants;
- Stage 4: Group discussion of ways to solve the case: the analysis of variants, either firstly in small groups (5-6 members) and then in plenary, or directly in plenary, each person presents his proposed variant; comparing the obtained results and their critical analysis in a free debate, moderated by the teacher; hierarchy of variants;
- Stage 5: Formulation of optimal conclusions based on unanimous decisions.
- Stage 6: Evaluating the way of solving the cas- situation and evaluating the group of participants, analyzing the degree of participation. At the same time, there are made predictions about the importance of retaining the solutions in order to apply them in similar situations.

The application of such a methodology in the educational process implies diversity and creativity in education, an important aspect that opens new perspectives in the professional training and personality of the student.

It should be mentioned that 76% of students consider that in their studying program, the case study is the most successful method, both for students from economic specialties and those from law. In their opinion, the method contributes to the development of analysis and decision-making skills; it orients the students to a deeper knowledge of the reality in which they live, including through debates of cases / problems within the instructional-educational process.

Bunching is a technique that is based on the development of students' free thinking, individually or in groups, regarding the understanding of concepts and ideas, as well as the correlation of connections between them.

The use of this learning technique allows the integration of previously acquired information with the one acquired during the activity, it stimulates the realization of new associative ideas. Thus, there can be acquired more knowledge, students will show a vivid interest in knowledge and will identify optimal solutions to a certain problem (Bradu, 2013)

Although it is a simpler variant of brainstorming, bunching is a method that involves identifying the logical connections between ideas, it can be used successfully both at the beginning of a lesson to update the previously taught knowledge and in the case of synthesis lessons, revision, systematization of knowledge.

Bunching is a technique of searching the ways to access one's own knowledge, highlighting the way to understand a certain topic, a certain content (Cerghit, 2006). We consider bunching an effective teaching and learning technique because it encourages the students to think freely and openly. Bunching works according to the following steps:

- 1. You write a word / topic (to be analyzed) in the middle of the board or on a sheet of paper;
- 2. Students will be asked to write down all the ideas, phrases or knowledge they have in mind associating to this topic, about the word from the center, drawing lines between them and the original word;
- 3. As new ideas come to their mind and they write them down the words, the students will draw lines between all the ideas that seem to be connected.
- 4. The activity stops when all the ideas are finished or when the given time limit is reached.

There are several rules to follow when using the bunching technique:

- Write down everything that comes to your mind regarding the topic / question under discussion.
- Do not judge / evaluate the ideas, but only the notations.
- Do not stop until you have reviewed all the ideas that come to your mind or until the time expires; if the ideas refuse to come insist and linger on the topic until some ideas appear.
- Let there appear as many and varied connections between ideas as possible; do not limit the number of ideas or the flow of connections between them.

Pair activity is an active-participatory method by which students will cooperate and work together to accomplish a given task. It is an easy-to-use method, as it involves forming a team, and the proposed topic will be analyzed within the team. The usefulness and advantages of this teaching-learning method are:

- cooperative learning,
- understanding the essentials of an important topic,
- developing students' communication, thinking and creativity skills,
- developing the analysis of capacity and synthesis of information. (Boncea, 2016)

Brainstorming is a teaching method that stimulates students' creativity. By stating a problem, several ideas will be spontaneously offered for solving. Thus, in order to know an object, phenomenon, process or to solve a problem, students will create, examine and propose ideas for solving a case, concrete situations, will think of creative, innovative concepts. (Oprea, 2008)

The use of brainstorming in the teaching-learning process leads to the development and stimulation of creativity, to involving the students, presenting their own opinions about the discussed problem, by highlighting the main arguments.

Thus, the application of the method is efficient by:

- stimulating creativity;
- developing critical thinking and argumentation skills;
- developing the communication skills;
- active participation of all students;
- increasing self-confidence and initiative;
- developing a positive environment.

Here, the survey's results show that 88% of surveyed students consider these techniques as effective ones in the teaching-learning process, because they encourage them to think freely and openly. Another advantage mentioned by them is the communication among the students. **Starbursting** is an active-participatory method, which involves formulating of as many questions as possible from other questions. By applying this method, the aim will be to make logical connections between these questions, between the students' ideas, in order to discover new information. The method can be done individually or in groups. (Pintilie, 2006)

Starbursting is an efficient method for developing creativity, similar to brainstorming. It starts from the center of the concept and spreads out, with questions, like the stellar explosion. How to proceed:

- 1. Write the idea or the problem on a piece of paper and write down as many questions as possible related to it. A good starting point is the ones like: What ?, Who ?, Where ?, Why ?, When ?.
- 2. The list of initial questions may lead to unexpected ones that require more concentration.

By applying starbursting, we will aim to get as many questions as possible and thus as many connections among concepts as possible.

It is a way to stimulate individual and group creativity. Organized in groups, starbursting facilitates the participation of the whole team, stimulates the creation of questions to questions, as brainstorming develops the construction of ideas on ideas.

Stages:

- 1. Proposing a problem:
- 2. The team can be organized in preferential groups: 5 groups per two students each;
- 3. The groups work to draw up a list of as many questions as possible;
- 4. Communication of group's work results: each group uses several sources of information to register the answers: textbooks, encyclopedias, information sites, educational software.
- 5. Highlighting the most interesting questions and appreciating the teamwork. Optionally, you can also develop answers to some of these questions.

The advantages of applying the starbursting method in the teaching-learning process are:

- easier understanding of concepts,
- developing creativity and critical thinking,

- developing communication and the spirit of cooperation among students,
- participation and involvement of the whole group.

56% of interviewers appreciate the objective effects of this technique. They mention that the Starbursting technique is easy to be applied in a wide range of fields. It is not so complicated and does not require detailed explanations. Participants quickly get involved in the game, this being on the one hand a way of active learning and, on the other hand, a source of new discoveries.

The game is the didactic method that develops the creative abilities of the students, develops the thinking and the imagination facilitating the process of understanding and consolidating the theoretical knowledge and the formation of abilities, the applied skills. In addition, the game is an important element in personality development (Lapuşin, Liviţchi, 2011).

In Vygotsky's opinion, "the game is the primary manifestation of children's creative attitudes toward their surroundings. The game awakens the imagination, creates good mood and stimulates the thinking". Taking into account the specifics of teaching-learning at university level and the training of future specialists, there will be made application games, demonstration games, creative games, symbolic games, games with / without material, etc.

This method was considered effective by 73% of respondents, as an argument being presented the advantages of this method:

- participation of all students, the whole group;
- stimulating the direct participation of students in different roles;
- developing the spirit of cooperation among the students;
- training critical thinking and creativity;
- developing the initiative spirit, their own values and performances.

Critical analysis, as an active-participatory method used in the teaching-learning process, develops the skills of evaluating a topic, issues, themes and logical, comprehensive analysis, highlighting the ideas and arguments, evidences in presenting some solutions. The method can be made individually, in pairs or in groups. Its application develops the abilities to choose, to analyze, to judge, to differentiate.

Examining a topic / problem and researching them from different aspects, comparing different points of view, they will elaborate certain arguments to support their own system of knowledge and values. Thus, critical analysis helps students to organize their ideas and arguments with concrete evidences, facilitating the understanding, interpretation and application of the obtained knowledge. It will stimulate the constructive critical spirit, the ability to bring arguments and identify different alternatives. (Oprea, 2008)

The method of thinking hat is an interactive technique, stimulating the creativity of the participants which is based on the interpretation of roles according to the chosen hat.

There are 6 thinking hats, each having a color: white, red, yellow, green, blue and black. The members of the group choose their hats and will, thus, interpret their precise role, as they see. The roles can be changed, the participants are free to say what they think, but to be according to the role they play. The color of the hat is what defines the role. (Pintilie, 2006)

Below, we will show how the one who "wears" one of the 6 thinking hats:

The white hat - offers an objective look at the information, being focused on objective facts and clear images. The thinker of the white hat is disciplined and direct. White (no color) indicates neutrality.

The red hat - legitimizes the emotions and feelings as an integral part of thinking. It makes possible their visualization, their expression. Wearing a red hat, the thinker can say, "That's how I feel about ...". The red hat allows the thinker to explore the feelings of the other

participants in the discussion, asking them what they think "from the perspective of the red hat", for example emotionally. The viewer from this perspective does not have to justify his feelings nor to find the logical explanations for him.

The black hat - is the warning hat, focused mainly on the negative appreciation of things. The thinker of the black hat points out what is wrong, incorrect and what are the mistakes. He explains what does not fit and why something is wrong; what are the risks, dangers, mistakes of the proposed approaches.

It is not an argument, but an objective attempt to highlight the negative elements. There can be used the negative wording, such as: "But if it doesn't match ..." "it does not only work, but it doesn't ..." The thinker does not express negative feelings, these are left to red hat, as the positive ones are left to the yellow hat. In the case of new ideas, the yellow hat should be used before the black one.

The yellow hat - is the symbol of positive and constructive thinking, of optimism. It focuses on positive assessments of the situation. It expresses hope; considers the benefits, the value of the information and the given facts. The thinker of the yellow hat struggles to find logical and practical supports for these benefits and values.

He offers suggestions, concrete and clear proposals. It requires a greater effort of thought. The benefits are not always rapidly noticed and must be sought. It does not refer to the creation of new ideas or solutions, these being left to the green hat.

The green hat - symbolizes creative thinking. The search for alternatives is the fundamental aspect of thinking under the green hat. It is used to reach new concepts and new perceptions, new variants, new possibilities. It requires a creative effort and multilateral thinking.

The blue hat - is the hat responsible for controlling the taken steps. It's the thought of having to explore the subject. The blue hat is the conductor of the orchestra and asks for the help of the other hats. The thinker in the blue hat defines the problem and leads the questions, concentrates the information during the activity and formulates the main ideas and conclusions at the end.

He monitors the game and considers the rules, solves conflicts and insists on building the thinking approach. He intervenes from time to time and also at the end. It can attract the attention of other hats, but by simple interjections. Even if he has the leading role, any hat is allowed to make comments and suggestions.

Thus, by dividing the 6 thinking hats, the roles of the students are distributed and they are offered the case under discussion so that everyone can prepare his ideas. The hat can be worn individually - and then the student fulfills his role - or several students can answer under the same hat. In this case, the students of the group that plays the role of a thinking hat cooperate in ensuring the best interpretation. They can each wear a hat of the same color, being aware that:

- The blue hat \rightarrow clarifies.
- The white hat \rightarrow informs.
- The green hat \rightarrow generates new ideas.
- The yellow hat \rightarrow brings benefits.
- The black hat \rightarrow identifies mistakes.
- The red hat \rightarrow says what he feels.

According to the results of the survey, 89% of respondents mention that it is their favorite technique and most often requested by students, because it involves and develops absolutely all social skills of participants, intercommunication and mutual tolerance, respect for each

other's opinion, stimulates participants' creativity, collective and individual thinking, but most importantly, it develops the skills of linguistic, logical and interpersonal intelligence.

Following the application of the above-mentioned active-participatory methods, the analysis of the fulfilled survey, we found that the students more easily acquire the taught knowledge, have a more responsible behavior, are more creative, more enterprising, come up with various proposals to solve the mentioned problems and the final assessments demonstrate an increase in the level of professional skills. In addition, the application of active-participatory methods in the teaching-learning process is in line with the students' expectations, who are innovative, creative, with a spirit of initiative and critical thinking. It depends on the competence, the ability of the teacher to apply them in the teaching-learning process through a direct connection with the trained one or through the realization of distance learning.

From the above it is clear that the main objective of teachers is to empower the student, to help him develop, to shape his personality and to develop his self-confidence, by using methods, interactive techniques focused on individual learning of the student. The emphasis is on the intellectual freedom of the student and on autonomy, considered the fundamental values in education.

4. Conclusions

In the current university educational approach, teachers will take into account the integration of active-participatory methods combined with the specific teaching-learning-assessment methods and will give great importance to modern and attractive means of learning.

Regardless the way the students have access to different sources of learning, through direct contact or individual study, face-to-face or online, the active-participatory methods are an **advantage** for both students and teachers, because they:

- facilitate the understanding of situations, problems, phenomena, processes and increases students' interest in research;
- ease the knowledge transfer;
- allow a complex, interdisciplinary approach, from several points of view;
- increase students' interest to know and research;
- energize the teaching-learning process;
- contribute to the formation of skills;
- contribute to the development of personality, development of abilities, skills;
- encourage independent work, initiatives, critical thinking.

And our task, of teachers, is not at all simple in the search and creation of possibilities for students to affirm themselves, to find themselves, to be original, ingenious, why not special.

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Does the Leader's Entrepreneurial Profile Matter? A Study for Portuguese Technology-based SMEs.

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Abstract. Arising from the globalization process, there is a rapid evolution in the business environment and strategies. Entrepreneurship is one of the main sources of innovation and renewal of business, driving economic growth and development. Using a sample of Portuguese Small and Medium-sized Enterprises (SMEs), this study seeks to analyze the influence of the leader's entrepreneurial profile on the company's internationalization process. Based on the literature review, we carried out a survey through which we seek to identify the entrepreneurial characteristics of the leader, study their entry modes in foreign markets and understand the relevance of entrepreneurial characteristics to the internationalization strategy. The results indicate that the entrepreneurial leader of Technology-based Portuguese SMEs, is mostly male (95.2%), holds higher education (93.7%), and previous experience in internationalized companies.

Key words: Entrepreneurship, Internationalization, Leader profile, Technology-based companies

1. Introduction

We live in the digitization era, which allows for an increasingly rapid fluency of information, and consequently shortens the distance between countries, people, and businesses. Similarly, the globalization phenomenon has made markets more open and competitive, so companies face many and different challenges – economic, financial, environmental, social, and technological (Simões, Esperança, & Simões, 2013).

Internationalization is then assumed as one of the main contributions to the growth and sustainable development of companies, and in many cases is crucial to their survival (Ciszewska-Mlinariu & Mlinariu, 2010). Indeed, international expansion requires companies to become more competitive. At the same time facilitates access to new products, forms of production, innovation, and the latest technology.

Entrepreneurship in addition to enhancing innovation and business development drives economic growth in various countries and sectors. In this context, technological-based enterprises are considered as one of the most dynamic sectors of modern economies.

To the Portuguese context, there are few studies specifically related to the leader's entrepreneurial profile influence on the internationalization process. This justifies the relevance of the study in the area of entrepreneurship and internationalization.

Applying a quantitative methodological approach, this paper aims to analyze the influence that the entrepreneurial attitude of the leader exerts on the degree of internationalization of technology-

based companies. In particular, we seek to identify the entrepreneurial characteristics of the leader and study his influence in the internationalization process and strategies.

This work begins by making a brief review of the literature concerning entrepreneurial profile. In the third section, we present the methodology, describing the collecting information process, as well as the construction of the questionnaire. Subsequently, the fourth section presents the results and their discussion. Finally, the main conclusions of the work are exposed.

2. Characteristics and entrepreneurial profile – literature review

The importance that entrepreneurship assumes for economic growth and development is widely recognized and consensual. Nevertheless, trying to delimit and identify the entrepreneur characteristics, as well as to define his profile, is not an easy task. The literature is wide and different authors propose different perspectives. Considering the main objective of this work, in this section, the literature review is sought to identify the characteristics of the entrepreneur and define his profile.

For Drucker (1985), entrepreneurship begins with the action, that is, with the creation of a new company, regardless of its success. However, although the entrepreneurship process begins with the creation of a new company, the factors leading up to its creation are fundamental in the process. The search for opportunities in the surrounding environment, the identification of opportunities, the evaluation of the possibility of programming the new company, individual attributes, sociodemographic characteristics, previous experience and entrepreneur's education, restrictions of the surrounding environment and the values of society should be considered as part of the entrepreneurship process (Raposo & Silva, 2000). There is, therefore, a question for which an answer is needed: what characterizes an entrepreneur, that is, what are its fundamental characteristics?

According to Moutinho (2010, p.71) "if the entrepreneur is the one who carries out acts of entrepreneurship and whether internationalization is an act of entrepreneurship, it necessarily depends on the entrepreneur, his characteristics, his social capital, and network".

Lapolli and Franzoni (2013), emphasize that an individual with an entrepreneurial profile holds five inseparable distinctive signs: speed, polyvalence, vision, implementation ability, and human relationship capacity. Each person has these five distinctive signs of entrepreneurship, and usually one, two, or three will be more pronounced. However, some of these characteristics are more developed in some individuals due to their experiences, so there is a link between the entrepreneurial profile and the action.

Timmons (1989) considers that an entrepreneur is characterized by his high management capacity and business know-how. In this sense, it is possible to realize that the entrepreneur, due to his characteristics, plays a decisive role in the development and growth of a company due to its capacity and role in detecting and developing opportunities and conditions for innovative business.

Dominguinhos and Simões (2004) share this perspective because they consider that the main characteristics of the entrepreneur are the ability to identify opportunities, visionary capacity, scientific and management capacities, the attitude towards risk and uncertainty, experience and knowledge acquired throughout the professional career, his networks, among others.

Also, Persinger, Civi, and Vostina (2007) refer to the personality of global entrepreneurs. These entrepreneurs are often identified with characteristics associated with personal objectives and motivations and availability to take risks.

Additionally, some authors highlight the importance of education and training in the entrepreneurial profile. Education and training are related to knowledge, ability to solve problems, motivation, and self-confidence. Entrepreneurs with higher academic backgrounds have higher expectations and are more attentive to international opportunities (Westhead, Wright, and Ucbasaran, 2001). The knowledge of several languages is also an important factor concerning the

international development of the company (Andersson, Gabrielsson & Wictor, 2004), because it facilitates the interaction with the foreign market, and brings it closer to local culture.

Other authors consider the relevance of the family background. For example, Matthews and Moser (1996) demonstrate that, regardless of the individual's gender, the existence in the family nucleus of people with entrepreneurial activities, in particular the father and mother, are key factors in the choice of the latter to pursue his own business.

Concerning gender, some studies also indicate that it is important to analyze the gender differences involved in entrepreneurship. According to Silveira and Gouvêa (2008), there are more difficulties in accessing entrepreneurship for women than for men. Marlow and Patton (2005) point out that there are disadvantages for women, namely stereotypes of inferiority with men, and greater difficulties in accessing finance, which can affect their performance as entrepreneurs. Nevertheless, there has been a considerable growth in female entrepreneurship, which has assumed an increasingly relevant role for contemporary economies, namely in the creation of jobs and wealth (Boaventura (2010); Minniti (2011)).

Other studies identify the relevance of international experience and knowledge for entrepreneurship and rapid internationalization (Westhead (1995); Baron (2004); Zuchella, Palamara, & Denicolai (2007)). Westhead (1995) finds out that entrepreneurs with the ability to internationalize more quickly were those who already had previous experience in internationalized companies so they are more aware of the opportunities to export. Zuchella et al., (2007) also point out the importance of experience, indicating that the only variable significantly associated with the precocity of internationalization was that entrepreneurs had previously worked in a similar context. Also from Baron's (2004) perspective, the experience and knowledge acquired, are fundamental to international entrepreneurship, because there is a comparison of the new stimulus with past events, which is perceived and apprehended differently by each individual. International personal experience does not emerge as a precondition for the early internationalization process of the company. Nevertheless, it is useful in building a global mindset. This means that although there is no direct relationship there is a decrease in the risk

internationalization process of the company. Nevertheless, it is useful in building a global mindset. This means that although there is no direct relationship there is a decrease in the risk perceived by the entrepreneur. Related to the experience is also the age of the individual. Age may be related to a lack of experience and financial resources but, in contrast, younger people are more willing to take the risks associated with starting their own business. Besides, younger entrepreneurs have grown up in a more global environment, probably, they traveled more, with greater contact with people of different cultures and languages, resulting in greater ease in taking advantage of international opportunities. However, while younger people are more likely to take advantage of international opportunities, older people are more likely to be exporters because of their resources, knowledge, and networking (Anderson et al., 2004).

According to the literature, table 1 contains a summary of the entrepreneur's profile characteristics.

Table 1. Entrepreneur's characteristics

Author (s)	Entrepreneur's characteristics
Timmons (1989) Westhead et al., (1995) Baron (2004) Dominguinhos & Simões (2004) Zuchella et al. (2007)	Experience and knowledge acquired: individuals with experience and knowledge make more conscious decisions, identify business opportunities, have a greater network, and the risk perceived by the entrepreneur is lower.
Matthews & Moser (1996)	Background and family context: existence in the family nucleus of people, particularly father and mother, with entrepreneurial antecedents
Westhead et al., (2001) Andersson et al., (2004)	Education and training background: individuals with higher education are more attentive to international opportunities. Language proficiency: facilitates communication and trading with foreign markets.

Marlow & Patton (2005) Silveira & Gouvêa (2008)	Gender: the female gender suffers from stereotyped inferiority to the male gender and has greater difficulties in accessing funding.
Boaventura (2010)	
Anderson et al., (2004)	Age: younger entrepreneurs find it easier to seize opportunities, and older ones have more resources, experience, knowledge, and contacts- networking
Persinger et al. (2007)	Motivation and goals of personal fulfillment, low-risk aversion.

Source: Own elaboration

In the context of technology-based companies, internationalization and international entrepreneurship are particularly relevant as companies, in this branch of economic activity, are often highly associated with the Born Global phenomenon. Authors such as Ribeiro and Pimentel (2011, p.9) state that at Born Global companies, you will find the typical entrepreneur of technology-based companies. As these entrepreneurs have very close ties with the academic world, and their areas of expertise are often global, it is expected that the internationalization of these companies will occur in general as a result of a scientific innovation generated in the company and the international networking developed by entrepreneurs in their field of knowledge. In terms of strategies, the scientific Born Global may have a deliberate process, in which the fast internationalization was planned.

Authors such as Welch and Loustarinen (1988), Rennie (1993), and Oviatt and McDougall (1994) identified the so-called Born Global as companies that did not follow the traditional pattern of an internationalization process. On the contrary, the companies began to promote international activities from their beginning or shortly thereafter (Pereira & Pinto, 2017 p.15). Therefore, in contrast to the traditional internationalization theories, the differential of these companies lies in the fact that they work with external markets almost immediately and for several markets simultaneously.

In this context, Fernandes and Seifert (2016), propose a new categorization of the so-called International New Ventures (INV), as presented in table 2.

Table 2. The type of INV and its characteristics

Type	Entrepreneur profile	Internationalization Strategy
Classic	 Previous international experience A strong network of international relations Experienced entrepreneur – Business knowledge 	- Deliberate and proactive
Adventurer	- Sense of opportunity- Proactivity- Little international experience	- Emergent and proactive
Pulled	 - Previous experience in the business or industry - Extensive technical knowledge - Network and connections with large companies 	- Emergent and reactive
Pushed	Strong administrative skillsInvestment and profitability visionNetwork and relations in the industry	- Reactive and deliberate
Technological	ScientistAcademic commitmentA network of relationships in his field of knowledge	- Emergent and deliberate - Proactive

Source: Fernandes and Seifert (2016), adapted.

¹ For example, Vernon (1966), Hymer (1976); Dunning (1995, 1998, 2000); Johanson e Wiedersheim-Paul (1975).

Taking into account the personal characteristics of the leader, namely education and training, family context, knowledge of languages, previous experience in internationalized companies, risk aversion, and age, we will try to analyze how they are related to the internationalization strategy of these technology-based companies.

3. Characteristics and entrepreneurial profile – literature review

The main purpose of this work is to identify the entrepreneurial profile of the leader of technology-based SMEs and to realize how this profile influences the process of internationalization of the company. Specifically, our goal is to obtain answers to the questions: what are the entrepreneurial characteristics of the company's leader? What are the entry modes and internationalization strategies? What are the leader's characteristics and the external factors that influence the internationalization process?

Machado (2001, p.7), states that technology-based companies are "industrial companies, committed to the design, development, and production of new products and/or processes, also characterized by the systematic application of technical-scientific knowledge. The author also states that these companies use innovative technologies, have high expenditures in research and development, employ qualified human resources (technical-scientific and engineering), and serve specific markets. Currently, these companies assume an important role in the economy, because technological investment tends to foster economic dynamism and foster the transforming capacity of economic and social reality, with changes in production and consumption patterns (Batista, 2014).

A quantitative methodology, using a questionnaire, was followed. The quantitative methodology is guided by the use of objective methods, seeking distance from the data, and has a mathematical orientation for results verification and quantification. These processes seek to translate general conclusions. Although the generalization cancels out the uniqueness of some situations, in addition to the advantages mentioned, it is recognized that it can be applied to a wider variety of situations (Serapioni, 2000).

The questionnaire, based on the literature, includes questions related to the variables mentioned in table 3.

Table 3. Variables addressed in the questionnaire

1. Company's characteristics	- number of employees;
	- sales volume;
	- year of foundation;
	- year of internationalization
2. Profile/Entrepreneur characteristics	- gender;
	- age;
	- level of education;
	- previous international experience;
	- factors that influence entrepreneurial ability;
	- father and mother's profession;
	- father and mother's educational background.
3. Internationalization process of the company	- weight of the external market in turnover;
	- number of countries in which it operates;
	- first international market;
	- motivations for internationalization;
	- barriers to internationalization.

Source: Own elaboration

The questionnaire was sent electronically, between July and September 2019, to companies located in the mainland Portugal territory witch had as their Economic Activity Code (EAC) one of the codes provided in Table 4. A (random) sample of Portuguese companies was considered from the SABI² database. 73 surveys were received, 63 of which were validated. The software used to analyze the data was the IBM SPSS Statistics 24.

Table 4. CAE Codes - Technology-based companies

CAE Codes	Description
6201	Computer programming activities: are included the activities of design, development, modification, testing, and assistance to computer programs (software), according to specific client needs.
6202	Computer consulting activities: include consulting in equipment, computer programs, and other information technologies.
6203	Management and use of computer equipment.
6209	Other activities related to information technology and computing.
631	Data processing activities, hosting of information, and related activities; web portals.

Source: Own elaboration

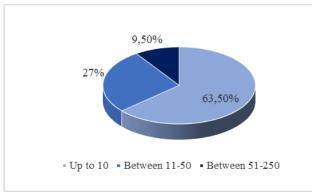
4. Results: analysis and discussion

We mentioned that the investigation has been grouped into three parts. We'll start by presenting, in a summarized and grouped way, the data obtained in the surveys. Subsequently, we proceed to the analysis and discussion of the results, trying to compare them with the literature.

4.1 Results

4.1.1 Companies characterization

All enterprises in the sample have less than 250 employees and a turnover of less than EUR 50 million, (Figure 1 and Figure 2). This means that al firms are SMEs, according to Commission Recommendation³ of 6 May 2003.



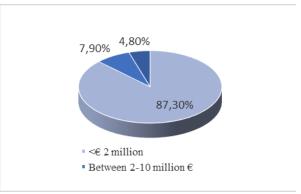


Figure 2. Turnover

Figure 1. Number of employees

Source: Own elaboration

Source: Own elaboration S

Considering the year, the company was founded, it appears that 44.4% had been founded in the last 5 years and 82.5% since 2005 (figure 3). To understand if the internationalization of

² The SABI database has business information from Portuguese and Spanish companies. Only Portuguese companies were considered.

³ Commission Recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises available at https://eur-lex.europa.eu/eli/reco/2003/361/oj

these companies was (or not) fast internationalization, we compared the foundation year with the year of the first activity abroad. It seems that in 61.9% of the companies the internationalization occurred in the same year of its foundation and that in 73% occurred until 6 years after it (figure 4). These results indicate that technology-based Portuguese SMEs have one of Born Global characteristics concerning Welch and Loustarinen (1988), Rennie (1993), and Oviatt and McDougall's (1994) perspective.

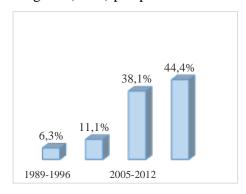


Figure 3. Year the company was established Source: Own elaboration

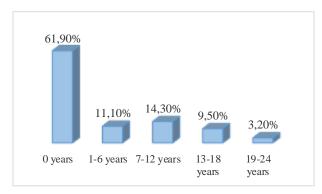
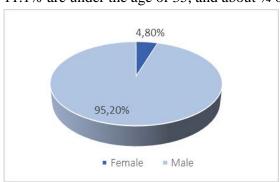


Figure 4. Difference between the year of foundation and the first activity abroad

Source: Own elaboration

4.1.2 Leader profile / characteristics

Regarding the leader's characteristics, it can be seen that the leader of these SMEs is predominantly male, only three leaders are female (figure 5). According to figure 6, the most common age is in the 41-50 age group (39.7%), with 63.5% being 41, or more, years old. Only 11.1% are under the age of 35, and about ¼ of the sample is in the 36-40 age group.



25,40% 3,20% 26-30 31-35 36-40 41-50 > 50 years years years years years

Figure 5. Gender Figure 6. Age group

Source: Own elaboration Source: Own elaboration

Regarding previous international experience, it is relevant to note that more than 84% of the leader's state that they already had an international experience when they started working in their current business (table 5).

Table 5 Previous international experience

	Yes = 84,1%	No= 15,9%	
Age group			
26-30 years	3,8%	0%	
31-35 years	9,4%	0%	
36-40 years	26,4%	20%	
41-50 years	41,5%	30%	
>50 years	18,%	50%	

Source: Own elaboration

A huge number of leaders (93.7%) have a university degree, of which 57.1% have a degree, 30.2% a master's degree, and 6.3% a PhD (figure 7). Only 6.3% of leaders have primary or secondary education levels. Additionally, data also indicate that all leaders under 40 years old have higher education levels, and 75% of leaders with basic education are over 50 years old.



Figure 7. Leader's level of education

Source: Own elaboration

Regarding the factors that influence the entrepreneurial capacity (table 6), it can be seen that the factors pointed out as "extremely important" and "very important" are "professional motivation" (60.3%), "personal fulfillment" (58.7%), and "the perception of business opportunity" (55.6%). Concerning "risk aversion", the results do not give a clear result indication.

Table 6. Factors influencing entrepreneurial capacity

Factors	Extremely important	Very important	Moderately important	Slightly important	Nothing important
Professional motivation	47,6%	12,7%	1,6%	7,9%	30,2%
Personal fulfillment	38,1%	20,6%	4,8%	14,3%	22,2%
Low level of risk aversion	12,7%	14,3%	41,3%	20,6%	11,1%
Perception of business opportunities	27,0%	28,6%	7,9%	17,5%	19,0%
Knowledge network and personal networking	7,9%	33,3%	27,0%	23,8%	7,9%
Access to finance	12,7%	23,8%	31,7%	12,7%	19,0%

Source: Own elaboration

The influence of the family members on the leader's entrepreneurial skills is one of the aspects under study. The results (table 7) suggest that most parents (father and mother) are employees (73.3%), regardless of their educational background. Besides, it can be seen that most parents have primary or secondary education (63.3% of fathers and 66.7% of mothers).

Thus, these results seem to contrast with literature which indicates that family background, and the highest level of parent's education, are relevant factors for the entrepreneurial profile. In this sample, these factors aren't relevant since the vast majority of parents are employees and have basic education.

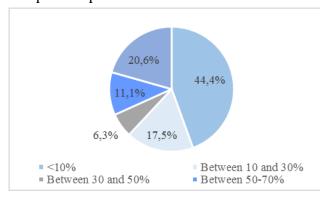
Table 7. Family background

	Father	Mothe
Level of education:		
- primary or secondary education	63,3%	66,7%
- degree/graduation	33,3%	28,3%
- marter's	3,4%	3,3%
- PhD	0%	1,7%
Kind of job:		
- Self-employed	26,7%	28,8%
- employee	73,3%	71,2%

Source: Own elaboration

4.1.3 The company's internationalization process

Figures 8 and 9, respectively, present the results for "the weight of the foreign market in turnover" and the "number of markets in which the company operates". In 31.8% of companies, the foreign market has a weight of over 50% in turnover. Only 11.1% of companies operate in more than 5 markets.



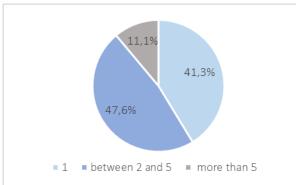


Figure 8. Foreign market weight in turnover

Source: Own elaboration

Figure 9. Number of foreign markets in which the company operates

Source: Own elaboration

When one looks at the age of the leader's companies, operating in more than 5 markets, it appears that none of the leaders is under the age of 36, indicating that, in this type of company, it seems that the age and experience of the leader are important factors for expansion in a larger number of foreign markets.

Table 8. Leader's age of companies operating in more than 5

Leader's age	Companies operating in more than 5
36-40 years	57,1%
41-50 years	28,6%
+ de 50 years	14,3%

Source: Own elaboration

Concerning the first external market, the results indicate that 57% of the companies chose a country within the European market, mainly due to its geographical, cultural, and economic proximity.

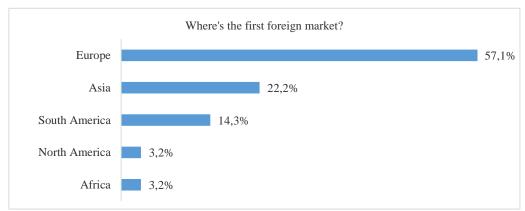


Figure 10. First foreign market

Source: Own elaboration

Indeed, when analyzing the motivations for internationalization, in addition to proximity, the other motivations pointed out for choosing this market were "need for growth", "access to technological knowledge" and "domestic market saturation".

The data provided in table 9 show that internationalization motives change with market geography. Most respondents agree that principle motivation is the "potential size of the market" and that "tax benefits" are the least motivating factor. The motivations with more "agree" answers are the "company's need for growth, easy geographic or cultural access, access to technological knowledge, and customer follow-up".

When we cross-check the answers of motivation with the first market choice, we can point out the results present in table 9.

Table 9. Internationalization motives

Motives	Market(s) in which they were pointed out
Easy geographical or cultural access	Europe
	North America
Need for growth	Europe
	North America
Economies of scale	Asia
Access to technological knowledge	Europe
	North America
Domestic market saturation	Europe
	North America
	Africa
Follow-up of clients	North America
	South America
	Asia

Source: Own elaboration

When analyzing the main difficulties/barriers to internationalization, it appears that the responses were very mixed with no consensus as to the main difficulties faced. The leaders were questioned about 10 factors that could be barriers in the internationalization process: strong competition in the target market; linguistic/cultural differences; lack of knowledge and experience in foreign markets; difficulties in financing access; legal and bureaucracy barriers; difficulty in hiring qualified human resources; tariff barriers; political and/or social instability; transportation costs; the level of corruption and uncertainty. The only factors that have achieved consensus are three and are present in table 10. The results for the remaining options were inconclusive.

Table 10. Difficulties/barriers to internationalization

	Answers			
Difficulties/barriers	"I totally agree" +	"I totally disagree"	"Neither agree nor	
	"I agree"	+ "disagree"	disagree"	
Bureaucracy and legal barriers	52,4%	20,6%	27%	
Strong competition in the target market	42,9%	23,8%	33,3%	
Language and cultural diferences	36,5%	27%	36,5%	

Source: Own elaboration

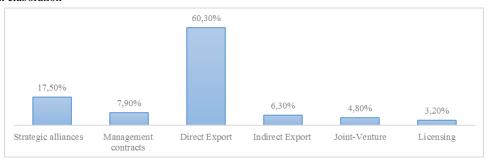


Figure 11. Entry modes

Source: Own elaboration

When the entry modes are analyzed, direct export is the most chosen mode, followed by strategic alliances and management contracts (figure 11), regardless of the number of markets in which the company operates (table 11).

Table 11. Entry mode and number of countries with business activity

Enders made	number of	number of countries with business activity			
Entry mode	1	1 between 2 e 5 More th		Total	
Strategic alliances	5	5	1	11	
Management contracts	3	2	0	5	
Direct Export	13	20	5	38	
Indirect Export	2	1	1	4	
Joint-Venture	2	1	0	3	
Licensing	1	1	0	2	
Total	26	30	7	63	

Source: Own elaboration

Considering the relationship between entry mode and the previous international experience (table 12), it appears that leaders with previous internationalization experience (53), had diversified choices as to the entry mode, being that the most used is direct export (58.5%) and strategic alliances (18.9%).

Table 12. Entry mode and previous international experience

Previous international experience						
Entry mode	Yes = 84,1%	No= 15,9%	Total			
Strategic alliances	10	1	11			
Management contracts	4	1	5			
Direct Export	31	7	38			
Indirect Export	3	1	4			
Joint-Venture	3	0	3			
Licensing	2	0	2			
Total	53	10	63			

Source: Own elaboration

Finally, we've analyzed the relationship between the leader's level of education and the entry mode choice (table 13). Direct export was selected by all individuals with the highest level of education (PhD) but also by 75% of leaders with the lowest education level. Export was also the most selected entry mode by respondents with a degree (52.7%) and a master's degree (63.2%).

 Table 13. Entry mode and education level

	Education					
Entry mode	primary or secondary education	Degree	Master's degree	PhD	Total	
Strategic alliances	0	8	3	0	11	
Management contracts	1	4	0	0	5	
Direct Export	3	19	12	4	38	
Indirect Export	0	3	1	0	4	
Joint-Venture	0	1	2	0	3	
Licensing	0	1	1	0	2	
Total	4	36	19	4	63	

Source: Own elaboration

4.2 Results discussion

Concerning the results, they indicate that the entrepreneurial leaders of the companies under analysis do indeed have common characteristics, such as the predominantly male gender (95.2%), higher education (93.7%), and internationalization experience (84, 1%). Most respondents are over 36 years old, with the majority between 41-50 years old.

Taking into account the Fernandes and Seifert (2016) classification of leader's profile, in this sample, it seems that we have the "classic entrepreneur" profile which is considered as a mature entrepreneur, with previous international knowledge and experience.

The results also indicate that most of the companies went international in the same year of their foundation (61.9%), or up to 6 years (73%). Therefore, in this context, they are called Born Global's, as are firms with a fast internationalization process (Welch and Loustarinen (1988), Rennie (1993), and Oviatt and McDougall (1994)).

According to the literature (Andersson et al. 2004; Dominguinhos & Simões, 2004; Westhead et al. 2001) individuals with a higher level of education have a greater capacity/facility to communicate/negotiate and increased ability to detect international opportunities. Therefore, they tend to be more enterprising. In this context, that is, to know whether linguistic and cultural differences represent difficulties in internationalization, the opinions of individuals with a master's or a degree are divergent. However, those with primary or secondary school education, as well as those with PhD, considered this factor as a barrier to the internationalization process. Thus, the results do not allow us to verify the literature's position since no pattern between the leader's level of education and the relevance of this barrier, in the internationalization process, has been identified.

Concerning the family background relevance, in this sample and contrary to what the literature points out (Matthews & Moser (1996), the influence of the education's level and the profession of the leader's parents on his/her entrepreneurial path was not identified since most are employees and have basic or secondary education.

As for other personal characteristics of the leader and their influence on the choice of the company's entry into foreign markets, the results indicate that, regardless of the level of education, direct export is the most used entry mode, whatever the previous international experience of the leader (tables 12 and 13). The results also indicate that this is the preferred entry mode regardless of the company's turnover, the weight of the foreign market in turnover, and the number of countries in which the firm operates. The advantages of this entry mode, such as the perception of lower risk, greater control over the exported product/service, lower costs, justify the preference of companies for this entry mode. Indeed, at this level, the results are in line with the perspective of authors such as Hollensen (2011), Fernandes (2014).

Given the entrepreneur's answers, factors such as motivation, personal fulfillment, and perception of business opportunities are considered extremely important to their entrepreneurial capacity, as indicated by Persinger et al. (2007). The knowledge network and personal networking are very important. On the other hand, access to finance and the low-risk aversion is moderately important. Regarding the remaining internal factors that influence the internationalization process, the business opportunities perception is, for the elderly, an important factor, as well as the low level of risk aversion to which they are more susceptible.

Considering the external factors, "the bureaucracy and legal barriers in foreign countries" was considered the main difficulty in the internationalization process, mainly for those whose first international market was Europe or Africa. The competition in the destination market was also considered, by most, as one of the main difficulties in the process, whatever is the chosen market.

Conclusion

Given the current context, economies, markets, and businesses are interlinked. Therefore, and with the fast technology advances, the internationalization theories have to evolve with the reality of business.

Bearing in mind the main objective of this study, it indicates that the leader's entrepreneurial profile has a relevant role in the company's internationalization process. It was possible to identify, according to the definition of Fernandes and Seifert (2016), that the entrepreneur's profile of these responding companies is the classic profile. Therefore, the entry mode choice into foreign markets and the internationalization strategy are influenced by internal factors and by the leader's characteristics, such as age, experience, education, as well as motivation, personal fulfillment, and perception of business opportunities. Such personal characteristics influence the company's internationalization process, from the reasons (influence, motivation) to its strategy (entry mode, number of countries, first market option).

Finally, having considered the influence of external factors, the results indicate that the main difficulties in the internationalization process of these companies seem to be the bureaucracy and legal barriers in the target markets. Given that only technology-based companies have been considered, the values (technology and innovation, global vision) and internationalization strategy (deliberate and proactive), associated with this profile, are in line with the characteristics of these companies (young, innovative, technological).

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Evaluation of Countries Travel and Tourism Efficiencies

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Abstract:

Tourism industry has an important role in a country's economy. In addition to creating economic growth and value, it also helps to create brands of countries. For this reason, countries transfer important resources to tourism industry. However all countries can't utilize the benefits of tourism at the same level. This paper aims to measure the travel and tourism performance of the countries all over the world. In this regard, Data Envelopment Analysis which is a widely used efficiency measurement technique is applied for 133 countries using the data of the year 2017. This research is one of the few studies comparing country efficiencies at the macro level. To our knowledge, it is the largest scale study in terms of the number of countries it analyzes. Government spending on travel and tourism activities, capital investments and employment in tourism have been chosen as inputs. The number of tourist arrivals and the direct contribution to GDP are the outputs of the model. DEA and ANOVA results reveal that out of 133 countries only 16 are efficient. European and Asian-Pasific countries have higher travel and tourism efficiencies than Middle East-African and American countries on average.

Key words: Tourism, Country efficiency, DEA

Jel Classification: D61, Z32, L83

1. Introduction

Travel and tourism is a rising industry and play an active role in the economy of the countries. According to The United Nations World Tourism Organization (UNWTO), tourist arrivals all over the world have been increased to 1.4 billion in 2018. Today, tourism industry has 10% of the world GDP, 7% of the global trade. In addition, approximately 11% of the working population all over the world are employed in the branches of the tourism sector (UNWTO, 2017). This sector continues to grow with increasing consumption, culture, technology, transportation access and wealth of people. It can be placed in the development strategies in countries' future plans.

Countries' revenues from the tourism sector do not show a balanced distribution worldwide. Europe continent is the most visited region in the world. The number of tourists visited this continent in 2017 was over 650 million, which constitutes approximately 51% of the total number of tourists in the world. Europe is followed by the Asia-Pacific Region and the Americas. The least visited region by tourists was the Middle East with 58 million and Africa with 63 million people. If we examine the tourism sector at the country level, we see that the most visited country

in 2017 is France which ranked first with 86.8 million tourists. This value is 19 million more than the total population of France. Spain is in the second rank according to the number of tourists which was 81.7 million in 2017 and this number is about 35 million more than the total population of the country. The United States is in the third rank with 76.9 million tourists. This number is approximately one fifth of the country's total population. China is the next country with 60.7 million tourists which is only one in twenty five of the country's population (Table 1).

Countries have different characteristics that affect the creation of tourism potentials. Utilization from the tourism potentials is also different. In this paper efficiency analysis has been applied to reveal the tourism performance of countries. In this sense, Data Envelopment Analysis (DEA) was utilized. DEA provides a methodology that measures efficiency in different scales while one or more input and outputs exist. It is important to determine inputs and outputs for the analysis. The literature has plenty of studies measuring efficiency of institutions in travel and tourism industry through DEA method. But most of them are in micro level evaluating the performance of hotels, travel agencies, and restaurants.

Table 1. Top ten countries attract the most tourists

Country	Tourist Arrivals (x1000)
France	86861
Spain	81786
United States	76941
China	60740
Italy	58253
Mexico	39291
United Kingdom	37651
Turkey	37601
Germany	37452

Source: https://data.worldbank.org/indicator/ST.INT.ARVL

This research is one of the few studies comparing country efficiencies at the macro level. To our knowledge, it is the largest scale study in terms of the number of countries it analyzes.

Banker and Morey's (1986) restaurant evaluation is one of the earliest DEA application in tourism sector. They used both CCR and BCC methods in their study. Anderson, et al., (2000) evaluated the hotel efficiencies in the United States while Hwang and Chang (2003), Su, C.S (2013) did similar studies for Taiwan hotels by DEA method. Wöber (2007) measured travel agencies efficiencies. Chen et al. (2018) assessed efficiencies of inbound tourist service. They stated that different nationalities generate different efficiency scores and the key element is identifying customer needs. Sestayo et al. (2019) studied to identify tourist destination effect on hotel efficiency. They found that occupancy level, degree of seasonality and market concentration are the variables with the greater impact on efficiency. Zhaet. al (2019) analyzed tourism growth sources in China by DEA. Kurt (2017) evaluated the efficiencies of 29 European countries and found that half of them are inefficient. Number of employees in the tourism sector, tourism expenses and number of beds have taken as the inputs of the model while tourist arrivals and tourism income were the outputs. Martin et al. (2017) created a composite index for ranking countries based on data envelopment analysis. Hadad et al. (2012) evaluated the tourism efficiencies of 105 countries using the data of the year 2008. The Inputs in their study were number of employees, number of rooms, natural and cultural resources. Their outputs were number of tourists and expenditure per tourist

The aim of this study is to measure efficiencies of countries across the world. We compared the mean efficiencies of 133 countries from Asia&Pacific, Europe, Middle East&Africa and America regions. Data of the countries obtained from worldbank.org and The United Nations World

Tourism Organization in 2017. Super efficiency DEA method is implemented with inputoriented CCR model. The inputs of the model are;

Government spending (US\$ in billion): Spending by government on Travel and Tourism services directly linked to visitors, such as cultural (e.g. museums) or recreational (e.g. national parks)

Capital investment (US\$ in billion): Capital investment spending by all sectors directly involved in Travel and Tourism. This also constitutes investment spending by other industries on specific tourism assets such as new visitor accommodation and passenger transport equipment, as well as restaurants and leisure facilities for specific tourism use.

Employment in tourism and travel industry (%): The number of jobs generated directly in the travel and tourism sector as a percent share of total employment. This value reflects the number of employees employed in travel and tourism sector.

The outputs of the model are:

Direct contribution to GDP (US\$ in billion): GDP generated by travel and tourism industries including hotels, travel agents, airlines and other tourist transport services, restaurant and leisure industries that deal directly with tourists.

Number of tourist arrivals: The total number of tourists coming to a country.

2. Methodology

The performance of an organization is usually evaluated by comparing with other organizations in the same industry. Data envelopment analysis (DEA) is a non-parametric method based on Linear Programming. It is used for performance measurement of decision making units (DMU) which was developed by Charnes, Cooper and Rhodes in 1978 (Charnes et. al., 1978). DEA is used for evaluating the relative efficiency of DMUs. It defines efficiency for each DMU as a weighted sum of outputs divided by a weighted sum of inputs where all efficiencies are restricted to lie between zero and one. The best DMUs have the full efficient status denoted by unity (1). In the results of DEA models, it is often to have more than one efficient DMU, especially when the number of inputs and outputs is large, or the number of DMUs is large. The Super-efficiency models rank efficient DMUs by assigning an efficiency score greater than 1. The larger the efficiency score, the more efficient the DMU is judged to be. In this study the super efficiency model with input oriented and constant return to scale is implemented (The Super-SBM-I-C model). This model measures the distance under the constant return to scale condition, i.e., lambda (λ) is greater than zero. Input oriented models minimize the amount of inputs of an inefficient DMU for becoming efficient by producing the same outputs while the output oriented models maximize the outputs of an inefficient DMU for becoming efficient by using the same inputs. The efficiency scores of DMUs produced by both models are the same.

The input oriented, constant return to scale super efficiency model is formulated as below; $\min \theta_0$

$$\begin{split} & s.\,t \\ & \sum_{j=1}^n \lambda_j \, \mathbf{x}_{ij} \leq \theta_0 \, \mathbf{x}_{i0}, \quad i=1,2,\ldots,m \\ & \sum_{\substack{j \neq j_0 \\ j \neq j_0}}^n \lambda_j \, \mathbf{y}_{rj} \geq \, \mathbf{y}_{r0}, \quad r=1,2,\ldots,s \\ & \lambda_j \geq 0, \quad j=1,2\ldots,n \end{split}$$

3. Application and results

According to Deming, without measuring something, it is impossible to improve it (Dilber et al., 2005). Therefore, to improve countries tourism performance, one needs to determine their performance levels first. The aim of this study is to measure countries tourism performance. According to UNWTO, 1,33 billion tourists traveled all over the world in 2017. Our sample consist of 1,31 billion tourists in 133 countries across the world that their data exist in the Worldbank.org and UNWTO data bases. The sample statistics and the efficiency results of the countries which are categorized by America, Asia&Pacific, Europe, Middle East&Africa are given in Table 3 and Table 4 respectively.

Table 3: Tourism statistics of the regions

		N	Mean	Std. Dev.	Min.	Max.
	America	29	0,841	3,38	0,01	18,27
	Asia&Pacific	27	0,796	1,96	0,01	9,03
Government	Europe	40	0,408	0,63	0,01	2,34
Spending	MiddleEast&Africa	37	0,078	0,15	0,01	0,88
	Total	133	0,490	1,85	0,01	18,27
	America	29	8,718	32,58	0,08	176,35
	Asia&Pacific	27	12,498	30,23	0,14	154,67
Capital	Europe	40	5,241	8,82	0,05	40,09
Investment	MiddleEast&Africa	37	1,901	4,12	0,04	24,20
	Total	133	6,543	21,16	0,04	176,35
	America	29	6,308	6,85	1,34	30,15
	Asia&Pacific	27	5,775	5,77	0,79	27,58
Employment	Europe	40	4,368	2,60	0,82	12,17
	MiddleEast&Africa	37	4,430	4,58	1,09	26,54
	Total	133	5,094	4,99	0,79	30,15
	America	29	26,389	94,76	0,19	509,42
	Asia&Pacific	27	32,881	78,30	0,28	402,31
GDP Effect	Europe	40	18,454	34,05	0,09	146,31
	MiddleEast&Africa	37	4,077	5,22	0,21	23,52
	Total	133	19,113	59,80	0,09	509,42
Tourist Arrivals (x1000)	America	29	7091	15501	247	76941
	Asia&Pacific	27	12610	13969	469	60740
	Europe	40	15481	20457	145	86861
	MiddleEast&Africa	37	3642	4738	143	20700
	Total	133	9775	15582	143	86861

Source: Authors

The disadvantage of DEA is that the efficiency it calculates is relative efficiency. It calculates the efficiencies of decision making units (DMUs) relative to other DMUs within the data set. If the data set changes, efficiency scores may also change. This disadvantage of DEA is not valid for our data set since the data set contains almost all tourism destinations with 133 countries in the world. So, the results are reliable.

According to the Super SBM-I-C analysis results, the average efficiency of 29 American continent countries was the lowest average with 0.303. Then, there are 37 Middle East and African countries, with an average efficiency of 0.308. The countries with the highest mean efficiency were the Asian&Pacific countries. The average efficiency of 27 countries on this

continent was found to be 0.616. The mean efficiency of the 40 European countries follows Asian&Pacific with an average of 0.494 (Table 4).

Table 4: Efficiency Measures of the regions

Region	N	Mean Eff	Std. Dev	Min	Max
America	29	0.303	0.264	0.049	1.149
Asia&Pacific	27	0.616	0.672	0.049	3.352
Europe	40	0.494	0.407	0.081	1.985
MiddleEast&Africa	37	0.308	0.232	0.079	1.400
Total	133	0.425	0.428	0.049	3.352

Source: Authors

In addition to the ANOVA test for testing the equality of mean efficiencies of the countries of the four regions, the Welch test and Kruskal-Wallis tests are also applied. Welch's Test is a robust alternative test of ANOVA when the population variances are not equal. Kruskal-Wallis test is a non-parametric alternative to ANOVA test for comparing the means of more than two groups. All the three tests show that the mean efficiencies are not equal at 5% level of significance. Multiple comparisons with Tukey HSD test were applied to understand which continents mean efficiencies are different. Test has revealed that the mean efficiency of Asia&Pacific is not equal to the mean efficiency of America and MiddleEast&Africa but equals to the mean efficiency of Europe (Table 5).

Table 5: Tests of the Equality of Mean efficiencies of the regions

	Statistic	df1	df2	Sig
ANOVA	4.111	3	129	0.008
Welch Test	3.711	3	64.27	0.016
Kruskal-Wallis H	13.572	3	-	0.004

		Mean Diff.		
(I)	(J)	(I-J)	Std. Err.	Sig.
	Asia&Pacific	-0.313	0.111	0.028
	Europe	-0.191	0.101	0.237
America	MiddleEast&Africa	-0.005	0.103	1
	America	0.313	0.111	0.028
Asia &	Europe	0.122	0.103	0.639
Pacific	MiddleEast&Africa	0.3	0.105	0.02
	America	0.191	0.101	0.237
	Asia&Pacific	-0.122	0.103	0.639
Europe	MiddleEast&Africa	0.186	0.094	0.204
	America	0.005	0.103	1
MiddleEast	Asia&Pacific	-0.308	0.105	0.02
& Africa	Europe	-0.186	0.094	0.204

Multiple Comparisons with Tukey HSD test: Dependent Variable: Efficiency

Source: Authors

4. Conclusion

In this study, travel and tourism efficiencies of countries are evaluated. In this context, 133 countries including 1.31 billion which can be counted as a total of 1.33 billion tourism trips all over the world have been evaluated. 16 of these 133 countries were found to be efficient

(efficiency greater than 1) and 117 were inefficient. The average efficiency score of these 133 countries was 0,425. The distribution of these 16 efficient countries by region with their efficiency score is as follows: 2 of the 29 countries in the American continent are efficient (USA=3,352 and Mexico=1,035). 6 of the 27 countries in the Asian&Pacific continent are (China=1,177, India=1,67, Malaysia=1,001, Philippines=3,352, Federation=1,071, and Thailand=1,116). 8 of the 40 countries in the European continent are efficient (Belarus=1,985, Ukrain=1,40, Germany=1,066, Spain=1,065, France=1,054, Georgia=1,097, Italy=1,321 and Turkey=1,083). None of the 37 countries in the African continent is efficient. America and Asian&Pacific countries are the countries with the highest average of all inputs in the analysis. While Asian&Pacific countries have the highest average in the GDP effect from the outputs, it is after Europe in the number of tourists. Although the averages of European countries are the lowest in all inputs, it is the region with the highest average in the number of tourists. The MiddleEast&Africa is the region with the least average of all inputs and outputs.

Each region has one or more tourism icon country and most of these countries are among the efficient category. For example Spain. France. Italy. Thailand. USA. etc. are important countries in tourism industry. Their infrastructure in tourism sector are highly improved. However it is revealed that being efficient in terms of the tourism does not depend on the income level of the countries. Upper and higher level income countries in each region mostly has been resulted in inefficient countries. This may be because of the government spending and capital investments of the rich countries can be too high. These amounts cannot be spent in low income countries. Our DEA results mostly suggest to decrease government spending on tourism for inefficient countries to become efficient. Low income level countries do not/cannot spend on tourism activities however they produce reasonable amount of outputs for number of tourist arrivals and GDP contribution. The question of why inefficient countries cannot use their resources efficiently or convert them into outputs as much as reference countries, is an important question. There may be technological, administrative or geographical and historical reasons of inefficiency, which are the subjects of other studies. This study is a descriptive study done to open a discussion to these areas.

Travel and tourism industry is an opportunity to be developed and receiving revenue especially for the low level income countries. Tourism has strategic importance as it contributes to the country reputation and the creation of country brand as well as generating income. For this reason, tourism performance should continuously be the evaluated for efficient management of country sources.

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Ten Years of Modern Demand Guarantee Practice: The Key Changes Introduced by ICC's URDG 758

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Abstract. The Uniform Rules for Demand Guarantees, 2010 Revision, International Chamber of Commerce Publication No. 758 (the "URDG 758") were adopted by the ICC Executive Board at its meeting in New Delhi on 3 December 2009. They became effective on 1 July, 2010 and almost immediately gained an enviable degree of worldwide acceptance. On the eve of their 10th anniversary, this paper provides a comprehensive overview of the latest revision by focusing, in an article-by-article discussion, on the key changes from the previous version.

Key words: Uniform Rules for Demand Guarantees, ICC Publication No. 758, URDG 758, URDG 458 revision

1. Historycal development of ICC uniform rules

Since the second half of the twentieth century, when demand guarantees emerged as a new instrument of international trade, the international trading practice has built a system of uniform rules which are, due to their widespread international use, widely accepted as applicable for legal qualification and for evaluating the essential characteristics of these instruments.

The International Chamber of Commerce (hereinafter: ICC) played a special role in designing and formulating this system, and during the process of shaping and codifying international trade practices until now it has issued several collections of uniform rules governing this area.

The first set of rules issued by the ICC was published in 1978 (ICC Uniform Rules for Contract Guarantees, Publication no. 325, hereinafter: URCG 325) and it regulates contract guarantees. The term implied guarantees that would be payable at the beneficiary's request, but only after the production of a judgment or an arbitral award, or based on the written consent of the instructing party. By setting such documentary payment terms, these guarantees, in terms of payment inefficiency, were practically equated with guarantees based on a ordinary guarantee which were issued by banks even before the occurrence of demand guarantees. This in no way suited the needs of trade practice, so the application of URCG 325 was very rarely contracted.

¹ The clear distinction between the two legal institutes is further complicated by terminological confusion, since various terms are used to indicate them in practice (demand guarantee, first demand guarantee, guarantee bond, guarantee, suretyship etc.). English courts have, after many years of practice, taken the position that in case of doubt about the legal qualification of a document, when it is not clear whether it is a demand guarantee or

In considering the reasons for the failure of URCG 325, it is said that the main drawback should be sought in the fact that no customer representatives participated in their preparation, but mainly representatives of banks and other persons, who primarily protected their interests and those of the instructing parties.² Because of their opposition to the use of demand guarantees, and because of the general intent of draftsmen to use these rules as to protect issuers and instructing parties from unjustified demands of payment, ultimately the URCG 325 did not even regulate demand guarantees.

Due to dissatisfied customers who refused to accept guarantees payable under special and complex procedure, and at the initiative of the British Bankers' Association to set new rules for contract guarantees or bonds, the ICC decided in the mid-1980s to begin work on developing new Uniform Rules for Bank Guarantees. It was pointed out that the main purpose of drafting the new rules was to seek a more realistic reflection of the international guarantee market and to achieve a more reasonable balance between the interests of all parties involved.

After many years of work, in 1992 the ICC published the Uniform Rules for Demand Guarantees (ICC Uniform Rules for Demand Guarantees, Publication no. 458, hereinafter: URDG 458) and in 1996 the Uniform Rules for Contract Bonds (ICC Uniform Rules for Contract Bonds, Publication no. 524, hereinafter: URCB 524). Both publications have significantly contributed to clearly distinguishing between certain types of banking guarantees, and in particular they highlighted the difference between demand guarantees, guaranties that are more similar to ordinary guarantee than to demand guarantees, and guarantees known as bonds.

Unlike the failed URCG 325, the URDG 458 focused on the international practice of those guarantees that are most used in international transactions. These rules explicitly emphasize that they apply to guarantees that are separate from underlying relationship, and only require the beneficiary to submit a written claim accompanied by a statement that the instructing party has breached his obligations, with a brief description of what the breach consists of.³ URDG 458 have been used in international business practice for over 17 years, and have been affirmed thanks to the support of international organizations, multilateral financial institutions, legislators and professional associations.⁴ Nevertheless, these rules were only the ICC's first attempt in codifying the practices of independent guarantees, and the long-standing application of their provisions has over time indicated the need for new international regulation.

Drafting of the new rules for demand guarantees began in 2007 under the supervision of the Banking Commission and the ICC Commercial Law and Practice Commission.

ordinary guarantee the rule is that the document is judged by its contents, not by who issued it or what it is called, see e.g. Siporex Trade SA. v Banque Indosuez [1986] 2 Lloyd's Rep. 147. To note the importance of the distinction between a demand guarantee or ordinary guarantee see Marubeni Hong Kong and South China Ltd V Government of Mongolia [2005] 2 Lloyd's Rep. 231. Interesting observations about the legal nature of demand guarantees are made by R.F. Bertrams in Bank Guarantees in International Trade, Kluwer Law International, 2004, p. 4, 11, 195-200, 226-231.

² B. Vukmir, *Razlozi za obustavu isplate bankarskih garancija na poziv*, Proceedings of the PFZ, 56, special edition, 253-279 (2006), p. 262.

³ The Request for filing a statement of breach of obligations under the underlying relationship was one of the most controversial issues in the drafting of URDG 458, more in *infra* 2.7.

⁴ Regarding acceptance in international practice, the URDG 458 they achieved particular success when they were adopted by the World Bank in their guarantee forms and the FIDIC (*Fédération Internationale des Ingénieurs Conseils*) in their general constructing conditions.

In their drafting, some useful solutions have been sought from the Convention on independent guarantees and stand-by letters of credit⁵, the 1998 International Standby Practices (*International Standby Practices 98*, Publication ICC no. 590, hereinafter: ISP 98), and in particular, the guarantee rules were aligned with the new ICC Uniform Customs and Practice for documentary credits published in 2007 (*ICC Uniform Customs and Practice for Documentary Credits*, Publication ICC no. 600, hereinafter: UCP 600)⁶. The result of these efforts is the new Uniform Rules for Demand Guarantees (*ICC Uniform Rules for Demand Guarantees*) Publication ICC no. 758 (hereinafter: URDG 758).

The URDG 758 were adopted by the ICC Executive Board on 3 December 2009, and came into force on 1 July 2010.

Below, we will analyse the most significant changes to the international regulation on demand guarantees introduced by the new rules.

2. Amendments in the last revision of the ICC uniform rules

2.1. Rules application

The URDG 758 in Article 1 set out the key criterion for application and ascribe that the Uniform Rules for Demand Guarantees are applicable to all demand guarantees and counterguarantees where the application of these rules is explicitly contracted (Article 1 a). It is also stipulated that the rules in question, when their application is contracted, are binding on all parties in relation to the guarantee or counter-guarantee, except in the part where the guarantee or counter-guarantee changes or excludes them (Article 1 a).

On the basis of stated facts, it can be clearly concluded that, in accordance with the provisions of the new rules, the application of URDG is always voluntary and it depends only on the will of the parties whether the URDG will be applied to the guarantee and to what extent. This fundamental principle of application was also valid in URDG 458. However, the new rules have taken into account the fact that URDG, even when not contracted, can in practice serve as proof of a trade custom existence. For this reason, the second draft provided for a provision stating that the rules contained in URDG 758 can be applicable as a trade custom even if the contractual parties did not explicitly subject their guarantee relationship to their application. This provision was later dropped at the request of several delegations, but the idea of including the explanation of application of the Uniform Rules as trade customs in the text of the new rules was not completely abandoned, and was eventually included in the foreword of the publication. The foreword states that URDG 758 can be used as a trade custom or

⁵ UNCITRAL Convention on independent guarantees and stand-by letters of credit, adopted in 1995, however, due to the non-acceptance by the states that play a more significant role in international trade affairs, it has not been successful. The States Parties to this Convention are: Belarus, Ecuador, El Salvador, Gabon, Kuwait, Liberia, Panama and Tunisia.

⁶ The 1993 Uniform Customs and Practice for Documentary Credits (*ICC Uniform Customs and Practice for Documentary Credits*), Publication ICC no. 500.

⁷ See Article 1 URDG 458.

⁸ The comment of Draft no. 3 (*ICC Document 1101rev3*) contains an explanation of the deletion of the provision of Article 1b from Draft no. 2 (*ICC Document 1101rev*) regarding the application of URDG 758 as trade customs. It is stated: "Article 1 (b) in the second draft was intended to be a reminder that the Uniform Rules on Demand Guarantees, as any other set of ICC Rules (Uniform Customs and Practice for Documentary Credits, Incoterms, etc.) may also apply when they are not explicitly included in the guarantee if (i) the judge or arbitrator considers that URDG express trade customs of the case in question, and if (ii) the applicable law provides for the application of trade customs as such. In earlier explanations, the Drafting Group emphasized that paragraph (b) does not require mandatory application of URDG if they are not explicitly included in the guarantee. This provision merely seeks to eliminate the possibility of misconception that URDG cannot serve parties, judges or arbitrators unless they are explicitly included in the guarantee. The provision in paragraph (b) is quite common in international texts (see for example ISP Article 1.03 and all UNCITRAL conventions).

following consistent practices established between the parties of a demand guarantee or counter-guarantee if so is provided by applicable law.

In addition to this interesting novelty, the rules on URDG application have been modified in relation to the URDG 458 insofar as they now explicitly include counter-guarantees. Namely, a significant omission in URDG 458 regarding the regulation of the rules application was the absence of a provision that would explicitly state that the provisions on guarantees apply equally to counter-guarantees. The ICC Banking Commission therefore had to issue an opinion citing URDG 458 articles which are to be applied equally to guarantees and counter guarantees. In order to avoid the situation, the new URDG 758 rules make it clear in Article 1 that the guarantee provisions apply equally to counter-guarantees.

Besides the inclusion of counter-guarantees in the implementing provisions, the new rules also clarify the relationship between the guarantee and the counter-guarantee with respect to the scope of application of URDG. It is determined that in cases where a guarantee is issued at the request of the counter-guarantor the URDG is also applied to the counter-guarantee, unless the counter-guarantee excludes their application (Article 1 b). However, if the URDG is to be applied to the counter-guarantee at the request of the counter-guarantor, it is not applied inversely, so the guarantee will not be subject to the URDG simply because they apply to the counter-guarantee (Article 1 b). The latter definition is understandable and logical since any other solution would present a trap for the guarantee beneficiary. However, protecting the beneficiary's position is not the only imperative of the said provision. Namely, it is important to note that also Article 1b requires the existence of an explicitly expressed will of the counter-guarantor in order for the URDG to be applicable either to a guarantee or to a counter-guarantee. Due to the provision thus prescribed, the rules provided for in Article 1 b will not apply in cases where the counter-guarantor does not make any claims in that direction in the counter-guarantee. This means that, if in a guarantee issued on the basis of such a counter-guarantee all parties imply the application of URDG, the URDG will not apply to the counter-guarantee only because they apply to the guarantee. 10

2.2. Definitions

Article 2 of URDG 758 provides definitions of a number of terms, among which there are several important innovations in relation to the previous revision of the rules. The first important novelty is the change in the meaning of the term instructing party, which in URDG 458 used to refer to the counter-guarantor, while now it is defined as a person other than a counter-guarantor, who gives instructions to issue a guarantee or a counter-guarantee and is liable for compensation to the guarantor (or, in the case of a counter-guarantee – the counter-guarantor). This is actually a person in our terminology called *principal*, for whom the former URDG used the term *applicant*. The term *applicant* itself has taken on a different meaning in the new rules because of its alignment with the UCP 600, and now implies a person who is in the guarantee designated as the payer in the underlying relationship, and who may or may not be the instructing party (in URDG 458 that person was called a *principal*). The new rules, therefore, differentiate between the principal whom they designate by the term *instructing*

Furthermore, it reflects the approach which courts and arbitrations have consistently practiced in disputes concerning international treaties, including, in the case of URDG 458, the courts in France, Belgium and China, as well as numerous arbitrations. Despite the above, comments received on the second draft still convey a sense of discomfort with the rule: 9 out of 14 comments to this paragraph requested that it be deleted (8 of which were comments on the first draft), 2 requested that the rule be moved to the foreword, and 2 requested further clarification. The drafting team appreciated this feedback and therefore decided to extract paragraph (b) from the main text of the rule."

⁹ See The ICC Banking Commission Opinion 470/TA.454rev,14 June 2000.

¹⁰ See Comment on Draft no. 2 (ICC Document 1101rev), explanation along Article 1 c.

party and the payer from the underlying relationship which they designate by the term applicant. These two people may or may not be different, and if they are different it is important to note that they may have different authorisation. For example, according to Article 16, the guarantor (or, in case of a counter-guarantee the counter-guarantor), must notify the instructing party without delay of any demand payment, while at the same time he has no such obligation to the payer from the underlying relationship (applicant). In this way what was particularly emphasized is the separation of the guarantee from the underlying relationship which was the reason for issuing the guarantee.

In addition to these changes which are related solely to those who participate in the guarantee business, we can find some completely new terms in URDG 758. The first new term is the *guarantor's own record*, which implies a record of both credit and debit by accounts maintained with the guarantor, and which can be used by the guarantor in the guarantee business if, on the basis of that record, he can identify the guarantee to which the credit or debit refer. The notion of the guarantor's own records is significant for Article 7 which regulates the issue of non-documentary conditions in the guarantee¹¹, and for Article 13 which regulates the issue of amount changes from the guarantee¹². In practice, it will usually be a deposit deposited with a guarantor bank.

A completely new term is *complying presentation*, which is related to regulating the procedure for examining a payment claim and consequently exercising the beneficiary's right to payment of a guarantee. Complying presentation means a presentation which is in compliance, firstly - with the terms of that guarantee, secondly - with the URDG 758 if they comply with those terms, and thirdly - in the absence of a relevant provision in the guarantee or in the URDG 758 - a presentation which is in accordance with international standard demand guarantee practice. ¹³

2.3. Interpretations

Given that interpretations of particular terms used in a significant number of provisions were not included in URDG 458, Article 3 represents another contribution of the recent edition of the Uniform Rules to increasing the level of legal certainty and avoiding unnecessary disputes.

The article in question thus states: (a) branches of a guarantor in different countries are considered to be separate entities (b) except where the context otherwise requires, a guarantee includes a counter-guarantee and any amendment to either, a guarantor includes a counter-guarantor, and a beneficiary includes the party in whose favour a counter-guarantee is issued. (c) any requirement for presentation of one or more originals or copies of an electronic document is satisfied by the presentation of one electronic document; (d) the terms "from" and "to" include, and "before" and "after" exclude the date or dates mentioned; (e) the term "within", when used in connection with a period after a given date or event, excludes that date or the date of that event but includes the last date of that period; (f) terms such as "first class", "well-known", "qualified", "independent", "official", "competent" or "local" when used to describe the issuer of a document allow any issuer except the beneficiary or the applicant to issue that document.

¹¹ More in *infra* point 2.4.

¹² More in *infra* point 2.6.

¹³ More in *infra* point 2.8.

2.4. Conditions for demand payment

URDG 758 pay particular attention to the conditions for demand payment, which is a welcome new feature in regards to the URDG 458, which did not fully regulate the status of the payment assumptions.

Article 7 of the URDG 758 now deals separately with payment terms and specifies that a guarantee should not contain a condition other than a date or the lapse of a period without specifying a document to indicate compliance with that condition. Accordingly, the same article authorises the guarantor to consider any non-documentary condition as not stated and will disregard it, except for the purpose of determining whether data that may appear in a document specified in and presented under the guarantee do not conflict with data in the guarantee. The prohibition of entering a non-documentary condition also provides for an exception, in the event that such a condition can be verified from the guarantor's own records¹⁴ or from the index indicated in the guarantee itself.¹⁵ This means that when URDG 758 is applied to the guarantee, despite the principle prohibition on entering a non-documentary condition, the guarantor will not be obliged to refuse payment if he can use his own information to verify the existence of such a condition.

The mentioned payment terms which are integrated in the most recent revision indicates the implementation of one of the fundamental principles of dealing with bank guarantees and letters of credit according to which banks in the guarantee and accreditation business deal only with documents only, and not with goods, services or other obligations to which the documents may relate. In other words, the provisions of Article 7 of URDG 758 explicitly confirmed the exclusively documentary nature of demand guarantees and thereby offset a significant deficiency in the URDG 458. The provisions governing non-documentary conditions were already included in ISP 98¹⁶ and UCP 500¹⁷, which is understandable given that in the credential business the documentary character of the instrument itself is much more pronounced than in the case with demand guarantees. For letters of credit containing such a condition, banks would either a) consider such a condition non-existent, or b) give the instrument an accessory character¹⁸, or c) require the submission of documents which prove the meeting of conditions. ¹⁹

2.5. Advising of guarantee

The issue of advising the beneficiary of guarantee was not regulated in URDG 458 and therefore in the latest ICC rules this omission was corrected.

Article 10 of UP 758 provides that a guarantee may be advised to a beneficiary through an advising party whether directly (hereinafter: advising party) or indirectly by utilizing the services of another party (hereinafter: second advising party) (Article 10). The advising party has to signify to the beneficiary and, if applicable, to the second advising party that it has

¹⁴ For the definition of the term "guarantor own record" see *supra* point 2.2.

¹⁵ The index means the price index, the interest index, and other similar indexes established by the authorities.

¹⁶ See Article 4.11 (a) ISP 98.

¹⁷ See Article 13 (c) UCP 500.

¹⁸ See Wichita Eagle and Beacon Publishing Company Inc. v Pacific National Bank of San Francisco 493 F 2d 1285 (9th Cir 1974), http://federal-circuits.vlex.com/vid/wichita-eagle-beacon-36787887. The Court here treated the document issued as a letter of credit as a guarantee because a breach of obligations under the basic contract was specified as a condition of payment, without specifying the documents confirming that fact.

¹⁹ See Banque de L'Indochine et de Suez SA v JH Rayner Ltd (Mincing Lane) Ltd [1982] 2 Lloyd's Rep. 476. In the present case, the court found that, where the letter of credit itself does not specify the documents which are to be presented in order to prove the occurrence of the conditions, the bank is authorized to require documentary evidence. See also Esal (Commodities) Ltd and Reltor Ltd v Oriental Credit Ltd, te predmet Banque du Caire SAE v Wells Fargo Bank NA [1985] 2 Lloyd's Rep. 546.

satisfied itself as to the apparent authenticity of the guarantee and that the advice accurately reflects the terms and conditions of the guarantee (Article 10 a). If second advising party services are utilized, then it has to signify to the beneficiary that it has satisfied itself as to the apparent authenticity of the advice it has received and that the advice accurately reflects the terms and conditions of the guarantee (Article 10 b). Independent of whether the advising is performed by advising or second advising party it must be without any additional representation or any undertaking whatsoever to the beneficiary (Article 10 c).

URDG 758 also elaborated on how to address obstacles that may arise in making advising requests. If a party is requested to advise a guarantee or an amendment but is not prepared or is unable to do so, it should without delay so inform the party from whom it received that guarantee, amendment or advice (Article 10 d). If a party is requested to advise a guarantee, and agrees to do so, but cannot satisfy itself as to the apparent authenticity of that guarantee or advice, it shall without delay so inform the party from which the instructions appear to have been received (Article 10 e). If the advising party or second advising party elects nonetheless to advise the guarantee, it shall inform the beneficiary or second advising party that it has not been able to satisfy itself as to the apparent authenticity of the guarantee or advice (Article 10 e).

With respect to the advising of guarantee amendments, URDG 758 specifically states that a guarantor using the services of an advising party or a second advising party, as well as an advising party using the services of a second advising party, to advise a guarantee should whenever possible use the same party to advise any amendment to that guarantee (Article 10 f).

From the rules laid down in Article 10 described above, it can be concluded that in advising a guarantee the determination of "apparent authenticity" is crucial.

From the rules set in Article 10 described above, it can be concluded that the determination of "apparent authenticity" is crucial for the advising of guarantee. This term is taken from uniform customs and practices for documentary credentials, and includes verification of the credential bank's existence, authentication of signatures of persons in the credential bank, as well as authentication of the credential itself. In doing so, the bank that undertook the obligation to advise the letter of credit is not required to investigate the authenticity "behind" the information it received, but is sufficient to satisfy it with obvious data indicating the credentials of the letter of credit. ²⁰ By analogy, a bank that has undertaken the obligation of advising a guarantee should have the same duties, especially given the fact that the rules in Article 10 of URDG 758 are almost copied from UCP 600.²¹

2.6. Amendments of guarantee content and amount

URDG 458 did not regulate the guarantor's conduct in the case of a request for the issue of a guarantee amendment, so given the frequency of such requests in practice, it was necessary to introduce this issue in the new rules.

Article 11 of URDG 758 sets a fundamental rule regarding amendments of the contents of guarantees and sets out that an amendment made without the beneficiary's agreement is not binding on the beneficiary (Article 11 b). Opposed to that, if the guarantor accepts to make an amendment, the guarantor is irrevocably bound by the amendment unless and until the beneficiary rejects that amendment (Article 11 b). Except where made in accordance with the terms of the guarantee, the beneficiary may reject an amendment of the guarantee at any time

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²⁰ As in B. Vukmir, *Pravo međunarodnih plaćanja – Instrumenti osiguranja plaćanja*, RRiF, 2007., p. 86-87.

²¹ See Article 9 UCP 600.

(Article 11 c). The beneficiary has this right until it notifies its acceptance of the amendment or makes a presentation that complies only with the guarantee as amended (Article 11 c).

Furthermore, a separate provision of the same article explicitly states that partial acceptance of an amendment is not allowed and will be deemed to be notification of rejection of the amendment (Article 11 e). It was also determined that a provision in the amendment would be ineffective if it would determine that the amendment would enter into force if the beneficiary does not reject it within a specified time limit (Article 11 f).

In addition, the rules of procedure for guarantee amendments require that where, at the time of receipt of instructions for the issue of an amendment to the guarantee, the guarantor for whatever reason is not prepared or is unable to issue that amendment, the guarantor shall without delay so inform the party that gave the guarantor its instructions (Article 11 a). The advising party shall then without delay inform the party from which it has received the amendment of the beneficiary's notification of acceptance or rejection of that amendment. (Article 11 d).

In addition to amendments of the very content of the guarantee, in practice, in some types of guarantees, there is often a case of changing the amount of the guarantee to which the guarantor is required to make payment. As a rule, such amendments are encountered with advance and performance bonds when the amount of the guarantee is reduced in proportion to the repaid advance or the amount of completed work. In such cases, the beneficiary must necessarily approve any reduction in the guarantee amount for the simple reason that the guarantee is issued in his interest. Approval of amount reduction is given either in a separate statement or in advance by inserting a special provision in the guarantee (reduction clause). In the latter case, where the beneficiary authorizes an amount reduction in the guarantee in advance, the guarantee text must be drafted clearly and unequivocally as to ensure that the guarantor is fully assured that the conditions on which the reduction in the guarantee amount is made are satisfied. The easiest way to attain this is when the guarantee text states that the reduction of the guarantee amount is conditional on the occurrence of a specific date. However, due to possible changes in the deadlines for fulfilling the obligation in underlying relationships, this is not always the best solution. In such cases, the occurrence of an event may be set as a condition of reducing the guarantee amount instead of a specific date. It is for the purpose of regulating such clauses which in advance stipulates a reduction in the amount of the guarantee upon the occurrence of a particular event, URDG 758 provided for in Article 13. The said article stipulates that the event will be considered to have occurred only: (a) when a document specified in the guarantee as indicating the occurrence of the event is presented to the guarantor, or (b) if no such document is specified in the guarantee, but the occurrence of the event is determinable from the guarantor's own records or from an index specified in the guarantee. ²²

²² In the case of (a), the text of the guarantee shall specify, for example: "The amount of the guarantee will be reduced by... (a percentage of the amount of the guarantee or the exact amount and currency is entered) after submission to the guarantor of the following documents (a list of documents is entered)." In case (b), for example: "The guarantee amount will be reduced by... (enter a percentage of the guarantee amount or the exact amount and currency) after the funds transfer (enter the correct amount and currency) into the account of the beneficiary opened with the guarantor (enter account number)" or state: "The amount of the guarantee will be reduced by... (enter a percentage of the guarantee amount or the exact amount and currency) according to the index (enter the index that causes the guarantee amount to decrease)". We draw attention to the fact that the provisions of Article 13 are consistent with the provisions of Article 7 according to which the occurrence of a condition can be determined from the guarantor's own record or index in the guarantee, see *supra* point 2.4.

2.7. Presenting a demand

In regards to presenting a demand Article 15 of URDG 758 determine that a demand must be supported by documents as the guarantee specifies, and by a statement by the beneficiary indicating in what respect the applicant is in breach of its obligations under the underlying relationship (Article 15 a). This statement may be in the demand or in a separate signed document accompanying or identifying the demand (Article 15 a). A similar provision which lays down the need to submit the beneficiary's accompanying statement on the breach of obligations of the instructing party from the underlying relationship and the manner in which the instructing party breaches those obligations (statement of breach) has been included in the final text of the URDG 458, but in the process of passing these rules it was a major issue and the subject of numerous debates. Its content was opposed by requests of the instructing parties that each payment is conditioned by proof of breach of obligations, but also by the requests of banks to release the guarantors from the obligation to examine the justification of presented demands.²³ In trying to find a balance in the distribution of risk between all interested parties, it is ultimately stipulated that the beneficiary who is requesting payment is required to submit a statement confirming that the instructing party has breached the obligations of the underlying relationship and a statement stating what the breach consists of.²⁴ The contested provision sought to reduce the presentation of unjustified demands, without violating the basic principle of demand guarantees - the principle of autonomy or independence of the guarantee (principle of autonomy or independence). ²⁵ Due to the set goals, it was not possible to achieve complete protection against unjustified requests, and in the end it is significantly limited by the fact that the requested statement is not given by an independent third party but by the beneficiary who, moreover, has no obligation to prove the claims. Namely, the Banking Commission has taken the position that the beneficiary should state in the statement only those details that are important, such as insufficient or poor quality deliveries, delivery delays and other possible omissions, but technical details and other details are not necessary (except when the guarantee or local regulations require otherwise). ²⁶ Some authors agree that, despite the fact that the statement does not require details of the instructing party's breach of obligations, the importance of the requested statement should not be easily diminished because it is to be assumed that those beneficiaries who would even be willing to unjustifiably demand payment would, with such conditions, likely avoid making a false statement and thus significantly reduce the number of unjustified requests.²⁷ Especially because such a statement in a significant number of cases is solid evidence of the assurance or negligence of the beneficiary at the moment of presenting a demand, also in cases of fraudulent demand presentation it sometimes provides evidence of such an action by the beneficiary, whereas a

²³ For a detailed discussion on different proposals of interest groups and the standpoints of the ICC in agreeing a final decision for presenting demands in URDG 458 see R. Goode, *The New ICC Uniform Rules for Demand Guarantees*, [1992] LMCLQ 190, p. 201-204.

²⁴ See Article 20 a (i.) and (ii.) URDG 458.

²⁵ The principle of independence of the guarantee is incorporated in Article 5 URDG 758. The same principle is in Article 2 (b) URDG 458, rule 1.06 (a) and (c) ISP98, Article 3 and 4 UCP 500 and Article 4 and 5 UCP 600. For the first time, the independence of the guarantee from the underlying relationship is emphasized in the case *Edward Owen Engineering Ltd v Barclays Bank International Ltd* [1978] 1 QB p. 171 where Lord Denning states: "The bank providing the performance guarantee must pay the guarantee in accordance with its terms. It is not in the least concerned with the relationship between the supplier and the buyer; neither does the question of whether the supplier has fulfilled its contractual obligation or not; nor does it question whether the supplier has breached its obligations or not. The bank must pay under the guarantee it issued, upon demand if so stipulated, without proof or condition. The only exception is when there is a clear fraud that the bank has been notified about."

²⁶ ICC Banking Comission Unpublished Opinions 1995.-2004., p. 210.

²⁷ Also in M. Kelly-Louw, *International Measures to Prohibit Fraudulent Calls on Demand Guarantees and Standby Letters of Credit*, JICL, p. 90, simmilar in R. Goode, *op.cit*. note. 33, p. 203, 204.

written demand without a statement of breach and indications of what the breach consists of does not constitute evidence of fraudulent demand presentation.²⁸ However, the instructing parties were not satisfied with the directive so stipulated and they advocated the determination that the statement should also include details of the violation which justifies payment. However, the prevailing view was that requiring a specification of the breach of obligations would be unacceptable, as it would lead to significant difficulties and uncertainty for both the beneficiary and the bank.

In spite of the disputes it raised, the request for the statement of reasons for the beneficiary's statement of breach of underlying relationship obligations was also retained in URDG 758. In the literature, some authors believe that this issue does not deserve special attention, since it is logical to provide the guarantor with some reason for demand payment.²⁹ This view is further justified by the fact that most demands contain some such justification, since guarantees are provided as security for the non-fulfilment of an obligation and it is therefore logical to state the reason for requesting payment.³⁰ It is true that a claim that would have been filed without such a justification on the basis of the URDG could be denied, but until such a statement does not have to be documented, or until it doesn't have to be given in some special form, and until it is only sufficient to state that the instructing party breached some of the obligations under the contract, such a demand will not present any particular problem to the beneficiaries.³¹

On the other hand, the provision of URDG on the need to submit a supporting statement is also criticized for the fact that in a guarantee subject to the application of URDG, such a payment condition may appear to the beneficiary as an unpleasant surprise if the guarantee itself does not contain such a provision.³² In order to avoid encountering payment conditions that the beneficiary did not expect when presenting a demand, it is recommended that the guarantees to which URDG applies still clearly state the payment terms.³³ Namely, there are no obstacles to do this. In those cases where the beneficiary or bank is not willing to accept that a statement of breach of the instructing party's obligations is submitted as a condition of payment, URDG 758 in Article 15 c, as well as URDG 458³⁴,, provide for the possibility for the contracting parties to expressly exclude the need to make the statement in question.³⁵

However, URDG 758 also contain one new restriction that is imposed on the beneficiary when demanding payment. They, unlike URDG 458, demand that the demand and the supporting statement of breach of the instructing party's obligations cannot be dated before

²⁸Also in Z. Slakoper, *Bankarske garancije prema odredbama novog Zakona o obveznim odnosima (u poredbenopravnom kontekstu)*, Zbornik Pravnog fakulteta Sveučilišta u Rijeci vol. 27, no. 1, 171-209, 2006., p. 195.

²⁹ Also in B. Vukmir, Nova pravila MTK za bankarske garancije (URDG 758), Pravo i porezi no. 3/10, p. 8.

³⁰ Ibid.

³¹ Ibid

³² Some experts have specifically pointed out that only guarantee terms, not URDG provisions, should be relevant for determining billing terms. These criticisms were not accepted because it was thought that by acknowledging them the needs of the market would again be neglected in the same way as in URCG 325. The reasons for rejecting these criticisms see R. Goode, op.cit. note. 33, p. 203.

³³ For the customer, the situation is particularly unpleasant when he does not know that he is obliged to submit a statement of breach of the instructing party's obligations in addition to the demand, and there is no time to correct this as the guarantee expires soon. Although less likely, the guarantor may overlook that the beneficiary's statement of breach of instructing party's obligations is required to comply with the demand and will therefore be exposed to inconvenience because, if he pays the guarantee, he will lose the right to recover the sums from the instructing party.

³⁴ See Article 20 c URDG 458.

³⁵ Article 15 c determines: "The requirement for a supporting statement in paragraph (a) or (b) of this article applies except to the extent the guarantee or counter-guarantee expressly excludes this requirement. Exclusion terms such as "The supporting statement under article 15 [(a)] [(b)] is excluded" satisfy the requirement of this paragraph. "

the date when the beneficiary is entitled to present a demand (Article 15 d). Any other document may be dated before that date, but no other document or statement may be dated later than the date of its presentation. (Article 15 d).

2.8. Demand examination

URDG 758 specify that the guarantor will examine the claim only on the basis of the submitted documentation and shall determine whether it appears on its face to be a complying presentation (Article 19 a). In order to understand this definition, it is necessary, first of all, to repeat what the rules mean by "complying presentation". According to Article 2 a complying presentation under a guarantee means a presentation that is in accordance with, first, the terms and conditions of that guarantee, second, the URDG 758 so far as consistent with those terms and conditions and, third, in the absence of a relevant provision in the guarantee or URDG 758, international standard demand guarantee practice. This provision is of particular importance because it establishes a hierarchy of sources that guarantors are required to follow when examining a demand. As already stated, it is determined that the most relevant source for compliance examining are the requirements of the guarantee itself, and only if they are insufficient the second and third sources for examining come into use - URDG 758 and international standard practice for demand guarantees. A special novelty in this regard is the reference to "international standard practice", which, like many other novelties, was also modelled based on UCP 600 for credentials. However, while as many as two versions of the International Standard Banking Practice have been issued by the ICC for letters of credit in the last ten years³⁶,, the international standard practice on demand guarantees has not yet been collected and published in one place. What is more, the literature raises the question of whether such a practice, to which courts and arbitrations could be invoked, really exists.³⁷ What is more, question are raised in literature of whether such a practice, which courts and arbitrations could invoke, really exists. However, although international practice on demand guarantees is not yet fully defined and published in the same way as international practice on letters of credit, it is to be assumed that some examples of such practice will still be easily determined thanks to the longstanding application of this instrument in international trade.

On the other hand, regarding the rules for examining demands, URDG 458 stipulate that all documents presented under the guarantee, as well as the guarantee itself, must be examined with reasonable care by the guarantor to determine whether they appear on their face to be complying with the requirements of the guarantee. ³⁸ The standard of examining presented documents "with reasonable care" was not retained in the new rules, but has now been removed as not sufficiently precise. That standard of examination was also contained in UCP 500³⁹, but was rejected in UCP 600⁴⁰. It was argued that the "reasonableness" criterion was left to the discretion of the court or arbitration in each particular case and therefore subject to broad interpretation.

Another important novelty regarding the examination of demands is the setting of a new examination deadline. According to URDG 458, banks were required to examine the demand and decide whether to accept or reject it within a reasonable time, without specifying how

³⁶ International Standard Banking Practice for the Examination of Documents under Documentary Credits, Publication ICC no. 681 (hereinafter: ISBP 681) published in 2007 as a revised version of Publication no. 645 from 2003 which was used with UCP 500. ISBP 681 with its 185 Articles gives answers to most relevant issues regarding how to interpret in a uniform way the provisions of UCP 600 with which it is used as a whole.

³⁷ Also in B. Vukmir, *op.cit*. note. 39, p. 9. The same author notes that some of the rules contained in international standard practice for letters of credit, which are of general importance, may also apply to guarantees.

³⁸ See Article 9 URDG 458.

³⁹ See Article 13 a UCP 500.

⁴⁰ See Article 14 a UCP 600.

many days were covered by the term "reasonable time". A similar provision was introduced in UCP 500. In the new rules in order to promote certainty and predictability, the ICC sought to exclude all imprecise standards, thus removing the "within a reasonable time" standard of examination. The new guarantee rules now stipulate that the guarantor must, within five business days following the day of presentation, examine that demand and determine if it is a complying demand (Article 20 a). This period is not shortened or otherwise affected by the expiry of the guarantee on or after the date of presentation (Article 20 a). These provisions are consistent with that of UCP 600 according to which each involved bank has 5 business days to examine the demand and the five-day deadline is not shortened or otherwise affected if the expiration date or the last day for presenting occurs on or after the date of presenting the demand. URDG 758 regulates this issue in more detail and further specifies that if the presentation indicates that it is to be completed later, it need not be examined until it is completed. (Article 20 a)

2.9. Currency of payment

From the changes already mentioned, it is clear that the new rules focused on solutions based on practice development and the need to avoid disputes. One of the more important examples of this is a rule that proposes a currency change when payment in the currency specified in the guarantee becomes impossible.

Article 21 states that the guarantor shall pay a complying demand in the currency specified in the guarantee (Article 21 a).

Furthermore, it is specified that if the guarantor is unable to make payment in the currency specified in the guarantee due to an impediment beyond its control or due to law regulations of the place for payment, the guarantor shall make payment in the currency of the place for payment even if the guarantee indicates that payment can only be made in the currency specified in the guarantee (Article 21 b). In such cases, payments must be made according to the applicable rate of exchange prevailing when payment is due (Article 21c). If the guarantor has not paid at the time when payment is due, the beneficiary may require payment according to the applicable rate of exchange prevailing either when payment was due or at the time of actual payment (Article 21 c).

These provisions have resolved a number of conflict situations where the guarantee provides for a non-convertible currency as a means of payment, and the demand is for an equivalent payment in another convertible currency. The guarantor now, under the cited provisions of URDG 758, is finally authorized, instead of the currency specified in the guarantee, to pay the guarantee in the currency of the place of payment.

2.10. Guarantee termination and the "extend or pay" request

The clause on guarantee duration is one of the most important components of the guarantee, since the possibility of the beneficiary to present a demand and present certain documents in the guarantee depends directly on the duration of the guarantee obligation. In the new rules, the issue of the termination of the guarantee was regulated in a similar way to the previous ones⁴⁴, but it was necessary for URDG 758 to regulate some questions about the duration of

⁴¹ See Article 10 URDG 458.

⁴² See Article 13 b UCP 500.

⁴³ See Article 14 b UCP 600.

⁴⁴ The guarantee may be terminated, either under URDG 458 and under URDG 758: on the expiry date (date or event specified in the guarantee), when there is nothing left to pay for it, or when the beneficiary's signed statement of exemption from the guarantee is submitted to the guarantor (see Article 22-26 URDG 458 and Article 25 URDG 758). If the conditions for termination of the guarantee are fulfilled, the guarantee shall be terminated whether or not the document itself has been returned to the guarantor (see Article 23 URDG 458 and Article 25 URDG 758).

the guarantee, which were not regulated in URDG 458. The most important issue is the absence of a guarantee termination clause in the document itself.

URDG758 determine that if the guarantee or the counter-guarantee states neither an expiry date nor expiry event, the guarantee shall terminate after the lapse of three years from the date of issue and the counter-guarantee shall terminate 30 calendar days after the guarantee terminates (Article 25 c). If the expiry date of a guarantee falls on a day that is not a business day at the place for presentation of the demand, the expiry date is extended to the first following business day at that place (Article 25 d). If the guarantee terminates as a result of another reasons other than because of the advent of the expiry date or event, the guarantor shall without delay so inform the instructing party or the counter-guarantor and, in that case, the counter-guarantor shall so inform the instructing party (Article 25 e).

When referring to the duration of the guarantee, particular consideration should be given to the fact that, in practice, at the time of the expiry of the guarantee beneficiaries often ask for an "extend or pay" request on the basis of which a temporary extension of the guarantee can be granted as an alternative to payment.

In case of an "extend or pay" request, URDG 458 require the guarantor to defer payment of the guarantee (... the guarantor shall than suspend payment of the demand...) for a reasonable time allowing the beneficiary and the instructing party to reach an agreement on payment or extension. ⁴⁵ URDG 758 make a significantly different solution regarding this request.

The first change to URDG 758 when applying for "extend or pay" was made regarding the time of suspension of payment. It is determined that where a complying demand includes, as an alternative, a request to extend the expiry, the guarantor may suspend payment for a period not exceeding 30 calendar days following its receipt of the demand (Article 23 a), and where, following such suspension, the guarantor makes a complying demand under the counter-guarantee the counter guarantor may suspend payment for a period not exceeding four calendar days less than the period during which payment of the demand under the guarantee was suspended (Article 23 b). We also note that, in order to avoid legal uncertainty, the "reasonable time" that URDG 458 leaves to the guarantor to extend the guarantee has here been eliminated. Furthermore, it is determined that the demand for payment is deemed to be withdrawn if the period of extension requested in the demand is granted within the specified time limit (Article 23 d). ⁴⁶ If the extension is not granted, the complying demand shall be paid without the need to present any further demand (Article 23 d).

The second change to the "extend or pay" request was made with respect to the guarantor's authority. Specifically, in the preparation of URDG 758, some comments stated that, in accordance with the decisions of URDG 458, the guarantor should be prevented from making a payment decision while the beneficiary and the instructing party negotiate payment or extension. Given that the obligation of the guarantor is independent of the instructing party-to-beneficiary relationship, such interpretations did not in any way meet the basic principles of demand guarantees and it was necessary to remove them. For this reason, the new rules determine that the guarantor or counter-guarantor may refuse to grant any extension even if instructed to do so (Article 23 e). Thus, although under URDG 758 an agreement between the instructing party and the beneficiary is still permitted, the guarantor (or, in the case of a counter-guarantee the counter-guarantor) now has the express authority to refuse the request for a guarantee extension, regardless of a reached agreement between the instructing party and beneficiary.

⁴⁵ See Article 26 URDG 458.

⁴⁶It follows from this provision that the parties are free to agree on a longer or shorter extension period, regardless of the extension period requested by the beneficiary.

2.11. Force majeure

The new provisions in the event of force majeure may be considered one of the most important changes in URDG 758. Compared to URDG 458, where regarding force majeure it was stipulated that guarantors and counter-guarantors do not take responsibility for the consequences that might result from force majeure events⁴⁷, URDG 758 significantly broadens the regulation of this area. The new rules regulate three different situations that may arise as a result of force majeure: a) the impossibility to present a demand, b) the impossibility to examine presented demands, and c) the impossibility to pay a compliant demand. Article 26 thus provides that if the guarantee expires at a time when the presentation of demand or payment is not possible due to force majeure:

- a) the guarantee and counter-guarantee shall be extended for a period of 30 calendar days from the date on which it would otherwise have expired, and the guarantor must inform the instructing party, or the counter-guarantor, of the force majeure and the extension, and the counter-guarantor shall so inform the instructing party (Article 26 b i);
- b) if the demand has already been presented but has not been examined due to force majeure, the period of 5 working days for examining the request shall not run until the guarantor business is restored (Article 26 b ii);
- c) if a complying demand was presented before the force majeure but not paid because of the force majeure it shall be paid when the force majeure ceases even if that guarantee has expired; in this situation the guarantor is entitled to present a demand under the counter-guarantee within 30 calendar days after cessation of the force majeure even if the counter-guarantee has expired meanwhile (Article 26 b iii). 48

From the above provisions, we can see that the new rules seek to protect the beneficiary from the negative consequences of force majeure that would last for a shorter period of time. Namely, it follows from the rule in point (i) that, in the event of the impossibility to present a demand due to force majeure, the guarantee will be automatically extended for 30 calendar days from the day when the guarantee originally had to expire. If, after those 30 days, the guarantor does not resume business, the guarantee will expire on the date specified in the guarantee, without the possibility of additional extension. 49 Thanks to this determination, the beneficiary now reserves the right to charge a guarantee if the guarantor resumes business before the expiry of the 30-day time limit. At the same time, this also provides protection for the instructing party and guarantors, since prescribing a 30-day extension avoids the situation of extending the guarantee for an indefinite period of time. On the other hand, points (ii) and (iii) contain rules that are particularly in favour of the beneficiary. According to the first, if the demand is presented before the force majeure, but has not been examined because of force majeure occurrence – the guarantee period shall be suspended. The demand can then only be examined from the moment the guarantor resumes business. According to the second, in the case where the demand has already been presented and examined, but due to the occurrence of force majeure it has not been paid, even though its conformity has been established -

⁴⁷ See Article 13 URDG 458.

⁴⁸ The same rules are provided for counter-guarantees, see Article 26 c i, ii, iii.

⁴⁹ The 30-day extension period was taken over from ISP 98 (Article 3.14), with the significant difference that under these rules, the validity of a standby letter of credit is extended by 30 calendar days after the bank resumes business, while under URDG 758, the guarantee is extended by 30 calendar days from days when the guarantee would otherwise expire (thereafter, the guarantee expires even if the bank has not yet resumed operations for reasons of force majeure). Contrary to these decisions, under UCP 600 (Article 36), if a bank terminates a business for reasons of force majeure, the credentials of a creditor cannot be extended after the bank has resumed business upon termination of force majeure.

payment will be made when force majeure ceases even if the guarantee expired during the force majeure. The instructing party shall be bound by any extension, suspension or payment under article 26 (Article 26 d), and the guarantor and the counter-guarantor assume no further liability for the consequences of the force majeure (Article 26 e).

These amendments corrected the unfair situation for beneficiaries from earlier rules, where in case of force majeure the beneficiary would have lost his rights under the guarantee if the expiry of the guaranty period coincided with the termination of the guarantor's business. In this way the position of the beneficiaries, in relation to URDG 458, is significantly improved.

2.12. Transfer of guarantee

Due to the needs of international banking practice, URDG 758 have applied a much more holistic approach to the transfer of guarantee rights than URDG 458.

In regulating this issue, URDG 458 only states that the right to make a demand under a guarantee ⁵⁰ is not assignable by a beneficiary to a third party, unless specifically provided for in the guarantee or in its annex, but regardless of that, the beneficiary always has the right to assign any proceeds to which he is or will be entitled under the guarantee. ⁵¹

Similar to URDG 458, URDG 758 distinguishes between transfer of guarantee and assignment of proceeds, with restrictions set only for the transfer of the instrument and not for the assignment of sums which are to be paid from the guarantee.

The basic rule of URDG 758 is that a guarantee is transferable only if the guarantee specifically states that it is "transferable", while the counter-guarantee is not transferable (Article 33 a). Even if the guarantee specifically states that it is transferable, the guarantor is not obliged to give effect to a request to transfer that guarantee after its issue except to the extent and in the manner expressly consented to by the guarantor (Article 33 b). Moreover, it is determined that a transferable guarantee means a guarantee that may be made available by the guarantor to a new beneficiary at the request of the existing beneficiary (Article 33 c). Therefore, the free transfer of the guarantee is excluded because each beneficiary is instructed to contact the guarantor with a request for approval of this procedure in order to transfer the guarantee to the new beneficiary. URDG 758 determines that a guarantee which is stated as transferable may be transferred more than once, but only for the full amount available under the guarantee at the time of transfer (Article 33 a). With respect to amendments to the guarantee, URDG 758 finally eliminates doubts from earlier rules on the issue of what exactly is covered by the transfer, clearly stating that a transferred guarantee includes all amendments to which the transferor and guarantor have agreed as of the date of transfer (Article 33 d i). In addition, the new rules contain another very important requirement for the transfer of a guarantee. This is the condition under which the transferor has to provide a signed statement to the guarantor that the transferee has acquired the transferor's rights and obligations in the underlying relationship (Article 33 d ii).

By settling the issue of the assignment of proceeds under the guarantee the URDG 758 reproduce the rule from URDG 458 according to which the beneficiary is entitled to assign any proceeds to which it may be or may become entitled under the guarantee regardless of whether or not the guarantee states that it is transferable (Article 33 g i). This reaffirms the long-lasting and generally accepted custom in the case of letters of credit and guarantees, according to which assigning proceeds from the instrument is free, as opposed to the transfer

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⁵⁰ The right of the beneficiary to make a request for payment under the guarantee is the most important and essential right that the beneficiary receives by transferring the guarantee, and that is the acctual purpose of transferring the guarantee, see B. Vukmir, op.cit. n. 16, p. 13

⁵¹ See Article 4 URDG 458.

of all rights from letters of credit and guarantees, which was never free. ⁵² However, the latest revision of the rules adds a significant limitation to this principle. According to URDG 758, the guarantor shall not be obliged to pay an assignee of these proceeds unless the guarantor has agreed to do so (Article 33 g ii). This unusual provision originated in ISP 98⁵³, and was introduced to protect a guarantor who, because of the abstract nature of the obligation, would not be able to refuse payment or impose claims on the new creditors against whom he would have any earlier claims. Given that the guarantor has this right regarding the transferor, in the absence of this rule he would be in a worse position than the one he was in before the assignment.

3. Model guarantee and counter-guarantee forms appended to the URDG 758

Through several decades of application of demand guarantees in business practice, the main element of successful international practice has proven to be a clearly written guarantee and counter-guarantee text. For this reason, the draftsmen of Publication no. 758 decided to add ready-to-use forms.

While drafting, there were doubts as to whether to offer a universal form for all types of guarantees or to compile multiple forms depending on the purpose of the guarantee. The universal form approach has prevailed over the approach covering multiple forms related to the purpose of each guarantee, because experience has shown that a comprehensive, ready-to-use set which combines rules and patterns is more acceptable to beneficiaries than previously separated Publications of ICC No. 458 and 503. 54

The forms offered in URDG 758 are designed to meet the requirements of parties in most cases, and therefore their use contributes significantly to unique business conditions and to avoid misunderstandings. It may, of course, be necessary to adapt certain provisions in some cases. Beneficiaries then have the option of modifying the unique form by entering one or more of the provisions proposed at the end of the Publication or even completely formulating any other provision. In both cases, the effort needed for such an adaptation is far less than what is required when drafting a guarantee without the URDG model form.

4. Conclusion

It has been consistently emphasized in scientific literature and professional papers that authors of recent international rules on demand guarantees sought to write them more clearly, accurately and comprehensively in comparison with URDG 458. A detailed analysis in this paper sought to determine whether this was indeed the case.

At the very beginning, it was determined that one article of the new rules provided a list of definitions of all significant terms in the guarantee business, specifically provided an interpretation of certain terms and gave the necessary clarification of the procedure of verifying correct presentations. In this way, the clarity of previously incomprehensible provisions and the legal certainty of their application were ensured.

Furthermore, for the sake of precision, URDG 758 sought to eliminate all the imprecise standards contained in URDG 458, and in particular the terms "reasonable care" and "reasonable time", which in practice posed a major issue. In order to promote certainty and

⁵² B. Vukmir, *Akreditiv, bankarska garancija i ugovor "ključ u ruke" prema izmjenama ZOO-a*, Računovodstvo, revizija i financije no. 5/2008, p. 172.

⁵³ See Article 6.06 - 6.10 ISP 98.

⁵⁴ ICC Publication no.503 published in 1994, two years after the publication of URDG 458, named Model Forms for Issuing Demand Guarantees, hereinafter: ICC Publication no. 503). The guarantee models published there indicated the content that a guarantee under URDG 458 should have. In particular, it should have served the parties not to inadvertently give a different character to the guarantee for which they wished to be called upon by the use of various terms and formulations. In practice, however, it has not achieved particular success.

predictability, they excluded these standards in almost every issue where they have been used, and the best examples are changes made in regard to the demand examining period and setting a deadline for deferring payments in the case of an "extend or pay" request.

URDG 758 also contain several novelties due to the development of practice and the need to avoid disputes. An example of this is the new rule that proposes replacing currency when payment in the currency specified in the guarantee becomes impossible. In such cases, a simple solution is provided whereby the guarantor is obliged to pay in the currency of the place of payment, even if the guarantee explicitly requests payment in another currency.

Another example is the new guarantee expiration mechanism in guarantees where either the expiration date or event are not specified. This undoubtedly had the effect of reducing the number of guarantees of indefinite validity, the issuing of which previously posed a risk on both guarantors and instructing parties, due to the uncertainty regarding the placement of demands.

URDG 758 also sought to correct the fact that a significant part of practice had been absent in earlier rules. This is not surprising, since what was understandable at the time of the first attempt to codify the practice of demand guarantees was no longer acceptable after almost two decades. This particularly refers to the absence of rules for non-documentary conditions, notification of the issue of a guarantee (advising), guarantee amendments, standards for examining demands and transfer of guarantees, but counter-guarantees were previously also only partially addressed. The new URDG 758 rules covered all of the above practices and clearly stipulated that guarantee provisions apply equally to counter-guarantees.

All of the above has certainly contributed to their international success. Following the URDG 758 endorsement by UNCITRAL in 2011, FIDIC upgraded the model guarantee forms for its model construction contracts to include the new rules and the World Bank has updated its Procurement Division's model guarantee forms so they are subject to URDG 758. Bank regulators and national lawmakers likewise approved URDG 758 and used them as a model for national statutes now in force in many countries. However, the final confirmation of the success of the new set of rules on demand guarantees was marked by the far wider acceptance of URDG 758 over URDG 458 by many national commercial banks and the business community globally. ⁵⁵

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⁵⁵ See First Findings - ICC Global Survey on URDG 758, ICC Banking Commission Miami 2018

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CIET Split 2020 Track 3

Electrical Engineering, Information Technology and Mechanical Engineering

Selecting the Right E-participation Tool: Multi-criteria Decision Making From a User Perspective

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Abstract. City managers and officials should aim to provide relevant information to the general public, obtain feedback from citizens and engage them to contribute to the programs and projects of their interest. Trends in digital transformation inform the way the citizen participation activities are planned, introducing digital communication channels and the variety of new user-friendly e-tools that can help local governments in collecting and understanding relevant needs of the general public or selected user groups. In that context, the paper investigates the potential of Multi-Criteria Decision-Making (MCDM) methods in selecting the e-participation tools to be used by local government officials. With an illustrative purpose, the paper describes and validates the protocol that could support local government officials and decision-makers in the process of selecting the most appropriate alternative (i.e. the e-participation tool) under certain conditions. Evaluation of the alternatives is based on criteria defined by experts using several MCDM methods: SAW, TOPSIS and PROMETHEE.

Keywords: e-participation, MCDM, city managers, PROMETHEE, TOPSIS.

1. Introduction

Citizen participation refers to the involvement of members of the general public in societal governance in terms of planning, organising, and community development, including activities that enable individuals to influence public decisions that affect their interests (Baum, 2015). An attempt to differentiate between the varying degrees of involvement and the role of the general public in participation processes was made by the International Association for Public Participation (IAPP, 2014) by providing an overview distinguishing between: informing (providing the general public with an objective information), consulting (obtaining public's feedback), involving (working directly with the public), engaging (partnering with the public in decision making) and empowering (placing final decision making in the hands of the public). Traditional mechanisms for citizen participation are characterised by many offline participation tools such as surveys, public hearings, town hall meetings, and similar. However, new digital channels and its' transformational potential significantly influenced this area with many city managers and officials looking for ways to engage and assess their citizens' opinions through official city websites or participation platforms. Deciding to engage citizens using digital channels is understandable as citizens are increasingly going online to express their concerns,

especially younger generations, this representing significant challenges and opportunities at the same time (Isin & Ruppert, 2015). Opting for digital-first strategies like the UK government (Mayer, 2019) or going "digital by default" (Corydon, Ganesan & Lundqvist, 2016) brings multiple benefits such as reduced costs, and more straightforward impact assessment since it is easier to extract the results from specific information systems and social networks. Other benefits may include better-informed decision making, more effective public policies, enhanced collaboration and more (Lips, 2019).

To achieve the intended results and simplify the process of electronic participation (eparticipation) or digital participation, many tools could support related strategy implementation ranging from e-surveys and e-polls to e-voting. Standard e-participation tools today are usable and accessible, could be customised and adapted to the specific needs of both citizens and city administrators. The important questions for city administrators are related to the selection of the e-tool(s) to be implemented in a city – how to select a tool to fit with the city requirements and specific situation optimally, given the specific timeline? What do citizens require and expect from their city in this interaction, and what do city administrators expect from them? These questions point to a multi-criterial problem that will be investigated in this paper. Most of today's decision-making problems are multi-criterial, no matter if they originate from the private or business sector, economy, industry or politics. With the advancement of information and communication (ICT) technologies, ongoing globalisation processes and enormous data and information load, it is customary to apply Multi-Criteria Decision-Making (MCDM) concepts as a tool that will save time and money while easing the work of many decisionmakers. Therefore, the objective of the paper is to explore the potential of MCDM methods in selecting e-participation tools to be used by government officials while final research questions are formulated as follows:

RQ1: How different MCDM methods affect e-participation tools' selection results?

RQ2: Which e-tools proved to be the most convenient for e-participation purposes, from a user perspective?

After presenting the rationale and the area to which this paper aims to contribute to, the remaining of the paper is organised as follows: section 2 describes the conceptual grounding of the paper by addressing e-participation trends in general, related tools, and usage; section 3 outlines the three MCDM methods that are used in the paper to select and rank possible e-participation alternatives (the tools); section 4 presents the results of a study; and section 5 discusses the results, study limitations and future research propositions, and concludes the paper.

2. Theoretical background: e-participation and related tools

From many definitions of e-participation for this paper, we emphasise one, in particular, that would serve as a guiding principle stating that e-participation is "the process of engaging citizens through ICTs in policy, decision-making, and service design and delivery in order to make it participatory, inclusive, and deliberative" (UNDESA, 2018, p.112). National-level cases demonstrate how e-participation has the potential to enhance citizens' participation in policy-making, ensure learning processes, collect innovative ideas and increase political legitimacy and trust (European Parliament, 2016). The purpose of the e-participation is "to increase citizens' abilities to participate in digital governance (including participation in the political process and transformation of digital government information and services)" (Sæbø, Rose & Flak, 2008, pp. 402-3). In addition to this citizen perspective, e-participation should be analysed from governments' perspective (UNDESA, 2018). Both are equally important to evaluate and guarantee the effective implementation of e-participation initiatives (Ribeiro, Cucha & Barboa, 2018). From the citizen's perspective, e-participation provides the opportunity to achieve and satisfy the need to be heard by politicians and to participate in the

decision-making through the use of ICT. On the other side, politicians are also able to promote and encourage public participation through communication channels with citizens and act in line with public opinion (Ergazakis, Metaxiotis & Tsitsanis, 2011).

United Nation E-government survey measures e-participation through the E-Participation Index (EPI) recognising the following three stages (UNDESA, 2018): e-information as availability of information on the internet, e-consultation (online public consultations) and e-decision-making (directly involving citizens in decision processes). E-information is fundamental since without the access to publicly published information, citizen participation cannot be evidence-based, entirely relevant or significant. For that reason, government bodies are often required to provide people with relevant information. E-consultation stands for mechanisms where officials will ask people for the feedback as a part of the process of crafting new policies and designing new services or projects (via surveys, focus groups, public hearings). E-decision-making refers to a process in which people provide their inputs to decision-making processes by direct e-voting or expressing their preference by rating the suggested options and proposals. These stages make up the most widely used e-participation model and correspond to three e-participation maturity stages.

On the same note, Tambouris, Liotias and Tarabanis (2007) defined the five levels of e-participation as e-inform, e-consult, e-involve, e-collaborate and e-empower. In brief, the authors define the levels in the following way: e-informing stands for a one-way online channel that provides citizens with needed information; e-consulting is a limited two-way channel that has the objective of collecting public feedback and alternatives; e-involving is about working online with the public to ensure that broader concerns are understood and taken into consideration; e-collaborating is an enhanced two-way channel between citizens and government officials where citizens actively participate in the development of alternatives and the identification of preferred solutions; while e-empowerment facilitates the transfer of influence, control and policymaking to the public.

Table 1. E-participation levels and corresponding e-tools (adapted from Al-Dalou' & Abu-Shanab, 2013)

E-participation level	Appropriate e-tools that could be employed to achieve the level				
E-informing	e-mailing list, virtual communities / online community networks (social				
	networks), chat rooms, mobile phones, webcasts, GIS tools, RSS feeds,				
	newsletters, FAQs, web portals, weblogs, video conferencing, alerts,				
	Wikis, podcast				
E-consulting	e-survey, feedback forms, e-mail, e-polls, newsgroups, weblogs, mobile				
	phones, virtual communities / online community networks, consultation				
	platforms, text to speech technology, e-panels, podcasts, Wikis, chat				
	rooms, video conferencing, e-referendum, instant messaging				
E-involving	e-mail, virtual e-meetings, chat rooms, discussion forums/boards, online				
	community networks (social networks), video conferencing, mobile				
	phones, consultation platforms, online citizen juries				
E-collaborating	e-debates, web virtual meetings (chat rooms, discussion forums/boars),				
	decision-making games, virtual communities (social networks, data				
	analysis tools)				
E-empowering	e-petitions, e-voting tools, e-bulletin boards, e-polls, virtual e-meetings,				
	chat rooms, discussion forums/boards, e-panel, virtual communities				
	networks (social networks), argument visualisation tools, natural language				
	interfaces				

The concept of e-participation can be implemented using different digital channels and tools some of which are presented in Table 1 and analysed further in the paper. The choice between the tools depends on the initiative(s) being implemented in the city. In any case, local governments should aim to ensure that citizens have a direct voice in public discussions and

decisions by employing tools for user inclusion and empowerment. In this way, local governments increase the percentage of acceptance of plans and new solutions and achieve other benefits, as mentioned earlier. The government officials need to continuously assess the content and methods and select the most suitable and effective tools (as in EIPP, 2009; Rexhepi, Filiposka & Trajkovik, 2018).

3. Multi-criteria decision-making and methods used

Multi-criteria decision-making refers to decision making in case there are conflicting criteria (Babić, 2017). Problems that MCDM methods can help resolve are from different domains and can be found in everyday life, in business and public sector, and all of these with common characteristics (ibid): (i) multiplicity of criteria, (ii) conflict among criteria, and (3) incomparable units of measure. Another essential characteristic is that there is a limited number of alternatives. Consequently, MCDM aims to provide an overall ranking of alternatives, from the most preferred to the least preferred, based on a stated set of alternatives (in this particular case – a limited number of e-participation tools) and a definite number of decision-making criteria (Liou & Tzeng, 2012).

The importance of criteria can be assessed by a single decision-maker or by multiple ones (for example, experts) in terms of priorities or weights. There are methods for group weight assessment (for example, group ranking, grading, pairwise comparisons and Delphi method), and methods for the single decision-maker (calculating eigenvector, weighted least squares and entropy method) (Babić, 2017). For the study presented in the paper, the grading method with experts was selected and is briefly addressed herein. Commonly, grading is done in a way that criteria is presented to each expert who then awards a numerical grade for each criterion in an interval from 0 to 10 or from 0 to 100. The weight is determined as follows:

$$wjk = \frac{pjk}{\sum_{j=1}^{n} pjk}$$

$$wj = \frac{\sum_{k=1}^{l} wjk}{\sum_{j=1}^{n} \sum_{k=1}^{l} wjk}$$

where n stands for the number of alternatives, ρ_{jk} as the grade from expert k to criteria j, w_{jk} as weight calculated for criteria j from expert k – normalised, and w_j as the total weight for criteria j.

Three methods are considered in the paper – Simple Additive Weighting Method (SAW), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) and Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE).

SAW is a widely used MCDM method where each alternative is related to weight importance obtained by one of the previously listed methods for assessment of the importance of criteria. With the presumption that there is a set of weights for all criteria $W = \{w_1, w_2, ..., w_n\}$, the best alternative is then alternative A^* :

$$A *= Ai \max i \frac{\sum_{j=1}^{n} w_j x_{ij}}{\sum_{j=1}^{n} w_j}$$

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method is based on the concept that the preferable alternative is the one closest to the ideal solution and the one with the largest distance from the anti-ideal solution (Hwang & Yoon, 1981). TOPSIS procedure includes determining the ideal and basal (anti-ideal) solutions and calculating the relative distance/closeness from the ideal and basal solutions using formula RCi = Si - /Si + Si meaning that alternative is closer to an ideal solution when RCi is closer to 1.

Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE) method was developed by Brans (1982) and later refined by Vincke and Brans (1985) and Brans, Vincke and Mareschal (1986). It is an outranking method for a finite set of alternative actions to be ranked and selected among criteria, which are often conflicting (Behzadian et al., 2010). Before PROMETHEE, MCDM methods were used only with quantitative data and could not be used in cases where there were qualitative data, however, to resolve this problem, PROMETHEE can support transforming qualitative data using an ordinal scale (Halouani et al., 2009). For each criterion fi a generalised criterion has to be defined using specific preference function (Brans & Mareschal, 2005); the authors propose six types of particular preference functions: usual criterion, U-shape criterion, V-shape criterion, level criterion, V-shape with indifference criterion, and Gaussian criterion. Out of the six functions, the analyst and decision-maker agree to select one for each criterion based on their foreknowledge about the intensity and the direction of the preference (Babić, 2017). For each case, other parameters representing real economic implications should be set up beforehand, such as q – difference threshold, defining the interval where the decision-maker is indifferent regarding the difference between the two alternatives per criterion, p - strict preference threshold, defining the value above there is a strict preference, s – parameter between the difference threshold q and the strict preference threshold p.

4. Case study and the results

With the purpose to identify the best (combination of) e-participation tools to be used by the City of Split, a dedicated workshop titled "Inclusive cities: tools and techniques" was organised in November 2019. It is important to emphasise that the point of view was from the user side since the workshop participants were very knowledgeable on the topic; however, none of them work in the city administration. Specifically, the workshop participants were enrolled and regularly attending an interdisciplinary two-month lifelong learning program titled "Shaping fair cities" and before the workshop had 34 hours of interactive lectures focusing on sustainable development, smart mobility, community engagement and similar. Furthermore, they were already knowledgeable about different socio-economic aspects of urban development as they were coming from different backgrounds (civil engineering, electrical engineering, education, business and other sectors) and with a keen interest in sustainable urban development either in their academic or professional career. For that matter, workshop participants were regarded as experts. In total, 13 workshop participants, residents of Split, were asked to rank e-participation tools which should be implemented in the City of Split (Croatia) as soon as possible. In addition, they were asked to select and assess the criteria they used. The problem that the experts faced is multi-criterial and the goal was to rank the definite number of e-tools (alternatives) which should be implemented in the specific city. Experts were given 16 different alternatives, i.e. most commonly used e-tools in European cities presented in Table 2. Although viewed separately in the relevant literature, surveys and polls were presented to experts as a single etool due to Croatian general understanding of the term "survey" which corresponds to both surveys and polls. The same has been done for webcasts and podcasts as similar technology is used and the tools accomplish the same purpose as presented above in Table 1.

Table 2. List of e-participation tools with related descriptions (taken and adapted from Tambouris et al., 2007, pp. 12-13; Spagnoli, Rasmussen & Thurston, 2017; Webster & Leleux, 2018)

E-participation tool	Description
Surveys / Quick polls	Web-based, self-administered questionnaires, where the website shows a list of questions which users answer and submit their responses online. Web-based instant surveys.

Frequently Asked	A 'tree' of questions and answers that can be searched using keywords or by			
Questions (FAQs)	inputting a question or statement.			
Chat rooms	Web applications where a chat session takes place in real-time.			
Discussion	Web applications for online discussion groups where users, usually with			
forum/board	common interests, can exchange open messages on specific e-participation			
	issues. Users can pick a topic, see a "thread" of messages, reply and post			
	their messages.			
Social	Relevant for collecting feedback from the stakeholders during all phases in			
media/networks	policymaking and plans, delivered by international providers as plug-and-			
	play solutions.			
E-voting	Remote internet-enabled voting or voting via mobile phone, providing a			
	secure environment for casting a vote and tallying of the votes.			
E-consultation	Web applications designed for consultations which allow a stakeholder to			
	provide information on an issue and others to answer specific questions			
	and/or submit open comments.			
E-petitioning	Web applications that host online petitions and allow citizens to sign in for			
	a petition by adding their name and address online.			
GIS-tools	Web applications that enable the users to have a look at maps underlying			
	planning issues and to use them in various ways and different private or			
- · · · · · · · · · · · · · · · · · · ·	business areas.			
Decision-making	Games which typically allow users to view and interact with animations that			
games	describe, illustrate or simulate relevant aspects of an issue; here with the specific scope of policy decision-making.			
M - 1-11				
Mobile apps	Mobile apps enable citizens and stakeholders to share open data and create innovative products/services collaboratively. Apps involve a large number			
	of citizens and enable them to participate actively.			
Citizens dashboards	An interactive application located on mobile phones, laptop or PCs that			
Citizens dashboards	provides opportunities for citizens and businesses to co-create by			
	commenting on urban problems or sustainability issues. Presenting city KPIs			
	and available e-services.			
Rating and voting	The system that enables to evaluate actual or potential services/products			
	designed in the co-analysis and co-design phase.			
Online newsletters	One-way communication tools to inform a general audience or a			
	preregistered audience of specific news items and events.			
Webcasts / Podcasts	Real-time recordings of meetings transmitted over the internet. Publishing			
Webcasts / I oucasts	multimedia files (audio and video) over the Internet where the content can			
	be downloaded automatically using software capable of reading RSS feeds.			
E-platform	Websites providing a gateway to a set of specific information and			
2 pauloim	applications integrating many/all the tools listed above and aggregating			
	content from various city departments.			
	1			

The following criteria were emphasised by experts as the most relevant (considering user perspective and needs) when selecting the most appropriate e-tools: user anonymity, ease of use, speed of implementation, multifunctionality of the e-tool, and price (Figure 1). All the alternatives are characterised by one type of attributes, qualitative ones that were transformed into numerical, four of which are benefit criteria and one a cost criterion. Also, it was necessary to perform attribute normalisation through linear transformation (needed for SAW method) and using vector normalisation (transformation of the minimum criteria to the maximising type needed for TOPSIS). For these purposes, calculations were made using standard formulae in Microsoft Excel.

Linear transformation of decision matrix has been done (separately for benefit and cost criteria) as SAW method requires comparable scales for all elements of the matrix table. Weights are

taken over from grading method: $W = \{0.197379; 0.226675; 0.207043; 0.191058, 0.17784\}$. The final score is calculated as scalar multiplication of the values for each alternative and given criteria weights. The best alternative – e-participation tool is social media/networks followed by surveys/polls, FAQs, online newsletters and webcasts/podcasts. For TOPSIS, after vector normalisation of attributes/criteria, ideal (A+) and anti-ideal (A-) alternatives were calculated, as well as Relative Closeness (RC) of each alternative in comparison to ideal solution A+ which was calculated using the formula: RCi = Si - / (Si + + Si -). RC of alternative A1 (survey) is the highest, i.e. closest to 1, meaning that according to the TOPSIS method, surveys/polls should be implemented first in the City of Split. After surveys/polls, the list of the most appropriate e-tools contains in descending order social networks, FAQs and online newsletters. PROMETHEE parameters used to rank the alternatives in Decision Lab are presented in Figure 1. Criteria weights were calculated using formulae and procedure presented in Section 3, rounding numbers to three decimals and multiplying with 1,000. Since later this is dived with the sum of weights, it will not affect the final score; $W = \{197; 227; 207; 191; 178\}$.

	User anonymi	ty Ease of use	Speed implementation	Tool multifunctionality	Price
Min/Max	Maximize	▼ Maximize	Maximize	Maximize	Minimize
Weight	198.0000	227.0000	207.0000	191.0000	178.0000
Preference Function	Usual	Usual	Usual	Usual	U-Shape
Indiference Threshold	-	-	-	-	1.0000
Preference Threshold	-	-	-	-	-
Gaussian Threshold	-	-	-	-	-
Threshold Unit	Absolute	Absolute	Absolute	Absolute	Absolute
Average Performance	3.13	3.69	3.31	3.19	3.25
Standard Dev.	1.54	0.95	1.08	1.05	1.29
Unit	points	points	points	points	points
Survey	5.00	5.00	4.00	4.00	2.00
FAQ	5.00	5.00	4.00	3.00	2.00
Chat room	3.00	3.00	4.00	3.00	2.00
Dis. forum	3.00	3.00	4.00	3.00	2.00
Social network	3.00	4.00	5.00	5.00	1.00
E-voting	1.00	3.00	1.00	2.00	5.00
E-consultation	1.00	3.00	2.00	3.00	4.00
E-petition	1.00	4.00	3.00	2.00	3.00
GIS	5.00	2.00	3.00	3.00	5.00
E-decision games	3.00	3.00	2.00	3.00	4.00
Mobile application	2.00	3.00	3.00	5.00	4.00
Dashboard	5.00	4.00	3.00	2.00	4.00
Rating & voting	2.00	5.00	4.00	3.00	3.00
Newsletter	4.00	5.00	5.00	2.00	2.00
Podcast/webcast	5.00	4.00	3.00	3.00	4.00
E-platform	2.00	3.00	3.00	5.00	5.00

Figure 1. Parameters and alternative assessments in Decision Lab [Screen print]

As a preference function for criteria C1(user anonymity), C2 (ease of use for users), C3 (speed of implementation), and C4 (multifunctionality of the e-tool) Type I or usual criterion preference function is selected, signifying that in case there a difference between the alternative assessments, the preference function equals 1. For C5 (the price) Type II or U-shape criterion preference function is selected, where indifference threshold is q=1, meaning that in case the difference is greater than 1, the tool with the lower price is strongly preferred. To evaluate the alternatives, the leaving flow and the entering flow (net flow) are reviewed (Figure 2) where

the higher the leaving flow and the lower the entering flow are, the better the alternative is. In that regard, the best alternative is A1 (Surveys/Polls) since it has the highest leaving flow (0.70) and the lowest entering flow (0.07). The second alternative is A5 i.e. social media/networks. The alternatives A5 and A2 (FAQs) are difficult to compare since A5 is better in terms of the leaving flow, and A2 in terms of the entering flow as demonstrated by the parallel positioning of the alternatives. The complete ranking of the alternatives from the best to worst is presented in Figure 3.

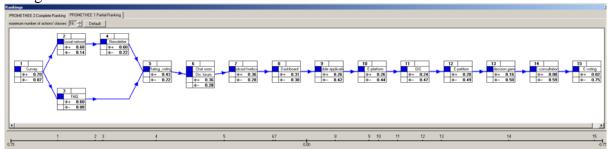


Figure 2. Results of the leaving flow and the entering flow – PROMETHEE I [Screen print from Decision lab]

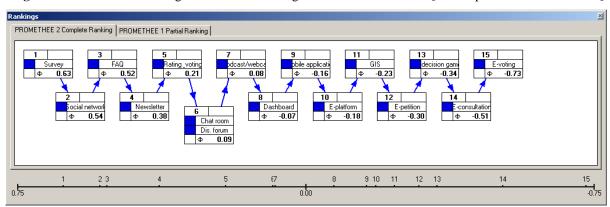


Figure 3. PROMETHEE II ranking results [Screen print from Decision lab]

5. Discussion and conclusions

Different MCDM methods showed similar tool selection's results as explained in this section as an answer on RQ1. For the top four (surveys/polls, social media/networks, FAQs, and online newsletters) and the bottom two alternatives (e-consultation and e-voting), the ranking using TOPSIS and PROMETHEE methods is the same, while using the SAW method the first and the second alternative are swapped. From the fifth to the fourteenth alternative, the ranking varies slightly between the methods used. The ranking is illustrated per method in Figure 4. The differences between the results from the three different methods can be attributed to the fact that each of the methods is based on a different principle: maximising benefits (WSA); distance from the ideal and anti-ideal alternative (TOPSIS); and the use of the preference function (PROMETHEE).

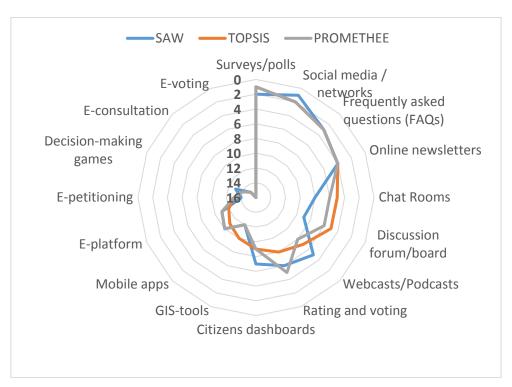


Figure 4. Rankings of e-participation tool for City of Split, sorted per TOPSIS method, clockwise

Overall, the workshop participants find that, based on the criteria, the most relevant for City of Split are the tools like social networks, survey/polls, FAQs, and newsletters that could result in the so-called quick wins and easy gains (as in other countries in the wider region, cf. Millard et al., 2018) relating to the first two levels of e-participation. The results, which answer RQ2, are in line with the present situation in the City of Split, where the level of implementation and usage of e-participation tools are still low, reduced to several tools. It is important to emphasise that this ranking based on the criteria selected/proposed by the participants themselves differs from the ranking list that was produced based on their free-form ranking. Specifically, they were asked to list the top 5 e-participation tools from the list which should be implemented in the City of Split as soon as possible. Out of the 13 participants, three of them ranked as first mobile apps, while at the same time two selected e-voting and two dashboards. Even when the second rank is considered, only two participants selected social media/networks and none of them surveys/polls. The ranking deviates significantly from the one based on the predefined criteria for the top three ranked tools, clearly demonstrating the importance of the MCDM methods in selecting the e-participation tools. Although preferred by users, looking at criteria such as time to implementation, level of anonymity, ease of use, the functionality of the tools and the price, more complex tools that result in higher levels of engagement such as decisionmaking games, e-consultations and e-voting are regarded as having lower priorities. Considering the technical complexity both in implementation and use, the ranking is explicable. Selecting an appropriate e-participation tool is a challenging process for city administrators as it requires knowledge about the tool and its proper application in various contexts of policymaking. One of the purposes of this paper was to explore some of the decision-making methods. SAW, TOPSIS and PROMETHEE have several advantages as they are consistent, easy to use and understand, and require less information from decision-makers compared to the Analytic Hierarchy Process (AHP) (Balali, Zahraie & Roozbahani, 2014). On the other hand, the shortcomings of the PROMETHEE method refer to the inability to break down the decision problem into simpler parts and assessment of criteria weights for which there are no clear instructions. For the TOPSIS method, a limitation is in determining the ideal and anti-ideal points, since the values of the maximum and minimum attributes for each criterion are taken,

while in practice it is often the case that these values are not always ideal or anti-ideal for determining the criteria. The success of each method depends on the accuracy of the criteria weights assessment.

In addition to the limitations of the methods, there are several weaknesses to this research study. The problem could have been defined in more detail, for example, with the stated general purpose (assessment of policies, collecting suggestions and similar) or e-participation stage (such as e-informing, e-empowering and other). In this study, the aim was very general, focusing on the priorities that could be implemented relatively swiftly, while criteria and assessments were for the most part descriptive in nature. Nevertheless, the contribution of the paper is reflected in adding to the growing number of studies that aim to demonstrate the potential of methods for the multi-criteria evaluation of alternatives in the public sector i.e. in digital governance in particular, for example, for the exploration and evaluation of e-government development, clarifying the position of each EU member state (Ardielli, 2016) or the analysis of economic activities of EU Member States and Candidate Countries using TOPSIS and WSA methods (Dinçer, 2011). In that regard, there are plans to extend the research and contextualise it based on the analysis of used e-participation tools in other Croatian cities, taking into account opinions of real experts – people in charge of cities' digital strategies.

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Usage of Collaboration Tools in Business Activities

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Abstract. Collaborative tools have become an integral part of today's business, especially as part of team collaboration. Companies invest in buying or developing collaborative tools because they believe they can save them time, money and resources, which adds value to the business. This paper describes the features of collaborative tools and presents research on the use of collaborative tools in business activities. The survey was conducted via an online questionnaire with three sets of questions on a convenience sample of 52 subjects using a Likert scale. The first set of questions collected data on team collaboration within the companies where the respondents work. The second set of questions collected data on collaborative tools used by the same companies. The third set of questions collected information about the companies themselves. The research confirmed the hypotheses and showed that employees in companies use collaborative tools and that make it easier for them to organize their business, which leads to greater efficiency and productivity.

Key words: team collaboration, collaboration tools, business activities, survey

1. Introduction

Collaboration can be defined as an action between a group of people working together to create something, such as a paper, a presentation, a class plan (Yang & Li, 2016). The collaboration can be established in a traditional as well as in a virtual team. (Webster, & Staple, 2006). Traditional teams are formed of individuals working in the same physical location, while virtual teams are made up of a group of individuals who may be dislocated but share a common goal. Nevertheless, the context in which companies do the work is modified, in regard to where the work is done, how the work is organized, who does the work, and with this the characteristics of the collaboration." (Soriano, Fernández, Jiménez, 2008). In some cases, online collaboration is established without explicit coordination and communication and without aligning tasks toward a strategic goal of the company. However, this should not be a regular policy because online collaboration should be planned through well-established project objectives that are aligned with the company strategy. Thus, teams are faced with a variety of challenges that require communication and collaboration tools with the purpose of maximizing their efficiency. Furthermore, the traditional model of employment is slowly disappearing as a result of new employment models that are emerging, like gig work (Ashford, Caza, & Reid, 2018). A large number of companies support remote work and, according to some predictions, by 2025, more than a third of organizations will have more than 50% of their staff working remotely (Study 2017, Forum 2018). It is precisely this flexibility that enables the development of technology, especially collaboration tools. In the highly competitive world, creativity is becoming an important factor in order to improve productivity and promote healthy employee relationships (Roffe, 1999). Compared to people who work independently, working in teams enables employees to be faster and more efficient in their work. Furthermore, team work also encourages self-analysis, faster problem solving, and better results due to team members learning from each other. Likewise, collaboration makes employees more responsible, which helps to increase motivation, especially when teams are working virtually. Large selections of collaborative tools are currently on the market, like Microsoft Teams, Slack, Assana, Yammer, Trello, etc. These applications are used for project management, monitoring and work assignments. Therefore, they represent an opportunity for more efficient office organization, thereby achieving a better ability to monitor the effectiveness of the project and employees.

2. Collaboration Tool Features

Nowadays, with the existing collaboration tools, organizations can create an interdisciplinary team composed of members with different skills and knowledge. (Lopes, Oliviera, Costa, 2015). The team has the possibility to store and share the documentation (OneDrive, GoogleDrive, Dropbox) which contributes to the faster information exchange. Whether a small, medium or large organization, collaboration is one of the key elements to a success. "Conceptual and case studies suggest that virtual collaboration outcomes depend on whether an appropriate collaboration tool is used to facilitate task accomplishment, how extensively team members adopt and utilize the collaboration tool, and how well team members coordinate with each other to work on the tasks" (Argote and Fahrenkopf, 2016; Quan-Haase et al., 2005). It is important to emphasize that online collaboration tools are not just for businesses with virtual team members who are dislocated, they also serve any company that strives for a more efficient and faster working model. Although communication is often an integral part of collaboration tools, it is rarely the only feature these tools can offer. Any software that offers interaction on a shared space can potentially be considered a collaboration tool. It is important to develop an interface with interactions based on pre-existing communication standards. Many tools consider traditional face-to-face interactions as a base for an application development that is attempting to mimic non-technology-mediated interactions. According to Rivera (2008), some of the features of a good collaboration tool are strong communication skills, simplicity, and real-time work. Lomas and Burke emphasized the meaning of the collaboration tools: "Today's Web 2.0 technologies are expanding the list of collaborative tools, taking advantage of a growing base of content creators and online experimenters to transition social tools into opportunities for academic collaboration and innovation" (Lomas, Burke, 2008). Modern collaboration tools and innovative technologies have reshaped the way employees do their jobs. They can have an impact on generating better results and increasing productivity that will help companies fight for competitive advantage. According to Lomas, Burke and Page (2008), with these technologies in mind, we can expand the list of features, including those that can promote brand new and different types of interaction like enhanced voice communications, photo sharing, integration and compatibility and privacy. The traditional form of voice communication has its limitations, such as lack of interactions and high call rates that limit talk time. For this reason, multi-party voice calls, video conferencing and call recording options are integrated. Photo Sharing is a feature that brings together potential contributors and establishes a new starting point of common interest. Most often, it involves posting photos to public sites where they can be selectively shared, viewed, flagged and categorized. That integrates with other applications or software. Integrations are the key to practical work. To avoid possible frustration in the future, an organization should use tools that support the type of documents that teams use. The most important feature is that related to privacy options which should be taken into consideration when selecting collaboration tools. Companies have to handle sensitive client information and employees will not want to risk sharing that information on public forums or sites.

3. Main objective and methodology

The main objective of the research is to establish the way organizations and teams are working within the company and which collaboration tools are being used. The research study was conducted on a convenient sample of 52 companies (small and medium). Since there was no possibility of using a random sample on a large number of subjects, a convenient sample was used because of its simplicity. It is "a sample whose structure is not predefined, but it includes those individuals who are available to the researcher at the time of measurement. This pattern is often used in practice, because it can be organized very easily" (Bubić, 2015). Data were collected through an anonymous online survey designed with the Likert scale. The presented scale expresses the degree of agreement with the position expressed in the statement (1 = strongly disagree, 2 = mostly disagree, 3 = neither agree nor disagree, 4 = mostly agree, 5 = strongly agree). The Likert scale was used to delve deeper into the research issue and to achieve better data analysis. The survey was shared via social networks and emails and is divided into 3 sections. The first part consists of 6 questions related to teamwork within the company. Within this part, the goal was to establish the experience and frequency of team work as well as the collaboration tools usage. Also, the goal is to determine whether companies are more likely to form small (up to 10 members), medium (10-20 members) or large (20 or more members) teams. The second part of the survey contains 7 questions related to collaborative tools, their characteristics, method and frequency of use. The last section contains general business-related questions to determine in what form, size and activities the collaborative tools are used, or are not used at all.

4. Research results

4.1. First part of the survey

The first part of the survey collected data on the teamwork organisation which reported that most of the respondents (*organisations*) are mostly performing their tasks within a team, average (3.65) and that their experiences are positive, average (3.83). It also showed that virtual teams are not a common occurrence and that companies still prefer traditional teams.

Table 1 Organization of the Teamwork within a company

Questions	N *	Average	Standard deviation	Coefficient of variability %
Q1 I do most of the work activities in a team	52	3.65	1.07	29 %
Q2 Team experiences are mostly positive for me	52	3.83	0.99	26 %
Q3 I often work in teams where at least one team member works from another location	52	2.92	1.54	53 %
Q4 If possible, I do most of the work digitally	52	4.37	0.92	21 %

^{*} N=number of respondents

Also, the first part of the conducted survey showed that 82.7 % of organizations completely agree that most of their jobs are done digitally, average (4.37) with the insignificant standard deviation (0.92). Although it is shown that traditional teams are the most common

within the enterprise, this high percentage indicates the decreasing use of traditional office tools and a greater orientation toward digitizing jobs.

Furthermore, questions 5 and 6 "How many members are in your team?" and "Proportion of using collaboration tools by time size" were constructed with closed-ended questions and not with a Likert scale. The results showed that 82.5 % of teams, with up to 10 members, use collaboration tools, and only 17.95 % of such teams do not use collaboration tools. 25 % of teams with a membership number between 10 and 20 use collaboration tools, while 75 % of mid-sized teams do not use them. Also, a large percentage of teams (60 %) made up of 20 or more members use collaboration tools, and 40 % of such large teams do not use collaboration tools. From this data, one can partially confirm that collaborative tools are the most used within small teams.

Table 2 The relationship of attending meetings on a monthly basis and using collaborative tools

I use collaborative tools	On a monthly basis, I attend meetings within the company in-person			
	Up to 4 hours	Up to 10 hours	12 hours and more	
Yes	59.46 %	18.92 %	21.62 %	
No	40 %	25.67 %	33.33 %	

Table 2 presents the correlation between time spent on meetings on a monthly basis and the use of collaboration tools. Of the companies using collaborative tools, 56.46 % attend meetings in person on a monthly basis up to 4 hours, 18.95 % attend up to 10 hours, and 21.62 % more than 12 hours. In companies that do not use collaborative tools, 40 % of respondents attend meetings up to 4 hours, 25.67 % by 10 hours, while 33.33 % attend more than 12 hours. In line with the above data, it was confirmed that organizations that do not use collaboration tools spend more time at in-person meetings. This indicates **that using collaborative tools contributes to saving time**. However, 21.62 % of companies that use collaborative tools still spend more than 12 hours in meetings. This can be due to the large percentage of using Jira as a collaboration tool that requires daily, weekly and monthly meetings. Although it takes more time, Jira thus increases the productivity and efficiency of the business.

4.2. Second part of survey

The second part of the survey addresses questions about collaboration tools, their characteristics, and how they can be used internally.

Table 3 The importance of collaboration tool features

Questions		N	Average	Standard deviation	Coefficient of variability %
Q1 Collaboration tools greatly facilitate team collaboration and task completion		52	4.21	0.95	22 %
Q2 The importance of collaboration tool features	Communication	52	3.69	1.31	35 %
	Usability	52	3.60	1.27	35 %
	Simplicity	52	3.52	1.23	35 %
	Availability	52	3.33	1.20	36 %

	Integration	52	3.12	1.12	36 %
	Compatibility	52	3.31	1.20	36 %
	Security	52	3.38	1.33	39 %
Q3 I am satisfied with the tool	service I use.	46	3.73	0.95	26 %
Q4 The use of collaboration to and improved the way I work	Q4 The use of collaboration tools has facilitated and improved the way I work		3.79	0.97	26 %
Q5 I use Microsoft Office 365	52	3.65	1.65	45 %	
Q6 I use Microsoft Teams ins Office 365.	52	2.87	1.71	60 %	

The highest average (4.21) with standard deviation of 0.95 implies that collaboration tools make collaboration and organization easier for companies. Most organizations are satisfied with the collaboration tool they are currently using and believe that the use of those tools eased down and improved the way they work. Organizations also evaluated the importance of communication and usability as the most important characteristic. This also confirms the fact that **collaboration tools are mostly used for communication and data transfer**. Interestingly, study has shown that respondents found integration as the least important feature of collaboration tools, which is in contrast with tendency of the most popular collaboration tools such as Microsoft Teams and Slack who constantly compete in offering a wider range of integration applications.

Table 4 Pearson Correlation Coefficient

	The use of collaboration tools has facilitated and improved the way I work
User satisfaction with the collaboration tool they're currently using	0.6
The use of collaboration tools greatly facilitates team collaboration and task completion	0.6

Pearson correlation coefficient (0.6) between facilitating and improving companies' performance using the collaboration tool and satisfaction with the service showed the importance to invest enough time in choosing the right collaboration tool. The extent to which the collaboration tool will facilitate and improve the way the entire enterprise works will depend on how well employees adopt and utilize a collaboration tool. That is, the effectiveness of the collaboration tool will be greater as employees are more satisfied with the collaboration tool.

Likewise, there is a medium-strong Pearson correlation coefficient between using a collaborative tool for facilitating and enhancing individual and teamwork. If an individual is more efficient and faster in performing his jobs, he will be more able to contribute to the team and the overall project. It is important that all members are well informed about all the functionalities and capabilities of the collaboration tool and able to use it in different business scenarios (Zhang, Sun, Yang, & Wang, 2018).

Question 7 was constructed with closed-ended questions. Figure 1 shows results about the most common used collaborative tools, and that are **Slack and Microsoft Teams**.

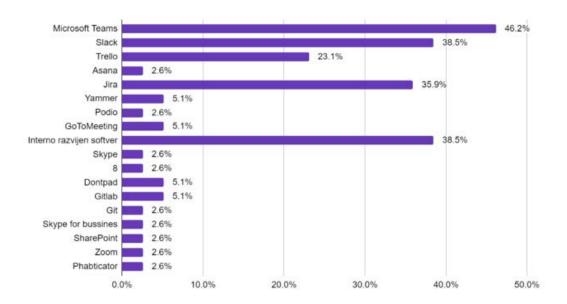


Figure 1 Results about the most common used collaborative tools

4.3. Third part of the survey

The third part of the survey interpreted the general characteristics of the companies and showed that 82.7 % of respondents work in a private company, while 17.3 % are employed by a state-owned company. This indicates that team collaboration is much more prevalent in a private company than in a state-owned company. In the conducted survey, most companies had 1-50 employees (44.2 %) and the share of respondents was highest in the field of Information and Communications (30.8 %).

5. Discussion

The results of the research show us how companies organize their business and work within the team. A high percentage of teamwork and positive team experience confirms that employees have an affinity for teamwork. Although collaboration tools focus on features that will enable and facilitate the deployment of virtual teams, research has shown that companies in Croatia still most often form teams where all employees are in the same physical location. Although the percentage of companies that have virtual teams is not large, the fact is that digitization is implemented in most of them, which indicates a shift towards more successful and efficient work and a departure from the traditional way of doing business. In order to improve productivity and cohesion, most companies choose to form small teams which is a good indicator because, according to the Hackman and Vidmar (1970), the optimum number for a team is close to five. Importantly, 71.2 % of respondents use collaboration tools which confirms the current golden age of collaborative tools. Businesses see the great benefit of using collaboration tools as an office organization and agree that they greatly facilitate collaboration between teams. One of the goals of this research was to obtain information on commonly used collaboration tools. According to the survey, most respondents use Microsoft Teams, Slack and in-house developed software solutions. The latter implies that a large percentage of companies still choose to invest in software development that will best suit their needs and business style. Quite a few companies have stated that they use Jira and Trello, the primary function of which is task management. This is another indicator that companies are moving away from traditional tools and ways to organize, assign and monitor business tasks and processes. The most commonly used tools for collaboration are for everyday communication and sharing and transfer of files, which is confirmed by the fact that the most important characteristics of the respondents were communication and usability. Instant messaging is also often used to facilitate

individual communication among employees. Collaboration tools are less commonly used for online meetings, video and audio conferences, which is also clear from the fact that virtual teams are not a common occurrence within businesses.

A small number of respondents use collaboration tools to work with external associates, which suggests that collaboration tools are primarily used for internal communication. Which tool will best suit an individual business depends on its business style and the functionality it requires. In addition to the communication and usability already mentioned, simplicity and security are also essential characteristics for the respondents. Accordingly, it is important for employees that their collaboration tools are secure and that they do not provide too many unnecessary features that can slow them down. Interestingly, according to the survey, integration, which is, for example, Slack's biggest asset, is the least important feature. Teamwork is most prevalent in private companies with fewer than 50 employees. As far as activities are concerned, teamwork is most common in professional, scientific and technical activities and information and technologies. The above activities mainly use advanced technologies and are expected to use collaborative tools accordingly. It is important to emphasize that the analysis showed that the use of collaboration tools saves time spent at meetings.

6. Conclusion

The importance of collaboration in today's agile work environment is beyond question. As the survey confirmed, collaborative tools make business organization easier, leading to greater efficiency and productivity. Team members use collaborative tools to help them collaborate, complete tasks, and save time. There is currently a large number of collaboration tools available on the market and it is up to companies to decide which collaboration tools are more suitable for their needs. As the survey showed, Slack and Microsoft Teams are collaboration tools that compete for market dominance, but also in-house developed software tools are equally represented. Nevertheless, with the world pandemic of COVID-19, companies are faced with a great challenge due to the physical contact restrictions. On March 13, 2020 the Croatian government decided to close all schools, kindergartens and faculties with further recommendations for online education. Tools like Teams, OneDrive and e-mail are good examples for online education and collaboration. Teams offer a virtual space for task management and documentation storage, as well as meeting opportunities (video in real time). In this particular case, the usage of collaboration tools is a highly effective way to continue work assignments and contact team members without losing team efficiency.

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Uncovering Barriers to Smart City Development in Croatia

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Abstract. In developing smart city initiatives and applications, city managers face many issues, some of which are interoperability of the available platforms, lack of collaboration between city departments, policy changes, qualifications and willingness of decision-makers and similar. A recent study by the author of this paper identified the most critical challenges for the implementation of smart city initiatives in Croatia based on the feedback of more than 60 experts and respondents that had a keen interest in smart cities. As a follow-up, a workshop with domain experts was conducted to inspect the main implementation challenges in more detail and compare and assess the appropriateness of internationally recognised smart city barriers in a given context. With the purpose to establish a hierarchy structure that illustrates the interrelationships among the main barriers, an Interpretive Structural Modelling (ISM) tool was used to interpret data collected from domain experts. The results could be useful for smart city solution providers and policymakers to understand the impact of forces on the smart city implementation projects, resulting in better decisions and more targeted policies.

Keywords: smart city, interpretive structural modelling

1. Introduction

According to the United Nations' Population Division (2019), more people live in urban areas than in rural areas, with over 55 per cent of the world's population residing in urban areas in 2018. The percentage is on the rise – more specifically, in 1950 about 30% of the world's population was urban, and by 2050 about 68% of the world's population is expected to be urban (ibid). Consequently, urban settings are facing significant changes and challenges arising from global shifts in the environment, rapid urbanisation, as well as due to aged urban infrastructure. Failure of urban planning and failure of critical infrastructure, among other particular societal, geopolitical, economic, environmental and technological risks, are presented in a detailed report by World Economic Forum (2015) underlying the risks of rapid and unplanned urbanisation but also debating the bugs and brittleness of new smart city systems. Deliberating "how smart is smart", the report provides examples where coding errors, the fragility of mobile cellular networks, congestion and similar issues have caused major outages in recent years and sudden and unexpected failure of these systems and vital digital infrastructures during crises (ibid).

Nevertheless, due to enormous potential and promises, investing in information technology-based systems branded as Smart City (SC) solutions has been growing steadily, with the global smart cities market size expected to exceed \$2.5 trillion by 2025 (Grand View Research, 2019) according to some forecasts. Smart city concept has been the subject of interdisciplinary research and has become central to various pioneering (inter)national studies, events and projects, governmental and corporate initiatives, institutional agendas, and strategic plans. Specifically, there are over 145.000 papers in Google Scholar database (excluding citations and patents) as of Feb 2020 on the topic of "smart city". This paper aims to contribute to the growing body of research on a national level focusing on the potentials and barriers in developing SC initiatives.

2. Conceptual grounding and methods

2.1 Smart cities in Croatia

As of 2014, smart cities on a national level have become a research focus of Croatian scientists. First talks focused on the presentation of good practices and the role of scientific community in developing sustainable and smart cities in Croatia (Jurlina Alibegović, 2014), while the first publications focused on the context and the potential of using public-private partnership models and the role of government officials in smart city projects (Milenković, Rašić & Vojković, 2017). On a national level, a proposition for city ranking was brought forth (Jurlina Alibegović & Šagovac, 2018) using 15 indicators to compare 25 Croatian large cities and further developed into a reference model for monitoring the success of Croatian large cities (Jurlina Alibegović, Kordej-De Villa & Šagovac, 2018) concluding that to date only two Croatian cities have prepared a smart management strategy and that only 30 (small and large) cities have developed smart projects in various sectors. Other researchers focused on smart city awareness amongst Croatian citizens (Rašić, Milenković & Vojković, 2018) and smart mobility in general (Brčić et al., 2018) or intelligent transport solutions in particular (Maglić et al., 2019). None of the presented studies focused on smart city challenges or barriers to smart city development in Croatia.

2.2 From the potentials and challenges to barriers to smart city development in Croatia

Based on relevant international research studies, the author of the paper conducted several stakeholder workshops focusing on the potentials, priorities and challenges of smart city projects in Croatia. Potentials and priorities for developing smart city initiatives were analysed with 17 experts based on their assessment of 59 smart city applications (from Woetzel et al., 2018) from eight different categories (Engagement and community, Economic development and housing, Energy, Waste, Water, Mobility, Security and Healthcare) out of which the experts agreed that water quality monitoring and smart parking were the most critical priorities for City of Split (Ćukušić, Jadrić & Mijač, 2019). With a broader pool of participants, i.e. 60 experts and respondents that had a keen interest in smart cities, the most relevant short-, medium-, and long-term challenges for the implementation of smart city initiatives in Croatia were identified using a list of 17 different challenges compiled from several sources. The results of the study exposed the strategic factors (e.g. leadership and vision, decision-makers' readiness and similar) as the most challenging ones in the long-run in the national context of Croatia (ibid). Other factors were categorised as operational (e.g. financial aspects, community engagement, open data access and more) and external (e.g. regulations on data protection and privacy, interoperability and other) challenges. While the selection of priorities was straightforward and in line with what was expected, identification of challenges was less useful since the list was not clearly defined nor based on an internationally-validated instrument. Consequently, the list of priorities was revisited in 2020, while the shift from smart city challenges to a more specific list of barriers was considered and is presented here. Even though the terms challenge and barrier are sometimes used interchangeably in research studies, there is a clear distinction between the terms. Both definitions are taken from Cambridge Dictionary (n.d.): while a challenge refers to a job, duty, or situation that is difficult because one must use a lot of effort, determination, and skill in order to be successful, a barrier is defined as more narrow and specific: something that prevents something else from happening or makes it more difficult. In innovation, for example, a barrier is a variety of factors which hamper, delay or block innovation (Hueske & Guenther, 2015). In the context of smart cities, based on a thorough review a recent study resulted with the list of 31 barriers to the development of smart cities (Rana et al., 2019b) that were tested with experts in India, while this paper presents the attempt to (i) test its applicability in Croatia and (ii) identify top 10 barriers to smart city development in Croatia.

2.3 Interpretive Structural Modelling (ISM)

One of the first applications of ISM was based on graph theory and mathematical foundations from the 1960s and the concept proposed by J. Warfield in 1973 (Malone, 1975). The purpose of one of the two Malone's cases was to analyse contextual interactions among different variables/barriers to investments in the central city Columbus, US. The process was designed for a group setting and later supported with computers that were used to guide participants through questions resulting in a common definition of the scope of a problem, and the relationship of its dependent parts (George Mason University Digital Exhibition, n.d.). The methodology proved useful and productive and was later used by many public and private organisations for decomposing complex problems into simpler ones paving the way for Warfield's work on systems science and interactive management (ibid).

There are some typical steps in the development of an ISM model that can be kicked-off with surveys, group problem solving or idea generation techniques, and supported by specialised tools. In one of the ISM-based studies (Jharkharia and Shankar, 2005) several steps in the development of an ISM model are presented including: identifying elements relevant to the problem or issues using standard techniques, establishing a contextual relationship between elements and pair-wise evaluations that result in a structural self-interaction matrix (SSIM) of elements, developing a reachability matrix from the SSIM, checking the matrix for transitivity of the contextual relations, partitioning of reachability matrix into different levels, drawing a directed graph (DIGRAPH), converting the resultant digraph into an ISM model and reviewing it to check for conceptual inconsistencies.

Sushil (2012) systematised the strengths and weaknesses of ISM in the following way:

- ISM strengths: the methodology enables the presentation of complex systems in a simplified way, provides the interpretation of embedded objects, transforms mental/conceptual models of systems into visible and well-defined models that can support theories and facilitate the identification of structures within the systems.
- ISM limitations: even though it can be used only by persons who are trained to interpret the data, the ISM models can still be subjected to multiple interpretations by users, as it does not reveal the causality of links to support new theories fully.

To overcome some of the limitations, i. e. to provide the basis for the interpretation of the links in the ISM models using the Interpretive Matrix, Sushil (2012) proposed to evolve the framework and methodology labelling it Total Interpretive Structural Modelling (TISM).

The ISM methodology has been used, for example, to inspect the mutual relationships among the 11 barriers that influence one another and adversely affect the IT-enablement of a supply chain (Jharkharia & Shankar, 2005) and also enablers that help to mitigate risk in a supply chain (Nishat Faisal, Banwet & Shankar, 2006). Another example includes the analysis of the interaction among the significant barriers, which hinder or prevent the application of reverse logistics in automobile industries (Ravi and Shankar, 2005) some of which are lack of appropriate performance metrics, financial constraints, lack of commitment by top management, reluctance of the support of dealers, distributors and retailers and other. More recently, Yadav et al. (2019) focused on the role of 10 lean implementation barriers identified from case studies revealing through ISM that lack of management commitment, leadership and resources are the key barriers to lean implementation in SMEs in India. Another recent example of ISM use is related to the identification of 16 representative factors that influence the development of renewable energy power generation projects in China (by Zhao, Chen & Li, 2019). From the information systems domain, a more recent study focuses on the 10 barriers that prevent the adoption of m-commerce amongst SMEs in the UK (Rana et al., 2019a) where, among others, perceived cost, perceived risk, inconvenience of use, privacy and security issues were considered.

2.4 IMS Software

Ever since J. Warfield developed the mathematical foundations for the computer-aided approach to ISM, there were several attempts to support it using a software tool (Watson, 1978). The company where he worked, Battelle Columbus Laboratories developed the first software in 1974, while today, his trust provides a version of the software free of charge (Warfield Intellectual Property Trust, 2020). The user interface of the ISM Software (n.d.) is presented in Figure 1. Software tools can adequately support the development of the ISM model hiding the mathematical calculations (development of the initial and final reachability matrices, partitioning of the FRM, developing the canonical form of FRM and analysing driving and dependence factors) from the users that are, for example, elaborated and detailed out in a recent study of IS project success factors (Hughes, Rana & Dwivedi, 2020).

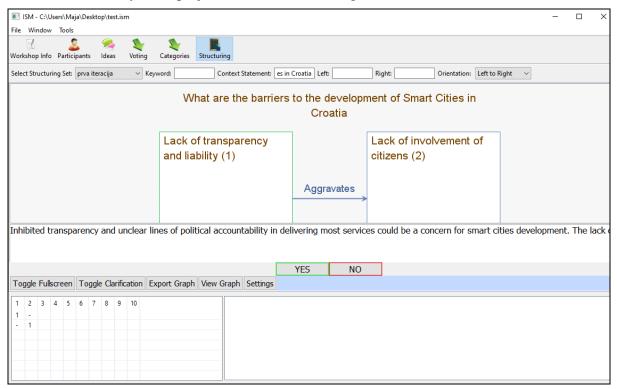


Figure 1 ISM Software user interface [Screen print]

2.5 Research objectives and the procedure

The objective of the study was twofold: first to revisit and rank the smart city priorities in the City of Split after two years and second to explore the contextual inter-relationships among the barriers affecting the smart city development in Croatia. For expert assessment, a questionnaire was prepared, starting with a brief statement of the research purpose and a set of questions to collect basic information about the respondents. The lists of 59 smart city applications (Woetzel et al., 2018) and 31 barriers to smart city development (Rana et al., 2019b) were reused as Part 1 and Part 2 of the questionnaire. Apart from assessing each list item (question) against a 5-point Likert scale from "1" for "irrelevant" to "5" for "extremely relevant", the participants were asked to rank top 5 smart city application priorities in the City of Split and top 5 barriers to smart city development in Croatia. For the analysis, only the explicitly declared top 5 priorities and barriers were used. While the ranking of the application priorities was interpreted in comparison with earlier results, the ranking of the barriers to smart city development was used to formulate the initial structuring set for ISM consisting of top 10 barriers. Using the ISM Software, ISM hierarchy structure was then established to show the inter-relationships among the barriers to smart city development in Croatia.

3. Priorities and barriers to smart city development from the national perspective

In November 2019, a dedicated two-hour workshop was organised with 21 participants. The participants were enrolled and regularly attending an interdisciplinary two-month lifelong learning program titled "Shaping fair cities" and before the workshop had 32 hours of interactive lectures focusing on sustainable development, smart mobility, community engagement and similar. Furthermore, they were already knowledgeable about different socio-economic aspects of urban development as they were coming from different backgrounds (civil engineering, electrical engineering, education, business and other sectors). During the first hour of the workshop, smart city applications and barriers to smart city development were presented to participants in detail, and the ranking followed. Each participant was allowed to list a maximum of five smart city applications and five barriers to smart city development. Top 10 smart city application priorities for City of Split based on the feedback from the participants are presented in Table 1.

Table 1 Top 10 smart city application priorities for City of Split, Croatia (prioritised and selected by the workshop participants from the list of smart city applications provided by Woetzel et al., 2018)

Original title and the category of an application	Brief description of a smart city application	No. of votes
Water quality monitoring (Water)	Real-time monitoring of water quality (in mains, rivers, oceans, and so forth) with alerts delivered to the public via channels such as the mobile app, email, text, or website. This warns the public against consuming or coming into contact with contaminated water and prompts cities and utilities to follow up promptly.	10
Digital citizen services (Engagement and community)	Digitisation of citizen-facing government administrative services such as income tax filing, car registration, or applying for unemployment benefits. Includes digitisation of the user journey as well as back-end support functions as needed.	9
Waste collection route optimization (Waste)	The use of sensors inside trash bins to measure trash volume and direct the routes of garbage trucks. This application keeps garbage trucks from travelling to trash bins with little waste volume.	9
Water consumption tracking (Water)	Feedback (via mobile app, email, text, and so forth) on a resident's water consumption to increase awareness and reduce consumption. Smart water meters allow utility companies to measure consumption remotely, reducing labour costs for a manual meter reading. It also enables the potential for dynamic pricing.	5
Intelligent traffic signals (Mobility)	Improvement of overall traffic flow through dynamic optimisation of traffic lights and speed limits, leading to higher average speeds on roads and less frequent stop-and-go conditions. Includes traffic light pre-emption technology, which gives priority to emergency vehicles, public buses, or both.	5
Digital business licensing and permitting (Economic development and housing)	Digitised process (such as an online portal) for businesses to obtain operating licenses and permits.	4
Building automation systems (Energy)	Systems that optimise energy and water use in commercial and public buildings by leveraging sensors and analytics to manually or automatically eliminate inefficiencies. It includes optimised lighting and HVAC as well as features such as access/security control and parking information.	4
Leakage detection and control (Water)	Remote monitoring of pipe conditions using sensors and control of pump pressure to reduce or prevent water leakage. The early identification of leaks can prompt follow-up actions from relevant city departments and utility companies.	4
Real-time public transit information (Mobility)	Real-time information about arrival and departure times for public transportation modes, including informal bus systems.	4
Smart parking (Mobility)	Systems that guide drivers directly to available spaces; can also influence demand through variable fees.	4

Out of the listed, six smart city applications (Water quality monitoring, Digital citizen services, Intelligent traffic signals, Digital business licensing and permitting, Real-time public transit information, and Smart parking) were also among the top 10 priorities identified by 17 participants in an earlier workshop in July 2018. As a replacement for Real-time air quality information, First aid alerts, Digital public transit payment, and Digital land-use and building permitting that were selected as priorities in 2018, in November 2019 participants emphasised/prioritised Waste collection route optimisation, Water consumption tracking, Building automation systems, and Leakage detection and control as priorities. This shift to applications that enable better water and waste management is understandable considering the related pressing issues in the City of Split (Total Croatia News, 2017; Total Croatia News, 2019).

Top 10 barriers to smart city development in Croatia based on the feedback from the participants are presented in Table 2.

Table 2 Top 10 barriers to smart city development in Croatia (prioritised and selected by the workshop participants from the list of 31 barriers provided by Rana et al., 2019b)

Original title, category and abbreviation of a barrier	Brief description of a barrier to the development of smart cities	No. of votes
Lack of transparency and liability (Legal and Ethical - L&E4)	Inhibited transparency and unclear lines of political accountability in delivering most services could be a concern for smart cities development. The lack of transparency risks isolating the very people smart cities technology is supposed to serve	10
Lack of involvement of citizens (Social - SOC1)	Lack of citizens' participation in realising how exactly the smart cities could possibly look like in their experience is reflected. The citizens should be encouraged to submit and evaluate ideas for innovation in smart city design.	9
Lack of trust between governed and government (Governance - GOV4)	Lack of trust between government and people can impede smart cities development	8
Lacking ecological view in behaviour	Lack of ecological view in pro-environmental behaviour toward consuming energy	7
(Environmental - ENV1)		
Lack of sustainability considerations (Environmental - ENV3)	Lack of more sustainable and more aware city (e.g. direct traffic, notify residents about available parking, reduce gas emissions etc.) means lack of better living conditions and experiences for all	7
Political instability (Governance - GOV3)	Smart cities will not become a reality until there is a political stability	6
Lacking technological knowledge among the planners	The planners and policymakers of smart cities development lack enabling or transformative technological knowledge that may be needed for smart cities development	5
(Technology - TECH1)		
Lack of developing a common information system model	Lack of a common IS model to ensure end-to-end visibility while managing smart city infrastructure and services	4
(Governance - GOV6)		
Poor data availability and scalability	There is a lack of specific data and corresponding scalable methods in smart city development agenda	4
(Technology - TECH6)		
Poor private-public participation	The poor private-public interaction can have negative impact on smart cities development projects	4
(Governance - GOV5)		

Out of the listed, six barriers to smart city development (Lack of transparency and liability, Lack of involvement of citizens, Lack of trust between governed and government, Lacking

technological knowledge among the planners, Poor data availability and scalability, Poor private-public participation) were also among the top 12 barriers (barriers ranked from 7 to 12 all had the same mean score of 3.5) for smart city development in India identified by experts in March 2017. The overlap differs slightly from the final ranking of specific barriers to smart city development in India after fuzzy AHP with only four of the same barriers in the top 10, understandably so. For example, the growing population and some infrastructural issues such as system failures issues are not relevant in the context of Croatia. Furthermore, it can be observed that barriers from almost all the categories (Governance, Social, Technology, Legal and Ethical) were voted as the most relevant ones on a national level, apart from the barriers listed in the category Economic. All the barriers received at least a vote; however, seven items received only one vote (Global economy volatility, Degree of inequality, Privacy and security issues, System failures issues, Integration and convergence issues across IT networks, Carbon emissions effect, and Cultural issues).

4. Structural map of barriers to smart city development in Croatia

As presented already, systems science and interactive management promoted by Warfield were extensively used since the early 1970s in the corporate (IBM was one of the first organisations to use the methodology) and academic settings. Success in identifying interrelations between the elements of similar nature and the potential to indicate areas of influence among them seem to be the main reasons for ISM's wide implementation (Rana et al., 2019a). In this study, ISM Software (n.d.) was used to structure the barriers to smart city development in Croatia with experts. The software alleviates the group of computations and facilitates processes of creative idea generation and voting concerning binary relations in the overall problem structure (Hogan, Harney & Broome, 2015). As the calculations are hidden from the end-user, a simplified graphic version of the results, a structural map, is available for interpretation. This section presents an application of the methodology to the challenge of building a consensus view of crucial barriers to smart city development in Croatia and a model of interdependencies that can be used to inform the design of new policies and provide new insights in smart city-related issues on a national level.

A structural map or an influence map (as in Broome & Fulbright, 1995) was generated based on the deliberation and voting that took place during the workshop structuring session (following the procedure described in Dwyer et al., 2016). For that purpose, questions were generated by the ISM Software and projected in full-screen mode. An example of a question was illustrated in Figure 1, where the form of the question was: "Barrier X aggravates barrier Y?". Participants engaged in a discussion about each question, followed by recording a vote "yes" or "no" depending on the majority (70%) opinion. The map of the structural model (Figure 2) reads from left to right with arrows indicating paths of influence labelled as "aggravates". Strongly connected elements at the same level are represented in the same box as separate bullets for a simplified presentation, indicating a reciprocal relationship between these elements whereby each element aggravates and is being aggravated by each of the other elements (ibid). The map includes five levels, where items further to the left would have a greater influence on other items (Broome & Fulbright, 1995). Among the 10 barriers, there are no independent variables in the process of smart city development, i.e. all ranked barriers are drivers and dependents and have an influence on the overall system. Two barriers, specifically "Political instability" and "Lacking technological knowledge among the planners", can be seen to aggravate remaining ones and as such are recognised as the most critical barriers and drivers that may be treated as the root causes of all the barriers. Issues such as "Lack of transparency and liability", "Lack of sustainability considerations", "Lack of developing a common information system model", and "Poor data availability and scalability" are at the lower-mid-level of the model, induced by lower-level barriers but also having strong driving power and inter-dependence and consequently should be addressed carefully. Further, "Lack of trust between governed and government" and "Lacking ecological view in behaviour" in particular, are weaker drivers but strongly dependent on the other barriers, whereas "Poor private-public participation" and "Lack of involvement of citizens" are at the top of the hierarchy and as such considered as the important and high-priority barriers.

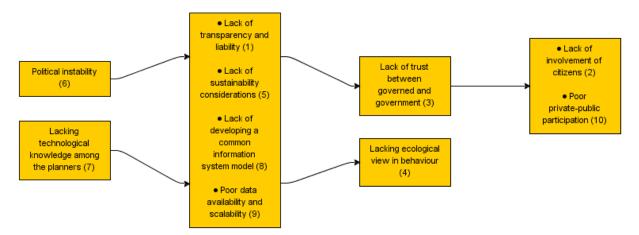


Figure 2 ISM-based model for the barriers to smart city development in Croatia designed by workshop participants; paths in the model are to be interpreted as "aggravates."

These barriers pose considerable challenges for city officials and public policymakers. Here, only a segment (10) of the major barriers identified in the literature (31) has been prioritised and highlighted in the form of a structural model, to facilitate the analysis of possible interrelations between the barriers. For the success of smart city initiatives, these barriers need to be tackled. The graphical representation corresponds to expert opinions concerning the importance and dependencies among the barriers. Specifically, political instability is designated as a very significant barrier. The World Bank (2019) measures the perception of political stability and absence of violence/terrorism as the likelihood of political instability and/or politically-motivated violence, including terrorism, providing a country score on the aggregate indicator ranging from approximately -2.5 to 2.5. Croatia's country score of 0.7 in 2018 (the highest rank in 2018 is for Monaco with the score 1.61) is well above average (-0.05). Therefore the perception of political instability may be linked more to the stability of the governing coalitions at the local and national level (e.g. The Guardian, 2016) than the actual political stability in the country. Nevertheless, delicate agreements between the many political parties may impede the design and development of initiatives with the transformational and reformational potential, leading to a lack of transparency, liability and trust between the stakeholders. From the model, it is observed that the lack of technical knowledge among the planners is another factor with high driving power and a root cause of remaining barriers. For successful smart city development, the focus should, therefore, be put on developing strategies to increase the awareness and knowledge about the potentials of new technologies and tools that are embedded in smart city solutions leading to the development of common interoperable information systems in public organisations and better availability and scalability of data. Only then the benefits of citizen involvement and private-public participation can be reaped as only through the engagement of citizens/users can the pressing issues be identified and resolved to fit the needs of future users. Policymakers should primarily target the low-level barriers, although some may be a part of the broader socioeconomic environment. In that, strategic partnerships with solution providers may prove beneficial as through devising future solutions, the level of understanding the problems and potentials in smart city domain increases while the infrastructural issues related to standard models and data availability can be resolved directly through partner support.

5. Conclusions

Although the structural model developed in this study represents only a segment of known barriers/issues in smart city development, identification of the main drivers and interdependencies can be considered as a reasonable contribution. While there are many international smart city success stories, the progress in Croatia is slow, as presented in section 2. Thus, the attempt to identify the main barriers affecting the smart city development in Croatia is important as it can support the public officials in deciding about the priorities and future steps. Although some of the barriers identified in the structural model refer to government perception and trust and as such may be considered as deeply political and are consequently difficult to tackle on a bottom-up level, the others refer to knowledge, skills, behaviours and underlying infrastructure that can be challenged at that level through targeted policies and projects.

One of the limitations of the study is the sample size and its homogeneity. Although appropriate for an exploratory study of this nature, as a follow-up to structural modelling, to get better insights and for generalisation of the results, this study is planned to be extended in several ways. Apart from repeating the ISM procedure as a supportive analytic tool with more groups to compare the results, there are plans to conduct an empirical study with different stakeholders to test the validity of the model(s) using structural equation modelling (SEM) (as in Thirupathi & Vinodh, 2016). Another way to validate and generalise the results would be by means of an in-depth case study. As a reference, an exemplary case study focusing on the governance enablers and inhibitors in smart city ecosystems by tracing the evolution of governance structures in a dutch smart city initiative (Ooms et al., 2020) will be used.

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Estimating the Attenuation Coefficient of Sea Water with the Lambert W Function

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Abstract. In underwater communication the data transfer is commonly provided by using cooper cables or fiber-optics. Even though these are capable of transporting electrical power and offer a high speed and reliable communication, their use can limit the range and maneuverability of underwater operations and increase the associated risks. Because of this, different underwater wireless communication techniques have been developed by using acoustics, radio frequency and visible light spectrum. When using visible light for underwater communication understanding optical properties of the water is crucial. One of the key parameters that needs to be determined is the attenuation coefficient. In this work the Lambert W function was used to estimate the attenuation coefficient of sea water, a key variable describing optical properties of sea water. The standard procedure of estimating the attenuation coefficient is by fitting the solution of the light penetration equation to optical data. By using the Lambert W function this procedure can be circumvented and the solution can be obtained without the fitting procedure.

Key words: Visible Light Communication, Underwater communication, Water attenuation coefficient, Lambert W function

1. Introduction

A major obstacle for a widespread use of underwater robots are problems associated with the communication of robots with platforms during missions. Underwater communication can be established by using cooper cables or fiber-optics, but their use can limit the range and maneuverability of underwater operations and increase the associated risks. Because of this, different underwater wireless communication techniques have been developed by using acoustics, radio waves and visible light spectrum. Acoustic-based solutions have long been the default wireless communication method for underwater applications, since it allows reasonable ranges. However, there are severe limitations in bandwidth and the data rates are slow with high latency. Terrestrial wireless communication based on radio waves, in comparison to acoustic waves, is faster, has a higher bandwidth and is more energetically efficient. However, the use of radio waves for underwater communication is problematic due to their strong attenuation. Underwater communication based on electromagnetic waves in the visible spectrum, compared to radio waves, can achieve higher data transfer rates, higher propagation speed (lower latency), lower power consumption and link distances in the order of 100-200 m. However, relatively low attenuation of light does become relevant for longer distances. Other problems are the possibility of ambient light interference and, to a certain degree, the dependence on a clear way for the light to travel [1].

The sea irradiance attenuation coefficient is a key variable describing optical properties of sea water. Irradiance attenuation coefficient, K, varies with depth, but the variation is not great for narrow spectral wavebands. Depth-averaged irradiance attenuation coefficient, K(av), summarizes in a single parameter the way in which the irradiance is attenuated with depth in a

given waterbody [2]. There are different ways of calculating the attenuation coefficient. The main goal of this work is to determine which of the implemented methods gives the best fit to the observed data of irradiance with depth, including the method using Lambert W function which has never before been used for describing underwater attenuation of irradiance.

2. Analysis

Irradiance diminishes in an approximately exponential manner with depth in accordance with the light penetration equation relation (1), which solution is given by relation (2). Z axis is set to be positive downwards.

$$\frac{dE(z)}{dz} = -K(z)E(z) \tag{1}$$

$$E(z) = E(0)e^{-K(z)z}$$
 (2)

K(z) is the attenuation coefficient as a function of depth, E(0) is surface irradiance and z is depth. If function K(z) is approximately uniform with depth, relation (2) can be expressed through depth-average attenuation coefficient K(av) as:

$$E(z) = E(0)e^{-K(av)z}.$$
(3)

Measuring underwater light intensity is done by using underwater optical sensors, which are typically lowered from research vessels at sea. Through these experiments values of irradiance at series of discrete depths are obtained. Several methods can be applied to estimate the attenuation coefficient for every depth from these measurements.

Several methods of determining sea irradiance attenuation coefficient and subsequently sea depth-averaged irradiance attenuation coefficient were implemented and compared. Attenuation coefficient at depth z can be expressed from relation (2) as:

$$K(z_{i+1}) = -\frac{1}{z_{i+2} - z_i} ln\left(\frac{E(z_{i+2})}{E(z_i)}\right),\tag{4}$$

and from relation (1) as:

$$K(z_i) = -\frac{1}{E(z_i)} \frac{dE(z_i)}{dz}, i = 1,2,3...n,$$
 (5)

where n is the total number of depth intervals [2]. The attenuateon coefficient at depth z can also be expressed by using the Lambert W function. In 1758. Johann Heinrich Lambert solved the trinomial equation $x = q + x^m$ by deriving a series development for x in powers of q. Further on he extended the series to give powers of x. On that ground in 1779 Leonhard Euler solved the equation of the form:

$$we^{w} = a, (6)$$

by finding the inverse of function $f(w) = we^w$, where w is any complex number. Today, this inverse is called the Lambert W function or the omega function. It cannot be expressed in terms of elementary functions. If z and w are any complex numbers, then expression:

$$we^w = z, (7)$$

holds if and only if:

$$w = W_k(z), \tag{8}$$

where k is some integer. $W_k(z)$ is a complex-valued function of one complex argument. For each integer k there is one branch. If z is real, then for $-1/e \le z < 0$ there are two real values of W(z). The branch satisfying $W(z) \ge -1$ is denoted by W_0 , and $W(z) \le -1$ by W_{-1} . W_0 is called the principal branch of the W function [3].

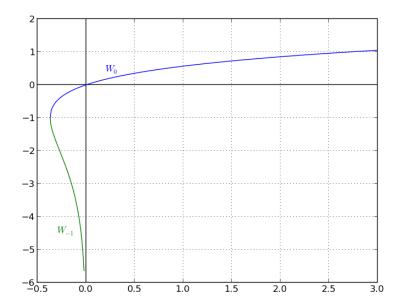


Figure 1 Diagram of the real branches of the Lambert W function [4]

Lambert W function laid dormant for quite some time until its re-emergence in the second half of the twentieth century. By inserting equation (2) into equation (1) we get:

$$\frac{dE(z)}{dz} = -K(z)E(0)e^{-K(z)z}. (9)$$

By multiplying both sides with z and rearranging we get:

$$-K(z)ze^{-K(z)z} = \frac{z}{E(0)} \frac{dE(z)}{dz}.$$
 (10)

Equation (10) is now in the form:

$$xe^x = a, (11)$$

which solution is by definition equal to W(a). It follows that equation (10) is solvable by the Lambert W function and the solution for K(z) is:

$$K(z) = -\frac{1}{z}W\left(\frac{z}{E_0}\frac{dE(z)}{dz}\right). \tag{12}$$

It follows that attenuation coefficient at depth z can then be expressed as:

$$K(z_i) = -\frac{1}{z_i} W\left(\frac{z_i}{E(0)} \frac{dE(z_i)}{dz}\right). \tag{13}$$

Derivatives in relation (5) and (13) can be calculated by the standard derivative approximations by finite differences. Once values of attenuation coefficient for all depths have been estimated depth-average attenuation coefficient and irradiance-weighted depth-average attenuation coefficient can be calculated by relations (14) and (15), respectively.

$$K(av) = \frac{\sum_{i=1}^{n} K(z_i)}{n},$$
 (14)

$$K_w(av) = \frac{\sum_{i=1}^n K(z_i)E(z_i)}{\sum_{i=1}^n E(z_i)}.$$
 (15)

Total of four methods are examined. Method based on equation (4) is called the logarithmic method. The one based on equation (5) is called the derivate method and the one based on equation (13) is called Lambert method. Least squares method is used to fit equation (2) to data of irradiance measurements with depth to determine the depth-average irradiance attenuation coefficient. This method is called the least square method. Set of pair values, of irradiance and depth, are called a profile. Derivative of irradiance, E(z), with respect to depth, z, which occurs

in derivative and Lambert methods, in equations (5) and (13) respectively, is approximated by forward, backward and centred derivative approximation by finite differences with first and second order errors. The best case is taken as representative of a given method.

A passing cloud can cause changes in underwater light field which can be a problem since taking underwater measurements of irradiance takes some time. For that reason, while making measurements of underwater irradiance surface irradiance is measured simultaneously. Instead of underwater irradiance, the ration of underwater irradiance and surface irradiance, which is called relative irradiance, is analysed. The attenuation rate of relative irradiance is the same as for irradiance [2].

Data used to test these methods are publicly available data from the Hawaii Ocean Time Series (HOT) [5]. A total of 72 profiles of relative irradiance measurements with depth are used in the analysis. Data were collected over the period from February 2010. until December 2018. approximately once a month. Measurement were done with a free falling optical profiler (Satlantic HyperPro unit) at Kahe station off the coast of Oahu island, Hawaiian Islands. Like a passing cloud, waves or a shadow of the ship used by scientists that are doing the measurement can also cause anomalies in measurements of irradiance. Due to this, out of 82 available profiles, 10 of them were discarded since they showed significant anomalies when plotted and were not considered representative.

Besides depth-average attenuation coefficient irradiance-weighted depth-average attenuation coefficient is also calculated. In the second case the irradiance values themselves are used to weight the estimates of the coefficients. Even though this procedure gives most weight to the upper region of the water column, where irradiance values are highest, there is nevertheless no arbitrary singling out of any particular layer since integration is carried out from the surface to infinity; that is, it is a true averaging over all depths. In practice, of course, it is only necessary to carry out integration down to depths where light levels become insignificant [2].

Depth-average attenuation coefficient is estimated using the least squares, logarithmic, derivate and Lambert method, while irradiance-weighted depth-average attenuation coefficient is estimated using logarithmic, derivate and Lambert method. The coefficients are estimated for all 72 profiles. On the bases of calculated coefficients, profiles are then generated according to relations (16) and (17).

$$E(z_i) = E(0)e^{-K(av)z_i}$$
(16)

$$E(z_i) = E(0)e^{-K_w(av)z_i}$$
(17)

By averaging average attenuation coefficients and average irradiance-weighted attenuation coefficients over all 72 profiles total average attenuation coefficient and total average irradiance-weighted attenuation coefficient are obtained. They are given by relations (18) and (19) and are listed in Table 1 for all methods.

$$K(av) = \frac{\sum_{j=1}^{72} K_j(av)}{m}$$
 (18)

$$K_w(av) = \frac{\sum_{j=1}^{72} K_{w,j}(av)}{m}$$
 (19)

The quality of generated profile in comparison with measured profile is given by determination coefficient, R^2 . Methods are compared on the basis of determination coefficient averaged over all 72 profiles.

Table 1 Depth-average attenuation coefficients, irradiance-weighted depth-average attenuation coefficient and associated determination coefficients for all methods

Method	Order of error	Difference approximation	$K(av)$ $[m^{-1}]$	\mathbb{R}^2	$K_W(av)$ $[m^{-1}]$	\mathbb{R}^2
Least squares	/	/	0.0398	0.9957	/	/
Logarithmic			0.0429	0.9921	0.0419	0.9947
	F	Forward	0.0419	0.9927	0.0413	0.9946
	First	Backward	0.0441	0.9910	0.0431	0.9937
Derivative	Second	Centred	0.0429	0.9921	0.0419	0.9947
		Forward	0.0438	0.9912	0.0445	0.9913
		Backward	0.0439	0.9911	0.0451	0.9908
	E' 4	Forward	0.0387	0.9906	0.0430	0.9586
	First	Backward	0.0367	0.9922	0.0356	0.9756
Lambert		Centred	0.0386	0.9934	0.0410	0.9767
	Second	Forward	0.0364	0.9918	0.0329	0.9640
		Backward	0.0364	0.9912	0.0319	0.9646

When using depth-average attenuation coefficient methods, in order from worst to best performing, are logarithmic method ($R^2=0.9921$), derivative method ($R^2=0.9927$), Lambert method ($R^2=0.9934$) and least squares method ($R^2=0.9957$), respectively. When using irradiance-weighted depth-average attenuation coefficient Lambert method ($R^2=0.9767$) is the worst, while derivative method ($R^2=0.9947$) and logarithmic method ($R^2=0.9907$) achieve the same result. respectively. Out of all methods, both with depth-average attenuation coefficient and irradiance-weighted depth-average attenuation coefficient the least squares method achieved the best result. The results are presented in table 1.

For both logarithmic method and derivative method better performance is achieved with irradiance-weighted depth-average attenuation coefficient, while for Lambert method performance is better for depth-average attenuation coefficient. Least squares method is used only with depth-average attenuation coefficient.

Error histograms between logarithmic values of measured profile and profiles approximated by models are shown in Fig. 2. As expected, errors are smallest and closest to normal distribution for least squares method which was shown to be the best performing method based on determination coefficient.

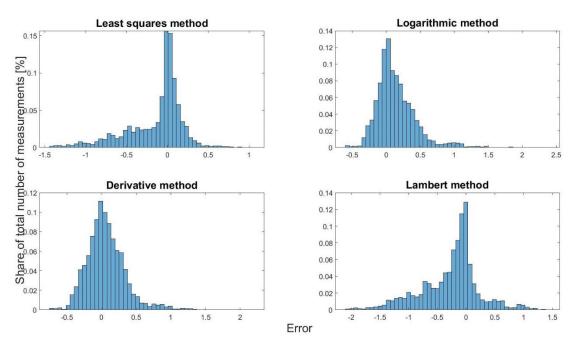


Figure 2 Error histogram of logarithmic values of measured and approximated relative irradiance for above methods

Error histograms between logarithmic values of measured profile and profiles approximated by irradiance-weighted models are shown in Fig. 3. Least squares method is not used with irradiance-weighted depth-average attenuation coefficient so an error histogram of least square method with depth-average attenuation coefficient is given in Figure 3. for comparison. Among irradiance-weighted methods errors are smallest and closest to normal distribution for logarithmic method, which is expected based on determination coefficient. When comparing histograms in Fig. 2 and Fig. 3 it should be kept in mind that values of error on x-axis vary between graphs.

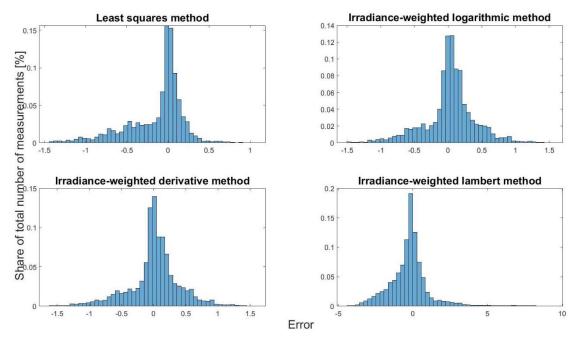


Figure 3 Error histogram of logarithmic values of measured and irradiance-weighted approximated relative irradiance for above methods with the exception of least squares method which is not an irradiance-weighted method

Relation between logarithmic values of relative irradiance of measured profiles and logarithmic values of relative irradiance of profiles approximated by all associated methods is shown in Fig 4. and for irradiance weighted methods (with the exception of least squares method) in Fig 5.

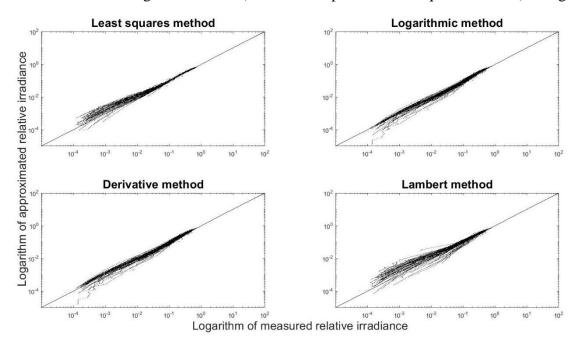


Figure 4 Relation between logarithmic values of measured irradiance and approximated irradiance

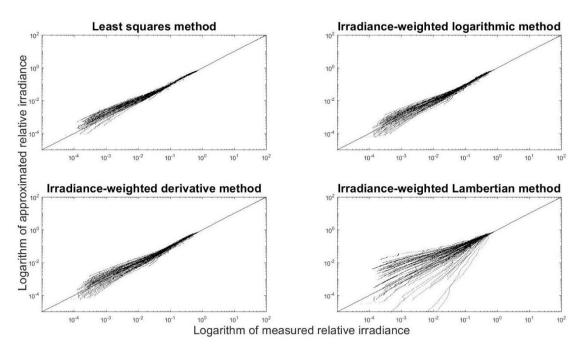


Figure 5 Relation between logarithmic values of measured irradiance and irradiance-weighted approximated irradiance with the exception of least squares method

For a visual representation of measured relative irradiances and relative irradiances approximated by selected methods one of 72 analysed profiles is selected. For it, measurements of relative irradiance together with relative irradiances approximated by least squares method, logarithmic method, derivative method and Lambert method are plotted in the Fig. 6.

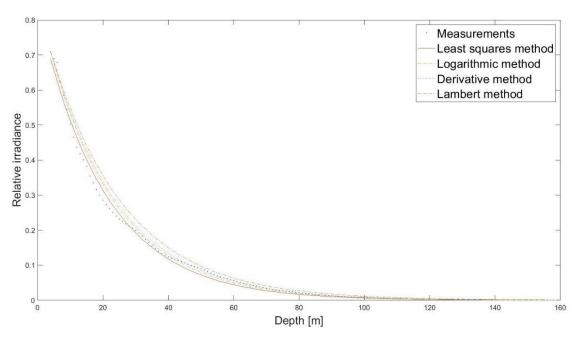


Figure 6 Measured and approximated relative irradiance values with depth for a selected profile

In Fig. 7. the plotted profiles are analogous to those in Fig. 6. but for irradiance-weighted methods with the exception of least squares method.

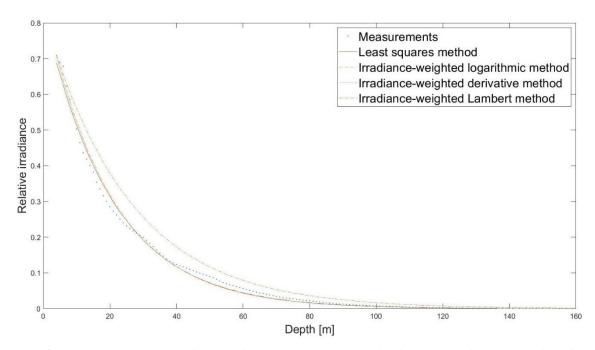


Figure 7 Measured and irradiance-weighted approximated relative irradiance (with the exception of least squares method) values with depth for a selected profile

3. Conclusion

Commonly used methods for calculating depth-average attenuation coefficient are logarithmic method and least squares method. Analysis presented here has shown that Lambert W function can successfully be used to determine sea attenuation coefficient as a function of depth and subsequently its depth-average value, but that least squares method is still more accurate. The

analysis has also shown that for logarithmic and derivative methods using irradiance-weighted attenuation coefficient is better than regular attenuation coefficient.

Methods displayed in this work can analogously be implemented for approximating sea depth-average attenuation coefficient or sea irradiance-weighted depth-average attenuation coefficient of irradiance in specific part of visible light spectrum, variables crucial for implementing underwater visible light communication technologies.

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Experimental Measurement and Numerical Analysis of Study of Temperature Fields in Cutting Zone Under Conditions of Continuous and Intermittent Scraping

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Abstract. Since the mechanical energy used in the process of cutting is mainly transformed into thermal energy and since produced thermal energy has negative effects on the tool itself and its work piece, it is significant to establish it and control it within the processing zone. According to latest research, the temperature within the cutting zone has the greatest influence on the output characteristics of the process of machining with optimal parameters of processing. The temperature within the zone of cutting on which the parameters of machining regime have significant influence is a very important indicator of the process of cutting and can be used as a criterion of the process optimization.

The significant scientific contribution of this professional works is development of numerical model for calculation and simulation of temperature field in the cutting tool during the process of turning longitudinal and transversal grooves. Therefore, the conditions for development of model for optimization of turning parameters from the aspect of cutting temperature and expanding possibilities for applying developed numerical model on other types of cutting processing are created. Up-to-date processing systems include CNC machining with variable processing parameters, whereas the tool goes through heating and cooling period during discontinuous cutting. Therefore, the dissertation puts an accent on experimental research of cutting temperatures in order to develop numerical model for the simulation in the conditions of continuous and intermittent cutting with the specific analysis of temperatures generated in the tool.

Key words:continuous and intermittent scraping, contact tool/chips, temperature field, experimental research, finite element method (FEM).

1. Introduction

Metal processing by turning is the most complex part of the technological process of manufacturing mechanical parts of desired shape and dimensions. With introduction of modern high-productive CNC machining systems there came along permanent efforts focused at decrease of main machining time by increasing cutting parameters and at prolonged durability and total tool life. Cutting tool is a subsystem of a machining system whose failure results in stopping the operation of the whole system. These failures depend on a number of factors and they represent a very complex phenomenon. Cutting tool failure time is not a constant quantity but a random quantity that can be predicted.

The heat generated in the cutting zone leads to heating of work piece, chips and cutting tool. Analysis of heat sources shows that the largest amount of heat is generated in the strain zone (shearing zone) and at the contact of rake face of tool cutting wedge and chips. These are the areas many researchers devote special attention to in studying the machining process by turning. Especially negative influence is exerted by the heat

transferred into the tool. Its consequence is drop of hardness of material which results in more intensive wear and plastic strain of tool cutting elements, loss of cutting abilities and bluntness. Therefore, knowledge of the temperature value and distribution within the tool is of an extraordinary practical importance. This knowledge makes it possible to determine optimal conditions and cutting parameters. Numerical solutions concerning cutting operations provide for economically far more favorable alternative for understanding the machining process. The main advantage of this approach is the fact that the models have been based on physical properties of the materials of tool and work piece, and the effect of any variation of the data related to cutting can be successfully predicted by modification of individual parameters. Limitation of the approach is associated with the ability to match the model to complexity of the machining process. That is an imperative, and then, in order to reduce experimental testing in development of new tools better numerical models of assumed machining process are searched for.

Modern machining systems imply CNC machining with varying machining parameters in conditions of continuous and intermittent cutting. For this reason the paper places the emphasis on numerical analysis of the temperatures of tool/chips contact and the temperatures within the tool by using the software package *Third Wave AdvantEdge*. The purpose of this paper is to make some advance towards development of numerical models for temperature calculation under conditions of continuous and intermittent cutting when machining. The paper is also supposed to give certain contribution to making possible practical application of simulation of temperature fields within cutting tool and to enlarge the areas of scientific investigations bearing in mind the complexity of the machining process in real production conditions.

2. Experimental investigation

2.1 Experimental conditions

Experimental research of scraping process were performed in laboratory for metal machining processes, at Faculty of enginnering sciences in Kragujevac. Conditions under which experiment was performed refer to material of workpiece, machine tool, cutting tool and parameters related to processing regime. Experimental research were done in order to calculate temperature inside the cutting tool during process of longitudinal scraping (continuos and intermittent mode of machining), using scraping knife with editable heavy metal plate, depending of parameters which were used during machining process. Workpiece is on one side clenched in head stock of lathe machine, and on otherside it relies on tip of the holder. Proceesing was done without using refrigerant and lubricant materials.

2.1.1. Workpiece

Experimental research were conducted using construction steel with designation 4140 according to AISI/SAE, and 42CrMo4 according to standard EN 10027 or Č.4732 according to old designation in Serbian standard. Workpiece with final measures is shown in Figure 2.1.

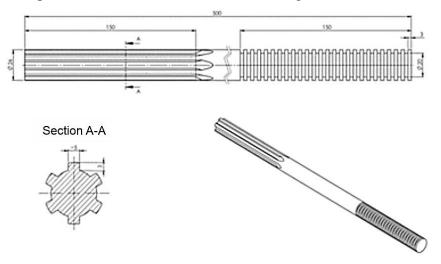


Figure 2.1 Workpiece for experimental research

Chemical composition of AISI 4140 steel is shown in Table 2.1, physical characteristics are specified in Table 2.2, and mechanical characteristics are specified in Table 2.3.

Table 2.1 Chemical composition of steel AISI 4140

ſ	Steel	С	Mn	Si	P	S	Cr	Ni	Cu	Mo	As	Al	V	Ti
	AISI 4140 (42CrMo4)	0,440	0,610	0,200	0,015	0,008	0,980	0,080	0,180	0,202	0,020	0,028	0,004	0,026

Table 2.2 Physical characteristics of steel AISI 4140

Steel	Specific density (kg/m³)	Melting point (°K)	Specific heat (J/kgK)	Heat conductivity (W/mK)	Heat spreading 300 °K (10-6/K)
AISI 4140 (42CrMo4)	7850	1850	363	41,7	11,9

Table 2.3 Mechanical characteristics of steel AISI 4140

Steel	Yield stress (MPa)	Tensile stress (MPa)	Elongation (L = 5d) % mm	Elastic modulus (GPa)	Hardness (HB)	Poisson's coefficient	Delivery state
AISI 4140 (42CrMo4)	1124	1059	11	210	217	0,3	soft tempered

2.1.2. Tool

Lathe knife with mechanically attached heavy metal plate was used in experimental research, which was manufacured by "CORUN" – Užice from Serbia (Figures 2.2 and 2.3).

Tool designations are in accordance with vendor's catalogue.



Figure 2.2 Cutting plate made of heavy metal (TNMG 160404-CM)



Figure 2.3 Tool holder PTGNR/L 2525 M16

For chosen cutting plate and tool holder, experiment was performed using following geometric parameters of machining process:

- rake angle, $\gamma = 10^{\circ}$,
- relief angle, $\alpha = 6^{\circ}$,
- blade inclination angle, $\lambda = -5^{\circ}$,
- tip of the knife radius, r = 0.4 mm,
- rounding radius of main cutting edge, $r_1 = 0.020$ mm,
- angle of attack, $\kappa = 91^{\circ}$.

Plate was coated with hard TiN layer, with thickness which varies in range $8 \div 15~\mu m$ (4C25 thick coating)

2.1.3. Machine tool

Experimental research was done using universal lathe machine BOEHRINGER UDF, manufactured by "Prvomajska" – Zagreb, with following characteristics:

- electromotor power 10 kW,
- maximum diametar of workpiece clamping was 320mm,
- maximum length of machining process was 2000 mm.

2.2 Temperature measurements in cutting zone

Temperature measurements during the experiment were conducted using thermovision camera FLIR E60, which is shown in Figure 2.4.



Figure 2.4 Thermovision camera FLIR E60

This thermovision camera covers measurement range from 20 to 650 °C, with measurement accuracy of ± 2 °C, resolution of 320x240 pixels and total number of pixels equal to 76800.

Based on vendor's recommendation, in experimental measurements coefficient of thermal emissions for surface area of TiN coated plate was 0.3.

In Figure 2.5, equipment for experimental research is shown.

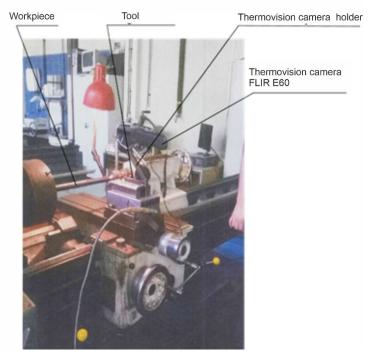


Figure 2.5 Measuring of cutting temperature using thermovision camera FLIR E60

Time interval for temperature measurements was set to fifteen seconds, which is enough for obtaining maximum temperature of cutting tool for this kind of machining process, and that was the goal of this

experiment. This assumption is also in accordance with other papers which could be found for this area of scientific research. Length of machining process was adjusted to machining regimes, according to duration of temperature measurements which was fifteen seconds.

Thermovision camera provides functionality of processing measurement results in software package *FLIR Research IR Max*.

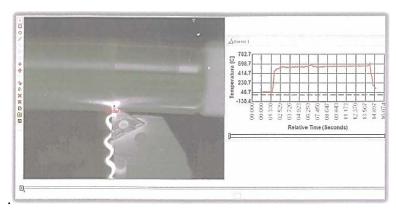


Figure 2.6 View of camera display during video recording and corresponding diagram of temperature changes in time domain

Thermovision camera with corresponding SW package gives an option for recording measuring process in video format, which could be analyzed after experiment is finished (Figure 2.6).

2.3 Results of experimental research

Graphical views of maximum temperatures with respect to duration of cutting process for given regimes, in conditions of continuous and intermittent machining, are shown in Figures 2.7 a), b) i c) and 2.8 a), b) i c).

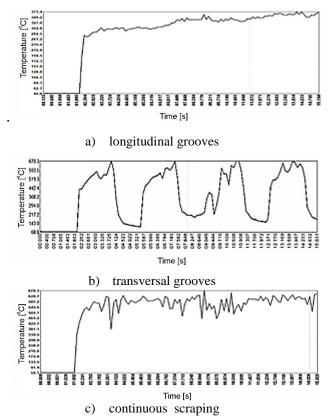


Figure 2.7 Maximum temperatures for given machining regime: V = 58 m/min; s = 0.14 mm/o; a = 0.5 mm

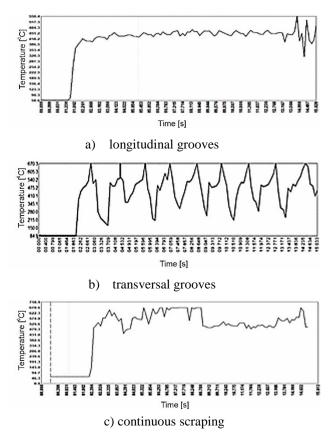


Figure 2.8 Maximum temperatures during machining regime: V = 92 m/min; s = 0.2 mm/o; a = 0.8 mmResults obtained by experiment are shown in Table 2.4.

Table 2.4 Temperature values obtained by experimental meaurements

No.	Machining regimes		Continuous machining	Machir transversa		Machining of longitudinal grooves	
	V m/min	V s a		T _{max} (°C)	T _{min} (°C)	T _{max} (°C)	T _{sr} (°C)
1.	92	0,2	0,8	641	220	670	450
2.	58	0,14	0,5	585	150	615	363

Simulation using finite element method in software package Third Wave AdvantEdge under conditions of continuous and intermittent scraping

Johnson – Cook simulation model is also often used in different software tools to estimate individual output parameters of cutting process (forces, temperatures, wear,..) and it is defined by the expression (1)[3].

$$\sigma = \left[A + B(\mathcal{E}_P)^n\right] \left[1 + C \cdot ln\left(\frac{\dot{\mathcal{E}}}{\dot{\mathcal{E}}_o}\right)\right] \left[1 - \left(\frac{T - T_{ref}}{T_{melt} - T_{ref}}\right)^m\right] \tag{1}$$

where: σ , Pa – the equivalent stress,

 $\dot{\mathcal{E}}$, s⁻¹ – the strain rate,

 $\dot{\mathcal{E}}_o$, s⁻¹ – the reference strain rate, T, °C – the temperature of the sample,

 T_{ref} , °K – the reference temperature,

A, MPa – the yield stress of the material at a reference deformation conditions,

B, MPa − the strain hardening constant,

C – the strain rate strengthening coefficient,

n – the strain hardening constant,

m – the thermal softening coefficient.

Table 3.1 represents values of the constants which showed the best matching between experimental research and simulations.

Table 3.1 Values of the parameters which were accepted for Johnson-Cook model

Parameter	$\dot{\mathcal{E}}_o$ (s ⁻¹)	T _{room} (°K)	T_{melt} (°K)	A (Pa)	<i>B</i> (Pa)	n	С	m
Value	0,001	300	1850	5,98·10 ⁸	$7,68 \cdot 10^8$	0,2092	0,0137	0,807

Beside numerical model of workpiece material, in simulations were used and input parameters of machining process (machining regime, geometry of the tool and physical/mechanical characteristics of tool and workpiece material). They are the same as for experimental research.

Physical/mechanical characteristics of heavy metal plate P35 and corresponding TiN coating are given in Table 3.2 [14].

Table 3.2 Physical/mechanical characteristics of cutting plate

Characteristics	Heavy metal (P35)	TiN – coating (5 μ m)
Elastic modulus, GPa	645	600
Poison's coefficient, V	0,24	0,25
Specificdensity, kgm ⁻³	14900	4650
Specificheat, J, kg ⁻¹ C ⁻¹	206	645
Heatconductivity, Wm ⁻¹ C ⁻¹	91	21
Heat spreading,μm, m ⁻¹ C ⁻¹	4,8	-

For numerical analysis purpoces, 2D simulation models for continuous scraping, scraping of transversal and longitudinal grooves with finite element model mesh, are shown in Figures 3.1, 3.2 and 3.3.

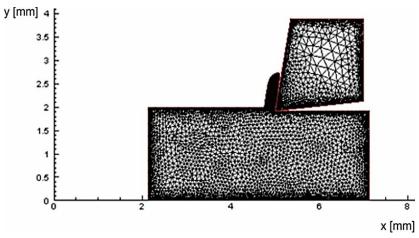


Figure 3.1 2D simulation model for continuous scraping

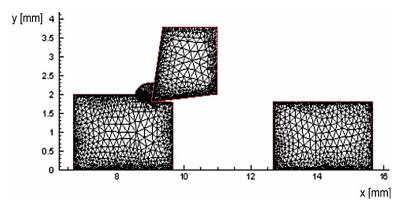


Figure 3.2 2D simulation model for transversal grooves scraping

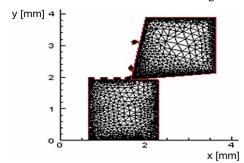


Figure 3.3 2D simulation model for longitudinal grooves scraping

3.1 Results of numerical simulations

Numerical values of temperatureon rake surface of the tool, as a function of cutting length for given machining regimes in case of intermittent (scraping of longitudinal and transversal grooves) and continuous machining, are shown in Figures 3.4 a), b) i c) i 3.5 a), b) i c).

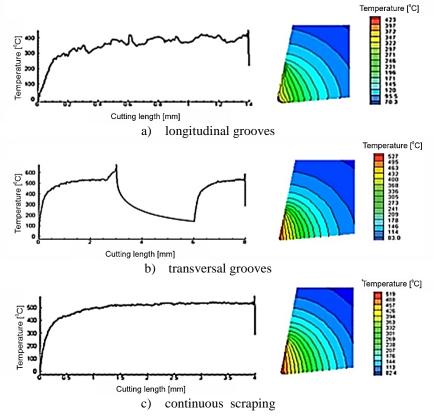


Figure 3.4 Maximum temperatures for following machining regime: V = 58 m/min; s = 0.14 mm/o; a = 0.5 mm

Beside graphical views, there is also isothermic distribution of temperatures with respect to rake surface depth in the zone of maximum temperatures. This zone is approximately located around the half of cutting depth, measured from tip of the tool and it is near to main cutting edge (between $0.1 \div 0.3$ mm). Therefore, temperature fields were formed with intersection plane which is orthogonal to main cutting edge of the tool.

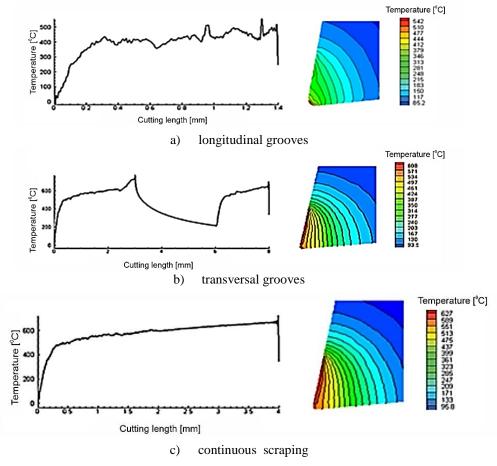


Figure 3.5 Maximum temperatures for following machining regime: $V = 92 \, \text{m/}_{\text{min}}$; $s = 0.2 \, \text{mm/}_{0}$; $a = 0.8 \, \text{mm}$

By analysing diagrams of maximum temperature variations as a function of cutting depth from Figures which are shown above, in Table 3.3. are specified temperature values obtained from simulations using *AdvantEdge* for both machining regimes.

Table 3.3 Temperature values obtained f	rom simulations	using software package Ad	dvantEdge
3.5.4.1.			

	Ma	chining regi	me	Continuous scraping	Transversal grooves scraping		Longitudinal grooves scraping	
No.	V (m/min)	s (mm/o)	a (mm)					
				T _{max} (°C)	T _{min} (°C)	T _{max} (°C)	$T_{sr} = (T_{max} + T_{min})/2(^{\circ}C)$	
1.	92	0,2	0,8	627	212	608	460	
2.	58	0,14	0,5	519	140	527	390	

In Figures 3.6 a), b) and c) are shown simulation models of isothermic temperature distributions inside the tool, workpiece and chip during continuous scraping, scraping of transversal and longitudinal grooves for certain machining regime.

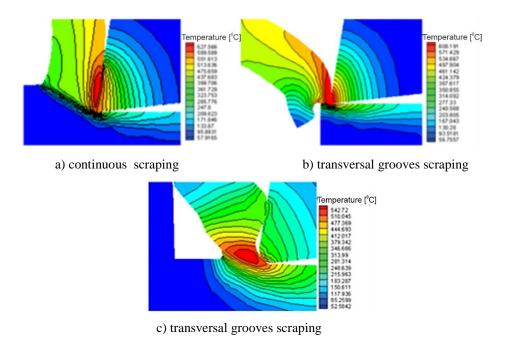


Figure 3.6 Temperature distributions on cutting contact zone (machining regime: $V = 92 \, \text{m/}_{\text{min}}$; $s = 0.2 \, \text{mm/}_{\text{o}}$; $a = 0.8 \, \text{mm}$)

4. Analysis of results

Verification of adequate model for simulation of continuous scraping, which gives resultin accordance with experimental results was initial step in designing simulation models for external longitudinal scraping of transversal and longitudinal grooves.

Results analysis includes analysis of temperatures inside the cutting tool, which were obtained by experimental research and simulations.

In table 4.1 are given temperature values obtained from experimental measurements and simulations, and Table 4.2 shows percent deviations obtained from comparison of simulations with experimental results.

No.	Machining regimes			Continuous machining		Transversal grooves machining				Longitudinal grooves machining	
	V m/min	s mm/o	a mm	Exp.	Sim.	Exp.	Sim.	Exp.	Sim.	Exp.	Sim.
				$\begin{matrix} T_{max} \\ ^{\circ}C \end{matrix}$	$\begin{matrix} T_{max} \\ ^{\circ}C \end{matrix}$	T_{min} $^{\circ}C$	T_{min} $^{\circ}C$	T _{max} °C	T _{max} °C	T_{sr} $^{\circ}C$	$^{T_{sr}}_{\circ C}$
1.	92	0,2	0,8	641	627	220	212	670	608	450	460
2.	58	0,14	0,5	585	519	150	140	615	527	363	390

Table 4.1 Temperature values obtained by experimental mesurements and simulations

Table 4.2 Percent deviations of temperature values obtained by simulations compared with experimental results

	Machining regimes			Continuous scraping	Transversal gr	Longitudinal grooves		
No.	V	s mm/o	a mm	$T_{\max exp} - T_{\max sim}$	$T_{\min exp} - T_{\min sim}$	$T_{\max exp} - T_{\max sim}$	$\frac{\text{scraping}}{T_{\text{sr}exp} - T_{\text{sr}sim}}$	
	m/min			<i>T</i> _{max exp} ⋅ 100%	$T_{\min exp}$ · 100%	$T_{\max exp}$ · 100%	$T_{\text{sr } exp} \ \cdot 100\%$	
1.	92	0,2	0,8	2,2	3,6	9,2	-2,2	
2.	58	0,14	0,5	11,2	6,6	14,3	-7,4	

In case of transversal grooves scraping, temperatures on rake side of the tool oscillate from maximum to minimal values in short period of time. Therefore, an average temperatures T_{sr} , were analysed in this case and they approximately represents arithmetic mean value of maximum and minimum temperatures for certain machining regime.

Deviations of numerical values comparing to experimental results are the following:

- Continuous scraping 2,2% i 11,2%,
- Transversal grooves scraping 3,6% i 6,6% i
- Longitudinal grooves scraping -2,2% i -7,4%.

Those deviations are not significant and they are within acceptable range, especially if investigation of simulation models for intermittent machining regime is considered. Deviations which are shown above confirmed accuracy of simulation models for given machining conditions, in case of thermal numerical analysis within the cutting zone.

5. Conclusion

This paper analyzed the topic which is very important nowadays, due to the fast progress of CNC machining systems development, usage of thermovision systems in metrology and usage of numerical models for simulations and calculations related to cutting processes.

Research which is covered in this paper showed that software package *AdvantEdge* for finite element model simulations of machining proces, either continuous or intermittent scraping, could be used for making predictions of temperatures inside cutting tool. After comparison with experimental results, it is verified that simulations could be used for prediction of temperatures inside cutting tool and that deviations from experimental results are in acceptable range. Results which were obtained should be used for increasing existing knowledge base related to this area of expertise, with final goal of replacing very complicated and expensive experiments.

Significant contribution of disertation is development of numerical model for calculation and simulation of temperature fields inside cutting tool, during intermittent scraping process (scraping of transversal and longitudinal grooves). Numerical models which were developed for those machining conditions are original and unique, and could be used for further development and implementation in intelligent industrial machining systems.

Conclusions from those investigations could be applied in different machining regimes, which use similar cutting conditions.

Experimental and numerical results for given scraping conditions obtained from this investigation, could be used for the purpose of comparison or application in new researches.

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CIET Split 2020 Track 4

Interdisciplinary
Teaching and Learning

STEAM Teachers

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Abstract. Over the last years (since 2005), the acronym STEM has increased its presence in education as an important way to adapt methodologies of science and technology education to new scenario. This new approach of scientific Problem Based Learning is evolving quickly and nowadays schools are already talking about STEAM. The inclusion of A, as a representative of the Arts or Humanities disciplines is not an arbitrary subject; it is done with the purpose of inviting other kind of students to scientific disciplines. A relevant purpose because although Europe faces a growing demand for STEM professional skills, there are still low levels of interest in science and maths. However, who is training future STEAM teachers? The research is showing that future teachers do not yet know the meaning of STEAM. In this paper, we show the results of a research done with university students of primary education and future secondary school teachers in Spain. We analyse their previous knowledge about STEM/STEAM and their ideas after being part of a seminar on STEAM projects design. The conclusions talk about the opportunity STEM projects are giving to science teachers regarding the possibility of changing their traditional way of teaching by introducing new technologies, new objectives, and new transdisciplinary contents to enhance creativity and design thinking. When STEAM education is located at the "intersection" of science, technology, engineering arts and mathematics, its meaning is generally expanded to refer to a break with "traditional" teaching.

Key words: Science Education, STEM, Primary Education, Secondary Education, Teachers Training

1. Introduction

The Scientix Observatory Report (Nistor et al., 2018) published by the European Commission explaining the new challenges for the Science, Technology, Engineering and Mathematics education practices has focused their actions on five objectives:

- To attract more students and teachers to STEM education through a global approach that serves to anticipate the skills needed for the society of the future
- To break down barriers with pragmatic initiatives to improve the quality of STEM education by strengthening knowledge exchanges
- To design an integrative curriculum and evaluate pedagogical innovations: it is necessary to implement successful experiences throughout the education system and disseminate them among European countries
- To develop a common European framework of reference for STEM education and coordinate national initiatives
- To encourage deeper collaboration with universities and industry to develop STEM teacher skills

To overcome these challenges, it is necessary to clarify who should lead these actions and make sure who is responsible for defining and implementing them. If this responsibility has to be assumed by teachers, it is necessary to prepare them introducing STEM educational perspectives inside the educational system.

Since Zollman (2012) called the current generation as the STEM generation, the presence of this acronym has been increasing in the educational world with a polysemic meaning that has integrated different perspectives. Many researchers have tried to formalize the meaning of this

new concept for science teaching. Balka (2011, p.7) proposed, "STEM literacy is the ability to identify, apply and integrate concepts of science, technology and mathematics to understand complex problems and to innovate in their solution".

It is important to understand that the real cause why STEM is arriving into education has to do with economical needs; we have to prepare professionals for the new society. Taking that fact into account, the way to implement these formative plans has to be defined by teachers to ensure that the educational perspective is included in this new challenge.

Following this perspective, there are some important facts that have been already analysed by research. Literacy on science and technology, through STEM approaches, should not be seen as a new specific content area. It has to be understood as a Project Based Learning approach oriented towards the scientific field (Domenech, 2017). This interdisciplinary approach has to be inclusive and it has to appeal to teachers from different disciplines, thus this shared responsibility will help educators to go further with these challenges.

Following the idea of defining the actions to develop STEM education by a pedagogic perspective it is important to include what Couso and Grimalt (2019) defined as 'stance on STEM' to refer the way students feel and act about STEM. It has been observed for decades that boys and girls do not act with the same perspective towards STEM filed: students' interest in STEM subjects declines in secondary education, with a special decrease with girls (Barmby, Kind, & Jones, 2008), and especially in relation to technology and physics (Tytler et al., 2008). The position that different kinds of students assume to get into STEM learning activities has to be an important factor to balance when we define STEM learning activities.

One action which focused on this aim is the addition of "A" representing the artistic disciplines into STEM to create STEAM. The inclusion of Arts discipline is not arbitrary and, in addition to widening the interdisciplinary perspective by incorporating scientific disciplines into an external discipline, responds to the need to break international stereotypes anchored in the technical sciences for more than 40 years (Ortega-Torres, Verdugo & Gomez, 2019). These patterns identify STEM professions with *men*, *white* and *brainy*.

Science research has shown consistent evidences of the relation between self-efficacy and performance and interest in STEM (OECD, 2008). Self-efficacy was defined by Albert Bandura (1995) to explain the belief in one's capabilities to accomplish a specific task, when this task is related to STEM then we can talk about STEM self-efficacy. Those students underrepresented in STEM fields tend to undervalue their own performance in this field. Hence another aspect to include in STEM educational projects has to be the improvement of students' self-efficacy feelings. Some authors have shown different options to improve it inside a learning process. Zimmerman (2000) shows that there are four categories to classify these actions: 1) experiential actions, 2) bring near referent models, 3) social reinforcement and 4) self-regulation learning activities.

Hence, the way to achieve the challenges defined by the European Commission is to have schools include an inclusive interdisciplinary approach, including Arts (or humanities) and the improvement of self-efficacy actions into STEAM educational plans to prepare all kinds of students for the STEM future that is already here.

2. STEAM teachers

Taking on the wide perspective defined before, future STEAM teachers will be the students with a Primary School Education degree and students of the Master in Teacher Education of Secondary Education. They will have to lead the inclusion of STEAM projects into school plans.

For that purpose, the first problem that we need to face is finding the 'place' in official curricula of these studies where to include the preparation for STEAM learning activities. There is not an official reference for STEAM in the Spanish National Curricula until today,

but it looks like the new regulation which is to be approved 'LOMLOE' (2020) will include some references.

2.1 STEAM seminar for future teachers

The training action performed to prepare future teachers on STEAM design learning activities had a duration of 12 hours; 3 lessons of 4 hours each with the following structure:

Table 1 STEAM seminar structure

Lesson		Contents			
	i.	What is STEM?			
Lesson 1	ii.	Why STEM?			
	iii.	PBL approach			
	iv.	Self-efficacy			
Lesson 2	ν.	From STEM to STEAM			
	vi.	STEM approach			
Lesson 3	vii.	Good practices of STEAM projects			
	viii.	Defining a STEAM project			

The first lesson was focused on describing the meaning of STEM and the reason why STEM is important in students' education. In this lesson, students had to organize themselves in groups of 4-5 people to work together. Before starting this first lesson, students were asked to answer a questionnaire (on-line version) with five short questions addressed to know their previous knowledge about STEM/STEAM.

The Lesson 2 was focused on analysing the importance of self-efficacy in science education and the aspirations of students. This lesson had some differences for the group of primary and secondary education based on the idea of interdisciplinary connections between subjects. In primary education, the teacher leads almost all subjects and in secondary education, there are different teachers for each discipline. This structural difference was included in the STEAM approach orientation.

In the last lesson, students analysed the characteristics of some STEAM projects from other schools (Primary or High School, depending on the group) and after this analysis, they had to design their own STEAM project idea with the "Canvas for STEAM projects" tool (figure 1).

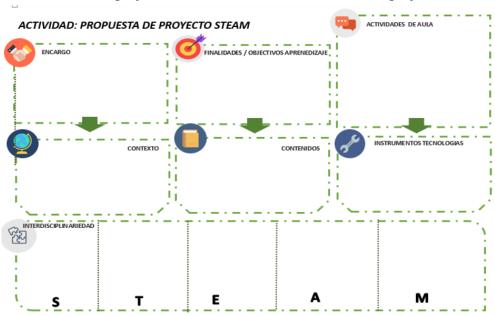


Figure 1 Canvas for STEAM projects (Spanish version)

This Canvas for STEAM projects tool is a panel divided in 3 parts. The first two parts are connected and divided in 3 different blocks:

- a) Challenge connected to Context
- b) Learning objectives connected to Contents
- c) Classroom activities connected to ICT tools.

Five blocks with S-T-E-A-M initials to describe the way the different disciplines are included in the project idea form the last part of this panel.

We can see the tool in the following Figure 1.

After this last lesson students had to answer a new questionnaire (on-line version) with 15 questions to find their vision about the difficulty in introducing STEAM projects in their educative levels.

2.1.1 Participants

The seminar was held in two consecutive courses (18/19 and 19/20) with two different groups each course. One group with students of the degree of primary education on their last 4th year, and another group with students of the Master on Secondary Education on the speciality of Technology. The total number of students was 180 distributed as follows in Table 2:

Table 2 Participants

Course	Primary Education Degree	Master on Secondary Education (Technology)
18/19	39	45
19/20	44	46

3. Results and discussion

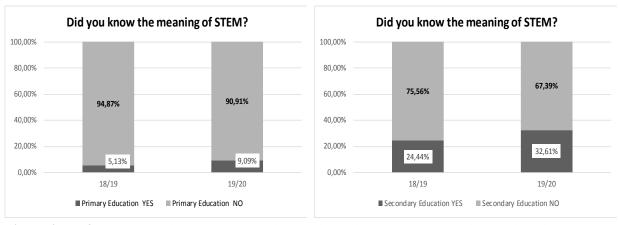


Figure 2 and 3: Future teachers (primary and secondary education) previous knowledge about STEM

As we can observe on Figure 2 and 3 above, the participants in this research showed a very low previous knowledge about STEM. This knowledge was lower at the future primary level teachers than at the future secondary school teachers. These results can be understood by two clear reasons: Students to become secondary school teachers were in the technological speciality of the Master course and their previous studies were engineering (63%), architecture (14%) and other university grades related with science and technology. That means the STEM concept was closer to them. On the other hand, students to become primary school teachers have few credits about science and most of them studied a non-science pathway before beginning the grade of education as research has shown (Verdugo-Perona, Solaz-Portolés & Sanjosé-López, 2017), that means the STEM concept was further from them.

According to this difference, it is also important to highlight the low prior knowledge about STEM that these engineers, architects and other different science graduates had: more than 67% of them did not know the meaning of STEM. These results confirm previous research results about the fact that STEM is a concept more used in research on education than in everyday education practices (Ortega-Torres, 2018).

From these results, it is also remarkable to see that a positive evolution on the previous knowledge about STEM is happening for future primary and secondary teachers. The primary future teachers from one course (18/19) to the following one (19/20) have almost double their previous knowledge while the future secondary school teachers have also improved their previous knowledge from 24,44% to 32,16%. The increasing presence of STEM educational actions (Grimalt-Álvaro & Couso, 2019) seems to cause impact on the knowledge for future teachers.

When we analyse the difficulties that future teachers encountered in defining future STEAM practices in planning their lessons there are some important differences between primary and high school future teachers as Figure 4 is showing next:

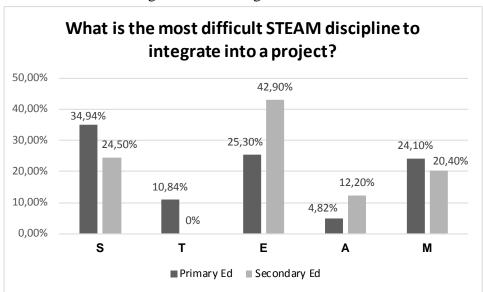


Figure 4: Future teachers' (primary and secondary education) difficulties to integrate STEM disciplines

The difficulties that future teachers encountered in defining future STEAM practices in planning their lessons show some important differences between primary and high-school future teachers.

The results for future secondary school teachers showed their perception of no difficulties to include technological actions in a STEAM project. This was an expected result because all the students were within the technology specialty of the Master. However, it is interesting to see that despite the fact that most of them (63%) where engineers, the Engineering discipline was the most complicated one to include in an educational STEAM project by their perception. It is also remarkable to see that the artistic discipline, which apparently was the farthest from their knowledge, was perceived to be easier to include in a project than Science or Mathematics.

Instead, the results for the future primary school teachers found that the most difficult discipline to be included in an educational STEAM project was Science (34,94%) followed by Engineering (25,30%) and Mathematics (24,10%). It is remarkable that Arts is the discipline with easier perception to be included into a STEAM project.

The comparison of these results shows some similarities between the two groups of students: Arts is the easier discipline to include inside a STEAM projects for both (leaving Technology apart). This fact highlights the possibility of including this discipline in a superficial way and

without giving it the relevance that other STEAM disciplines have. This common trend should be avoided to balance the different perceptions of self-efficacy that students have previously. (Grimalt & Couso, 2018).

The perception of high difficulty to include Engineering has to do with the absence of this discipline as a subject in the formal education pathway. Hence, there are no references of specific educational activities promoting it.

Finally, the perception of more difficulty to include Science with primary school future teachers reinforces the lack of science in their studies (Verdugo et al. opus cit.) and their low confidence to work with its concepts. Besides, the similar difficulty perceived to include Mathematics in STEAM projects could be understood because of the traditional difficulty associated with maths (Romero–Bojórquez et al, 2014).

Looking for the future predisposition that secondary and primary school teachers would have to implement STEAM projects in their actions we found positive results. As Figure 5 shows, there is a positive evaluation (high and very high) about the need to include STEAM projects into formal education curricula, this is higher than 80% with both groups: 92,3% for secondary school teachers and 81,92 for primary school teachers.

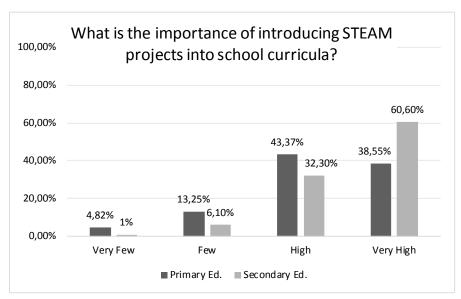


Figure 5: Predisposition to include STEAM projects in teachers' planning

4. Conclusions

As a first conclusion, we can assume that the objective to bring closer the concept of STEAM to the future teachers has been achieved with the performance of the STEAM design projects seminar described in this paper. Future teachers still have a low knowledge about STEAM and this instruction has given them an introduction to go further.

The results also show interest in the inclusion of STEAM in the study plans; this means that when teachers acquire knowledge about STEAM, they consider these types of projects to be necessary in the education curriculum.

We can conclude also that there is still an important difference between understanding and knowledge about STEAM in future primary or secondary teachers. This fact highlights the need to start working on STEAM project design strategies with more emphasis in primary education curricula to enable continued action in secondary education and post-compulsory studies.

Another important aspect to have into account is the need to find strategies to include Arts discipline teachers into the interdisciplinary teams to work on STEAM projects: their experience and knowledge about this area is the way to give relevance to its implication in these kinds of projects.

This research gives evidence about the positive evolution that is happening regarding the recognition and knowledge about STEAM in education and needs to be complemented by new research focused

on the same objective to analyse in a deeper way whether this improvement is already been consolidated or not yet.

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Experience of Active Learning of Physics: The Case of Students of Undergraduate University Study of Food Technology

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Abstract

This article presents personal experiences of active learning students from Food Technology, an undergraduate university study in a single intensive semester course of physics. The research was conducted in the academic years of 2015/2016, 2016/2017, 2017/2018 and 2018/2019 at the Faculty of Chemistry and Technology, University of Split. The active learning took place during laboratory exercises as part of the Physics course, enriched by the educational intervention that includes simple physical experiments and discussions. In this study, students were using sequences of active learning: (1) Predict-Observe-Explain and (2) Observe-Explain-Predict-Test. Those learning sequences activate existing students' knowledge and test it by comparing predicted and observed experiments. These sequences were carried out by using simple experiments which include physical phenomena. Alternative learning concepts are well known to students and their written reports evidently show positive perception of active learning method and teaching procedures. All students indicated a positive attitude towards main features of the new learning method: deeper understanding of the physical laws, increased active involvement through discussion and experimentation, as well as change the perception of physical laws applicable to common, real-life experiences. A detailed analysis of students' comments resulted in a list of favourite simple experiments as Strange balance, Crushed can, Bernoulli's principle – Chimney and they are presented in more detail in this paper.

Keywords: undergraduate physics, active learning methods, Strange balance, Crushed can, Bernoulli's principle – Chimney.

1. Introduction

We are witnessing constant and accelerated changes in society and all areas of life. Individuals are expected to have lifelong learning and continuous development of its own competencies, constructing new and reconstructing existing knowledge.

With this in mind, active learning in the classroom is increasingly encouraged. Students actively participate in scientific processes, they research, create and present during the teaching process.

Here we differentiate two teaching approaches:

- 1. Passive teaching
- 2. Active teaching

Passive learning is the most widespread method of learning. The focus in on the teachers, as they conveys the facts to a large number of students.

This approach to learning contributes more to development of specific competences – mainly to procedural competencies related to the profession.

The main drawback of passive teaching is the lack of development of the skills needed for scientific research and critical thinking. The prevalence of this type of teaching is partially due to the curriculum, which is based on a large number of facts, which then results in a large number of classical lectures.

Natural science learning should be active and constructive in order to facilitate development of critical thinking. With active learning, students are encouraged to participate actively in teaching and to draw conclusions while trying to understand teaching material.

Students also engage in the interpretation and explanation of data and results in collaboration with colleagues and teachers. The teacher guides the process and creates such learning environment where students can actively participate in the experiments.

In active learning, students not only develop knowledge but also organize, analyze, apply, and evaluate it through various thought processes. [1]

Students also offer their solutions to a variety of physical phenomena, and each solution has its advantages and disadvantages.

Great universities such as Cambridge [2], Stanford [3], Massachusetts Institute of Technology (MIT) are aware of all the above facts and encourage active learning (for example, by listing some of the methods on Checklist for Effective Lecturing on their websites).

In the mid-20th century, American philosopher and educational reformer, John Dewey, said:

"Give the pupils something to do, not something to learn; and the doing is of such a nature as demanding thinking; learning naturally results." [2]

They all suggest adopting instructional practices that engage students in the learning process is the defining feature of active learning.

The importance of student engagement is widely accepted and there is considerable evidence to support the effectiveness of student engagement on a wide range of learning outcomes.

Analysis of the literature suggests that students must do more than just listen. They must read, write, discuss and be engaged in solving problems. Most importantly, to be actively involved, students must engage in higher-order thinking tasks such as analysis, synthesis, and evaluation. [4,5,6,7,8] Research results by Scott Freeman et al. (2014) indicate that average examination scores improved about 6% in active learning sections, and students in classes with traditional lectures were 1.5 times more likely to fail than students in classes with active learning. [9]

In order to meet the needs of standard physics courses, a number of teaching methods and syllabuses have been developed.

As a consequence, constructivism occurs which implies the activity of all subjects, and above all, the activity of students. Teaching strategies ensure questioning, research, reflection and practical activities, all to avoid mere recall of facts.

The constructivist approach gives importance to students as active participants in learning processes that interact with the environment and interpret information based on their previous experiences. [10]

The basic concepts of constructivist learning environment include open-ended, authentic and demanding tasks with appropriate level of activity and student collaboration.

Teaching strategies include problem solving, teamwork, problem-based learning and common problem solving:

Problem-Based Learning and Cooperative Group Problem Solving.

Examples of active physics learning methods:

Physics by Inquiry, Tutorials in Introductory Physics, Workshop Physics, Studio Physics, SCALE-UP, and TEAL.

Therefore, since teaching formats have a large influence on what students can get from courses of physics, objectives and methods of education in the context of these courses should be given a serious consideration. This article presents personal experiences of first-year students at Food Technology, undergraduate university study with active learning of physics, i.e. taking active participation in carrying out experiments and discussing the processes and outcomes.

2. Study design

2.1. About the study Food Technology and the course Physics

Food Technology, undergraduate university study at the Faculty of Chemistry and Technology (FCT) at the University of Split educates students in accordance with the European Directive 2005/36/EC. The education is tailored to the needs of Croatian and European markets with a focus on the specific features and the Mediterranean orientation of FCT and SM of the University of Split.

After graduating high school, students may continue their studies at the graduate level for a period of 3 years (180 credits). Physics is an obligatory course that students take in their first year of undergraduate programme. This undergraduate university study has the course of Physics organised as an intense one semester course. The number of ECTS assigned for the course is 6.0. The type of instruction and the number of contact hours per semester is following: 30 hours of lectures, 15 hours of seminars and 30 hours of practical laboratory work.

Types of teachings and teaching materials: lectures, exercises, multimedia, laboratory, group and individual consultations and seminars. The curriculum is presented on web link https://nastava.ktfsplit.hr/predmet.php?lang=en&kod=KTK102.

Active learning of physics through experimentation and discussion was conducted in the academic years of 2015/2016, 2016/2017, 2017/2018 and 2018/2019 as the practical part of the Physics course.

The study included 98 first-year students of the Food Technology undergraduate university study (Table 1). In four academic years students worked in groups of 12 - 13, with total of 8 groups. At the end of the course the students were asked to write about their impressions of the experiments and the experience of active learning in general.

articipants

academic year	2015/2016	2016/2017	2017/2018	2018/2019	total
female	20	19	20	21	80
male	4	5	4	5	18
Σ	24	24	24	26	98

2.2. Learning physics through experimentation and discussion

In this process, standard topics in physics are covered - but using a new approach of active learning where students are active participants in the process of construction and reconstruction of their own knowledge. An essential element of active learning is the use of sequence: predict - observe - explain [11] or observe - explain - predict - test [12]. These sequences activate students' prior knowledge and put it to the test by comparing the predicted

and noticed. Sequences of active learning are implemented using simple experiments involving physical phenomena on which students have well-known "alternative conceptions" [13,14]:

- 1. Force and the concept of movement
- 2. Pressure (hydrostatic, hydraulic, atmospheric, hydrodynamic)
- 3. Heath
- 4. Sound waves.

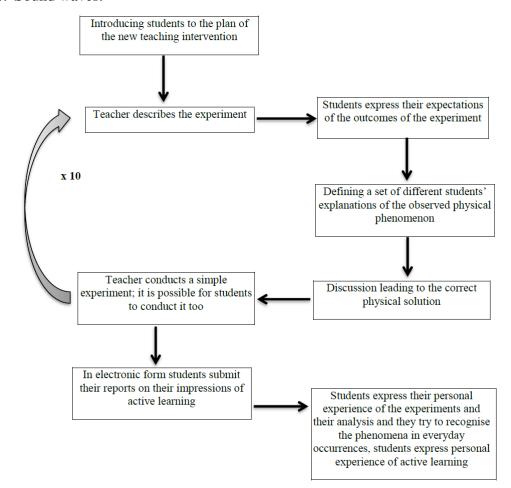


Figure 1 The cycle of active learning of physics using simple experiments for one group (12 - 13 students).

The process of active learning is conducted with a total of 8 groups. Figure 1 shows the cycle of active learning of physics using simple experiments for one group (12 or 13 students). In this case of teaching physics through experimentation and discussion, a set of simple experiments (one or more) was conducted each time the group met in the physics laboratory (Table 2). After completing the laboratory exercises defined by the curriculum, a simple experiment was described to a group of students but without executing it. Students were asked to predict the possible outcome of the experiment, to offer an explanation of the expected results and finally to share their ideas with the group.

Once the number of possible outcomes of the experiment in the group was defined, i.e. the number of different groups of students who shared the same "physical" attitude, the students engaged in a discussion and attempts to explain why they expected such outcomes. The discussion allowed both the teacher and the students to recognise the problem of students' alternative pre-conceptions as well as the level of scientific thinking. After the discussion the experiment was conducted by the teacher and the students observed and recorded the outcome. Surprising outcomes commonly elicited enjoyment and positive emotions with

students. Often the students asked for the experiment to be repeated because they did not believe it was possible. The teacher insisted that it should be students to perform the repeated experiment. The students would then continue the debate based on the reasons for predicting particular outcomes. In collaboration with the teacher, correct physical interpretation of the observed phenomenon would be reached in course of the final discussion.

During the execution of the experiment the seating arrangement in the laboratory was informal. The students wanted to get as close to the site of performance, and they were allowed to carry out the experiment themselves.

Students have shown a significant improvement in activity throughout the course. Through these classes, students were given an opportunity to express their current understanding and intuition related to various physical phenomena, just to be challenged with discussions and active experiments, which was ultimately leading to better understanding of the matter.

After the completion of all laboratory exercises the students were asked to submit, in electronic format, a report on personal impressions on the experiments as well as their attitude towards the educational intervention based on simple experiments and discussion.

2.3. List of experiments

Table 2 lists all sets of simple experiments shown as part of the laboratory exercises.

Table 2 List of all simple exercises with a short description and the number of students' commentaries.

Work session	Experiment	Description of the experiment	Number of students' commentaries
	Coin collision	Collisions of 5 equal coins in different combinations. The combinations in	5
1		which one of the coins is held by a finger are also observed.	
	Inertia ring	A cardboard ring is put on top of a bottle. A small iron object is put on the ring.	11
		If you suddenly pull the ring the object falls into the bottle.	
2	Accelerometer	Bottle corks are connected with a thread. One tap is pushed in, then the bottle is	22
		filled with water and closed with the other tap. Then the bottle is turned neck	
		down with the tap inside tightening the thread in an effort to rise to the surface.	
		The inside tap is observed while the bottle is moving at some acceleration.	
3	Nails	11 nails are put on top of one nail which is nailed into a stand.	53
	Strange balance	A spoon and a fork are placed on a toothpick and it is together placed on the	89
	C	edge of a glass so that the system is balanced. Finally, both ends of the	
		toothpick are lit.	
	Plastic bottle (one hole – up -	A hole is made on a plastic bottle. The bottle is filled with water and the hole is	12
	down)	kept closed. We toss the bottle up and down.	
4	A bottle and many holes	A series of small holes is made on a bottle. The bottle is filled with water and	15
	·	tapped. The flow of water is controlled by turning the tap on the bottle.	
	A bottle and a balloon	A hole is made on a plastic bottle. A balloon is put in the bottle. We try blowing	17
		the balloon with the hole open and with the hole closed.	
	Horizontal projectile	Three small holes are made on a plastic bottle (at 1/4, 1/2 and 3/4 of the bottle	21
		length). The level of water is kept stable. The jets from the holes are observed.	
5	Balloon filled with air and	A balloon is blown and placed above the open flame. The balloon is filled with	51
	water	water and placed above the open flame again.	
	Glass filled with water	A paper cup is filled with a bit of water and placed on the source of heat until	19
		the water boils.	
6	Crushed can	Some water is poured into a tin and is heated. After the water has boiled the tin	98
		is immersed into a container filled with cold water, mouth side down.	
7	Water in a bowl and a candle	e We pour about 1 dl of coloured water in a bowl and we place a candle in the	12
		middle. We light the candle and cover it with a glass.	
	Bernoulli' principle	Cardboards are cut into a rectangular shape and are hung on two pens. Then we	5
8		blow between the cardboards.	
	Bernoulli's principle -	A cardboard tube is placed above the bottom of a glass in which there are	62
	Chimney	pieces of paper. The hairdryer blows horizontally in the upper end of the tube.	
		The aim is for the pieces of paper to start flying out.	
9	Sound - resonance, sound	Two equal tuning forks with the corresponding resonant boxes are placed on the	48

	forks	table. We hit the first fork. The other fork resonates.	
	Beats	Two tuning forks slightly different in frequency are made to flicker. They hear	33
		the sound strikes. The sonic booms are heard.	
	Spinning plastic tube	We spin a long plastic tube (1.3 m) producing different harmonics.	14
10	Playing music on a glass	By circling with the finger on the edge of a glass we produce a sound.	3
	Glass and a ping-pong ball	We initiate flicker on a glass by circling motion. We put the glass	11
		perpendicularly against the wall and we throw a ping-pong ball inside. After	
		that we make the glass flicker.	

Analysing students' reports we have obtained the information on the most mentioned experiments and the impressions of the students related to the presented experiments (Table 2).

Table 3 shows most discussed experiments: Crushed can, Strange balance and Bernoulli's principle - Chimney.

All students (100%) have commented on the *Crushed can, Strange balance* was reported by 89 (91%) students while 65 (66%) students offered comments about the *Bernoulli's principle - Chimney*.

These experiments make the top list of experiments.

Table 3 Top three list of experiments.

	Experiment	Number of students'
		commentaries (%)
1.	Crushed can	98 (100)
2.	Strange balance	89 (91)
3.	Bernoulli's principle - Chimney	65 (66)

3. Top three experiments

In this section, we will observe in detail the experiments that students commented most. Also, for each experiment we will present typical students' comments.

3.1. Experiment: Crushed can

An empty soda can will be filled with water (about 0.3 dl). Then the can will be placed on a burner in order to get the water to boil. The water will be left to boil for 20 to 30 seconds, so that the interior of the can will be completely filled with hot steam (Figure 2).

In the meantime, while waiting for water to boil, a bowl with cold water will be prepared. Using a protective glove (to avoid being burned) the soda can will be taken from the burner and quickly dipped into the cold water, but upside down.

The students had to predict:

What will happen to the can when it's dipped into the cold water?

Most of the students predicted that, once the can was immersed into the cold water, it would slowly cool by letting the water slowly enter the can thus gaining thermodynamic balance. They compared it to throwing a hot stone or another solid body into the water, forgetting about the steam in the can.

Then the experiment was conducted. The students noticed the surprising outcome of the experiment: when the can touched the cold water it collapsed (Figure 3).

Students' personal experience tells them that it takes a noticeable force to smash a can. The experiment was followed by students' explanation of the observed phenomenon. The teacher led the discussion using the following questions:

What force is responsible for can deformation? What happened with the water in the can while it was getting hotter? What happens with steam when we dip the can in the cold water?

What is the relationship between the pressure and temperature? What happens with the pressure in the can after can is dipped into the cold water?

The students finally concluded that a sudden condensation of steam causes that pressure of the remaining steam to decreases dramatically (less steam – less pressure). That's why the difference between the pressures of inside steam and outside air develops. This difference is large enough to let the air to smash the can.



Figure 3 An example of a simple experiment – "Crushed can". Heating up the can on a stove.



Figure 2 An example of a simple experiment – "Crushed can". Display of the can after contact with cold water.

Student comment: When you asked us to consider the force that crushed/flattened the can my mind was a mess. I did not have the slightest idea of how and what to do. But, just because this was my favourite experiment I set aside some time to research it. As you can see, I thought about the experiment and I tried to take different points of view. I'd like to train my brain to think in a similar way in the future. That is why I believe that these experiments are fruitful ... not because I will need this particular material in my life (though you never know) but because I believe I can learn to think differently, in a scientific way.

3.2. Experiment: Strange balance

This experiment requires: a glass, toothpick, two forks. Students were asked to predict: is it possible for two forks to stand firmly on a toothpick with one end on the edge of the glass? Start by pushing the two centre tines on the fork upward a little. Push the fork and spoon together so the bowl of the spoon is under the two centre tines, but over the outer two tines of the fork. It's useful if the fork and the spoon weigh about the same.

Balance the utensils (fork and spoon) on a fingertip to find the middle point. This is where the toothpick should be inserted between the utensils.

Work the toothpick into the tines of the fork. Carefully set the toothpick on the rim of the glass. Slowly slide it in or out across the rim until you've found the best balance point. Both handles will be curving downward below the rim of the glass and the toothpick will be almost horizontal (Figure 4).

After the strange balance was achieved, the student was asked to predict the following:

What happens to the system if we fire a toothpick on both sides?

Strike a match and burn the end of the toothpick hanging over the inside of the glass. To everyone's amazement, the toothpick will burn down to the very edge of the glass but the utensils will not fall. When that flame stops, light the end on the outside of the glass and watch it burn. It stops at the utensils but they remain balanced (Figure 5).

The centre of gravity of an object refers to the central location that gravity acts on the object. In this activity, the centre of gravity is straight down from the spot where the toothpick sits on the rim of the glass (called the pivot point). If you look closely at your balancing utensils, you'll notice that the handles are curved well below the toothpick. This actually moves the centre of gravity directly below the point where the toothpick touches the rim.

If the glass has slanted sides, the centre of gravity— where the utensils balance front and back, left and right, up and down— is actually located in mid-air next to the glass. A tightrope or high wire walker often uses a long stick for balancing in the same way as the forks are used in this experiment. If you burned the ends of the toothpick, you may have been surprised that the utensils remained balanced. Why didn't the flame keep burning and cause a collapse? Fire requires three things: heat, fuel, and oxygen. Take away one of these and the fire goes out. The fuel and oxygen were there but you took away the heat. The glass and the metal rob the flame of its heat and it dies.

Figure 4 An example of a simple experiment – "Strange balance". Setting up a balanced system

Figure 5 An example of a simple experiment – "Strange balance". Display of the system after combustion of both ends of the toothpick.

Student comment: Even after a thorough explanation of how the spoon and fork (implanted into each other) manage to stay in balance on a small part of the toothpick laid at the edge of a glass I remain very sceptical. How is it really possible?! On such a small part of a toothpick only a few centimetres long. However, highlight of the experiment was the fact that even after the toothpick was lit and burnt on both its ends the spoon and the fork remained suspended on the toothpick without moving. The moment created a big question mark in my head. How is that possible? Why? A lot of questions were spinning in my head with one that was particularly puzzling me: why was the toothpick extinguished when it ran into an obstacle. However, after I shrugged off the first impressions, I realized why the toothpick was extinguished but the question of how it was possible for the fork and the spoon to continue standing still on the edge of the glass on the burnt-out part of the toothpick continued to puzzle me.

The experiment made me realize how much impact physics has on our lives, it is all around us, it controls us, and if any of its laws were even slightly changed, our world would not function as it does now.

3.3. Experiment: Bernoulli's principle – Chimney

The accessories we need for the experiment are: paper tube (about 30 cm long), glass cup, bunch of finely chopped papers and an electric hairdryer.

Let's put a glass on the table and put a bunch of chopped paper in it. We ask students the question: "Predict what will happen when I blow a blow dryer on a tube?" (Figure 6)

The outcome of the experiment is shown in Figure 7. The papers leave the glass and pass through the tube to the top and then move in the direction of blowing wind from the hair dryer.

When wind blows across the top of the chimney, the pressure is lower than inside the house. Hence, air and smoke are pushed up the chimney by the higher indoor pressure. Even on an apparently still night there is usually enough ambient air flow at the top of a chimney to assist upward flow of smoke.

Bernoulli's principle uses wind speed differences to move air. It is a general principle of fluid dynamics, saying that the faster air moves, the lower its pressure. Outdoor air further from the ground is less obstructed, so it moves faster than lower air, and thus has lower pressure. This lower pressure can help suck fresh air through the building. A building's surroundings can greatly affect this strategy, by causing more or less obstruction.

The advantage of Bernoulli's principle over the stack effect is that it multiplies the effectiveness of wind ventilation. The advantage of stack ventilation over Bernoulli's principle is that it does not need wind: it works just as well on still, breezeless days when it may be most needed. In many cases, designing for one effectively designs for both, but some strategies can be employed to emphasize one or the other. For instance, a simple chimney optimizes for the stack effect, while wind scoops optimize for Bernoulli's principle.



Figure 6 An example of a simple experiment – "Beroulli's principle - Chimney". Before starting the hairdryer.



Figure 7 An example of a simple experiment – "Beroulli's principle -Chimney". During the blowing of the hairdryer.

Student comment: The professor first performed an experiment with tiny pieces of paper and a hair dryer. The hair dryer blew the air up a paper tube and he managed to get all pieces of paper to fly into the air. It was so interesting that I immediately asked myself "..... How is this possible, ... as if it suddenly began to snow in our small room", we all laughed.

4. The experience of active learning

At the end of the study, the students had to electronically submit report about their experiences and evaluate this new method with a grade, as well as compare it with their former experience in physics class.

In these reports, the students true wish for a change in university classes of physics is recognized.

Representative example of student commentary on a new teaching method follows.

Student comment: I have always been interested in how and why certain equations in physics can be used, what is its origin and how it would look like if we applied it under conditions different from the ideal ones in out exercises. An important role in getting those answers for me was this course, which showed a whole spectrum of concepts familiar from the previous, high school education, but throwing a new light on our previous knowledge. Almost no equation is a mere quotient or a sum, it is a combination of limits and integrals, it is a derivation of the given parameter or some other form of operation we were not familiar with before; it is a true union of mathematics and physics explaining the true origin of things. It was extremely gratifying to see the origin of all the equations that we had used so many times before not even thinking about the story they are hiding. What used to be mere inserting the numbers in the equations has acquired new, stronger and more understandable meaning. Enriched with theoretical knowledge we also had the opportunity to see and physics in practice by solving simple examples in the form of laboratory exercises that offered the opportunity to share a moment of true applied physics.

The vast majority of students did not experience this kind of teaching before or they did but very rarely, as in my case, which deprived us of the opportunity to gain a certain level of practical knowledge. Although the lab sessions included continuous testing I never found it difficult to prepare for it, but I looked forward to being part of my little science team. The simple experiments that supplemented each topic and that every student will certainly evaluate as the most interesting part of the course, added an extra value to the laboratory work. Using the common and readily available items such as plastic bottles, paper, or water, each experiment exercised an impressive dose of simplicity and yet it hid so much of unexpected. This should perhaps remind us that in everyday life we often take for granted what may hide a large dose of exceptional? Each experiment that was carried out evidently had the outcomes contrary to our expectations, and every question the professor asked about the possible outcomes of the experiment result in a clear "no" answer. However, a nail managed to hold eleven other nails and water boiled in a paper cup, and one toothpick managed to hold metal forks and spoons. Sometimes we simply refused to believe what we saw, because it seemed simply impossible to us. Just like the philosophy that teaches us to abandon the illusions of our own senses and to go into the unknown, every new step in the experiment "threw" us from our self-explanatory and logical world by opposing the sound rationalism. Thinking about how some experiments were possible required using our complete acquired knowledge, all laws of physics that we have available, still we struggled to explain to ourselves how what we saw was possible - and we finally did understand, with different face of physics that taught us to think.

5. Discussion and conclusion

The goals of education should meet the demands of a rapidly changing world. The concept of active learning is student-centered, it stems from a constructivist view of learning, which emphasizes a need that students actively construct knowledge. The teacher should take the role of facilitator, not the source of knowledge. As the constructivist view implies, student-centered education typically emphasizes learning methods in active engagement and research in which students can effectively construct their teacher-led understanding.

Physics courses in Croatian elementary schools, high schools and colleges use traditional methods. In such an environment, students rarely show an interest in physics. Students typically lack motivation to discover an unknown because they do not see the expediency of physics knowledge.

New methods of teaching physics are necessary to:

- reduce student resistance to "demanding" physics courses,
- help students develop scientific thinking skills as well as a deeper understanding of physical knowledge
- enrich existing curriculum with specific forms of student activities, for the purpose of presenting the broad applicability of physical knowledge.

Students recognize changes in the teaching process that aim to increase interest in physics.

The experiences of the students of the undergraduate study of Food Technology were presented after the laboratory exercises from the Physics course. Laboratory exercises were based on simple experiments and discussions.

Analysis of the report (before attending the Physics course):

- most students come with either a negative or a reserved attitude towards the Physics course
- had no knowledge of the course
- did not have high expectations
- Physics the most challenging course in the first year of study.

After attending the Physics course (New Learning Methods, Experimentation, and Discussion):

- positive attitude of students towards all the main features of the new learning method:
 - deeper understanding of physical laws,
 - increased active involvement through discussion and experimentation,
 - stimulating thinking and searching for physical solutions to explain the outcome of the observed experiment,
 - communication with one another (often outside the physical laboratory)
- positive attitude towards surprising effect experiments (list of top 3 simple experiments)
- significant shift in interest in physics, physical knowledge and science
- changing the perception of physical laws applicable to common real-life experiences.

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Modelling and Growth Simulation of Social Network Facebook as Complex System Example

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Abstract. In the last few years, we have witnessed the great popularity of various social networks, including Facebook. At the same time, complex systems research is becoming increasingly important as we encounter examples of complex systems in a number of areas. Using differential equations, we propose a new model for Facebook as an example of a dynamic complex system. The ability to predict growth allows one to make the right investment or marketing decision or make comparison with other social networks.

Key words: complex system, modelling, Facebook

1. Introduction

The study and modelling of complex systems has evolved in recent years as a new scientific discipline that can be applied to various scientific fields. Biological systems [1], social systems [2], road networks [3] or computer networks [4] all represent entities which consist of numerous interconnected components interacting with each other. Therefore, such entities are declared in the literature as complex systems [5]. Basic characteristic of a complex system is that it is dynamic in nature. In order to understand it, one needs to know more than just the behavior of its individual components. It is important to understand the functioning of a complex system as a whole. As stated in [6], the system dynamics arises bottom-up based on nonlinear interactions among individual components. Specific application can be found in ecology [1], where the complex system understanding depends on inter-connections between subsystems as well as the internal behavior of their individual members such as people, plants or groups.

Digital social network is also an example of a complex system. With the rapid development of Internet technology, the online social networks such as Facebook, YouTube and Twitter have become very popular and today they represent the usual way of life in a digital age. The number of their users is increasing every day, while at the same time some users may log out of their social accounts and quit the social network. Other characteristic of a complex social network besides the constant change in the number of participants is the dynamics of the network topological structure [7].

In recent years, online social networking became inevitable media for fast communication and the effective information exchange. Hence, two dynamic processes are commonly studied in the literature, i.e. information spreading and network evolution. The first process is also called online information diffusion, having one of the most important functionalities to spread the latest news, headlines or movie recommendations across the network [8].

Information diffusion can be modeled with the use of ordinary differential equations, whose focus is only on the temporal dimension [9]. Also, several authors ([10],[11]) studied information diffusion in online social networks by using models with partial differential equations. As is well known, these models are more difficult, because with partial differential equations one can describe both temporal and spatial characteristics of spreading information over the networks. Chai et al. [7] claim that more real-world problems are not deterministic, so they propose the stochastic approach in order to build the information diffusion model. Also, numerical simulations on real-world Facebook data is conducted to verify the theoretical analysis and evaluate the parameters that influence on the information diffusion process. Wang et al. [8] develop diffusive logistic model for predicting information diffusion in online social networks. Their approach divides the diffusion in two separate dimensions (temporal and spatial), and the model for each dimension is derived. Spatial dimension is referred to as growth of the network and it is modeled with simple logistic function [12].

Basically, the use of the logistic function is common to predict the population growth over time ([6],[13]). Since the second dynamic process that is commonly studied in the literature concerning the complex social networks is network evolution, Budka et al. [14] investigate on this issue. They study the data preparation process for the predictive modelling of the evolution of complex networked systems and use an e-mail based social network as an example to verify their findings. They also identify many interesting open issues for future work in this direction. Acevedo et al. [15] approach this problem in another context. They define a diffusion system to model the recovery of forests. Their model consists of a diffusion term that describes the continuous spread of forest in space and time dimension, and a logistic population growth component to predict the increase of the forest size.

As stated in [14], the widely used model for large networks is power-law, and it is used for real-world examples such as World-Wide Web [16], Internet [17] or other large networks. Zang et al. [18] studied the growth dynamics of real social networks in China and find as well that both node and link in real social networks follow near power law growth dynamics. They present their dynamic model to describe the network growth. On the other hand, Davis [19] apply a multiple regression model to predict the number of users in a population based on the number of journal article downloads.

In this paper, we deal with the problem of the complex network growth in terms of number of users. We concentrate on Facebook as an example of a complex dynamic system. We propose a model of growth in the number of Facebook users by using the population equation and modified logistic equation, together with the (possible) interactions in a competition between two social networking services.

The paper is organized as follows. In Section 2 we give a theoretical background: complex systems definition together with basic features and fundamentals of mathematical modelling. In Section 3 we present social network Facebook as complex system example followed by different modelling approaches for the observed system. Conclusion is given in Section 4.

2. Theoretical background

There is no commonly accepted definition of complex systems, and some of the most commonly cited would be [5], [20]:

"A system comprised of a (usually large) number of (usually strongly) interacting entities, processes, or agents, the understanding of which requires the development, or the use of, new scientific tools, nonlinear models, out-of equilibrium descriptions and computer simulations."

"A system that can be analyzed into many components having relatively many relations among them, so that the behavior of each component depends on the behavior of others." (Herbert Simon)

"A system that involves numerous interacting agents whose aggregate behaviors are to be understood. Such aggregate activity is nonlinear, hence it cannot simply be derived from summation of individual components behavior." (Jerome Singer)

Given the diversity of definitions of a complex system (regardless of the common premise), there is no reasoned list of properties that would characterize a complex system. However, some of the basic features of complex systems, in addition to number and linearity, would be ([21],[22],[23]):

- Self-organization: refers to the development of the system in an organized form without the influence of external factors (there is no hierarchy, no central control unit).
- Adaptation: Represents a modification of the behavior of the system to accommodate the requirements posed by exogenous factors (e.g., network users) or changes in the environment.
- Emergence: Instead of planning or controlling, agents in the system act in a seemingly random way. From all these interactions, patterns emerge that reflect the behavior of agents within the system and the behavior of the system itself.
- Connectivity: The ways in which agents in the system connect and interconnect are crucial to the survival of the system.

We could say that a complex system is any system that contains a large number of interactive components (these can be agents, processes, etc.) whose total activity is nonlinear (in the sense that it cannot be obtained from the sum of the activities of the individual components). This definition is applicable to systems in various scientific fields. Looking at groups of animals (ants, fish, birds) we can see many features of coordinated behavior, regardless of the absence of a visible "leader". However, such self-organization is not only specific to animal groups, we also find it if we look at vehicles in traffic or pedestrian groups on the sidewalk. We also find a high degree of self-organization in social networks.

A model is a logical description (mathematical representation) of the behavior of a system, process, or component. Although many of the features of the system may seem important, not all can be implemented into the model. Only a few relevant features that are considered to play a key role in interpreting the observed phenomena should be retained. Mathematical models can be divided according to different criteria:

- linear/nonlinear: depending on whether the variables used can be related by linear equations
- deterministic/stochastic: in deterministic models there are no parameters characterized by probability
- static/dynamic: the dynamic system changes depending on the time while static is in a stable state
- continuous/discrete: in a discrete model the variables change countable times over a period of time while in the continuous models the variables change continuously

- qualitative/quantitative: quantitative models provide a detailed numerical result, while qualitative models provide a general description of the answer

A dynamic system is defined completely if we know: a state space whose elements represent all possible states of the system, time (can be discrete or continuous) and evolution law (a rule that allows determining states at some point t knowing states at all previous times) [24]. In most cases, knowing the state at the beginning of the system consideration allows you to determine the state at any time.

Dynamic systems can be divided into two categories. Depending on whether a time variable can be considered continuous or discrete, the dynamics of a given system are described by differential equations or finite difference equations.

One way to model dynamic systems is to use differential equations.

3. Facebook as a complex system

For the example of the complex system we want to model, we will take the social network Facebook. Facebook's growth model is an example of a dynamic system. The state space is a set of non-negative real (integer) values, and we will try to describe the growth of the network by solving nonlinear differential equations of the first order (population and modified logistic).

Digital social networks have become very popular in recent years. One of the most used is Facebook, first published in April 2004. Since then, it has grown rapidly and on the beginning of 2020. has around 2.5 billion monthly active users (users that have logged in during the past 30 days), according to [25].



Figure 1 Facebook users network ([26])

Table 1 Facebook users (in millions) from 12/2004. to 12/2019. ([25])

2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	6	12	58	145	360	608	845	1056	1228	1393	1591	1860

2017	2018	2019	
2129	2320	2498	

Suppose for some reason (marketing, for the sake of a decision to invest in stocks, or out of sheer curiosity) we want to predict the number of Facebook users in the next three years. The number of users is changing (still growing) day by day, which makes our system dynamic.

3.1 Modelling using the population equation

The simplest model of population growth is described by the population equation and implies the following: the population growth rate is proportional to its size [27]. If y(t) denote the population size at time t, we could write:

$$\frac{dy}{dt} = ky$$

The solution to the given differential equation is

$$v(t) = Ae^{kt}$$

whereby the constant A can be determined as follows:

- if we know the initial state of the population y_0 (the state at time t=0) it can be shown that $A=y_0$ whence it follows

$$y(t) = y_0 e^{kt} \tag{1}$$

- if instead of the initial population at the time t=0 we know the state of the population at another time t_0 , and we denote it again by $y(t_0)=y_0$ we get that $A=y_0e^{-kt_0}$ whence

$$y(t) = y_0 e^{k(t - t_0)} (2)$$

In our case, for the initial state of the number of users we take the state in 12/2004 (the initial state, that is, the first version of Facebook was published in April 2004. However, it is clear that at the time of publication the number of users is 0, but in 12/2004 number of users was 1 (million)). Therefore, for $t_0 = 2004$, $y_0 = 1$ from equation (2) we obtain

$$y(t) = e^{k(t-2004)}$$

It is necessary to determine the constant k. For example, for t = 2016 we get $k = \frac{ln1712}{2016-2004} \approx 0.62$ and the equation is

$$y(t) = e^{0.62(t - 2004)}$$

However, if we compare the values obtained by the equation with the actual values, we see that the model does not describe very well the growth of the Facebook population.

Given the slow growth at the outset, the determination of the proportionality coefficient by using data for another year also fails to produce satisfactory results. The discrepancies are too large and we can conclude that the population equation does not describe well the growth of Facebook's population. One reason may lie in the fact that the population equation does not impose any growth restriction, such a calculation can make us realize that at some point the Facebook population is more numerous than the human population itself. Therefore, a better approach would be to take into account possible limitations (human size, age, internet availability, technology availability in general).

3.2 Modelling using a modified logistic equation - a first approach

In nature, it is often the case that the population initially grows at some rate of growth k, but this growth decreases as the population approaches the maximum capacity of the system K (with K being a constant) [27]. We describe such a system by the logistic equation first used by Pierre Francois Verhulst in 1838, describing population growth taking into account the constraint given. The logistic equation is given by the expression

$$\frac{dy}{dt} = ky(1 - \frac{y}{K})\tag{3}$$

whose solution is

$$y(t) = \frac{K}{1 + Ae^{-kt}} \tag{4}$$

where

$$A = \frac{K - y_0}{y_0} \tag{5}$$

We will apply Equation (4) to our case, however, with one modification. The maximum capacity of the *K* system in our case will not be constant but will also change with time. We will assume that all users of the Internet can have a Facebook account, so their total number will be a limiting factor.

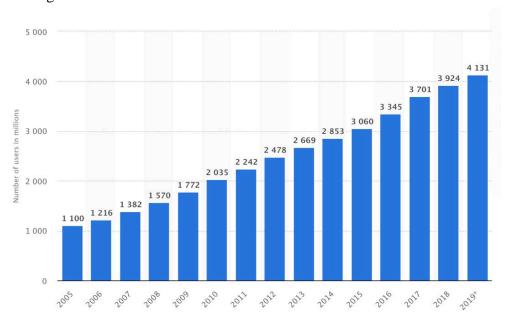


Figure 2 Number of internet users worldwide from 2005 to 2019 ([28])

According to [28] in 2019, the human population is just over 7.7 billion people, of which about 58%, or 4.5 billion, have internet access. It is necessary to find a functional link between Internet users and the entire population. If we look at Figure 2, we can see that the number of Internet users has been growing very fast at first, almost exponentially, while this growth since 2005 has been approximately linear. Therefore, we will apply a correlation or regression analysis to the data given in Table 2 (applied to the period from 2005 to the present) for the purpose of establishing functional connectivity.

Correlation analysis is part of statistics that examine the association between observed variables, while regression analysis for the variables among which an association is established determines the analytical expression that would describe the relationship between them. After determining the expression that relates the observed quantities, it is necessary to determine how well the term describes the dependence of the observed quantities. The coefficient of determination (R^2) gives us information about the validity of the obtained model; R^2 moves within the interval [0,1] and the closer the value is to 1 the model is more representative.

The following calculations based on the data in Table 2 are made using Excel statistic package.

Table 2 Human population size and number of internet users between 2005-2019 ([28],[29]):

Year	Human population (in billions)	Internet users (in millions)
2005	6.51	1100
2006	6.60	1216

2007	6.68	1382
2008	6.76	1570
2009	6.84	1772
2010	6.92	2035
2011	7.01	2242
2012	7.09	2478
2013	7.18	2669
2014	7.26	2853
2015	7.34	3060
2016	7.43	3345
2017	7.51	3701
2018	7.59	3924
2019	7.70	4131

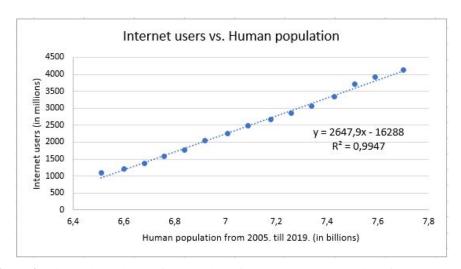


Figure 3 Linear dependence of the number of Internet users on the size of the human population

Correlation analysis revealed a high correlation rate between the number of Internet users (in millions) and the size of human population (in billions). Linear model is obtained by regression analysis (Figure 3):

$$KI = 2647,9453 \cdot P - 16287,7557 \tag{6}$$

with coefficient of determination $R^2 = 0.9947$.

According to the above, we determined the linear dependence of the number of Internet users on the size of the overall population. If we use the population equation given in (2) to predict human population growth, and the data in Table 2 we obtain that the size of the human population (in 000) at time t (in years) is:

$$P(t) = 6.51 \cdot e^{0.012(t - 2005)} \tag{7}$$

Applied on (6) it gives:

$$KI(t) = 2647,9453 \cdot 6.51 \cdot e^{0.012(t-2005)} - 16287,7557$$

or

$$KI(t) = 17238.1239 \cdot e^{0.012(t-2005)} - 16287,7557$$
 (8)

As noted above, the number of internet users KI will represent the maximum system capacity in the logistic equation (3) that gives

$$\frac{dy}{dt} = ky(1 - \frac{y}{17238.1239 \cdot e^{0.012(t - 2005)} - 16287,7557})$$

or

$$\frac{dy}{dt} - ky = -\frac{k}{17238.1239 \cdot e^{0.012(t - 2005)} - 16287.7557} y^2 \tag{9}$$

which is Bernoulli's differential equation. Unfortunately, analytical solution of this differential equation leads to a non-elementary integral, which is impractical to use in simulating the growth of the number of users, and therefore we will simplify the calculation of the maximum capacity of the system.

3.3 Modelling using a modified logistic equation - another approach

We will try to represent the growth of the Internet population by the population equation (the exponential equation directly depending on the year, bypassing the total population). Considering that in the world of internet technology, innovations are quickly pushing out of use something that was at the top of the popularity rankings until yesterday, for the purpose of calculating it as accurately as possible, we will focus on a slightly shorter period, more precisely from 2010 to the present.

Using (2) and the data given in Table 2, using the regression analysis already indicated, it can be shown that

$$KI(t) = 2.0474 \cdot 10^{-66} e^{0.0790515475t} \tag{10}$$

with a graph given on Figure 4.

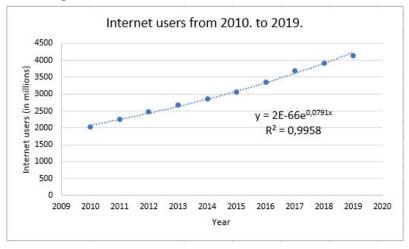


Figure 4 (Exponential) growth of the number of Internet users

If (10) is used to calculate the maximum capacity of the system in equation (3), it follows

$$\frac{dy}{dt} = ky(1 - \frac{y}{2.0474 \cdot 10^{-66} e^{0.0790515475t}})$$
 (11)

After arranging, we obtain Bernoulli's differential equation:

$$\frac{dy}{dt} - ky = -\frac{ky^2}{2.0474 \cdot 10^{-66} e^{0.0790515475t}}$$

or

$$y' - ky = -\frac{k y^2}{Ae^{Bt}} \tag{12}$$

with $A = 2.0474 \cdot 10^{-66}$ and B = 0.0790515475.

Using substitution
$$z = \frac{1}{y}$$
 it follows $-\frac{z'}{z^2} - k\frac{1}{z} = -\frac{k}{Ae^{Bt}z^2}$ or
$$z' + kz = \frac{k}{Ae^{Bt}}$$
 (13)

which is a first order linear differential equation with solution

$$z(t) = k \frac{e^{-Bt}}{A(-B+k)} + Ce^{-kt}$$

or

$$y(t) = \frac{1}{Ce^{-kt} + \frac{k}{A(k-B)}e^{-Bt}}$$
 (14)

Initial condition y(2010) = 608 with condition y(2015) = 1591 gives

$$608 = \frac{1}{Ce^{-2010k} + \frac{k}{A(k-B)} e^{-2010B}}$$

$$1591 = \frac{1}{Ce^{-2015k} + \frac{k}{A(k-B)} e^{-2015B}}$$

It follows

$$\left(\frac{1}{608} - \frac{k}{A(k-B)} e^{-2010 B}\right) e^{2010 k} = \left(\frac{1}{1591} - \frac{k}{A(k-B)} e^{-2015 B}\right) e^{2015 k}$$

Using bisection or any other numerical method for determining function zero points via the Wolfram Mathematica software package gives $k \to 0.32367409250222$ and thus $C = 3.54006 \cdot 10^{279}$.

Accordingly, the growth of the Facebook population is described by the equation

$$y(t) = \frac{1}{Ce^{-kt} + \frac{k}{A(k-B)}e^{-Bt}}$$
 (15)

with the above parameter values k, C ($A = 2.0474 \cdot 10^{-66}$, B = 0.0790515475).

3.4 Modelling two competing services using a modified population equation

In order to describe the comparison / interaction of the two systems, we will model the two competing social networking services (Facebook and Twitter, Tumbler or Instagram) with the system of ordinary differential equations, which follows from the previous model:

$$y'(t) = a(t)y(t)\left(1 - \frac{y(t)}{K(t) - z(t)}\right)$$
$$z'(t) = b(t)z(t)\left(1 - \frac{z(t)}{K(t) - y(t)}\right)$$
$$y(0) = y_0 \quad z(0) = z_0$$

where y(t) and z(t) is number of services users, K(t) max number of users, for example K=3400[000000] could be the maximum number of people on Earth who have internet access at all, y_0 i z_0 number of users [000000] in starting moment, and functions a(t) and b(t) are generalization of growth rates of both services.

We will look at the behavior of the system depending on different initial values and different functions that represent the growth rate.

The system is not analytically solvable, we will solve it numerically, using the Wolfram Mathematica software package.

a) Let
$$K = 3400$$
, $a(t) = 0.5$, $b(t) = 0.8$, $y(0) = 100$, $z(0) = 10$

Figure 6 Comparison of the number of users of two competing services – case 1

Figure 6 shows an increase in the number of users of two competing services. Given the initial conditions, the number of users of the first service (shown in the blue graph) is always greater than the number of users of the second service.

b) Let
$$K = 3400$$
, $a(t) = 0.4 + 0.5 cost$, $b(t) = 0.1 + 0.8 cos \frac{t}{4}$, $y(0) = 100$, $z(0) = 50$

With the above conditions, after a while the number of users of the second service exceeds the number of users of the first service, but after that it decreases rapidly (Figure 7).

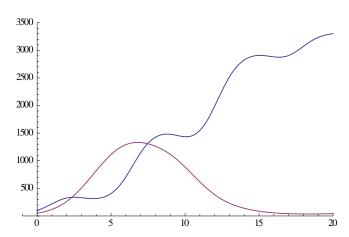


Figure 7 Comparison of the number of users of two competing services – case 2

By interpreting the functions a(t) and b(t) as investment strategies, one could investigate which investment strategy produces optimal results in conquering the market.

It is also possible to use K(t) to describe the "market" of an IT product with regard to technological obsolescence, that is, as part of a market still interested in a particular technology, even though it has been overtaken by time, such as developing countries, or on the periphery that are still using older versions of computers / operating systems / programs because they can't afford better. The simplest model of declining market interest is reciprocally linear, for example, assuming $K(t) = \frac{3400}{1 + \frac{t}{10}}$, a curve showing a decrease in market interest over 20 years would look like:

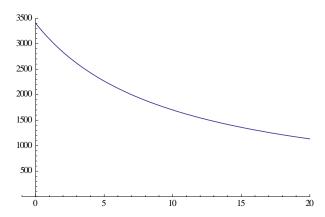


Figure 8 Declining market interest over time

c) Now let's see how the decline in market interest will affect the number of service users, let's say $K(t) = \frac{3400}{1 + \frac{t}{10}}$, a(t) = 0.5, b(t) = 0.8, y(0) = 100, z(0) = 25. The result is shown on Figure 9.

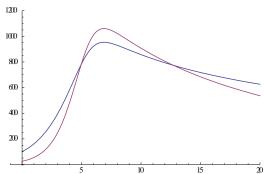


Figure 9 Comparison of the number of users of two competing services – case 3

Assuming that $K(t) = \frac{3400}{1 + \frac{t}{10}}$, a situation is modeled which assumes that at zero moment the demand for the product is maximum while it decreases below. A more realistic variant might be if we put $K(t) = 3400 \cdot e^{-\frac{(t-5)^2}{10^2}}$, where the Gaussian curve predicts market maximization in 5 years and its relatively rapid decline over the next 10 years as shown in Figure 10.

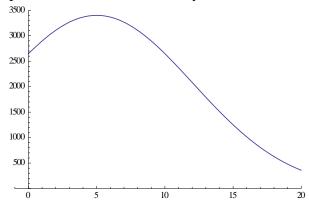


Figure 10 Declining market interest over time

d) Now, let's look at how market interest described in this way will affect the number of service users with unchanged other conditions:

$$K(t) = 3400 \cdot e^{-\frac{(t-5)^2}{10^2}}, \ a(t) = 0.5, \ b(t) = 0.8, \ y(0) = 100, \ z(0) = 25.$$

Results are shown on Figure 11.

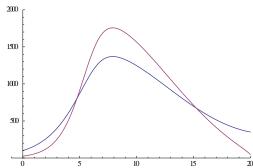


Figure 11 Comparison of the number of users of two competing services – case 4

e) Dependence of the number of service users with the stated decline of market interest while the remaining initial conditions are the same as in the case of b):

$$K = 3400 \cdot e^{-\frac{(t-5)^2}{10^2}}$$
, $a(t) = 0.4 + 0.5 cost$, $b(t) = 0.1 + 0.8 cos \frac{t}{4}$, $y(0) = 100$, $z(0) = 50$ Results are shown on Figure 12.

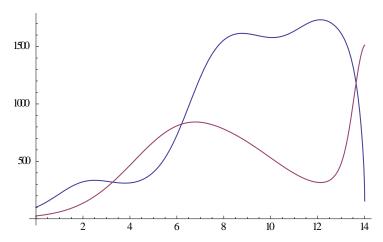


Figure 12 Comparison of the number of users of two competing services – case 5

4. Conclusion

Modelling and simulating complex systems is a complex job that requires a fair knowledge of mathematical tools, among other disciplines. These examples show that it is necessary to find a compromise between the simplicity of the model and the usability of the results obtained.

Comparing the results obtained in the above cases, we see large differences in the resultant number of users for the observed services. Even small changes in the set model can have a significant impact on the results obtained, and thus influence important decisions.

Fast and flexible modelling of phenomena not very different from the above mentioned, based on exponential growth and spread in a population, as the current Covid – 19 crisis shows, could prove to be vitally important concerning problems much less trivial then IT investment strategies and resulting in important decisions and consequences ensuing not in years, but days.

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CIET Split 2020 Track 1

Finance & Accounting

Application of the Chinese Postman Problem in Optimizing the Waste Collecting Routes

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Abstract. In this paper, the possibility of applying Chinese postman problem in finding optimal routes for waste collection is presented. The examples of two cities: city of Split in the Republic of Croatia and city of Yongin in the Republic of Korea are considered. Along with the basic notions of graph theory, heuristic algorithms have been clarified in order to solve the various variants of the Chinese postman problem. In the city areas of Split and Yongin, modeling of the examined areas was done using graphs, after which optimal routes of waste collection were determined both by presented heuristic algorithm and using the CPP module of problem solving software package LogisticsLab.

Key words: graph theory, optimization, Chinese postman problem, waste collection routes

1. Introduction

Waste management is a very complex activity that affects all sectors of the economy, production and consumption. Waste management means collection, transportation, usage and disposal of waste, including monitoring of such procedures and subsequent maintenance of disposal locations, and includes actions undertaken by a trader or broker.

The cost of collecting and transporting waste accounts for 85% of total waste management costs. One way to reduce collection and transportation costs is to optimize waste collection routes. 1 2 3

¹ Confer. Apayadin O, Gonullu MT. Route optimization for solid waste collection: Trabzon (Turkey) case study. Global Nest Journal. 2007; Vol 9, No 1, pp 6-11

² Confer. Le Hoang Son, Amal Louati. Modeling municipal solid waste collection: A generalized vehicle routing model with multiple transfer stations, gather sites and inhomogeneous vehicles in time windows. Waste management 52. 2016;34-49

³ Confer. Sahoo S, Kim S, Kim BI, Kraas B, Popov Jr A. Routing optimization for waste management. Interfaces; 2005 Vol 35, No 1, pp 24-36

Thus, for example, according to the results of the case study in Buenos Aires, the length of the waste collecting routes were reduced by as much as 39% and the work (although the variables were not optimized) decreased by 43%. This latter result is partly due to the fact that distance is one of the constituent factors of the work, but also the analysis of multiple solutions to the problem of a travelling salesman. Extrapolation of these outcomes across the southern Buenos Aires area suggests potential savings of more than \$200,000 per year with less traffic accidents, less vehicle driver fatigue and less air pollution.⁴

As an example of solving optimization of the total traveled distance during waste collection in the area of one block in Split and one in Mohyeon, Yongin, primarily heuristic algorithms will be used, which are in general used for solving certain variants of the Chinese postman's problem.

Chinese postman problem is one of the most famous problems in the graph theory with the possibility of its application in everyday life, such as mail delivery, newspapers delivery⁵, the planning of large conventional railway lines⁶, etc.

2. Basic concepts of graph theory

The graph (network) is a structure composed of a series of points that are interconnected by a series of edges. In the graph, the movement between two points that are interconnected by the edge is enabled. If the movement along the each edge is possible in both directions, that is called an undirected graph (Fig 1.a); if the movement along the each edge is only possible in one direction, the graph is called directed (digraph, Fig 1.b), otherwise it is called the mixed graph (Fig 1.c).

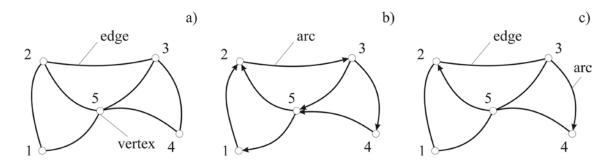


Figure 1 Graphs: a) undirected, b) directed, c) mixed

The points in the graph are called vertices (sing. vertex). In undirected graph, the lines are called edges, and in directed arcs (or directed edges). Accordingly, a mixed graph is composed of vertices that are connected both with edges and arcs.

If the numbers, which represent money or time or the distance between the vertices, are given to individual edges or arcs, they are called the weights of a particular edge or arc, and such graphs are called weighted graphs. (Fig 2)

⁴ Bonomo F, Duran G, Larumbe F, Marenco J. A method for optimizing waste collection using mathematical programming: A Buenos Aires case study. Waste Management & Research. 2012;30(3) p.311-324

⁵ Confer. Karskens J. Mail Delivery Problem: Route optimization with capacity constraints [Research paper] University of Amsterdam; 2013

⁶ Confer. Yilmaz M, Codur MK, Yilmaz H. Chinese postman problem approach for a large-scale conventional rail network in Turkey. Technical Gazette 2017; p.1471-1477

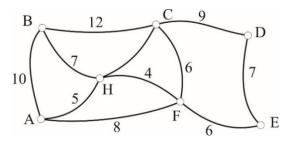


Figure 2 Weighted graph

It should be noted that the lengths of the edges or arcs are not drawn in scale, i. e. they are not drawn in proportion to the weight of a particular edge or arc.

The degree of a vertex in an undirected graph (hereinafter: the graph) represents the number of edges connected to that vertex and may be even or odd.

Since each edge of the graph has two ends, then the sum of the degrees of all vertices in the graph equals twice the number of all edges of that graph and according to that, is an even number. It can also be concluded that in each graph the number of vertices with odd degrees (if any) must be an even number. Thus, in one graph there can be 2, 4, 6, ... vertices of odd degree.

Transition from one vertex of the graph to another, along the edges that connect them, is called a walk. If the starting vertex is the same as the ending vertex, that is considered to be a closed walk. If the starting vertex is not the same as the ending vertex, that is called an open walk.

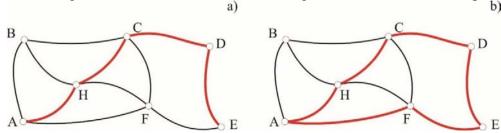


Figure 3 The path between the graph vertices: a) open, b) closed

A path is a walk during which no edge of the graph is passed more than once (A-H-C-D-E; Fig 3.a). The walk that starts and ends in the same vertex of the graph (closed path) is called a cycle. (A-H-C-D-E-F-A; Fig 3.b).

A walk in which every edge of the graph is visited exactly once and starts and ends on the same vertex is called an Eulerian cycle (Fig 4.a). The Fig 4 shows the order of passage of each edge using numbers from 1-13 (A-B-H-F-E-D-C-F-A-H-C-B-G-A).

If the considered graph allows Eulerian cycle, that graph is called an Euler graph

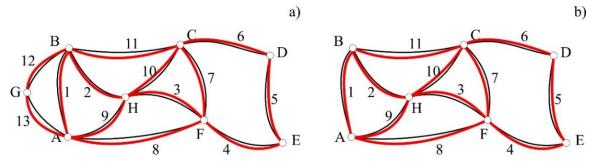


Figure 4 a) Euler cycle, b) Euler path

If the described walk does not end in the same vertex from which it started, it is an Euler's path (Fig 4.b).

For some undirected graph to be Euler's, all the vertices must be of even degree. A graph that is not Euler's, contains Euler's path if and only if it has exactly two vertices of odd degree.

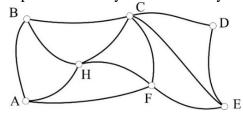


Figure 5 A graph that does not allow either Euler cycle or Euler path

If the number of vertices with an odd degree is greater than 2 (4, 6, 8, and so on) then the considered graph does not contain either Eulerian cycle or Euler's path (Fig 5).

In the example shown above (Fig 5), there are four vertices with an odd degree: A, B and E with 3 exits from vertex and C with 5.

Directed graphs (digraphs) introduce two new terms, input and output vertex. The input degree of some vertex is the number of arcs that this vertex is the top (arcs that enter this vertex). According to that, the output degree of a vertex is the number of arcs for which this vertex is considered to be the beginning vertex (vertex from which the arcs are leaving from). The symmetric vertex is a vertex whose input degree is equal to the output degree, and the graph with all symmetrical vertices is a symmetric graph.

A directed graph is Euler's (containing Euler's cycle) if and only if its input degree is equal to the output degree, that is, if it is symmetrical.

Fig 6.a shows the directed graph. It can easily be stated that the input degrees of each vertices are equal to the output degrees of these vertices and it can be concluded that this is Euler's graph. Euler's cycle on that graph is shown in Fig 6.b where the numbers on the arcs indicate the order in which these arcs are passed (A-G-B-H-F-E-D-C-F-A-B-C-H-A).

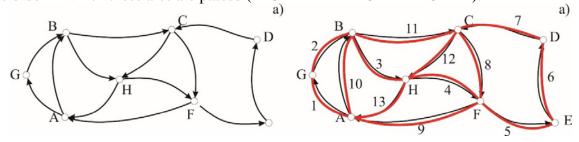


Figure 6 a) Directed graph, b) directed Euler cycle

The path that starts from one vertex, where all graph vertices are passed exactly once, and ends in the starting vertex is called Hamilton cycle (Fig 7.a).

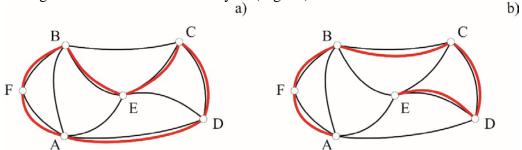


Figure 7 a) Hamilton cycle, b) Hamilton path

If the considered path is not closed (it does not end in the starting vertex) then it is Hamilton's path (Fig 7.b).

The mathematical term (condition) that would answer the question whether there is a graph with Hamilton cycle is not yet defined.

2.1 Chinese postman problem

The Chinese Postman Problem (CPP), is defined in the following way: it is necessary to find the shortest way in which a postman has to go through, starting from the post office, to deliver mail in a certain neighborhood where he must pass every street at least once and return to the post office in the end.⁷

Since it is required for solving this problem to take into account the length of the streets or the time that is required for passing of each street, the mathematical model used in this problem will be a weighted graph.

The problem was originally studied by the Chinese mathematician Kwam Mei-Ko in the 1960s and is one of the most popular problem of graph theory.

Precisely because of the variety of practical examples in which it can be applied, a series of variations of this problem have been developed.

The three basic variants are: UCPP - Undirected Chinese Postman Problem where every street (edge of the graph) can be passed in any direction, DCPP - Directed Chinese Postman Problem where every street (arc of the graph) must be passed in a specific direction, and Mixed Chinese Postman Problem (MCPP), where one part of the streets (edges) can be passed in any direction, and the other part of the streets (arcs) must be passed in the specific direction.

For the control of the calculations conducted by hand, LogisticsLab-4-0-3 program⁸ will be used. It is available for download on http://logisticslab.org/ and is free of charge for academic purposes.

2.1.1 Chinese postman problem on undirected graphs (UCPP)

The solution of the Chinese postman problem on an undirected graph is based on the fact that the graph of the considered problem needs to be reduced to the Euler's graph (if it is not already), which is done as follows:

1. Determine the degree of each of the vertex in the graph,

If the degrees of all the vertices of the graph are even then the graph allows the Euler cycle, which is also the optimal tour, and the sum of the lengths of each edge of the graph gives the length of the shortest path that the postman needs to pass:

$$L_{\min} = \sum_{i=1}^{m} l_i$$

where m is number of graph's edges, and l_i - length of edge i,

2. If the graph of the considered problem has two or more vertices of odd degree, then these vertices should be made even by the addition of artificial edges parallel to the existing edges and representing the shortest path between the joining vertices; the edges used in that merger must be passed, in fact, through again. The resulting graph allows the Euler cycle, and the shortest route the postman has to cross is the sum of the lengths

⁷ Plazibat B, Reić L. Operacijska istraživanja u MS Excelu, Sveučilište u Splitu, Sveučilišni Odjel za stručne studije 2017, Split

⁸ Mike Steglich, Dieter Feige and Peter Klaus: Logistik-Entscheidungen: Modellbasierte Entscheidungsunterstützung in der Logistik mit LogisticsLab, 2nd. ed., De Gruyter, Berlin and Boston 2016, p. 29 ff.

of all edges of the graph increased by the sum of the lengths of those added edges that the postman needs to go over:

$$L_{\min} = \sum_{i=1}^{m} n_i \cdot l_i$$

where m - is number of the graph's edges, l_i - length of edge i and n_i - number which shows how many times did the postman pass the edge i (where $n_i \ge 1$).

2.1.2 Chinese postman problem on directed graph (DCPP)

The solution of the Chinese Postman's problem on a directed graph is based on the theory that the graph of the considered problem needs to (if not already) be reduced to a directed Euler graph⁹, which is performed as follows:

- 1. The input and output degrees of each of the vertices in the graph are determined.
- 2. If the input degree in each vertex is equal to the output degree, the graph is symmetrical and even therefore permits the directed Euler cycle, which is also the optimal tour. The sum of the lengths of all edges of the considered graph gives the length of the shortest path the postman needs to pass:

$$L_{\min} = \sum_{i=1}^{m} l_i$$

where m is number of graph's edges, l_i - length of edge i.

- 3. If the graph of the considered problem is not symmetrical, i.e. it contains vertices with different input and output degrees, it should be made into symmetrical by adding artificial arcs that are parallel to the existing ones:
 - a. If in the considered asymmetric vertex v the input degree is vu and the output degree is vi, and if vu > vi then the difference Sv = vu vi is called the vertex supply v and it shows the number of artificial vertices that begin with the vertex v (output from that vertex) that need to be added so that the vertex becomes symmetrical).
 - b. If in the considered asymmetric vertex v is applied vi > vu then the difference Dv = vi vu is called the demand of the vertex v and it shows the number of artificial vertices that end in the vertex v (they enter that vertex) which need to be added so that the vertex becomes symmetrical.
- 4. The total supply of all vertices that have higher inputs than the outputs must be equal to the total demand of all vertices that have higher output level than the input
- 5. Now vertices must be paired in order to make them symmetrical, and the additional artificial arcs must have minimal total length because the postman must go through these arcs again, and in the end the obtained graph is symmetrical and allows the directed Euler cycle; the shortest way a postman has to cross is equal to the sum of the length of all the graphs arcs plus the sum of the additional arcs that the postman needs to pass again:

$$L_{\min} = \sum_{i=1}^{m} n_i \cdot l_i$$

⁹ Golemac A., Mimica A., i Vučičić T.: Od koenigsberških mostova do kineskog poštara, Math.e: Hrvatski matematički elektronički časopis, 2012. Retrieved from: http://e.math.hr/math_e_article/br21/golemac2 (11.6.2018.)

where m - is number of graph's edges, l_i - length of i edge and n_i - number which shows how many times did the postman pass the edge i (where $n_i \ge 1$).

2.1.3 Chinese postman problem on mixed graph (MCPP)

Heuristic algorithms for solving the MCPP have been developed in two directions: by reducing it on the problem of the integral linear programming or on approximate heuristic algorithms.

The mixed graphs discussed in this paper are relatively simple, and the initial step of one of the two most significant proposed heuristic algorithms will be used: the default mixed graph will be converted to undirected (all of the graph's arcs will be converted to edges), after which the next steps required for troubleshooting on a undirected graph (UCPP) will be applied, which in several iterations (trial and error) should lead to an optimal solution.

After converting arcs into edges, the following should be considered:

- 1. all odd-degree nodes should be made even-degree by adding artificial edges,
- 2. when connecting odd-degree nodes using an edge that is originally an arc, the default direction of that arc must be maintained,
- 3. all graph vertices must ultimately be symmetrical, i.e. their input level must be equal to the output; special attention should be given to vertices that are connected to the remaining graph vertices only or mainly with the arcs.

3. Calculation and analysis of the results

In this paper, two practical examples of waste collection have been calculated with the minimal waste collecting vehicle travel distance: one in the Split area, more precisely the area bordered by Velebit Street (north and east), Matica hrvatska Street (south), and Bruno Bušić Street (west) (Fig 8), and the other is WangSanRi (왕신리) in Mohyeon, Yongin, South Korea (Fig 9).



Figure 8 Map of the selected area of the city of Split



Figure 9 Map of the selected area in Mohyeon (WangSanRi (왕선리))Yongin, South Korea

The examples were first solved manually using the Chinese postman method on a mixed graph using a heuristic algorithm, and then on a computer using the CPP module from LogisticsLab. The maps of the selected areas are presented in Google Maps, while the lengths of the edges (streets) are measured by using the 'Measure by distance' option on the right-click pop out menu in Google Maps.

3.1 Selected area in city of Split

Considered area of the city of Split is displayed on the graph in Fig 10. The graph consists of 33 vertices and 49 edges (streets). The vertices are marked with the letter N and with the corresponding numbers (from N1 to N33). The vehicle moves from the vertex N1, must pass all the edges of the graph and then return to vertex N1.

Of total 49 edges, there are five arcs (one-way streets), while the others are edges (two-way streets). Edges in Fig 11 are marked by numbers, while the weights of each edge and/or arc are shown in Table 1.

Table 1 The weights of the graph vertices that these edges merge (Split)

edge NO	first vertex	second vertex	weight (in meters)
1	N1	N4	434
2	N1	N8	550
3	N2	N3	131

edge NO	first vertex	second vertex	weight (in meters)
25	N15	N16	457
26	N16	N17	327
27	N16	N21	111

4	N2	N9	285
5	N3	N4	260
6	N3	N10	305
7	N4	N5	59
8	N5	N6	335
9	N5	N14	417
10	N6	N7	557
11	N6	N15	231
12	N7	N8	40
13	N7	N17	231
14	N8	N22	388
15	N9	N10	74
16	N9	N18	267
17	N10	N12	280
18	N11	N13	227
19	N12	N11	237
20	N12	N13	123
21	N12	N19	78
22	N13	N14	80
23	N14	N15	94
24	N14	N20	194

28	N18	N19	266
29	N18	N23	238
30	N19	N20	273
31	N19	N25	114
32	N20	N21	418
33	N20	N27	170
34	N21	N22	412
35	N22	N33	215
36	N23	N24	118
37	N23	N28	98
38	N24	N25	263
39	N24	N29	85
40	N25	N26	250
41	N26	N24	400
42	N26	N27	121
43	N27	N30	203
44	N28	N29	152
45	N29	N30	524
46	N30	N31	303
47	N31	N32	530
48	N31	N33	715
49	N32	N33	179
Total 1	ength of all	edges:	12819

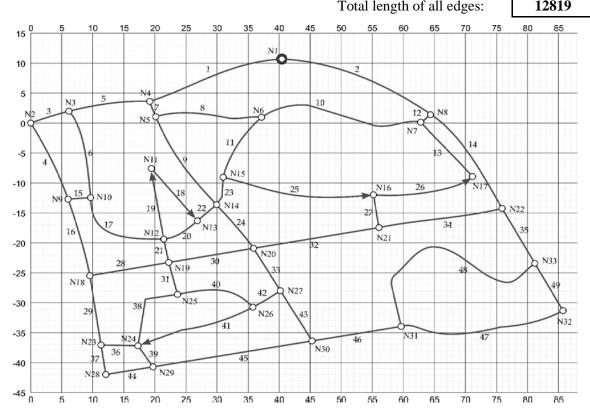


Figure 10 Mixed graph of the area in city of Split

After the preparation and entry of the data with the CPP module, a solution of the discussed problem is presented in Fig 11.

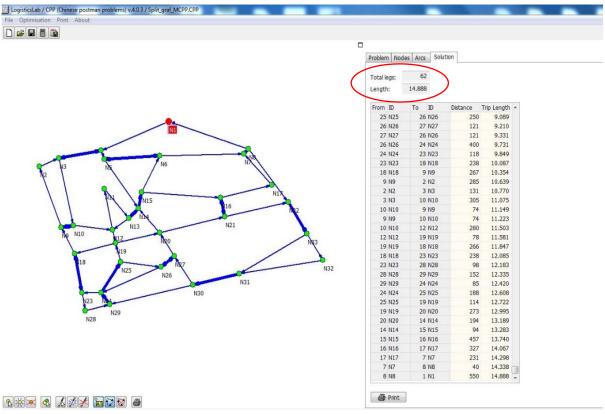


Figure 11 A display of the solution (Split) calculated by using program CPP.exe

It is concluded that the shortest path that a vehicle has to travel in order to complete the task at hand is 14,888 meters, which is 2,069 meters more than the total length of all edges of the graph (12,819 meters). The optimal tour can be read from the table in Fig. 11 to the right.

Identical result is obtained when this problem is solved on undirected graph, with the assumption that all the streets are bi-directional.

3.2 Selected area in city Mohyeon, Yongin, South Korea

Considered area of the city Mohyeon, Yongin is displayed on the graph in Fig 12. The graph consists of 26 vertices and 40 edges (street). Vertices are marked with the letter N and with the corresponding numbers (from N1 to N30). The vehicle moves from the vertex N1, it must pass through all the edges of the graph and then return to vertex N1.

All the streets in the selected part of the city are two-way, so the graph is undirected and consists of 40 edges. The edges on Fig 12 are indicated by numbers, while the weights of each edge or arc are shown in Table 2.

Table 2 The weights of the graph vertices that these edges merge (WangSangRi, Mohyeon, Yongin)

edge NO	first vertex	second vertex	weight (in metres)
1	N1	N2	314
2	N1	N3	273
3	N2	N4	354
4	N3	N4	161

edge NO	first vertex	second vertex	weight (in meters)
21	N13	N15	162
22	N14	N15	265
23	N14	N16	85
24	N15	N17	74

5	N3	N5	336
6	N4	N5	389
7	N4	N6	350
8	N5	N6	270
9	N5	N7	99
10	N6	N8	99
11	N7	N8	270
12	N7	N14	349
13	N8	N9	206
14	N9	N10	98
15	N9	N11	86
16	N9	N13	70
17	N10	N12	58
18	N11	N13	105
19	N12	N13	70
20	N12	N14	225

25	N16	N17	255
26	N16	N18	80
27	N17	N18	230
28	N17	N19	75
29	N18	N19	226
30	N18	N20	195
31	N19	N21	153
32	N19	N22	108
33	N19	N21	119
34	N20	N23	182
35	N21	N22	101
36	N21	N24	217
37	N23	N24	142
38	N23	N25	136
39	N24	N26	82
40	N25	N26	169
Total length of all edges:			7238

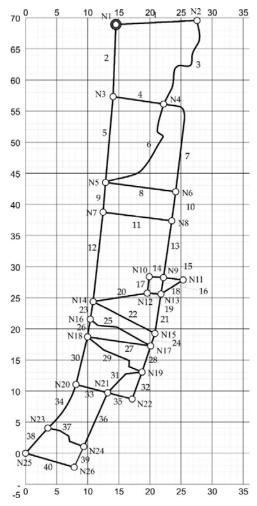


Figure 12 Undirected graph of the considered area of WangSanRi, Mohyeon, Yongin

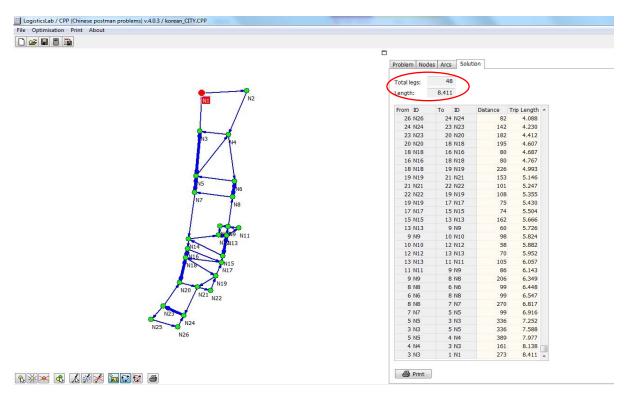


Figure 13 A display of the solution (WangSanRi, Mohyeon, Yongin) calculated by using program CPP.exe

After the preparation and entry of the data using the CPP module, a solution of the discussed problem is presented in Fig 13.

It is concluded that the shortest route the vehicle has to travel in order to perform the task is 8,411 meters, i. e. 1,173 meters more than the total length of all the edges of the graph (7,238 meters).

The optimal tour can be seen in the table in Fig 13 to the right.

4. Conclusion

This paper presents the possibility of applying the Chinese postman problem in optimizing the waste collection routes in the city of Split, Croatia, and the city of Mohyeon, Yongin, South Korea. Whilst doing so, heuristic algorithms for solving the Chinese postman problem were also explained.

On the actual real examples of waste collection, it has been shown that by using the chosen method and with relatively large number of vertices and edges of the graphs, the optimal routes of the waste collecting vehicle can be calculated in real time, either by manual computation or by using the computer program.

Even though the obtained solutions are subjected to the various influences such as road works, changing two-way streets into one-way streets (and vice versa) etc., they can be used as a useful guide in defining the order of visiting the streets for the purpose of minimizing the waste collection routes.

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Internal Rate of Return Method - a Commonly Used Method with Few Advantages and Many Disadvantages?

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Abstract. The financial textbooks state that it is always best to use the net present value (NPV) method when making investment decision. However, many studies show that in reality, managers prefer the internal rate of return (IRR) method to assess capital project. The IRR method, by definition, represents the average annual rate of return with assumption that that excess money from project will be reinvested at a rate that is exactly the same as IRR. The IRR method by definition points to the lack of the method itself, which is the reinvestment rate. IRR does have its allure, primarily because its result is shown as a percentage and it is easy to interpret it and compare it with other investments. That ease of comparison seems to outweigh components that most managers' view as largely technical deficiencies. The aim of this paper is to show the main disadvantages of the IRR method, which one should be aware of when using the method itself. The paper also raises the question regarding the real cash flow upon which the IRR method is used, especially when not only equity, but also, debt is involved in financing the project. In such a case, for each project stakeholder, making a decision through the IRR method also requires the creation of a separate cash flow.

Key words: internal rate of return, net present value, capital budgeting, capital project

1. Introduction

The decision to choose the most economically feasible project first of all starts from its initial form, an idea that, accompanied by good strategy and the use of capital budgeting techniques, creates its flexibility to the risks it always has. Also, the most economically profitable project should be the one that, in relation to all other projects of the same risk, gives the investor the most value from the project itself, therefore, a financial expert should always be involved in the process of evaluating the most economically profitable project because among the several offered alternatives, which often give the wrong initial signals, always just one leads to maximizing well-being at the desired rates.

This paper demonstrates the impact of the internal rate of return (IRR) on decisions whether starting the project will be economically profitable, or whether the investor can expect returns from the project he has set as targeted. Given the variable cash flows of an observed project that directly affect IRR, it is important to show all the advantages and disadvantages of applying the IRR method, as well as the firm connection of the IRR method to another, theoretically superior, NPV method. These two methods are one of most relevant methods for deciding is the project economically profitable.

The financial textbooks state that it is always best to use the net present value (NPV) method when making investment decision. However, many studies show that in reality, managers prefer the internal rate of return (IRR) method to assess capital project. In a survey of 90 US firms and 65 Canadian firms by Payne, Heath and Gale (1999) managers of US firms ranked

IRR as number one, ahead of NPV, which was refereed the second most important technique while in Canada IRR was ranked as number two and NPV as number one in importance. When compared to mentioned survey, research of Brounen, de Jong and Koedijk (2004) showed that most European firms select payback period as their most frequently used capital budgeting technique. In the U.K., the Netherlands, Germany and France respectively 69.2%, 64.7%, 50.0% and 50.9% of CFOs use the payback period as their most wanted tool. In Europe the payback period criterion is immediately followed by NPV and IRR methods. In the U.K., Netherlands, Germany and France respectively 53.1%, 56.0%, 44.1% and 44.1% of CFOs use the IRR method while 47.0%, 70.0%, 47.6% and 35.1 of all CEOs in these countries rely on the NPV method.

The relative popularity of the payback period in Europe is surprising, because financial textbooks have discussed the shortcomings of the payback criterion for many decades. As is well know the payback period ignores the time value of money and cash flows beyond the cut-off date. When Brounen, de Jong and Koedijk (2004) in their research took firm characteristics into account they notice that use of payback criterion is more popular among smaller firms (except for the U.K) and among firms with management belonging to the highest age cluster. The pay-back period is more popular among private companies than among public corporations. The NPV is used significantly more often by large firms and by firms, managed by CEO with an MBA.

2. Internal rate of return (IRR) method

Internal rate of return (IRR) is one of the fundamental criteria for financial decision making, which in its relative expression provides information to the investor on the return on his investment. According to Orsag (2002) IRR is a discount rate that reduces the project's net cash flows throughout the life of the project to the value of its investment costs. It is a rate of return on investment in a project that respects the time value of cash flows throughout the life of the project.

IRR represents a discount rate which leads to a project net present value (NPV) of zero where present value of the cash inflows equals to the cash outflows. It also means that IRR is the discount rate that makes NPV equal 0.

One of the fundamental features of IRR is to compare discounted cash receipts and expenditures with zero to obtain the required rate. From the above mentioned it follows that IRR in application is one of the more demanding methods for the calculation of which requires certain mathematical knowledge, especially since its calculation is made by trial and error or modern approach using software such as MS Excel.

The IRR is always expressed as a percentage. For a project to be acceptable under the IRR method, the discount rate must exceed the project's cost of capital, otherwise known as the hurdle rate or opportunity cost of capital. An IRR less the hurdle rate represents a cost to shareholder and project should be rejected. An IRR greater than the hurdle rate represents a return on investment, increasing shareholder wealth and project should be accepted.

From the above definitions of the IRR method we can distinguish the most significant characteristics of IRR method, which are:

- One of the fundamental measures of project profitability.
- Uses the concept of the time value of money, that is, discounts the expected future cash flows to the present value because money today is worth more than money tomorrow.
- It is calculated by trial and error or by software e.g. MS Excel.
- It is closely related to the NPV method.
- Assumes reinvestment of excess cash at a rate equal to IRR.

- Can be interpreted as the maximum interest rate on the loan used to fund the project.

3. Advantages of IRR method

Some of the basic benefits of the IRR method are:

- It takes into account the concept of time value of money
- It's easy to use
- It avoids subjective determination of the discount rate

The first big advantage of IRR is that it takes into account the concept of time value of money that says that the money available today is worth more than the same amount of money tomorrow.

Another advantage of the IRR method is its simplicity of use since the result of the calculation gained in relative value is:

- Easily comparable (comparison of IRR with the required, expected rate of return by investors but also when comparing the IRR of one potential project with another potential project).
- Easy to understand (IRR shows the real profitability of the project, after accounting for all cash flows).
- Easiness of decision making regarding project selection where a project whose IRR is higher than the required rate of return is accepted.

A third advantage of the IRR method is that it avoids the subjective determination of the discount rate, since the IRR itself is a discount rate at which the NPV of the project is zero. IRR provides an accurate information on the amount of rate of return an investor can expect by choosing a project using the IRR method as an indicator and therefore can compare this rate with the cost of capital and hence make a decision on the choice of a capital project based on facts.

4. Disadvantages (pitfalls) of IRR method

Unfortunately, IRR gives rise to serious conceptual and technical problems:

- Multiple IRRs may arise.
- A real-valued IRR may not exist, so that the comparison with the cost of capital is not possible.
- The IRR may not be used if the cost of capital is variable over time.
- The IRR is not capable of signalling the entire loss of investment (-100%).
- It assumes that cash flows are reinvested at the IRR rate, which is usually not possible in real situation.
- It neglects the size of the project, that is, the IRR is a relative measure of project profitability, which means that it provides information only on the average annual rate of return and not on the absolute amount (not necessarily a disadvantage).
- It takes too much time to manually calculate IRR using the trial and error method (by calculating with MS Excel, this deficiency was eliminated).

There are lot of IRR shortcomings and a huge amount of contribution have been devoted to searching for corrective procedures capable of healing its flaws. In next part of paper, we will give a greater overview of some of the above shortcomings of IRR method.

4.1. Multiple IRRs

The first fundamental drawback of IRR is that multiple internal rates of profitability can occur in one project. This means that if the project's cash flows diverge from the standard ones, where after the initial investment, which should be followed by positive cash flows, negative

cash flows occur again, then the IRR calculation rule alone is no longer valid. As this is a rather complex problem, it will be illustrated in the following example.

The project, which requires an initial investment of HRK 220000 and expects to receive cash flows from operations in the amount of HRK 150000 in each of the next four years, will enter an additional cost in the fifth year, cash outflow of HRK 400000. The IRR of this project will have two different rates as shown in the Table 1.

Table 1 Multiple IRRs

Year	Cash flows of project	IRR 1	IRR 2
0	-22000		
1	15000		27,78%
2	15000	5.620/	
3	15000	5,62%	
4	15000		
5	-40000		

Source: author's calculation

The two IRR rates from the previous calculation show values where the NPV of the project is zero and that the NPV of the project will be positive only with a capital cost rate ranging from 5.62% to 27.78%.

How much IRRs can be in accordance with the cash flow shown? The answer is that the maximum number of IRRs obtained is equal to the number of sign changes in the cash flows of the project. As in the example shown, the project had a change of sign in a project cash flows two times, from - to +, and finally from + to -, so it is possible that the project has two IRRs.

A solution to the problem of multiple IRRs may be to convert multiple IRRs to single IRR. The intended solution is then an extended yield function that reduces unconventional cash flows to conventional ones, avoiding the possibility of multiple IRRs. This is achieved by discounting the negative cash flow at the cost of equity (the default discount rate) and subtracting it from the positive cash flow in the year to which that negative cash flow is reduced by discounting. In this way, multiple negative net cash flows are avoided so that an unambiguous solution is obtained using the internal rate of return method.

According to Bierman and Smidt (2007) it is important to determine whether cash flows are conventional because a conventional investment will have at most one positive internal rate of return. If an investment is not conventional, we call it an unconventional investment. With an unconventional investment, any of the following situations is possible:

- the investment does not have an internal rate of return
- the investment has one internal rate of return.
- the investment has more internal rates of profitability.

Considering the above mentioned, the conclusion is that the lack of multiple internal rates can be eliminated with the foregoing features that the application looks like the following:

The investor wants to evaluate the project XY whose parameters are set out in the Table 2. The required investor rate (hurdle rate) is 10%.

Table 2 Projected cash flows of the XY project before applying the extended yield function

Year	Project XY cash flows	IRR 1	IRR 2
0	-105000		
1	80000		
2	80000		
3	80000	0,88%	57,63%
4	80000		
5	80000		
6	-300000		

Source: Authors' calculation

In the example in Table 2, the following can be detected:

- the project has a negative cash flow in year 6,
- the project has a multiple IRR rate

To solve the problem of multiple IRR next steps should be done. The expenditure in year 6 should be discounted in such a way that its value in year 0 will be calculated. Using the formula for calculating present value, the present value of future expenditure (-300000) is -169342.18 This amount is counted against the initial investment amount in year 0. Now all expenditures are considered as one expenditure in the first year of the project. Their sum is -274,342.18. Using the obtained parameters, we arrive at the final evaluation projected in the following Table 3.

Table 3 IRR after application of the extended yield function

Year	Project XY cash flows	IRR 1	IRR 2
0	-274342,18		
1	80000		
2	80000		
3	80000	14,05%	14,05%
4	80000		
5	80000		
6	0,00		

Source: Authors' calculation

It is noticeable that the application of the extended yield function results in a change in the IRR which is now 14.05% and as such is unique, which was not the situation in the previous calculation method presented in Table 2. To conclude, the investor can rely on this method of calculation, which provides him with the necessary information when making his decision, although the calculation itself takes a little longer.

4.2. IRRs reinvested rate

Another fundamental disadvantage of the IRR method is the assumption that the generated cash flows will be reinvested at a rate exactly equal to the IRR. Reinvestment at an IRR rate would mean that all cash flows during the project life are reinvested until its end at the same IRR rate. According to Kelleher and MacCormack (2004) this is often not possible in practice because the IRR, or rather the rate of return that an investor expects, can be much higher than

the discount rate that defines the cost of capital, so this situation can lead to wrong conclusions.

Although lately some economic journals have called this lack of IRR a myth, as it is clear that the IRR method discounts all cash flows by discounting them to their present value, not their future value. The question is then how can this deficiency be called a myth on the one hand and the most dangerous assumption on the other. The answer to this question is given in the following example shown with Figure 1.

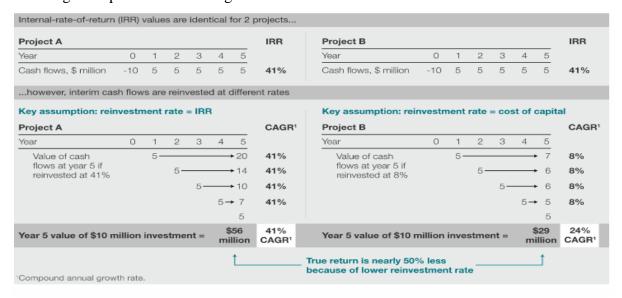


Figure 1 Modelling returns using internal rate of return (IRR) vs. cost of capital

The figure shows two mutually exclusive projects with different investment assumptions but with the same cash flows for the duration of each project. Also, both projects have the same IRR, equal risk level and duration. Project A assumes that the cash flows generated will be reinvested at an IRR rate of 41% and, on the other hand, project B assumes that the cash flows will be reinvested at a capital cost rate of 8%. For Project A, an investment of 10 billion \$ with 41% reinvestment rate upon completion of the project would generate 56 billion \$ while in project B would generate an identical investment amount of 29 billion \$. The question is, what is the more realistic approach to this assessment? The answer should be summarized in what aspect the investor will make the decision about the reality of applying the calculated rate, because if the investor thinks that the project could really earn 41% of the added value annually, then Project A is definitely better. There is a general opinion that the cost of capital, which is often lower than the IRR rate, better reflects the rate that a company could earn. Such an opinion proved to be very grounded in practice, therefore, a kind of response to the shortcomings of the IRR method contained in the modified internal profitability rate was necessary.

4.3. Modified internal rate of return (MIRR)

The modified internal rate of return (MIRR) is a kind of answer to both of the fundamental drawbacks of the IRR previously presented (assumption that the generated cash flows will be reinvested at the IRR rate and the lack of multiple IRRs that occur when an investment is made unconventional, that is, when cash flows change signs in the years after the initial investment).

Given that the IRR contains the implicit assumption of reinvestment of cash flows at a rate equal to the IRR, with a modified internal rate of return (MIRR), the reinvestment rate can be modified, as the name implies, and therefore the rate of reinvestment will be adjusted to the

actual situation. Most often, the MIRR includes the rate of reinvestment at cost of capital, but it is also possible to choose any other rate that is more relevant to the current investment project.

The following examples will, for simplicity, use in parallel identical values to the examples used to display multiple IRRs and to an extended yield function that eliminates the lack of multiple IRRs.

Table 4 MIRR calculation for multiple IRRs

Year	Project cash flows	IRR 1	IRR 2	MIRR
0	-105000			
1	80000			
2	80000			
3	80000	0,88%	57,63%	11,85%
4	80000			
5	80000	1		
6	-300000			

Source: Authors' calculation

Table 4 shows multiple IRR rates, in this case 0.88% and 57.63%, which represent incomplete and useless information to the investor. Assuming that the investor wants a return of 10% on the invested (cost of capital) but also wants to reinvest at the rate of also 10%, we come to the calculation of the modified internal profitability rate of 11.85%.

If we take the MIRR calculation after applying the extended yield function, the situation is as in the following Table 5.

Table 5 Calculation of MIRR after application of the extended yield function

Year	Project cash flows	IRR 1	IRR 2	MIRR
0	-274342,18			
1	80000			
2	80000			
3	80000	14,05%	14,05%	11,85%
4	80000			
5	80000			
6	0,00			

Source: Authors' calculation

Table 5 shows that there is no longer a lack of multiple returns in the calculation of IRR, therefore, all project cash flows are also used in the MIRR calculation, but, as shown above, the negative cash flow from year 6 is discounted to the initial year of the project and added to the same as an initial outlay. In this case, with all cash flows, a reinvestment rate of 10% is used, but the MIRR calculation does not use the data on the rate of return on investment since it is contained in the discounted negative cash flow from year 6. As seen, in both cases MIRR is 11.85%, which confirms the correctness of the calculation but also that MIRR eliminates the lack of multiple IRRs.

From all the previous examples, it can be concluded that the MIRR eliminates the basic two disadvantages of the IRR and its application in these cases is a more tangible choice for the investor and provides greater security when comparing different sizes of investment projects, but this method raises the question of the accuracy of the assumed rate cost of capital (discount rates).

5. Conclusion

A fundamental feature of the IRR method is the fact that IRR has its drawbacks and, as such, is vulnerable to project evaluation errors. It is important to mention the fact that only projects of equal risk can be compared if one wants to make the most precise decision on which project to choose. It is also of greatest importance to estimate the cost of capital as accurately as this is the basis from which the IRR method is applied.

The IRR method stands out as an objective method for project evaluation because with its great ease of implementation, it eliminates its fundamental shortcomings with modifications. Although IRR seems to be a kind of alternative to the NPV method, few can agree, because it is the combination of the two methods that make the best choice. This is supported by the fact that IRR method is a relative indicator of the profitability of the observed project and the NPV is an absolute indicator of the expected realized value of the project. Unlike the NPV method, the IRR method is a much more representative illustration of the actual state of a particular project and does not require negotiating a discount rate to cover the cost of capital while the NPV of a project is absolutely dependent on the discount rate used. Based upon the afore mentioned, it can be concluded that IRR is a necessary indicator in assessing the economic viability of a project, because in most possible scenarios it provides greater comparability of projects, especially in situations where it is necessary to arrive at a calculation in the shortest possible time.

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Retail: Problems, Development Trends

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Abstract. Currently, the development of globalization trends has led to a kind of revolution in the global retail system. Retail companies play a significant role in society. They are one of the first to respond to changes in market conditions, as they directly interact with a wide range of consumers: and the problem of determining the factors affecting the effectiveness of companies, as well as the nature of their influence, are becoming increasingly important. The reason for this is both structural problems in the economies of many countries and the natural desire of various companies to maximize their market position. The realities of today allow us to make sure: retail is increasingly using online space to increase the efficiency and effectiveness of interaction with the consumer. In the vast majority of cases, it is here that the initial knowledge of the offer, the characteristics of the goods and services is obtained, the consumer values of the competitor products are compared, and sales transactions are selected and updated. In contrast to traditional retailing, the online retail sector shows strong growth, and the most competitive position is taken by companies whose indispensable attribute is online interaction with the consumer. In this context, this paper presents an analysis of the development of retail as a business activity, the main problems and opportunities of retail companies and the impact of various factors on their activities, The peculiarity of estimation of financial results of activity of retail enterprises is taken into account, and peculiarities of estimation of competition in the field of retail are identified. Conclusions have been drawn on the importance of retail as a sector of the economy, showing that in order to maintain a market position in economically difficult times, it is necessary to develop and implement a holistic anti-crisis concept, including tools for overcoming the situation.

Key words: retail, network retail, competitiveness, market

1. Introduction

With the changes currently taking place in the consumer market, companies are forced to seek new approaches to consumer consciousness. Currently, the domestic retail is moving towards the consolidation of the existing trading networks through the cooperation of several traders under the same brand. Any market players are perfecting logistics schemes to promote trade flows, others see an exit in the physical capture of the market and the proliferation of trading networks in the regions, still others are going in a more efficient way, By personifying its appeal to customers through the use of new digital technologies. The work of the retail team today is aimed at promoting into new market segments and unfolding new trade formats.

The Riteil differs from other sectors of the national economy in that it is subject to stronger competitive forces as a result of the existence of a significant number of competitors. This is confirmed by the number of companies in the trade sector and can be explained by the low

entry barriers in this market. The market for the network is a dynamic force characterized by the entry or exit of major players and the continuous change of leadership. The modernization of trade increases consumer comfort and satisfaction, and the development of new forms of trade, in particular on-line trade, thus contributing to consumer welfare.

Since the retail sector establishes the link between producer and consumer, thus acting on the market of the purchase and marketing of products it is necessary to carry out a complex analysis of the results of the activity depending on a constantly changing market environment. This will make the company sustainable profitable and competitive, ensure its development, anticipate the future.

By conducting a systematic and in-depth analysis of commercial activities, it is possible: to assess the commercial performance of the enterprise as a whole and its structural units in a rapid, qualitative and professional manner; to identify and take into account the factors in a precise and timely manner, Influencing profits by specific traded goods and services; determining trade costs and trends, which are necessary for determining the selling price and calculating the profitability; To find the best ways to solve the commercial problems of the trading enterprise and to obtain sufficient profit in the short and long term.

In modern conditions, the economy of Moldova is characterized by financial instability, inconsistency of tax, monetary, customs, investment policies, insufficient budget financing, inflation, uncertainty in the behavior of buyers, suppliers, competitors. In addition, entrepreneurs are forced to conduct their economic activities in the face of fierce competition. This situation is aggravated by growing expectations of consumers in relation to purchased goods or services. The development and survival of modern retail are driven by constant changes in consumer preferences and the emergence of new players in the retail market.

The quantitative and qualitative expansion of the institutional structures in the retail market has contributed to the restructuring of the sphere of circulation, one of whose manifestations has been the strengthening of the monopoly position of trade networks.

In this context, research on the state and trends of retail development, problems in this area, estimation of financial performance of retail enterprises, peculiarities of evaluation of competition in retail is particularly relevant.

2. Current status and development trends of retail

The development of processes in the context of scientific and technological progress necessarily leads to the emergence of optimizing formats for organizing trading activities. Today, retail is one of the most successfully developing sectors of the economy, since regardless of the format, time and place of action, it makes money by retailing goods and services to the final customer, relying on the achievements of science, own knowledge, and personnel experience. The basic principles of retail are the openness and accessibility of goods and services, and one of the reasons for the popularity of retail is the ability to ensure that the consumer basket is filled with a better service in one place. Malls are an example of today's retail centers. Trade, as a type of entrepreneurial activity and the field of scientific research, has been formed over a long period of time.

The first stage in the evolution of the trade sector covers the period from the 1920s to the beginning of the 1950s, when abroad the "erasing of the barrier" between the consumer and the goods took place, while until that moment all world trade was conducted exclusively through the counter. A number of experts associate the emergence of self-service with the Great Depression in the United States, since it was there, in 1929, to lower prices and reduce the cost of organizing trade, self-service stores were created, which led to a reduction in the staff of sellers. However, others believe that the first self-service stores were opened in California back in 1912. At about the same time, the first network of six Humpty Dumpty

Stories retail outlets was launched. The first supermarket in the modern sense of the format was opened in 1916, and seven years after that, the retail chain already numbered 2.8 thousand stores. The first shopping center appeared in America in the 1920s and the first hypermarket in 1930. At the same time, large stores specializing in sales promotion programs - promotions and discounts - were opened in Belgium and France on the outskirts of cities. The economic sense of the innovation was to reduce costs by acquiring low-cost suburban real estate and setting lower prices for goods, which ultimately attracted buyers. (Berman, 2006, p. 125).

In the 40s of the XIX century, electronic commerce was born, when large American trading systems were united by a telegraph network, which transmitted information about prices on markets in different parts of the country. The first examples of electronic commerce are rooted in banking operations and the process, called "wire transfers." With the invention of the telephone, it became possible to submit applications for the purchase and sale of goods, manage a bank account, etc. With the development of electronics, financial institutions have the opportunity to develop fast, safe, cheap and reliable means of calculation.

In the period from the mid 1950s to the 1970s, attention to customers increased, new service methods were introduced, more and more diverse products appeared, marketing and logistics concepts became widespread in trade, solutions were developed to reduce the number of order cycles, production was optimized, it was established that material flows at the stages of storage and transportation of goods should be linked into a single management system. All this has significantly reduced costs and increased economic effect by combining disparate distribution functions.

In the late 1950s and early 1960s, the United States began to develop online trading formats, and thanks to the removal of legislative restrictions on monopolies, Wal-Mart, Target, and Kmart retail chains increased their momentum. The tendency to organize suburban shopping centers with large parking lots and large trading and catering enterprises was developing, and discount trade was improving. With the organization of warehouses, the computerization of management processes began. In the same period, as a result of the introduction of the latest, for the second half of the 20th century, technologies for automating sales of goods and services and the implementation of the automated resource management system of large companies in the USA, electronic commerce in the modern sense was born. Moreover, the first e-commerce systems arose in the 60s and were used by transport companies to order tickets and exchange data between different services when preparing flights.

The third stage, limited by the time frame of the 1970s, is characterized as a stage of optimization of trading processes. Specialists at this time are engaged in the distribution and use of the total resource potential of trade organizations. With regard to the electronic sector of the economy, in the USA, the nature of relations in the markets for goods and services, as well as the relationship between sellers and buyers has fundamentally changed. The most important object of production and consumer activity has become information products and services managed, organized, transmitted and stored in electronic form.

In Europe, the development of e-commerce systems began with the introduction of electronic mechanisms in settlement systems, namely, clearing and transfer systems in the UK. So, already in 1968, in the United Kingdom, an electronic transfer and clearing system BACS (Bankers Automated Clearing Services) was created in the UK to service commercial non-cash transactions. A similar system in the USA was founded by the New York Association of Clearing Chambers in 1970 to switch from paper-based settlements to electronic settlements. However, effective automated commercial interaction became possible only with the availability and smooth functioning of the Internet, which appeared in 1969, and the legal framework that streamlined and regulated commercial relations on the Internet.

In the 1980s of the last century, the rapid growth of e-commerce turnover began, structural changes were taking place in the business, and the ideology of quality management was being introduced into the management of trading enterprises. Thanks to the development of personal computers, Electronic Data Interchange (EDI) technologies have come to retail. The trading sector receives an on-line monitoring tool for the movement of logistics flows, from procurement and effective work with suppliers to the sale of products to the final consumer, and it becomes possible to provide remote access using telecommunication and satellite technologies, electronic data exchange, high-speed computer networks, etc. The next evolutionary stage, starting from the '90s of the last century to the present, the world economy is undergoing functional changes in approaches to the organization and management of market business processes. Many firms are actively expanding their activities beyond the regional or national level, gradually entering the global market.

At the same time, e-commerce began to include not only on-line transactions, but also activities such as conducting market research, identifying opportunities and partners, maintaining relationships with suppliers and consumers, organizing workflow, etc. One of the first authors, who examined the theoretical aspects of this phenomenon, and characterizing e-commerce, is an American economist David Kosiur. He is among researchers who view e-commerce as e-commerce. These authors consider electronic commerce and electronic commerce as synonyms or special cases of each other. The broadest definition of the concept of "electronic commerce" is given in the book of the American economist Gary P., which includes all types of economic activities that use Internet technology. Internet technologies are understood as the use of the Internet system itself, the World Wide Web space and others, such as wireless data transmission systems and mobile telephone networks (Gary, 2011, p. 4). At the same time, the idea to sell products on the Internet on a large scale appeared in 1994, when Amazon founder Jeffrey Bezos, vice president of the hedge fund D.E. Shaw & Co, decided to create a remote selling store. Barcode and electronic money transfer technologies are widely distributed. (Timmers, 1998, p. 5)

According to practitioners' estimates, a development stage is currently being observed, which is characterized by growing competition, the structuring of the retail market, and the dominance and accelerated development of network forms of business organization. For example, the strategy for the development of trade in the Republic of Moldova for the period up to 2020 indicates that retail trade is at a stage of rapid growth. However, it is expected that in 10-15 years this growth will slow down. Thus, for the further development of the trading industry, it is now necessary to make a quantum leap. Another reason for finding the best ways to develop trade is the entry into the Moldovan market of international retail chains, which have already taken leading positions and are currently competing not only with national chains, but also with each other. In this competitive struggle, domestic trade cannot take a leading position at present, since global trading companies that have successfully mastered the markets work together with large international logistics companies.

However, the truly revolutionary changes in the development of the trading business and logistics in Moldova, as well as in other countries, are brought by the Internet. It was its development that made it possible to reconnect the producer and the consumer in a new way, to form new channels of communication access to consumer demand, to reduce costs as much as possible and to offer a cheaper product, weakening the price positioning of stationary retail. It was the development of Internet commerce that made it possible to reduce the long intermediary chain, increase the perimeter of the supply chain while reducing the cost of goods distribution. Such a transition was actually revolutionary for modern retail, since it led to the emergence of a new business model of sales organization, which in itself is no less rapidly evolving today under the influence of its equally complex operational improvement.

Currently, in all areas of activity, globalization is intensely manifested. The Internet, mobile technologies, corporate information systems and other devices have firmly entered into the business practice of trading, service and other companies engaged in entrepreneurial activities. Globalization of business is driven by increased international trade and competition, driven by reduced trade barriers between countries. (Mahadevan, 2000)

In addition, the main trend of the decade, according to experts, is the growth of trade through the Internet. This sector currently accounts for more than 10% of the US retail market and more than 13% of the UK. By 2022, online trading is expected to account for about a third of the global market. However, the conclusion that traditional retail formats will disappear in the next decade is wrong. This should serve only as an impetus to the development of new business strategies and their further development. (Emerging Trends Report, 2013)

The use of Internet by enterprises allows you to: create a favorable image of your company or your products; make information about your company or your products available to Internet users; reduce advertising costs and provide support to their advertising agents; realize all the possibilities of presenting product information; promptly make changes to your price list, information about yourself or products, announce new products, quickly respond to a market situation; sell your products over the Internet without opening new outlets. Thus, the electronic network interaction of business entities in the sphere of circulation, acting as sellers, and buyers, and information figures of the market, end users of goods and services, government bodies - an objective necessity of modern business.

3. The specifics of assessing the financial results of the activities of business entities in the field of retail

Currently, business entities in the field of retail operate in a rapidly changing macroeconomic situation, in connection with which the issues of ensuring financial results and financial sustainability of their activities become the most relevant. Fulfillment of this goal requires a timely response to changes in the market situation and the achievement of sustainable financial development, and each trading operation should be accompanied by a high level of profitability with minimal risk. In this regard, in accordance with the objectives of the activity, retail enterprises should: take into account the needs of consumers and their purchasing power; to develop an assortment policy; to optimize the processes of delivery, storage, preparation for the sale and sale of goods; to provide a given turnover of material and labor resources. Trade enterprises should be focused not only on structural and organizational development, but also on improving financial results and financial stability of their activities.

For a trading company to function successfully, it is necessary to conduct an in-depth analysis of its business activities depending on a constantly changing market environment. This will make the company sustainable profitable and competitive, ensure its development, and anticipate the future. Evaluation of effectiveness is based on indicators that measure the results of the enterprise with the resources or costs used to achieve them. Therefore, a comprehensive study of the main results of activities and the state of resources of the analyzed economic entity is a prerequisite for calculating and analyzing the performance indicators of its functioning. In order to evaluate effectiveness, it is necessary to conduct a comprehensive analysis of the formation of such key performance indicators as commodity turnover, expenses, income, profit, as well as indicators characterizing the state of the enterprise's resources: the number and structure of labor resources, the dynamics of the cost and composition of fixed assets and current assets of the enterprise and etc.

Today, for a comprehensive assessment of the effectiveness of an enterprise, a system of indicators is needed, and the most important indicator of the effectiveness of a trading enterprise is profit, which reflects the results of the entire trading activity of the enterprise -

the volume, composition and assortment structure of products sold, labor productivity, cost level, the presence of non-production costs and losses, etc. The presence of profit indicates that the costs of trade enterprises fully cover income from the sale of goods and the provision of services. In trade distinguish between profit from the sale of goods (operating profit), the difference between trade margins and distribution costs and net, and book, profit. Of great importance is the factor analysis of profit from the sale of goods, since by its value it is possible to assess the profitability or disadvantage of the sale. To characterize the economic efficiency of a trading enterprise, as well as to conduct a comparative analysis, it is necessary to know not only the absolute value of profit, but also its level. The level of profit characterizes the profitability of trade organizations - the ratio of the amount of profit to turnover. The economic meaning of this indicator is to characterize the share of profit for every 100 MDL of goods turnover. Profitability is higher for those structures that have a wide range of goods, high turnover, and well-established business relations and increase the pace of retail turnover, improve work with customers. Profitability indicators more fully than profit characterize the final results of managing, because their value shows the ratio of the effect with cash or used resources. The system of indicators for assessing the profitability of the enterprise: net profit; profitability of products; profitability of core business; return on total capital; return on equity; payback period. In the process of analysis, it is necessary to study the dynamics of the listed profitability indicators, the implementation of the plan according to their level and conduct inter-farm comparisons with competing enterprises.

Evaluation of the effectiveness of commercial activities also provides for the determination of the indicator of retail turnover which characterizes the volume of activity, and its growth in comparable prices helps to increase consumer satisfaction. According to the growth rate of retail trade turnover, it is possible to rank trading enterprises and determine the rating of each of them in the aggregate. The rating tracks real shifts in the relative position of the studied objects. The rating score can be widely used in connection with the unification of business entities in organizational structures (retail enterprises are part of trading organizations). As an indicator, retail turnover is fundamental to the calculation of qualitative indicators of the effectiveness of commercial activities such as: turnover; labor productivity, cost-intensiveness, return on assets, profitability, etc.

Equally important, in assessing effectiveness, belongs to indicators that reflect financial solvency. The financial condition is characterized by a system of indicators reflecting the state of capital in the process of its circulation and the ability of the enterprise to finance its activities at a fixed point in time. With its help, a development strategy and tactics are developed, plans and managerial decisions are substantiated, their implementation is monitored, reserves for increasing efficiency are identified, and performance results are evaluated. For this purpose, a system of indicators of solvency, liquidity, return on equity, asset turnover, and the balance sheet total is calculated.

The signal indicator in which the financial condition is manifested is the solvency of the enterprise, which means its ability to satisfy payment requirements on time, repay loans, pay staff, and make payments to the budget. Assessment of the solvency of the enterprise, that is, the ability of the enterprise to repay short-term debt at the expense of certain elements of working capital, is carried out using liquidity ratios. Liquidity and solvency of the organization are reflected using such ratios as: absolute liquidity ratio; quick ratio; current ratio. Using the criterion of profitability allows you to evaluate the efficiency of use of the assets of the enterprise, i.e. determine the share of gross profit attributable to the monetary unit of sales. At the same time, profitability shows the amount of net income received by the company per monetary unit of sales. So, the indicator of turnover determines how efficiently the assets are used to increase sales. The financial support of commercial activities is responsible for indicators of the financial stability of the enterprise, these indicators include:

autonomy ratio; the ratio of own working capital; coefficient of maneuverability of equity; fixed asset index; comprehensive indicator of financial stability.

In a market economy, the key to survival and the foundation of a stable position of the enterprise is its financial stability. It reflects such a state of financial resources in which the enterprise, freely maneuvering money, is able, through their efficient use, to ensure an uninterrupted process of production and sales of products, as well as costs for its expansion and updating. To assess the financial stability of the enterprise requires an analysis of its financial condition. Financial condition is a set of indicators reflecting the availability, placement and use of financial resources. The financial condition is characterized by the availability of financial resources necessary for the normal functioning of the enterprise, the appropriateness of their location and efficient use, financial relationships with other legal and physical entities, solvency and financial stability. Assessing the financial stability of an enterprise involves the study of key parameters and ratios that give an objective picture of its financial condition. It is carried out by calculating a system of coefficients, namely: liquidity; business activity; resource efficiency; profitability; capital structure; market activity; financial leverage effect; operating leverage, profitability threshold and financial strength margin.

Long-term financial stability is characterized, therefore, by the ratio of own and borrowed funds. However, this indicator provides only a general assessment of financial stability. Therefore, in the global and domestic accounting and analytical practice, a system of indicators has been developed, namely: equity concentration coefficient; coefficient of financial dependence; coefficient of maneuverability of equity; concentration ratio of borrowed capital; the ratio of the structure of long-term investments; long-term borrowing ratio; the ratio of the structure of borrowed capital; ratio of borrowed and own funds. The effectiveness of economic ratios is due to the fact that they most accurately determine the strengths and weaknesses of the financial situation of the enterprise, point out issues in its activities that require further study, identify the main areas and influencing factors that cannot be followed by considering individual reporting indicators using methods vertical, horizontal and trend analysis. The use of indicators of financial stability in the dynamics will increase the level of development of managerial decisions aimed at shaping the trend of stabilization processes. Systematization of indicators provides the basis for monitoring financial stability.

For the implementation of economic and financial activities, retail enterprises must have certain types of non-current and working capital, ensuring uninterrupted processes of production and sale of products. The size and composition of these funds depend on the nature, volume and content of economic activity. The sources of their formation are own and borrowed capital. The composition and structure of assets depend on the size and structure of capital. Consequently, the analysis of the organization's assets is directly related to the analysis of the sources of their formation and liquidity, the ability to quickly release from the economic turnover the money necessary for normal economic and financial activities, and the ability to timely fulfill their current and long-term obligations. (Nikishin, Pankina, 2015, p. 15)

At the same time, for the effective development of activities, retail enterprises are forced to pay very much attention to working capital management. It involves the organization of cash flows, receivables, inventories, securities and others, as it is aimed at meeting the needs of the market. A special place in assessing the performance of enterprises is given to current assets, since their effective use most affects the financial condition. It depends on the degree of optimality of the structure of current assets, the assessment of which should be based on criteria such as liquidity and solvency. The assessment of business activity is aimed at analyzing the results and the effectiveness of the current core business. The system of indicators for assessing the business activity of an enterprise includes: labor productivity; return on assets; the turnover of funds in the calculations (in turns); The turnover of funds in

the calculations (in days); inventory turnover (in revolutions); inventory turnover (in days); accounts payable turnover (in days); operating cycle duration; repayment ratio of receivables; return on equity. When determining the effectiveness of a trading company, it is necessary to take into account the number of employees and wages. In the analysis, the establishment of a ratio of the volume of sales of goods, gross income and distribution costs per worker is of no small importance. These indicators should be improved by improving trade and technological processes leading to a decrease in the number of employees and salary costs.

The final stage is a comprehensive assessment of activities carried out by comparing the costs incurred with the results achieved for these elements. Based on the results of this analysis, the qualitative and quantitative activities of the trading enterprise are evaluated; measures are being developed to improve the financial condition, paying particular attention to the development of the financial strategy of the enterprise for the future. To assess the economic effect of a commercial commercial enterprise, a system of economic indicators is used. The criterion for evaluating the effectiveness of commercial activities can serve as profitability on invested capital, and, increasing the rate of return on invested capital can be achieved in three ways: profit growth; reduced investment (for example, by reducing inventory) while maintaining the same levels of sales and profits; doubling of sales (in the case of a significant increase in market share) with constant levels of profit and investment.

4. The special features of the assessment of competition in trade

Under market economy conditions, trading activity is a complex one, and in addition to the primary activity, to ensure the movement of goods from producer to consumer, there are a multitude of variables that allow differentiation of the entities participating in these relationships, in particular: the characteristic of the services provided, pricing policy, product range, size and location of stores etc. Although commercial enterprises are very different, they compete with each other for market resources, and the level of competition between them influences the welfare of consumers. At the same time, competition can only be manifested within a relevant market, consisting of the geographical dimension and the product market. Thus, the correct identification of the relevant market is the first step and a mandatory requirement for the assessment of competition. In certain situations, determining the relevant market may be a simple activity, but not in the case of trading activity, which is a complex activity sector, structured on multiple internal domains, in which the distribution, distribution, storage, supply of goods is of particular importance wholesale, the application of different modern forms of product marketing (Şavga, Sitnicenco, 2016, p. 39). Thus, the notion of trade has a complex content, determining an economic function that consists in the purchase of raw materials or products to resell them at the same physical stage to consumers (final or intermediate) under the conditions requested and convenient to them (Patriche et.al, 1999).

According to the provisions of the Competition Law no.183 of 11.07.2012, the relevant product market comprises all the products considered by consumers as interchangeable or substitutable due to their use, due to their physical, functional and price characteristics. The retail trade is characterized by the existence of two product markets: the downstream market and the upstream market. The retail sector is the main supplier of products for final consumers and, being the last link on the supply chain of these products, it interacts directly with them. Important, in terms of consumer welfare, is the role that the trade sector plays in the formation of final prices and, at the same time, in offering a wide range of associated goods and services. Also, as a buyer of goods and services, the retailer interacts with the suppliers of products, this causes an incorrect functioning of the distribution sector to generate negative effects on the entire food supply chain, on the final consumers, but also on the economy.

The development of modern commerce has led to the fact that determining the size of the product in the retail sector does not refer only to the type of goods sold (grocery, clothing, furniture, etc.), but must answer the question of how merchants meet the needs of consumers. Thus, the combination "Price - Quality - Assortment - Services" best characterizes the product market in retail. In order to assess the size of the relevant market, it is necessary for competing companies to offer consumers products that are considered by consumers to be interchangeable or substitutable. At the same time, the offer of goods from the same product line or the same brand by a trader will not necessarily be appreciated by the consumer as an interchangeable or substitutable with the offer of another trader.

Depending on the sorting policy, the trader may be of specialized orientation or generalist. A wide range of products is characteristic of supermarkets / hypermarkets that can sell in addition to food and non-food products (clothing, detergents, toys, etc., and in some countries and petroleum products). In this case the question arises to what extent specialized stores are competing (perceived as competitors) of generalist stores.

Although non-food products marketed by supermarkets / hypermarkets may be non-essential for them, the assortment, size and coverage of the network and place it in the category of important sellers of such products, which again places it in the category of competitors from the consumer point of view. The asymmetry of the traders manifested at the level of specialization, can be reflected also by the average value of the purchases (the shopping basket). Supermarkets may compete with small shops for current shopping (small baskets), but small stores cannot compete with supermarkets for major shopping (big baskets).

The historical evolution of the trading system in the Republic of Moldova was influenced by the socio-economic changes that took place, in particular the transition from the centralized control system to the market economy. Thus, if previously there were two large trading structures, the state trade and the trade of the consumer cooperation, with the transition to the market economy the trading system was fragmented, being dominated by private operators from independent shops. Specific to the current period is the development of chain stores and the development of shops that focus on the offer of low prices applied, to their own brands.

A problem characteristic of the chains of stores with national coverage is what would be the geographical size of the market on which the companies enter the competition and what are the effects on the consumers. Although store networks, as a rule, have a uniform policy throughout the territory, there may be a number of variables characteristic of certain areas: the number and type of promotions and special offers; the extent of advertising; assortment, availability and quality of products; pre and post sale services; the appearance of the store (renovation decisions); store facilities (parking, ATM, cafe, currency exchange, etc.); working time (opening and closing time).

Thus, through the variables mentioned above, the store networks adapt their activity of the subdivision to the conditions of local competition, more than that, even though the supply of chain stores is largely uniform, the prices of the stores in the same network in different localities vary, being rather a reflection of competition at local rather than national level.

For the geographical delimitation of the relevant market, the term "catchment area" is used, which is assessed by determining the distance or time of travel to the store. In Europe the catchment area of a hypermarket varies around 20-30 minutes (or within a range of 20-30 km), for medium-sized stores, from 10 minutes to 30 minutes depending on the country. In the US distances are expressed in miles and represent 3-4 miles for supermarkets and 5-6 miles for natural and organic premium supermarkets (OECD, 2015).

The geographic area formed as a result of moving to a certain distance or a certain walking time from a store, is called the corresponding, isochronous or isodistance, and constitutes the geographical dimension of the relevant market examined. The geographical perimeter of the

retail market is defined by the travel time between the central point and the outer boundary of the area. The isochronous radius of the store differs, but usually depends on the size of the city. In the European Union based on retail studies, the travel time accepted by the buyer was established: 15 minutes for large cities; 20 minutes for medium and small cities; 25 minutes for a rural area (Final report, 2014).

For the Republic of Moldova the relevant market of the product in the retail trade, constitutes the retail services, and taking into account the combination "Price - Quality - Assortment - Services" can be delimited according to the provisions of Government Decision no. 931 of 08.12.2011 regarding the conduct of the retail trade, in the following categories: small shops, the commercial surface up to 250 m²; medium shops, commercial area from 250 m² to 2000 m²; large stores, commercial area of over 2000 m².

The development of the methodology for evaluating the competition also implies the identification of indicators with economic content based on which appropriate conclusions can be made regarding the level of competition in the sector. The assessment of competition in the retail sector contributes to creating a clear vision on the competitive environment, the commercial strategies adopted, the role of public authorities and finally the impact on consumer welfare.

Economic theory indicates a direct link between the degree of market concentration and the performance of market enterprises. At the same time, the provisions of the competition law establish certain thresholds for the market shares of the companies involved. From these considerations for evaluating the competition in the trade it is necessary to calculate the indicators of the degree of market concentration. For this purpose, a number of indicators are calculated, among which:

- 1. Concentration rate (CR) represents the sum of the market shares of the largest n players in the market. It generally comprises a small number of companies 3-5, to highlight the oligopoly character of the market.
- 2. The Herfindahl Hirschman Index (HHI) represents the sum of the market share squares of all companies on the market. Thus, it establishes the degree of concentration. The levels of this Index within the EU are <1000 for the low concentration level, 1000-2000 for the level of the medium and> 2000 for the high level, when in the USA these are: <1500 the low level, 1500-2500- the medium and > 2500 high level.
- 3. The Hall Tideman Index (HTI) comprises the market shares of all enterprises and attaches great importance to companies with a reduced market share. In the case of retail trade in the Republic of Moldova there is a high degree of probability that small commercial enterprises will have an important influence on the isocron-sized market.

Regarding specific indicators of the evaluation of the competition in commerce, we highlight the following:

- 1. Substitution rate reflects the substitution level of the commercial services provided by some stores from other stores, taking into account the combination of the factors "Price Quality Assortment Services".
- 2. The intensity of competition by substitution. The high degree of substitution of the commercial services of the shops stimulates the competition. Thus, the lower the variation in substitution rates, the greater the intensity of competition.
- 3. Intensity of competition through concentration. A high degree of market concentration is not considered as beneficial for competition, on the other hand a low or medium degree of market concentration stimulates the competitive behavior of the companies.
- 4. Intensity of competition through profitability. High profitability shows signs of market power of the trader and low competitive pressure.

5. Integrated index of competition intensity, determined by the geometric mean of the intensity of competition by substitution, intensity of competition by concentration and intensity of competition by profitability. The approximation of 1 of the given index indicates the acute competition in the retail marke.

Thus, the assessment of competition in trade based on the analyzed indicators will allow creating a clear vision on the degree of rivalry of the competitors in the market and can be a starting point for the decisions of both traders and public authorities.

5. Conclusion

The gradual intensification of competition in the market and the change in supply and demand for various goods observed in the country necessitate the formation of a business management system for enterprises in the retail structure that can adequately respond to the effects of external and internal environment of a high degree of variability and uncertainty. The situation in the field of domestic retail is still quite tense. Amid rising prices, inflation, job cuts, declining incomes and total "borrowing", the republic's population, having radically changed the demand structure, are moving to price segments designed for the economical buyer, losing loyalty to well-known brands, not only reviewing the composition of their consumer basket in favor cheaper goods or substitute goods, but also reduce consumption.

An analysis of the trends that determine the modern transformation of the trading business and logistics allows us to conclude that their change has a more natural evolutionary character. However, the truly revolutionary changes in the development of the trading business and logistics in the Republic of Moldova, as well as in other countries, were brought by the Internet. It was its development that made it possible to reconnect the producer and the consumer in a new way, to form new channels of communication access to consumer demand, to reduce costs as much as possible and to offer a cheaper product, weakening the price positioning of stationary retail.

The development of Internet commerce has made it possible to reduce the long intermediary chain, increase the perimeter of the supply chain while reducing the cost of goods distribution. Such a transition was actually revolutionary for modern retail, since it led to the emergence of a new business model of sales organization, which in itself is evolving no less rapidly today under the influence of its no less complex operational improvement. An analysis of empirical data shows that the development of online retail has led to several significant changes in the supply of goods to the consumer market.

The guarantee of survival and the basis for the stability of the organization's position is its financial condition, that is, the state of its financial resources, their distribution and use, which ensures the development of the organization on the basis of profit and capital growth while maintaining solvency and creditworthiness under the conditions of an acceptable level of risk.

The stability of the organization, first of all, depends on the optimality of the composition and structure of assets, as well as on the correct choice of strategy for managing them. Achieving high financial results of a trading company, maximizing profits and improving the effectiveness of marketing technology cannot be achieved without effective management of financial flows, the ability to manage efficiently, that is, the development of a competent financial policy of the enterprise.

Another important factor of financial stability is the composition and structure of financial resources and the correct management of them. In the course of its activities, the organization uses all its sources of financial resources and fully covers the reserves and costs, and this is important. Since the stock of sources of equity is the stock of financial stability of the organization, provided that its own funds exceed borrowed.

From the point of view of ensuring economic efficiency, a separate place is given to assessing the competitiveness of retail enterprises. Thus, the assessment of competition in trade is different from the same operation in other sectors of the economy. Although the stages of the journey are the same, the complex nature of this field makes us make an extra effort for it. For the retail trade, not the good exposed for sale forms the product market but the commercial service characterized by the combination "Price-Quality-Assortment-Services". Competition assessment based on the integrated index of competition intensity allows creating a clear vision on the degree of rivalry of the competitors in the market and can be a starting point for the decisions of both traders and public authorities.

From our opinion, a systematic and in-depth analysis of commercial activities allows you to quickly, efficiently and professionally evaluate the effectiveness of commercial work; timely find and take into account factors affecting the performance of activities; determine the costs of trading activities and trends; find the best ways to solve the commercial problems of the trading company and to obtain sufficient profit in the near and distant future.

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Impact of Technological Changes on Investment Habits of Individuals and Households

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Abstract. In the last few decades there have been a lot of changes in legislative and technological frame determining investment habits of individuals and households in Croatia. Development of technological options and easy solutions for consumers in undoubtable but did it make impact on investment habits is to be discovered. Very important is also the question of consumer's ability to evaluate and respond rationally making the best choice for themselves. Advantages and disadvantages of contemporary technological environment for individual's rational behaviour and decision making process will be observed. Changes that have occurred will be displayed and analysed with scope to determent whether they have influenced individuals and households to invest more in specific financial instruments, like stocks and bonds.

Key words: Investment habits; individuals and households; technological changes

1. Introduction

If we compared the way of doing certain things now with how we used to do it in the past, we would easily spot the changes in such and the main reason behind those changes would be technology. After the famous Industrial Revolution, technology is advancing in accelerating pace like never before. Today just with a few mouse clicks or finger taps on our smartphones, we can buy and sell things we want, pay our bills, search any information we need in the moment and use many other useful services. Also, not only quantity of those services is increasing but overall quality and safety as well. Those changes indeed affected personal finance area. With the great number of online banking and brokerage services, online wallets, personal finance management applications and overall availability of financial and market information, investing is a lot easier. This study will attempt to identify and observe the magnitude of technological impact on investing habits in Croatia. With that purpose we will analyse and compare changes in the view of investing structure of households and also changes in legislative framework.

2. Investment habits of individuals and households

Since Croatia left planned economy system a few decades ago and developed a new market-based system, households are challenged with globally fast paced technological advancements. With development of Croatian markets and emergence of more complex financial products, the question of financial literacy is crucial. According to Remund (2010), one of the many definitions of financial literacy would define it as ability to use knowledge and skills to manage financial resources efficient for a lifetime. Croatian Financial Services Supervisory Agency made an analysis of financial literacy in Croatia according to the

methodology of OECD. Analysis included persons aged between 18 and 79 years with regard to education, income, region, gender and the size of the settlement. The results of study showed that average rate of financial literacy in Croatia, in the scale of minimum 1 point up to the maximum of 21 points, is 11,7 points. Among the general population, the least financial literate citizens are young people under 19 years old (average score of 9.3), which opens the question of education efficiency in Croatia. The most literate citizens in the field of personal finance were among the highly educated people (12.80) and those living in urban area (13.10) with more than 100.000 inhabitants (CFSSA, 2015). In the Table 1 we will observe the value and structure of financial assets of Croatian households with scope of deducing the investing habits of Croats.

Table 1 Structure of financial assets of households in Croatia from the latest 2018 data (in million kunas).

Currency and Deposits	239.290,26	50,68%	
Bonds	1.233,96	0,26%	
Stocks and mutual investing funds	97.576,63	20,66%	
Insurance, pension funds and warranties	119.170,36	25,24%	
Financial derivatives	0,09	0,00%	
Other	14.929,84	3,16%	
Total financial assets	472.201,14	100%	

Source: Authors systematization according to the data from CNB

As data present, more than 50% of the total financial assets of households are held as currency or deposits in the banks. There are several problems with this amount of money kept in such form. First major problem is current deposit holding condition. Examining data from the past several years we can see the great decline of interest rates. For example, wagged monthly average interest rate in December 2013 on term deposits was 2,98% annual, while in December 2018 was 0,58% (CNB, 2020). Declining of interest rates is still continuing. Despite such negative conditions, the amount of deposits are increasing which is a great sign of ignorance in the field of personal finance. With estimated inflation of 1,70% in 2018 (CNB, 2020), individuals who keep their money at their bank account, in form of term deposits or cash are losing value of their money, mostly without even realizing it. There are also some other problems related to high stake of currency and deposits in total financial assets, such as opportunity cost and huge leverage given to the banks.

If we compare, according to the latest OECD data, the stake of currency and deposits in total financial assets of Croatia (50,68%) with high financially literate countries such as USA (13,20%), Sweden (14,60%), Canada (21,50%) or United Kingdom (25,10%) we can observe negative correlation between financial literacy of households with amount of money kept as deposits or currency (OECD, 2020).

With technological advancements, the number of online brokerage services, mobile banking applications and online wallets has rapidly increased. Also, the costs of those services thanks to advancing technology and increased supply for such are declining. Such conditions made investing in financial products cheaper and more available. In Croatia, wagged percentage of investments in stocks and mutual funds are 20,66% of the total financial assets (CNB, 2020). We will compare recent results with other financially literate countries.

According to the same OECD data, in 2018 the stake of stocks and mutual investing funds in total financial assets is 45,10% in United States, 45,30% in Sweden, 36,90% in Canada and 15,20% in United Kingdom (OECD, 2020).

As data present, households in Croatia have the least amount of assets invested in stocks and mutual funds, except for households in United Kingdom which most of their money (45%) invest in pension funds (OECD, 2020).

To observe results of technological impact on investing habits we will examine changes in the structure of financial assets from the few past several years.

Table 2 Structure of financial assets of Croatian households in 2001, 2007 and 2018 (in million kunas).

Year	2003.	2007.	2018.
Stocks and mutual funds	22,99%	34,78%	20,66%
Bonds	0,00%	0,00%	0,26%
Insurance, pension funds and warranties	3,25%	10,71%	25,24%

Source: Author systematization according to the data from CNB

We can see the negative trend of individuals investing in stocks and mutual funds. Even in 2003, the stake of stocks and mutual funds was higher than in 2018. One of the main reasons for such results would be, despite the lack of knowledge in personal finance, the global financial crisis of 2007/2008. As data present, in 2007, large number of individuals were investing in stocks. It was the great time for Zagreb Stock Exchange, but unfortunately too many households and individuals didn't know or understand the risk factor on investing in such securities. Even those who made analysis for such securities couldn't predict devastating global financial crisis. As consequence, those who held stocks suffered great financial losses. The worst thing was not just about the money they lost, but the loss of confidence and lack of security on those kind of investments. If we can say that oil is economy's blood, the heart of economy would be stock exchange (Bazdan, 2006, 90). The problem indicates that without proper development of stock exchange, economic growth is slowed.

One of the positive trends of investment habits would be continuing growth in the field of insurance, pension funds and warranties.

To evaluate technological influences on investing it is necessary to take in account the information literacy of individuals. According to different studies concluding that financial assets usually increase in regard to the life stage while computer literacy decrease with age. It would be rational deduction that in this period only minority fully prosper from technological advances in the view of investing. In the future, since younger generations and general population are getting more information literate, growth in this form of investing is expected.

2.1 Legislative framework

In this chapter we will take a look at legislative framework of capital market in Croatia and it changes over time in regard to technological advancements. We will also observe latest announced legal changes with purpose of determining the direction and overall government goal in the view of capital market.

Legal background behind Croatian capital market at first was regulated by Capital Market Law which (Official Gazette 88/08) was issued at 28th of July 2008. Since then, it was changed total seven times with the purpose of Croatian financial market integration into united European Union member states market. With Croatia's accession to the European Union, the provisions were set to enable market liberalization and cross-border cooperation. In 2018 due to the need for harmonization of the Croatian capital market regulatory framework with EU regulations, a new Capital Market Act was adopted (Official Gazette 65/18). We will try to examine recent changes in market regulations.

Latest changes in relation with previous Act additionally regulate business area of authorized professionals who operate business with financial instruments. The terms of trading of financial instruments are regulated in detail which includes commodity derivatives, emission units and derivatives on emission units. Also, the institute of data delivery service was introduced with purpose of maximizing transparency and minimizing data fragmentation. One of the significant benefits for individual investors would be improved protection with goal to strengthen the framework for providing services of investment consulting and portfolio management (Official Gazette 17/20).

With development of technology and market infrastructure the larger regulatory requirements are being introduced. It likewise includes regulation of dematerialized financial instruments, organization and authority of central securities depository (CSD), also the rights and obligations of participants on capital market. Very important inclination would be fight against trading with insider information, illegal publishing of insider information and market manipulation (Official Gazette 17/20). The structure of Capital Market Act draws a conclusion that violations of the duty to publish the mandatory information can be grouped into three groups. As stated by Čulinović Herceg (2009), first group would be announcements when entering primary market, second covers periodical information on secondary market and third final refers to the duty of the issuer to disclose privileged information that directly relates to the issuer. In the view of increasing market and regulatory transparency as the main target of this Act it will equally increase report responsibility and liability of the Croatian Financial Services Supervisory Agency and European Securities and Markets Authority (ESMA). Act will also stricter the penalties and sanctions against the legal entities and individuals who violate the market rules (Official Gazette 17/20).

There are some other expected important changes in administrative field. Recent law draft proposes raising the threshold for the obligation of publishing a prospectus for the public offering of securities from five to eight million euros (in kuna equivalent). It includes obligation of making tender information document for all securities offers between four and eight million euros (Official Gazette 17/20). This change would considerably decrease administrative burden for issuers or bidders and it would reduce the cost of securities emission.

Since previous and current law limits the service of market intermediaries only to legal forms of limited liability companies and joint-stock companies, the new bill draft proposes allowing this kind of business to individuals (Official Gazette 17/20).

We can see that direction of Croatian government is going toward market liberalization, increased transparency and regulation, removal of unnecessary administrative burden and fight against market frauds and manipulation. If we compare recent legislative framework with the first one, the result undoubtedly shows increased transparency, more efficient regulation and overall safer investing environment. Despite such positive trends, there is still a lot of space for improvement in the legal field.

2.2 Technical solutions

As we discussed and observed investment habits of households and legislative changes, the main reason for non-consumption of various available financial products and unused technological benefits in investing field is financial (information) illiteracy. According to Buljan Barbača (2016), responsibility for financial literacy should be dispersed on individual level (each person needs to work on their financial education), on financial institution responsibility (providing access to clear and transparent information) and on the government responsibility in the view of appropriate laws. Aside from responsibility, the major solution for this problem would be financial education of citizens. Even though Croatian government implemented several financial education programs directed by the Ministry of Finance, our

observation would be that it's still not enough. Financial education of younger population is necessary. Especially, teaching and understanding the difference between investing and speculating. "An investment operation is one which, upon thorough analysis, promises safety of principal and an adequate return. Operations not meeting these requirements are speculative" (Graham, 1949, 18). In other words, investing requires a lot of financial and business knowledge, which only minority truly possess. Also, the basic understanding of monetary policy is required for investors since it affects investment portfolio and net worth (Shaban, Al-Zubi, & AlGhusin, 2017, 543). Nevertheless, it doesn't mean that financially literate people without such knowledge shouldn't buy securities, but important part is emphasizing awareness of such speculative behaviour and risk within. Lately there was a lot of buzz and demands for education reform but very small voice of those proposing implementing personal finance as subject in public schools. We believe that if younger generations were properly taught personal finance, from simple to more complex matter, it would solve some of the mentioned issues. Also, not only younger population should be financially educated but population in general. There might be some creative ideas in solving this problem like through television or other popular broadcasting media but we leave that question up to the government. With purpose of using technology to its potential financial literacy must correlate with information literacy. If these two forms of literacy aren't correlated, technological potential is wasted.

3. Conclusion

This analysis provide us reasonable evidence to conclude that Croatian households are not fully enjoying benefits of technological advancements in the view of investing. The major argument for such claim would be the structure of total financial assets which shows huge amount of money held as deposits despite current negative holding conditions. Also, when we compare the structure of total financial assets in Croatia with some highly developed countries, the result indicates that individuals and households in Croatia are generally consuming less financial products. As we discussed, this issue might be due financial illiteracy of citizens. In other words, people are ignorant in regard to personal finance. Investing in stocks and mutual funds is decreasing over time which is a problem for capital market in Croatia. On the other hand, there is positive trend of investing in pension funds and insurances. The best solution for this issue would be financial education of citizens in Croatia. Research made by Croatian Financial Services Supervisory Agency shows that younger generations are among the least financial literate citizens. Easy solution would be mandatory teaching of personal finance in public schools. We believe that teaching of money managing, basics of investing and finance, debt management and such would not only be beneficial but also crucial for younger generations. Since they are generally information literate additional financial literacy would result in enjoying the greater benefits of technology. As we observed changes in legislative framework and investing environment, the analysis shows positive trend of market liberalization and overall increased safety. Final conclusion of this study would point to financial illiteracy as the main reason for the lack of use of technological advancements in investing.

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Impact of IFRS 16 on Financial Ratios

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Abstract The aim of this paper is to research the impact that changes of International financial reporting standard 16 have on financial ratios. International financial reporting standard (IFRS) 16 –"Leases" brings significantly different approach on presenting lease liabilities. It is implemented as of January, 1st 2019 and is mandatory for all companies which apply IFRS in their financial reporting. Following reporting requirements of this standard all leases have to be presented in full in financial statements including those leases that were previously considered as "operating lease". Operating lease was previously presented only as operating expense in the amount of yearly lease expense with no other influence on balance sheet. With the new requirements those leases also have to be fully (discounted value of future payments) presented within balance sheet, leading to increase of lease assets and financial liabilities. Consequently, higher total assets and financial liabilities will influence Balance sheet financial ratios, especially leverage ratios. Implementation of IFRS 16 also affects Profit and loss account considering that lease assets will now be depreciated and will bring interest expense. Those changes will lead to changes in profitability ratios, especially on EBITDA level.

Key words: IFRS 16, lease, operating lease, financial ratios

1. Introduction

A lease is a contract which enables someone to rent an asset under certain conditions. Those conditions are defined in detail trough leasing contract.

Leasing is commonly used financing source, because it allows lessee to gain use of an assets without actually purchasing it. Such financing option demands less cash outflow at the beginning of use and spreading cash outflow through entire usage period. Also, leasing is favourable financing option when limited time usage of an assets is planned because it allows change or return of an asset when needed.

Leasing financing include operating and finance leasing. Those two types of leases differ from each other in respect to usage rights as well as their presentation in financial statement. Each leasing contract should be analysed and then placed under one of those two leasing categories.

Changes in leasing accounting brought on by introduction of new International financial reporting standard 16 (IFRS 16) are significant, especially regarding presentation of operating lease. Consequently, implementation of IFRS 16 also has significant impact on balance sheet and profit and loss financial ratios, will is the focus of this paper. Given the fact that accounting in lessors financial statements is not affected with new IFRS 16 this paper will focus on lessee accounting.

The paper analysis impact of the new reporting standard on financial ratios. The scope of analysis within this paper will include following financial ratios and positions:

Debt ratio as a ratio between total debt and total assets. Debt ratio shows leverage, or how strongly we lean on debt to finance total assets.

Total assets turnover as a ratio between total revenue and total assets. Total assets turnover is a ratio showing efficiency in using assets for making revenue. Larger assets on the same amount of revenue decreases assets activity.

Interest coverage as a ratio between operating profit and interest costs. This ratio present ability to cover interest costs from ordinary operations measured by operating profit. Larger interest costs on the same level of operating profit results in lower interest coverage ratio.

EBITDA meaning earnings before interest, tax, depreciation and amortization. EBITDA reflects profitability from ordinary core business, excluding depreciation and amortization as non cash positions of the profit and loss account.

EBIT meaning earnings before interest and tax. EBIT shows profitability from operating activities.

Net profit which is final profit amount after all expenses and tax that is realized in a year.

2. Accounting according to the International accounting standard (IAS) 17 "Leases"

Up until year 2019 and introduction of International financial reporting standard (IFRS) 16, International accounting standard (IAS) 17 "Leases" had the objective to prescribe the appropriate accounting policies and disclosures to apply in relation to finance and operating leases.

As defined in IAS 17 "Leases" leases are to be classified as finance lease when all the risks and rewards of ownership is transferred from lessor to the lessee. In financial statements this is reflected as rise of assets and liability recognition by the lessee and a receivable by the lessor. The following principles should be applied in the financial statements of lessees:

at commencement of the lease term, finance leases should be recorded as an asset and a liability at the lower of the fair value of the asset and the present value of the minimum lease payments (discounted at the interest rate implicit in the lease, if practicable, or else at the entity's incremental borrowing rate)

finance lease payments should be apportioned between the finance charge and the reduction of the outstanding liability (the finance charge to be allocated so as to produce a constant periodic rate of interest on the remaining balance of the liability)

the depreciation policy for assets held under finance leases should be consistent with that for owned assets. If there is no reasonable certainty that the lessee will obtain ownership at the end of the lease – the asset should be depreciated over the shorter of the lease term or the life of the asset

On the other hand, lease is classified as operating lease when there is no transfer of risks and rewards of ownership. Within financial statements, operating lease results in expense recognition by the lessee, with the asset remaining recognized by the lessor.

As stated in the IAS 17, for operating lease in the financial statements of lessees the lease payments should be recognised as an expense in the income statement over the lease term on a straight-line basis, unless another systematic basis is more representative of the time pattern of the user's benefit.

One of the interesting financing possibilities in leasing scope is sale and lease back transactions resulting with operating lease. Those arrangements free companies of their fixed assets, thus

raising significant liquid funds today, while enabling them to continue to use the assets as before, now only paying monthly leasing expanse.

Regarding accounting of sale and lease back transactions that result in an operating lease IAS 17 instructs as follows:

- if the transaction is clearly carried out at fair value the profit or loss from the sale of assets should be recognised immediately
- ➤ if the sale price is below fair value profit or loss should be recognised immediately, except if a loss is compensated for by future rentals at below market price, the loss should be amortised over the period of use
- if the sale price is above fair value the excess over fair value should be deferred and amortised over the period of use
- ➤ if the fair value at the time of the transaction is less than the carrying amount a loss equal to the difference should be recognised immediately

3. Accounting according to the International financial reporting standard 16 (IFRS)

New International financial reporting standard (IFRS) 16 "Leases" is implemented as of January, 1st 2019 and is mandatory for all companies which apply IFRS in their financial reporting. New standard brings significantly different approach on presenting leasing liabilities, especially regarding operating lease.

IFRS 16 specifies how an IFRS reporter will recognize, measure, present and disclose leases.

IFRS 16 introduces a single lessee accounting model and requires a lessee to recognize assets and liabilities for all leases with a term of more than 12 months, unless the underlying asset is of low value. Lessors continue to classify leases as operating or finance leases, with accounting substantially unchanged from accounting requirements of predecessor standard, IAS 17.

Seeing as new IFRS 16 eliminated the distinction between operating and finance leases for lessees, new lease asset (representing the right to use the leased item for the lease term) and lease liability (representing the obligation to pay rentals) are recognized for all leases.

According to IFRS 16 assets and liabilities arising from a lease are initially measured on a present value basis. The measurement includes non-cancellable lease payments and also includes payments to be made in optional periods if the lessee is reasonably certain to exercise an option to extend the lease, or not to exercise an option to terminate the lease. Generally, the initial lease asset equals the lease liability.

Upon lease commencement a lessee recognises a right-of-use asset and a lease liability.

The right-of-use asset is initially measured at the amount of the lease liability plus any initial direct costs incurred by the lessee. Adjustments may also be required for lease incentives, payments at or prior to commencement and restoration obligations or similar.

After lease commencement, a lessee shall measure the right-of-use asset using a cost model, unless:

- i. the right-of-use asset is an investment property and the lessee fair values its investment property under <u>IAS 40</u>; or
- ii. the right-of-use asset relates to a class of property, plant and equipment (PPE) to which the lessee applies <u>IAS 16</u>'s revaluation model, in which case all right-of-use assets relating to that class of PPE can be revalued.

Under the cost model a right-of-use asset is measured at cost less accumulated depreciation and accumulated impairment.

The lease liability is initially measured at the present value of the lease payments payable over the lease term, discounted at the rate implicit in the lease if that can be readily determined. If that rate cannot be readily determined, the lessee shall use their incremental borrowing rate.

Variable lease payments that depend on an index or a rate are included in the initial measurement of the lease liability and are initially measured using the index or rate as at the commencement date. Amounts expected to be payable by the lessee under residual value guarantees are also included.

Variable lease payments that are not included in the measurement of the lease liability are recognised in profit or loss in the period in which the event or condition that triggers payment occurs, unless the costs are included in the carrying amount of another asset under another Standard.

The lease liability is subsequently remeasured to reflect changes in:

- > the lease term (using a revised discount rate);
- the assessment of a purchase option (using a revised discount rate);
- ➤ the amounts expected to be payable under residual value guarantees (using an unchanged discount rate); or
- ➤ future lease payments resulting from a change in an index or a rate used to determine those payments (using an unchanged discount rate).
- ➤ The remeasurements are treated as adjustments to the right-of-use asset.
- Lease modifications may also prompt remeasurement of the lease liability unless they are to be treated as separate leases.

In the case of sale and lease back transaction, the seller measures the right-of-use asset at the proportion of the previous carrying amount that relates to the right of use retained. Accordingly, the seller only recognizes the amount of gain or loss that relates to the rights transferred to the buyer.

If the fair value of the sale consideration does not equal the asset's fair value, or if the lease payments are not market rates, the sales proceeds are adjusted to fair value, either by accounting for prepayments or additional financing.

4. Impact of IFRS 16 on financial ratios

Following the change in the requirements set by a new standard, the reporting logic shifted and transfer of risks and awards became irrelevant. In the lessees accounting, now there is only one single type of lease, there is no more distinction between operating and finance lease. Now, all lessees must report the right-of-use assets, meaning they must recognize an asset and liability at the inception of a lease.

Consequently, companies will report higher total assets and higher financial liabilities. This will impact mostly leverage financial ratios, activity ratios etc. In the Profit and loss account there is no longer an operating expense, unless leasing payment comprises of lease and non-lease component, in which case non-lease component will be reported under operating expense. Instead of operating expense, companies will now present depreciation expense and interest rate expense. This will impact mostly profitability financial ratios.

It is evident that financial ratios will undoubtedly be impacted, but not all in the same direction. For example, leverage ratios will certainly be deteriorated with higher reported liabilities. On the other hand, EBITDA for example will be improved considering that operating lease expenses are not presented anymore, while now there is depreciation expense and interest rate expense, but none of those expenses influence EBITDA.

The difference between "old" standard IAS 17 and "new" standard IFRS 16 regarding reporting in financial statements is presented below through an example of operating lease.

Example:

- A company leases an equipment for a period of 4 years, starting 31.12.xxx0.
- Annual lease payment is 100.000 kn and it consists entirely of lease component, there is no service (non-lease) component in the payment amount.
- There is no residual value of the equipment at the end of the lease and there is no option to renew the lease or purchase the equipment.
- The rate implicit in the lease is 4%.

Table 1 Lease example

*		
ANNUAL LEASE PAYMENT 100.0		
LEASE PERIOD (years)	4	
RATE	4%	
PRESENT VALUE* 362.990		
*Present value of future lease payments is calculated using discount rate of 4%, which is equal to the rate implicit in the lease		
DEPRECIATION *	90.747	
* Depreciation is calculated lineary distributing cost over the lease period		

Source: author

Under International accounting standard 17 (IAS 17) operating lease is reported within financial statements as it is presented in the following table.

Table 2 Lease reporting under IAS 17

	IAS 17						
		31.12.xxx0	31.12.xxx1	31.12.xxx2	31.12.xxx3	31.12.xxx4	TOTAL
	Leased assets (right-of-use assets)	0	0	0	0	0	0
BALANCE	TOTAL ASSETS	0	0	0	0	0	0
SHEET	Lease liability (financial liability)	0	0	0	0	0	0
	TOTAL E&L	0	0	0	0	0	0
P&L	oper.expenses	0	100.000	100.000	100.000	100.000	400.000
IXL	NET PROFIT	0	-100.000	-100.000	-100.000	-100.000	-400.000

Source: author

Under International financial reporting standard 16 (IFRS 16) operating lease is reported within financial statements as it is presented in the following table.

As presented in the table 2 operating lease when reported under IAS 17 brings only operating expense which is the same trough entire lease term (IAS 17 dictates that lease payments should be recognised as an expense in the income statement over the lease term on a straight-line basis).

There is no reported assets nor liabilities.

On the under hand when same lease is reported under IFRS 16, as presented in the table 3, it effects both Balance sheet and Profit and loss account. Under IFRS 16, company reports both assets (right-of-use assets) and financial liabilities in their balance sheet. At the beginning assets and liabilities are presented at present value of future lease payments which is calculated using

discount rate implicit in the lease (4% in the above example). In each year of lease term company will report depreciation and interest expense within Profit and loss account. Depreciation is linear over lease term, under the presumption that there is no residual value at the end of the lease and there is no option to renew the lease or purchase the asset. Interest rate is the one implicit in the lease, calculated with simple interest calculation.

Table 3 Lease reporting under IFRS 16

	IFRS 16						
		31.12.xxx0	31.12.xxx1	31.12.xxx2	31.12.xxx3	31.12.xxx4	TOTAL
	Leased assets (right-of-use assets)	362.990	272.242	181.495	90.747	0	0
BALANCE	TOTAL ASSETS	362.990	272.242	181.495	90.747	0	0
SHEET	Lease liability (financial liability)	-362.990	-277.509	-188.609	-96.154	0	0
	TOTAL E&L	-362,990	-277.509	-188.609	-96.154	0	0
	Operating expenses	0	0	0	0	0	0
P&L	Depreciation	0	-90.747	-90.747	-90.747	-90.747	-362.990
ræL	Interest expense	0	-14.520	-11.100	-7.544	-3.846	-37.010
	NET PROFIT	0	-105.267	-101.848	-98.292	-94.594	-400.000

Source: author

Over the lease term, assets will be decreased each year for the amount of depreciation. Outstanding balance of financial liabilities will be decreased over lease term by repayment of the lease.

From the tables above, it is evident that final impact on net profit over entire term of the lease is the same, however it is distributed differently over the years and more importantly it effects different expenses. However, impact on balance sheet is substantial.

Following changes in the financial statements reporting, impact on financial ratios will also be substantial, but not all influences will be negative. Impact of implementation of IFRS 16 on financial ratios is presented in the following table.

Table 4 Impact of IFRS 16 on financial ratios

FINANCIAL RATIOS	IMPACT	EXPLANATION
DEBT RATIO (total debt / total assets)	NEGATIVE	increase due to an increase in liabilities
TOTAL ASSETS TURNOVER (total revenue / total assets)	NEGATIVE	decrease trough increase of reported assets
INTEREST COVERAGE (operating profit / interest)	NEGATIVE	due to the increase of interest expenses
EBITDA (Earnings Before Interest, Tax, Depreciation, Amortization)	POSITIVE	increase due to the fact that operating expenses are lower or non-existing and depreciation and interest expenses do not influence EBITDA
EBIT (Earnings Before Interest and Tax)	POSITIVE	increase due to the fact that depreciation is generally lower than operating expenses presented under IAS 17, however this impact is less significant than the one on EBITDA
NET PROFIT	NEUTRAL	impact on the net income is the same if observed in total over the leasing period, however it is distributed differently over the years so the impact on net income is higher in the first 2 years, and lower in the last years.

Source: authors

As presented in the table 4 implementation of IFRS 16 will have negative influence on debt ratio and total assets turnover due to the fact that financial liabilities are higher and assets are higher. It will also have negative impact on interest coverage due to the fact that interest cost is now reported.

On the other hand, it will have positive impact on EBITDA due to the fact that instead of operating expenses, companies now report depreciation and interest expenses which are excluded from EBITDA. Similar, but expectedly less significant positive effect will be visible also on EBIT.

As explained before, if observed in total amount which affects net profit over entire lease term there is no influence on net profit. However, throughout the lease term there are differences in impact as well as in the structure of the expenses.

5. Conclusion

New International financial reporting standard (IFRS) 16 "Leases" implemented at the beginning of year 2019 brings significantly different approach on presenting leasing liabilities, especially regarding operating lease.

Following reporting requirements of this standard operating leases are now capitalized and fully reported in financial statements.

This standard aimed at increasing transparency of financial statements. It can be argued that for an average user transparency is in fact increased because operating leases are now fully presented within financial statements. However, it should be pointed out than even before IFRS 16 operating leases were not hidden, but rather listed and presented within Notes which provided quality information for professional users in their decision-making process.

Operating leases under IAS 17 were recorded off balance and only annual leasing payments represented annual operating expense within Profit and loss account.

Under IFRS 16 operating leases are fully reported within financial statements. In balance sheet company reports right-of-use assets and financial liabilities in the amount of discounted present value. In Profit and loss account company reports depreciation and interest costs, while there is no more operating expense (unless lease payment includes also non-lease payment).

Consequently, higher total assets and financial liabilities impacts balance sheet financial ratios, especially leverage ratios. Changes in the Profit and loss account structure impacts profitability ratios, especially on EBITDA level.

Implementation of IFRS 16 has negative influence on debt ratio and total assets turnover due to the fact that financial liabilities are higher and right-of-use assets are higher. It also has negative impact on interest coverage due to the fact that interest cost is now increased.

On the other hand, it has positive impact on EBITDA due to the fact that instead of operating expenses, companies now report depreciation and interest expenses which are excluded from EBITDA. Similar, but expectedly less significant positive effect will be visible also on EBIT.

Net profit in accumulated effect over lease term is not impacted, however impact varies from period to period.

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Tax and Accounting Treatment of Intra-EU Acquisition of Goods

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Abstract: Common Market of the European Union allows companies and citizens to acquire assets easier in other EU Member States. The common market provides many benefits, but it also brings many challenges that companies face dealing with assessment of value added tax and its accounting. This paper will show tax and accounting framework related to acquisition of goods from another Member States of the European Union and the particularities that occur during that kind of purchase and sale. Furthermore, this paper will show the particularities of value added tax calculation, depending on whether the transactions take place between taxpayers or whether the ultimate acquirer is a non-taxable person. This paper will give particular attention to the thresholds that appear under the legislation that covers value added tax. Accordingly, companies must consider importance of the threshold for distance selling when they sell goods to other EU Member States. This paper will also show the acquisition threshold and its impact on value added taxation. Finally, in order to obtain a complete picture of VAT legislation, the amounts of the threshold for distance selling and the acquisition threshold in the Member States of the European Union will be presented.

Keywords: acquisition of goods, value added tax, threshold for distance selling, acquisition threshold

1. Introduction

In today's globalized world, small companies acquire goods from other countries on a daily basis. This particularly applies to purchases from another EU Member States. This paper will show tax and accounting framework related to acquisition of goods from another Member States of the European Union and the particularities that occur during that kind of purchase and sale. The point is also to show differences in tax treatment depending on who is the recipient of the good from another Member State. In order to better understand these issues after presenting accounting and tax treatment, the final section will also provide an overview of threshold for distance selling and acquisition thresholds relevant to EU tax treatment of the acquisition of goods.

2. Acquisition of goods

Pursuant to the VI guideline, which is responsible for partially harmonizing legislation on value added taxation. Croatia has also defined the acquisition of goods within the EU.

The basic principle when delivering between two taxpayers (B2B) is that the goods are taxed in the country of the buyer according to the principle.

When delivering between a taxpayer and someone who is not (B2C), the basic principle is that the goods are taxed in the seller's country.

Accordingly, Article 9 of the VAT Act defines the acquisition of goods within the European Union as:

- (1) "Acquisition of goods within the European Union" means the acquisition of the right to dispose of movable tangible property as owner, which the seller or acquirer of goods or another person for his own account dispatches or transports to the acquirer of those goods to a Member State other than the Member State where the dispatch began or the transportation of those goods.
- (2) If the importer of the good is a legal person who is not a taxpayer and carries out the acquisition of goods within the European Union in another Member State, he is entitled to a refund of the VAT he has paid in respect of the importation of the goods into the country, if he proves that the VAT has been charged to the acquisition of goods within the European Union in the Member State in which the dispatch or transport of those goods has ended. (Value Added Tax Act OG 73/13 Article 9.)

Article 4 of the Law on Value Added Tax defines what the subject of taxation is:

- 1. The supply of goods on the home territory for consideration, performed by the taxable person acting as such;
- 2. The acquisition of goods within the European Union carried out on the home territory for consideration:
 - a) A taxpayer acting as such or a non-taxable legal person, if the seller (supplier) is a taxpayer acting as such in another Member State and who is not exempt from VAT in accordance with the regulations of that Member State the payer is not bound by the provisions of Article 13, paragraphs 3, 4 and 10 of this Law,
 - b) In the case of new means of transport, a taxpayer or a legal person other than the taxpayer whose other acquisitions are not subject to VAT in accordance with Article 5 (1) (a) and (b) of this Act or any other person who is not Tax collector,
 - c) In the case of products subject to excise duty, if excise duty on intra-European Union acquisition is levied domestically in accordance with the rules governing excise duty, the taxpayer or non-taxable legal entity whose other acquisitions are not subject to VAT, in accordance with Article 5 (1) (a) and (b) of this Act. (Value Added Tax Act OG 73/13 Article 4.)

Article 5 of the Law on Value Added Tax defines what is not exceptionally subject to VAT:

- a) the acquisition of goods within the European Union by a taxpayer or a non-taxable legal entity if the supply of such goods domestically would be exempted in accordance with Article 47 (1) and Article 48 (1) (a), (b), c), d) and e) of this Law,
- b) the acquisition of goods within the European Union, except for the goods referred to in points (a), (c) and (d) of this paragraph, and with the exception of new means of transport or goods subject to excise duty, carried out by a taxpayer exclusively engaged in the supply of goods or services for which VAT is not allowed -a (pre-tax) or non-taxable legal entity,
- c) the acquisition within the European Union of second-hand goods, works of art, collectibles or antiques referred to in Article 95 (1) of this Act if the seller is a reseller acting as such and

the VAT on those goods is levied in the Member State in which the dispatch begins or transport in accordance with a special margin taxation procedure,

- d) the acquisition within the European Union of second-hand goods, works of art, collectibles or antiques referred to in Article 95 (1) of this Act if the seller is the organizer of the sale by public auction acting as such and the VAT on those goods is levied in the Member State where commenced their shipment or transport in accordance with a special procedure for sale by public auction.
- (2) Paragraph 1, point b) of this Article shall apply if the following conditions are fulfilled:
- a) the total value of the acquisition of goods within the European Union during the current calendar year does not exceed HRK 77,000 (the acquisition threshold); and
- b) the total value of the acquisition of goods within the European Union in the previous calendar year did not exceed the acquisition threshold referred to in point (a) of this paragraph. (Value Added Tax Act OG 73/13 Article 5.)

3. Tax and accounting treatment for the procurement of goods

Within this chapter, we will show the sale of goods to another EU Member State to a buyer who is also a taxpayer but also to a buyer who is not a taxpayer.

In the second part of the chapter, we will present the acquisition of goods from another EU Member State.

3.1. Sale of goods to another Member State

Example: Supply of B2B goods: Company A from Split, which manufactures marine equipment, sold and delivered the winch to Hamburg and obtained the VIES number. The company from Split issued an invoice in the amount of HRK 30,000. The corresponding account is in accordance with Article 41. 1 of the VAT Law exempt from VAT.

Accounting treatment according to the RRIF chart of accounts:

1210 Buyers of goods from the EU	7530 Revenue from the sale of goods in the EU
1) 30,000	30,000 (1

Tax treatment:

- When issuing an invoice, you must complete column 9 in the IRA Exit Account Book.
- At the end of the accounting period, when submitting the relevant VAT form, fill in the order in the form under I.3. SUPPLIES OF GOODS WITHIN THE EU.

Example: Supply of B2C goods: Company A from Split, which manufactures marine equipment, sells and delivers the winch to a natural person form Hamburg (a natural person is not a taxpayer and does not have a VIES number). The company from Split issued an invoice in the amount of HRK 30,000 plus HRK 7,500 VAT.

Accounting treatment according to the RRIF chart of accounts

1203 Customers citizens	7500	Product sales revenue
1) 37,500		30,000 (1

240012 VAT liability at the rate of 25% 7,500 (1

Tax treatment:

- When issuing an invoice, columns 21 and 22 must be completed in the IRA Exit Account Book.
- At the end of the accounting period, when submitting the corresponding VAT form, fill in the order in the form under II.3. SUPPLIES OF GOODS AND SERVICES IN THE REPUBLIC OF CROATIA at a rate 25%.

The above examples show a difference in tax treatment with regard to whether the same product was sold to a taxpayer, i.e. a company in Germany, or sold to a non-taxable natural person.

3.2. Acquisition of goods from another EU Member State

Example: Supply of B2B goods: Company A from Split purchased material from company C from Ancona (company A provided a valid VIES number). The company from Ancona has issued an invoice in the amount of EUR 4,000. The corresponding account is exempt from VAT in Italy, in accordance with the Italian VAT Law.

Accounting treatment according to the RRIF chart of accounts:

3100 Stocks of	Raw Materials	2210 Suppliers	of goods from EU
1) 29,800			29,800 (1
240022-VAT liabil	ities for the acquisition of	of goods 25% 14022 Input tax from I	EU Acquisition -25%
	7,450 (1a	1a) 7,450	

Tax treatment:

- When receiving the invoice, the VAT S form must be completed.
- At the end of the accounting period, when submitting the corresponding VAT form, fill in the order in the form under II.7. AQUISITION OF GOODS WITHIN THE EU at a rate 25% and III. INPUT VAT RELATED TO AQUSITION OF GOODS WITHIN THE EU at a rate 25%.

Example: Supply of B2C goods: Natural person A.A. from Split bought goods from company C from Ancona (natural person A.A. does not have a valid VIES number). Company C from Ancona has issued an invoice in the amount of EUR 2,000 plus EUR 440 VAT.

Tax treatment:

- Given that the natural person A.A. is not a taxpayer and does not have a valid VIES number Company C has issued an invoice with Italian VAT.
- Natural person A.A. must pay Italian VAT and is not entitled to a refund.

4. Acquisition threshold and threshold for distance selling

The acquisition threshold is the total amount of value of goods procured from other Member States, excluding VAT, to be paid or paid in the Member State in which the shipment or transport of those goods began, excluding the amount of acquisition of new means of transport and goods subject to excise duty. (Mazaras Tax Advisory; p. 95 2015)

The acquisition threshold in Croatia since joining the EU is HRK 77,000.

Table 1 Threshold for application of the special scheme for acquisitions by taxable persons not entitled to deduct input tax and by non-taxable legal persons (Source: https://vat_in_ec_annexi.pdf)

EU MEMBER COUNTRY	NATIONAL CURRENCY	EURO EQUIVALENT
Belgium	11,200 EUR	
Bulgaria	20,000 BGN	10,226 EUR
Croatia	77,000 HRK	10,410 EUR
Czech Republic	326,000 CZK	12,795 EUR
Denmark	80,000 DKK	10,717 EUR
Germany	12,500 EUR	
Estonia	10,000 EUR	
Ireland	41,000 EUR	
Greece	10,000 EUR	
Spain	10,000 EUR	
France	10,000 EUR	
Italy	10,000 EUR	
Cyprus	10,251.61 EUR	
Latvia	10,000 EUR	
Lithuania	14,000 EUR	
Luxembourg	10,000 EUR	
Hungary	10,000 EUR	
Malta	10,000 EUR	
Netherlands	10,000 EUR	
Austria	11,000 EUR	
Poland	50,000 PLN	11,785 EUR
Portugal	10,000 EUR	
Romania	34,000 RON	7,291 EUR
Slovenia	10,000 EUR	
Slovakia	14,000 EUR	
Finland	10,000 EUR	
Sweden	90,000 SEK	8,535 EUR

The threshold for distance selling is the value of deliveries prescribed by each Member State in the range of 35,000 to 100,000 euros, and the same applies to long-distance deliveries, i.e. deliveries made by a taxpayer from one Member State to final consumers in another Member State. Mazaras Tax Advisory; page 93 2015)

The threshold for distance selling in Croatia since joining the EU is HRK 270,000.

Table 2 Threshold for application of the special scheme for distance selling (Source: https://vat_in_ec_annexi.pdf)

EU MEMBER COUNTRY	NATIONAL CURRENCY	EURO EQUIVALENT
Belgium	35,000 EUR	
Bulgaria	70,000 BGN	35,791 EUR
Croatia	270,000 HRK	36,501 EUR
Czech Republic	1,140,000 CZK	44,744 EUR
Denmark	280,000 DKK	37,510 EUR
Germany	100,000 EUR	
Estonia	35,000 EUR	
Ireland	35,000 EUR	
Greece	35,000 EUR	
Spain	35,000 EUR	
France	35,000 EUR	
Italy	100,000 EUR	
Cyprus	35,000 EUR	
Latvia	35,000 EUR	
Lithuania	35,000 EUR	
Luxembourg	100,000 EUR	
Hungary	35,000 EUR	
Malta	35,000 EUR	
Netherlands	100,000 EUR	
Austria	35,000 EUR	
Poland	160,000 PLN	37,712 EUR
Portugal	35,000 EUR	
Romania	118,000 RON	35,305 EUR
Slovenia	35,000 EUR	
Slovakia	35,000 EUR	
Finland	35,000 EUR	
Sweden	320,000 SEK	30,346 EUR

5. Conclusion

Acquisition of goods within EU Member States occurs on a daily basis, between value added taxpayers and non-taxpayers. Value-added tax legislation treats the acquisition of goods differently depending on who the acquirer is. This paper showed the particularities of value added tax calculation, depending on whether the transactions take place between taxpayers or whether the ultimate acquirer is a non-taxable person. It is necessary to emphasize the importance of valid tax numbers for the correct tax and accounting treatment for acquisition of goods within EU Member States. In order to obtain broader picture in this area, they are shown after the definitions and amounts of both the acquisition threshold and threshold for distance selling in the Member States of the European Union. Knowing the acquisition thresholds is important for individuals because they become small taxpayers when they cross it. Threshold for distance selling are very important to taxpayers as they become taxpayers in the EU Member State where they crossed that threshold.

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Local Action Groups as Bearer of Local Development

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Abstract. Since the Republic of Croatia joined the European Union, high hopes have been put into withdrawing money from EU funds. The Croatian economy has stagnated for years, especially after the global financial crisis in 2008. The following needs and priorities have been identified: to launch large infrastructure projects, increase employment, reduce young people's emigration, revive agriculture. This goals can be achieved with the help from EU funds because in the financial period 2014-2020 from European structural and investment funds Croatia has a total amount of 10,676 billion euros at its disposal. Allocation of funds for agriculture and rural development amounts to 2,026 billion euros. European Agricultural Fund for Rural Development (EAFRD) is the financial instrument for this allocation. In order to be able to use EU funds, the Member State must adopt a strategic document that complies with EU policies, in this case, it is the Strategy of Rural Development of the Republic of Croatia. One of the measures in the rural development Programme is the LEADER measure which is used to finance Local Action Groups (LAGs) . Research in this paper is directed towards the LAG Cetinska Krajina. This LAG is located on the Dalmatian inland area and encompasses three cities and two municipalities. The goal of the LAG is, by using the bottom-up approach, to ensure the access to EU funds to all citizens.

Key words: Local Action Group; EAFRD; LEADER

1. European agricultural fund for rural development - EAFRD

The European Agricultural Fund for Rural Development (EAFRD) aims to strengthen Europe's rural development policy and simplify its implementation. The Fund is funded by the Common Agricultural Policy (CAP) and contributes to achieving the Europe 2020 objectives by promoting sustainable rural development throughout the European Union. It contributes to ecological and territorial balance, climate protection and innovation in the agricultural sector. In the 2014-2020 financial period, the budget foreseen for the agricultural program and rural development is € 95.577 billion, accounting for 24.4% of the total budget. The total allocation for the Rural Development Program 2014-2020 is EUR 2.383 billion, of which EUR 2.026 billion will be available to the Republic of Croatia from the European Agricultural Fund for Rural Development.

The funds of the program can be used by agricultural operators, agricultural organizations, associations and unions, environmental associations, organizations

providing services in community culture, including the media, women's associations, farmers, foresters and young people.

The general objectives of the EAFRD are:

- 1. Strengthening the competitiveness of the agricultural and forestry sectors and improving the quality of life in rural areas
- 2. Environmental protection outside urban areas
- 3. Encouraging diversification of the rural economy

Rural development contributes to the competitiveness of agriculture, the sustainable management of natural resources and climate change, and the balanced territorial development of rural areas.

Within the framework of technical assistance and networking actions, EAFRD will finance the establishment of a European Rural Development Network, an EIP (European Innovation Partnership) network, a European Rural Development Evaluation Network and national rural networks. It will also contribute to the objectives of the program EIP for agricultural productivity and sustainability through support to EIP operational groups. The activities supported by the program are divided into four axes: AX: Competitiveness, AX: Environmental Protection and Land Management, AX: Economic Diversity and Quality of Life, AX: LEADER. (European funds, 2020)

1.1. Common agricultural policy

The EU's Common Agricultural Policy (CAP) was established in 1962 as a partnership between agriculture and society and between Europe and its farmers. Her goals are:

- supporting farmers and improving agricultural productivity, ensuring a stable supply of affordable food
- protection of the right of European Union (EU) farmers to adequate earnings
- contributing to the fight against climate change and the sustainable management of natural resources
- conservation of rural areas and landscapes across the EU
- maintaining the dynamism of the rural economy by promoting employment in agriculture, agri-food industries and related sectors

CAP is a common policy of all EU countries governed at European level and funded by EU funds.

The CAP is funded by two funds as part of the EU budget:

- The European Agricultural Guarantee Fund (EAGF) provides direct support and financing for market measures
- The European Agricultural Fund for Rural Development (EAFRD) finances rural development. (European Commission, 2020)

2. Rural development program of the Republic of Croatia

The value of the rural development program of the Republic of Croatia for the period 2014-2020 is about 2.4 billion euros. The goal of the program is to increase the competitiveness of Croatian agriculture, forestry and processing industry, but also to improve living and working conditions in rural areas in general.

Comparison of the main structural indicators and macroeconomic aggregates for Croatia and EU-member countries leads to the conclusion that Croatian agriculture doesn't achieve high results. Some of the indicators point out directly on the week points of Croatian agriculture that should be solved by the policy measures if it's expected for the sector to maintain and achieve better position on the European scene. Starting from the average farm size (14.1 ha), Eurostat data shows that with 5.6 ha Croatia is on the 24th place with regard to utilized agricultural area. On the other hand, Croatia is in the group of countries with high share (49%) of farms that produce more than 50% of their output for own use. (Franić, Jurišić & Gelo, 2014, p.19).

Eligible investments within the measures of the Rural Development Program of the Republic of Croatia for the period 2014-2020 are mostly co-financed by European Union funds through the European Agricultural Fund for Rural Development (EAFRD), while the rest is co-financed by the State Budget of the Republic of Croatia. One of these measures is the LEADER measure, which is the beneficiary of the LAG, and will be discussed further below.

2.2. LEADER

Emphasis on the local population is one of the primary characteristics of the implementation of rural development in rural communities. The special feature of LEADER projects, and therefore of the LEADER program itself, is reflected in the special feature of trust in people living in rural areas and in their ability to discover what best fits their environment, culture, work traditions and skills.

LEADER is an acronym for the French term "Liaison Entre Actions de Développement de l'Économie Rurale", which represents the EU's initiative to support rural development projects launched locally to create jobs and revitalize rural areas. The program relies on the development and implementation of local development strategies (LDSs) that allow the integrated implementation of economic and social cohesion implemented by local action groups (LAGs). LAGs are associations that provide direct support to local development stakeholders and projects of national rural development programs. In the context of rural development in Western European countries, which is still heavily dominated by the disintegrated sectorial approach, both academics and practitioners often find the well-known LEADER approach and its guiding principles, in other words, development which is area-based, bottom-up, public-private, integrated, innovative, co-operative and involving networking, overly idealistic and impractical (Lukić & Obad, 2016, p. 74).

Nevertheless, the number of Local action groups (LAGs) rose steadily during the last 29 years and today there are almost 3100 of them. Simultaneously, their total public budget grew more than 8 times.

LEADER is based on 7 basic principles that serve as a roadmap for local development by talking about how and what not to do:

- 1. APPROACH BASED ON THE PECULIARITIES OF THE AREAS Each rural area has its own characteristics, potentials, specificities and distinctiveness and needs to be planned and built for the future.
- 2. A BRIDGE-UP APPROACH Widespread involvement of all available forces in local communities will contribute to quality development through a wealth of ideas and possible solutions.

- 3. ESTABLISHING LOCAL PARTNERSHIPS Connecting, establishing partnerships and developing a culture of cooperation are crucial. LEADER's original idea is to create local public-private partnerships in the form of LAGs.
- 4. INNOVATIVE tradition is certainly the cornerstone of sustainable rural development, but innovation is necessary to present traditional values in a new and competitive market.
- 5. INTEGRAL AND MULTI-SECTOR APPROACH horizontal, cross-sectoral linking as well as linking of local, regional and national institutions is particularly important in achieving sustainable rural development.
- 6. NETWORKING AND COOPERATION networking, launching and implementing joint projects of two or more LAGs within a country, region and / or the European Union, learning from good practices, transferring and sharing knowledge and experience are of particular importance in the implementation of LEADER.
- 7. SUSTAINABLE RURAL DEVELOPMENT development based on the preservation and balanced development of environmental, social and economic capital. (LAG Sjeverna Istra, 2020)

At least 5% of EAFRD's total contribution to rural development is reserved for LEADER access.

Each country submits to the European Commission its national strategic plan, which contains guidelines for the implementation of EU priorities, taking into account national and regional needs. The National Strategic Plan is implemented through rural development programs. EU strategic guidelines serve as reference documents during the preparation of the national strategic plan and program for rural development; they outline EU programs and a range of implementation options. The relevant national institutions, set up by the governments of the Member States and are tasked with implementing the programs covered by the rural development plan at national level, call for submission of project proposals and tenders. EAFRD operates in Member States through rural development programs.

These programs are implementing a strategy that will meet the Union's priorities for rural development through a series of measures, seeking the assistance of the European Agricultural Fund for Rural Development. There must be consistency between grants from the European Agricultural Fund for Rural Development and measures financed by the European Agricultural Guarantee Fund.

Member States of the European Union may include thematic sub-programs as part of their rural development programs, contributing to Union priorities for rural development aimed at addressing specifically identified needs, especially targeting: young farmers, small farms, mountainous areas and small supply chains.

The maximum co-financing rate is: 85% of eligible expenditure in less developed regions, outermost regions and smaller Aegean islands, and 50% of eligible public expenditure in other regions. The minimum co-financing rate is 20% of eligible public expenditure. (Rural development, 2020)

2.3. LEADER Network of Croatia

The LEADER Network of Croatia is a national non-governmental association of LAGs and supporting organizations/institutions exclusively from the public and civilian

sectors for the development of rural areas operating at the national level and providing expert assistance to LAGs and their multisectoral development stakeholders.

It was established on the initiative of 20 LAGs and 7 institutions and organization of the national level of activity, in Karlovac, on 12 April 2012.

In 2019, the LEADER Network of Croatia has 37 LAGs, of which 35 are LAGs and 2 FLAGs are LAGs and 10 reputable national scientific institutions and organizations for rural development. 36 LAGs have been approved to implement the LEADER / CLLD under the Framework Rural Development Programs and Operational Program for Maritime Affairs and Fisheries for the Republic of Croatia for the Period 2014-2020.

LAGs in the LEADER Network of Croatia include:

- 30,247 km2 of the Republic of Croatia (53% of the total area)
- 1,660,282 inhabitants (39% of the total population of Croatia)
- 329 local self-government units (59% of the total number of LSGs in the Republic of Croatia; 71 cities, 56% of the total number of cities in the Republic of Croatia; 258 municipalities, 60% of the total number of municipalities in the Republic of Croatia; within whose administrative boundaries there are 4,162 settlements or 61% of all settlements in the Republic of Croatia). (LEADER network Croatia, 2020)

There are 56 LAGs operating in the Republic of Croatia, which cover an area of 52,190.05km2, which makes 92.30% of the total area of the Republic of Croatia, and 2,446,567 inhabitants live in the area of LAGs, which makes up 57.10% of the total population of Croatia.

3. Local action group Cetinska Krajina

LAG Cetinska Krajina was founded on January 11, 2013 in the area of Cetinska Krajina, which covers the areas of three cities: Sinj, Trilj, Vrlika, and two municipalities: Otok and Hrvace. LAG was established as a partnership between local self-governments, entrepreneurs and civil society of the entire Cetinska Krajina region. Area of operation of the LAG Cetinska Krajina is the area of administrative units in Sinj, Trilj, Vrlika, Otok and Hrvace. The LAG is legally formed as an association, in accordance with the Law on Associations and has 66 members from the area of five LSGs.

Table 1 Structure of LAG members

Sector	Number of members	Participation in membership (%)
LSG/public	13	19.70
Non profit sector	19	28.79
Profit sector	34	51.51

Source: LAG Cetinska Krajina

LAG Cetinska Krajina is co-financed by the EU accession program IPARD through the LEADER measure.

LAGs establish communication and synergy of all elements of society in order to build local capacity to manage, exploit economic potential and develop new values. The task

of the LAG is to develop a strategy and prepare its area for the use of national and European development funds.

3.1. Objectives of the LEADER program and the LAG Cetinska Krajina:

MAIN OBJECTIVES:

- Improving living and working conditions;
- Creating new, sustainable earning opportunities;
- Preserving and creating jobs;
- Diversification of economic activities.

SPECIFIC OBJECTIVES:

- Encouraging and developing activities of the rural population to work together through cooperative projects;
- Developing integrated local development strategies and preparing them for implementation;
- Promoting local initiatives and partnerships by involving local communities, business and local government representatives;
- Transfer of achievements, experience and expertise, and availability of information and conclusions through the network.

OPERATIONAL OBJECTIVES:

- Capacity building among rural residents and LAG members through training and education;
- Development, organization and management of LAGs;
- Preparation and implementation of local development strategies and related local projects. (LAG Cetinska krajina, 2020)

Financing LAG Cetinska Krajina occurs from several sources: membership fees, donations and support from the EU and national funds, which will be continued in the future. Financial capacities for the implementation of the activities of the Local Development Strategy for the period 2014-2020 will be provided by Measure 19.2. Implementation of operations within the CLLD strategy from the PRR.

3.2. Analysis of development needs and potentials of the area

Table 2 Strengths, weaknesses, opportunities and threats of the LAG area

STRENGHT	WEAKNESSES
a significant number of registered PGs in the	Negative demographic trends in the LAG area
LAG area	
a large number of small PGs in the LAG area	outdated machinery in agriculture
the rich historical and cultural heritage of the	insufficient valorisation of traditional products in
LAG area	the LAG area
favorable climatic conditions for agriculture and	over-parcelization of agricultural land
livestock	
plenty of unpolluted water	unsettled property and legal relations
a wide range of opportunities for active tourism	the tourist offer does not follow the needs of the
development	guests and does not develop accordingly

a developed tradition of horse breeding and equestrian sport	Limited access to high-speed internet in certain areas of the LAG
high level of environmental protection	unsatisfactory orderliness, maintenance and
	characterization of roads and paths in the LAG
	area
	lack of irrigation systems
	insufficient education of public administration employees about withdrawal of EU funds
OPPORTUNITIES	THREATS
increased demand for specific forms of tourism	departure of the working population (young
_	people leave, leaving the village)
EU funding from the Rural Development	high tax burdens
Program	
EU funds for the development of entrepreneurial	para-fiscal charges
and agronomic zones	
the increasing valorisation of organic farming	unregulated markets and developed gray
	economy
	insufficiently good professional support in the
	agriculture and animal husbandry

Source: LAG Cetinska Krajina

In order to reduce rural immigration, it is necessary to optimize the usage of environmental, agricultural and tourist potentials of rural areas through innovations and entrepreneurship. Fostering entrepreneurship in agro-tourism sector should not only create value for the local community, but also contribute to preservation of rural heritage while at the same time encouraging sustainable tourism in rural areas. Merging elements of farming and tourism in order to enhance distribution of farming products and provide travellers unique rural experience, it promises substantial benefits for the rural areas, reducing unemployment, rural migration and poverty. (Stanovčić, Peković, Vukčević & Perović, 2018, p.107-109)

Table 3 Development problems and development needs of the LAG Cetinska Krajina

Development problems	Development needs
Insufficient development of agricultural farms	Strengthen the competitiveness of PG's and their
	recognition in the market.
Insufficient infrastructure and lack of basic	Development and improvement of infrastructure
services to meet the needs of the local	and basic service needs of the local population in
population	order to improve the quality of life.
Insufficient knowledge of heritage branding and	Cooperation and transfer of knowledge and
traditional products	skills of good practice in branding heritage and
	traditional products
Insufficient activity and education of the local	Empowering local people and raising awareness
population regarding the possibility of	of the opportunities for collaboration through
cooperation between different segments of the	partnerships of different segments in the
local community aimed at sustainable rural	community based on the LEADER approach.
development	

Source: LAG Cetinska Krajina

3.3. LDS goals, priorities and measures for the LAG area based on RDP 2014-2020 capabilities

STRATEGIC OBJECTIVE 1 "Empowering agricultural holdings": The purpose of this objective is to increase the number of agricultural farms that will create restructured and/or modernized agricultural farms; and to modernize production technology.

STRATEGIC OBJECTIVE 2 "Development and improvement of infrastructure and basic services to the needs of the local population in order to improve the quality of life": Development and improvement of the infrastructure and adaptation of the basic services to the needs of the local population aims at improving satisfaction and overall quality of life.

STRATEGIC OBJECTIVE 3 "Strengthening the LAG Area Capacity by Implementing the LEADER Approach Strengthening the LAG Area Capacity through the Implementation of the LEADER Approach": Desires to stimulate population activity in transferring knowledge and skills of good practice in local branding and participation in local community development. (Local development strategy, 2020, p.33).

Table 4 Scheme of goals and activities of LAG Cetinska Krajina

Specific object Empowerment of holdings		Specific objective 2: Development and improvement of infrastructure and basic services to the needs of the local population in order to improve the quality of life	Specific objective 3: Strengthening the capacity of the LAG area by implementing the LEADER approach	
Priority 1.1. Support existing medium busines competitive and projects		Priority 2.1. Development of infrastructure that promotes the promotion of local, cultural and sports facilities	Priority 3.1. Strengthening the capacity of the LAG	Priority 3.2. Delivering knowledge transfer and good practice examples through collaboration with other LAGs
Measures: 1.1.1. Restructuring, modernization and increasing the competitivene ss of farms	Measures: 1.1.2. Supporting the development of small farms	Measures: 2.1.1. Investing in launching, improving or expanding local basic services for the rural population, including leisure and cultural activities and related infrastructure	Measures: 3.1.1. Ongoing costs and animation	Measures: 3.2.2. Implementation of LAGs cooperation activities.

Source: LAG Cetinska Krajina

These measures refer to future LAG tenders on the basis of which selected projects are financed for which the maximum amount of project value can be up to EUR 100,000. They refer to the development problems and needs of the Cetina region, which are defined by the analysis of the situation and SWOT analysis.

3.4.Project selection at LAG level

The Cetinska Krajina LAG and the Paying Agency signed a Grant Agreement on February 23, 2017, for HRK 7,014,193.20 (EUR 937,125) for the implementation of Sub-Measure 19.2, Sub-Measure 19.3. and Sub-Measure 19.4, Annex to the Grant Agreement to Selected LAG no. 1 signed on 10.01.2019, and on 29 December 2017 they signed an Agreement on Cooperation in the Performing of Delegated Administrative Checks defining the functions and responsibilities between the Paying Agency and the LAG in carrying out the following delegated administrative checks:

- user acceptability and
- compliance with the selection criteria

The LAG may call for tenders for each type of measure according to the Action and Financial Plan specified in the LDS Implementation Plan and the LDS Action and Financial Plan if the Paying Agency has announced at least one national tender for that type of operation.

After the LAG has announced tenders for the types of operations/measures selected in the Strategy, the project selection procedures include:

- Phase 1: administrative control of the project
- Phase 2: project evaluation
- Phase 3: selection of projects by the UAG LAG
- Phase 4: Objections to LAG decisions

This chapter presents the allocation of funds available to the Cetinska Krajina LAG for the 2014-2020 programming period. The funds that the LAG has received for use are the funds of the Rural Development Program of the Republic of Croatia 2014-2020.

For the duration of this programming period and under the Agreement on the allocation of funds to selected LAG, between the Paying Agency and the LAG Cetinska Krajina which was signed on 23 February 2017, the LAG will dispose of €937,125. Below is the division of finances of the Local Development Strategy of the LAG Cetinska Krajina 2014-2020. (Local development strategy, 2020, p. 40)

Table 5 Division of Finance in Local Development Strategie of LAG Cetinska Krajina 2014-2020.

GOALS	%
SG1 Empowerment of agricultural holdings	60.82
SG2 Development and improvement of infrastructure and basic services to the needs of the local population in order to improve the quality of life	15.37
SG 3 Strengthening the capacity of the LAG area by implementing the LEADER approach	23.81
PRIORITIES	
P 1.1. Support existing micro, small and medium-sized businesses in competitive and sustainable projects	60.82
P 2.1. Development of infrastructure that encourages the promotion of local, cultural and sports facilities	15.37
P 3.1. Strengthening the capacity of the LAG	20

P 3.2. Delivering knowledge transfer and good practice examples through collaboration with other LAGs	3.81
MEASURES	
M 1.1.1. Restructuring, modernizing and increasing the competitiveness of agricultural holdings	9.60
M 1.1.2. Supporting the development of small farms	51.22
M 2.1.1. Investing in launching, improving or expanding local basic services for the rural population, including leisure and cultural activities and related infrastructure	15.37
M 3.1.1. Ongoing costs and animation	n/p
M 3.2.2. Implementation of LAGs cooperation activities.	n/p

Source: LAG Cetinska Krajina

Conclusion

The European Union has adopted the LEADER program, which aims to develop rural areas throughout the European Union. The LEADER program is based on the implementation of local development strategies managed by LAGs.

Local Action Groups (LAGs) are bodies whose purpose is to support rural development. They seek to connect and network with different stakeholders to encourage the development of local initiatives together. The LAGs bring together representatives of small businesses, OPGs, non-profit organizations, local governments and other stakeholders who jointly agree on the development of their region. They are a necessary instrument for the development policies of the local areas that they represent because they design and implement a local development strategy that identifies problems and benefits of a particular geographical area.

LAG Cetinska krajina recognized the importance of European funds in the development of rural areas and adopted a document, a local development strategy, in which it indicates the goals and priorities that will be financed by EU funds. LAG Cetinska krajina has so far announced three tenders, approved 34 projects and awarded total of 3.992.200 HRK to small farms and the town of Vrlika and the municipality of Otok.

The area in which LAG Cetinska krajina operates is facing many challenges today, which leaves room for further work and development of LAG activities. The success of LAGs in solving problems and challanges that encounteres in Cetina region as well, was extremely high, which brings hope that LAG Cetinska krajina will succeed in achieving its objectives.

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Modernization of the Financial-Banking Sector in the Context of Accession to the European Union

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Abstract. The existence of a functioning market economy is one of the main conditions a state must meet in order to become a member of the European Union. In this context, the National Bank of Moldova, as the central bank of the state and the National Commission of the Financial Market having specific competences, actively participates in the internal legislative, institutional and functional changes meant to contribute to achievement of the economic criterion of accession to the European Union, thus ensuring a greater approximation of the Republic of Moldova to the European Union. Within the limits of their duties, the respective institutions promote the alignment of the normative framework and its activities with the legislation and best practices of the European Union.

Key words: Financial Market, National Bank, currency

1. Introduction

Today's European Union is the result of an ever-evolving integration and expansion process that has contributed to the stability, development and prosperity of the whole of Europe, thus representing one of the most important phenomena the European continent knows. If initially the integration process aimed at preserving peace and eliminating the danger of a new war, then there were many advantages of increasing cooperation between European states.

The establishment of a common market and the gradual approximation of the Member States' economic policies aimed at promoting a harmonious development of economic activities, a sustainable and balanced growth, increasing stability, an accelerated increase in living standards and closer relations between Member States.

During the last decade in Moldova the normative framework for ensuring the smooth functioning of the banking and non-banking financial market has been developed and modified in accordance with the EU/international principles and standards. In this context, major EU financial directives have been transposed into the main financial market regulation laws as a whole.

Thus, clear policy actions, including measures, stemming from the country commitments assumed by the Association Agreement between the Republic of Moldova on the one hand and the European Union and the European Atomic Energy Community and their Member States on the other (The EU-Moldova Association Agreement).

The Republic of Moldova must overcome the European and World Consumer Consumers Syndrome, it would be right to generate and create international products, appreciated and necessary for the financial market in the European Union and globally.

2. Harmonizing and aligning national financial policy and legislation with EU legislation to implement best Community practices

The Republic of Moldova, with the support of the EU, adopts rules and practices to ensure the stability and integrity of the financial system and financial services through appropriate

cooperation between the actors of the financial system, the regulatory bodies and the supervisory bodies. Achieving these goals is necessary for building an economy and encouraging trade between the Republic of Moldova and the EU.

The effort of the Republic of Moldova to harmonize its legislation with EU legislative acts in the field of financial services falls within a period of one to five years.

The Republic of Moldova must assimilate the European standards set out in 40 directives and recommendations, which refer to:

- prudential policies on acquisitions and increases in holdings in the financial sector;
- the supervision of credit institutions, insurance and investment companies belonging to a financial conglomerate;
- initiating and pursuing the activity of credit institutions;
- access to activity, conduct and prudential supervision of the activities of electronic money institutions;
- Deposit Guarantee Schemes;
- the annual accounts and the consolidated accounts of banks and other financial institutions;
- reorganization and liquidation of credit institutions;
- initiating and pursuing the business of insurance;
- civil liability insurance for motor vehicle damage and control of the obligation to insure such liability;
- activities and supervision of institutions for the provision of occupational pensions;
- markets of financial instruments;
- organizational requirements and operating conditions of investment companies;
- investor compensation schemes;
- combating abusive use of confidential information and market manipulation;
- credit rating agencies;
- undertakings for collective investment in transferable securities;
- financial guarantee contracts, etc. (MFA, 2013)

The strategic vision of the National Bank of Moldova and National Commission for Financial Markets is aimed at strengthening the system of regulation and supervision of the financial market and increasing its competitiveness by improving the regulatory framework and harmonizing it with the acquis communautaire under the implementation of supervisory mechanisms based on risk prevention and management and prudential approaches. (NCFM, 2018)

In this context, increased attention is paid to activities aimed at increasing the level of financial education, as an active measure of protecting consumers of banking and non-banking financial services and products, increasing their confidence.

These institutions tend to improve the quality of the assistantship of market participants, generating increased financial inclusion and interest in recording progress in building confidence in the financial system and related instruments.

The main milestones and initiatives are the wider and more effective application of financial engineering to attract private capital and strengthen the country's economic competitiveness. As a result of the global economic and financial crisis, the level of investment has fallen in the EU. The investment plan for Europe, known as the "Juncker Plan", aims at removing

obstacles to investment by ensuring the visibility and technical assistance needed for investment projects and by making intelligent use of financial resources.

The Twinning project "Strengthening the National Bank of Moldova's Banking and Regulatory Capacity in the Context of European Union Requirements" launched on 30 June 2015 and implemented for two years by the National Bank of Moldova (NBM) and the consortium of the National Bank of Romania (NBR) and De Nederlandsche Bank (DNB), aims to support the NBM in consolidating the prudential supervision framework by harmonizing with the standards of the EU central banks.

The project also aimed to improve banking legislation, aimed at asserting a solid and competitive banking sector.

Within the Twinning project, increased attention was paid to the development of supervisory tools and the overall strengthening of the NBM oversight function. All the activities carried out allowed both the improvement of the knowledge of the NBM employees and the banks, as well as the analysis of the prospects for implementing the new legislative framework and its potential impact on the stability of the banking sector in the Republic of Moldova. The most important results of the project are:

- drafting a new banking law the Law on Banking Activity, which will allow the National Bank of Moldova to issue secondary normative acts regulating the prudential requirements submitted to the banks for each field;
- the elaboration of 20 draft secondary regulations that ensure the transposition of the provisions of the European regulatory framework on banks;
- drafting the NBM internal rules that will allow for the effective exercise of the supervisory function and the modification of the organizational structure of the National Bank of Moldova:
- increasing the level of expertise of supervisors and bank representatives on the Basel III framework through internal trainings, case studies, practical exercises in the Republic of Moldova, Romania, the Netherlands and others. (NBM, 2017)

The results and benefits of the project become visible with the implementation of the new legal framework and the application of new risk-based supervision practices. Even if the direct beneficiaries of the project are the NBM and licensed banks in the Republic of Moldova, the final beneficiaries will be citizens of the Republic of Moldova, who will enjoy a viable, stable and secure banking system.

Also, establishing a new legal framework equivalent to that applicable in the European states contributes to improving the image of the financial sector in the Republic of Moldova and attracting new investors, which will stimulate the economic growth in the Republic of Moldova.

In this context, we note that the European Union launched the Twinning Project "Development and strengthening of the operational and institutional capacities of the National Commission of Financial Market in the field of prudential regulation and supervision" on 12 August 2015. (NCFM, 2015)

Its implementation was entrusted to the Polish Financial Supervisory Authority (KNF) for the benefit of the National Commission of Financial Market (NCFM), responsible for overseeing the non-banking financial market in Moldova. This is of major importance for the Republic of Moldova, as it allows the creation of an efficient mechanism for protecting investors and beneficiaries of non-bank financial services in our country.

Special emphasis is placed on the development and implementation of the NCFM's risk-based oversight system as well as the alignment with the EU acquis and the implementation of best practices of the European Union regarding the supervision of non-bank financial markets.

Under the Association Agreement, the Republic of Moldova benefits from financial assistance through the relevant EU funding mechanisms and instruments. The Republic of Moldova also benefits from loans from the European Investment Bank (EIB), the European Bank for Reconstruction and Development (EBRD) and other international financial institutions. Priority areas and volume of European financial assistance are agreed in annual action programs based on multiannual frameworks reflecting agreed policy priorities.

On May 2, 2014, the European Commission approved a support program for the Republic of Moldova (€30 million), aimed at the competitiveness of small businesses, the development of national legislation in line with EU quality standards and export promotion as well as information campaigns on the Deep and Comprehensive Free Trade Area (DCFTA) Agreement with the EU, investment and communication opportunities.

At the same time, in order to help the Ministry of Finance, the Parliament and the Supreme Audit Institution of the Republic of Moldova in the process of consolidating good governance, effective fiscal policy, transparent and accountable public finance policy and public financial management consolidation systems, The EU has provided € 37 million in support for political reforms in the Republic of Moldova.

It also needs to be referred to the "Support for the use of remittances to create new businesses and jobs" project, funded by the European Union and co-financed by the Czech Development Cooperation in the amount of 500,000 Euros. At the same time, with the support of the International Fund for Agricultural Development (IFAD), it facilitated access to capital markets, supporting agricultural producers by granting loans for business development and granting loans with portions of grants to young entrepreneurs initiating or develops a business in rural areas. (IDIS, 2016)

It is noteworthy that in order to constitute the Central Securities Depository in 2017, Law no. 58 of 06.04.2017 for the amendment and completion of some legislative acts, in order to bring them in accordance with the Law no.234 of 03.10.2016 on the Single Central Securities Depository.

Please note that the open tender tender procedure for the Unique Central Securities Depository, related implementation services as well as warranty (maintenance and support) has been initiated by the publication of the notice of participation in the Procurement Bulletin no. 49/2017 of 20.06.2017. (NBM, 2019)

Following the adoption on October 4, 2016, of the Bank's Resolution and Resolution No. 232 of October 3, 2016, in accordance with Article 9 of the Law, the NBM has asked banks to develop and maintain a recovery plan that provides for the measures to be taken by to them to restore their financial position in case of significant deterioration.

At the same time, in order to facilitate the elaboration of the recovery plan, the Guidance on the elaboration of the recovery plan, containing detailed information on all aspects to be included in the plan, has been developed and submitted to the banks. In this regard, a draft law on the Macro-prudential Policy Committee was drafted. (MFA, 2016)

On June 23, 2017, the draft law on the activity of banks (formerly called the Law on Access to Credit Companies and the Supervisory Supervision of Credit Companies and Investment Firms) was approved by the Government.

During the reference period, the Executive Committee of the National Bank of Moldova approved Decision No. 165 of June 28, 2017 "On Amending and Supplementing Some Normative Acts of the National Bank of Moldova".

The purpose of this Decision is to bring the Regulation on Monetary Market Operations of the National Bank of Moldova (OM 2014, no. 293-296, art. 1386) and the Regulation on the System of Registration of Securities Accounts (OM 2012, no. 252-253, art. 1547), in

accordance with Law no.184 of 22.07.2016 on financial collateral contracts (OM 2016, no. 293-305, art. 622). (NBM, 2016)

On May 4, 2017, the Executive Committee of the NBM approved the Decision on the modification and completion of the Regulation on the Automated Interbank Payment System and published in the Official Gazette of the Republic of Moldova no. 155-161 of 19 May 2017 (Article 934). The Decision of the Executive Committee of the NBM no. 142 of 2 June 2017 (OM No 181-189 of 9 June 2017, Article 1082 whereby the Automated Interbank Payment System (AIPS) and the Securities Account Entitlement System (SAES) were designated as systems fall under Law 183 of 22 July 2016 on settlement finality in payment and securities settlement systems.

On July 30, 2018, the new regulations came into force according to the requirements of Basel III (in terms of the European CRD IV / CRR framework). The new regulations have also set the size of capital buffers that will mitigate if necessary the impact of systemic crises on own funds. (NBM, 2018)

In 2018, with the entry into force of Law no. 202/2017 on the activity of banks, the National Bank of Moldova:

- has approved eight regulations (normative acts), which address the requirements of own funds and the treatment of credit, market, operational and settlement / delivery risks in the context of own funds, as well as the requirements for the capital amortization;
- has approved the Instruction on the submission by banks of the COREP Supervisory Surveillance Reports which set out uniform requirements for supervisory reporting and the format and manner of reporting of information on own funds and risk exposures;
- has approved the Regulation on external auditing of banks, which determines the requirements related to the external audit of the financial statements and for other purposes;
- amended the regulatory framework for the holding of participation shares in the bank's share capital with a view to improving the mechanisms of access to the financial and banking market for persons, including those that apply supervisory and prudential regulation requirements at least equivalent to those applicable in the Republic of Moldova; which correspond to the legal requirements regarding the quality of the bank's shareholder;
- has adjusted the examination process regarding the obtaining of the prior approval of the National Bank of Moldova for the acquisition or increase of the qualified holding in a bank;
- approved the Regulation on requirements for members of the bank's management body, mixed financial holding company or mixed holding company, the heads of branches of a bank in another state, the persons holding key positions and the liquidator of the bank in liquidation;
- has endorsed the Banking Management Regulation, which brings the requirements for internal governance and risk management into line with EU standards. At the same time, it introduces a new process for banks the Internal Capital Adequacy Assessment (ICAAP);
- some amendments have been introduced to the Regulation on Calculation of Voting Rights and the Registration of the Transfer of Ownership Rights on Banks' Shares and to the Chart of Accounts of Licensed Banks of the Republic of Moldova. (NBM, 2018)

Regarding normative acts related to own funds and risk treatment, they were developed in the context of the transposition of Directive 2013/36 / EU and Regulation 575/2013, which implements the Basel III international regulatory framework. The National Bank of Moldova continues the elaboration of the normative acts, in order to implement the provisions of Law no. 202/2017 on the activity of banks.

Aligning the banking legislation of the Republic of Moldova to international standards by improving quantitative and qualitative bank management mechanisms contributes to the promotion of a secure and stable banking sector, to increasing the transparency, confidence and attractiveness of the domestic banking sector for potential investors and creditors of banks, as well as for depositors, to the development of new financial products and services. (NBM, 2018)

International cooperation is one of the main objectives of the National Commission for the Financial Market. The permanent exchange of information, knowledge and experience with external partners is meant to facilitate the process of harmonizing the regulatory and institutional framework in the financial market area of the Republic of Moldova with the requirements of the European Union.

In this context, the National Commission for the Financial Market establishes new rules on the insurance market, according to which the mandatory state products, due to the legal requirements, are to be offered without commissions by the insurance companies. In accordance with the Law on amending and completing some legislative acts, the legislator has made a number of amendments and completions to the legislation in force in the field of insurance. (NCFM, 2018)

A number of 140 companies have the right to pursue professionally non-bank lending and financial leasing activities under the Law on Non-Banking Credit Organizations, in force since 1 October 2018.

These data are contained in the Register authorized non-bank lending organizations, held by the National Commission for the Financial Market (NCFM), on 1 April 2019. (NCFM, 2019)

We mention that the recently approved legal framework creates prerequisites for resetting the policy on compulsory motor third party liability insurance so that consumers and market participants will benefit from clear, predictable and transparent rules. Any intermediation on this mandatory insurance segment is acceptable under the terms of excluding commissions, fees or other payments.

3. The economic situation and the financial market of the Republic of Moldova in the process of restructuring

The international situation has had mixed effects on the Moldovan economy and, consequently, on the financial market. On the one hand, positive global economic dynamics (+ 3.7% in 2017) created favorable conditions for economic growth in the Republic of Moldova. In the European Union - the main trading partner of our country - economic growth reached 2.5% and the unemployment rate decreased and registered the value of 3.3%.

On the other hand, the increase in global demand was the main cause of rising international commodity prices, including food and energy. Accelerating the rise in oil prices was also caused by the reduction in extraction limits under the OPEC agreement. (NBM, 2018)

In the Republic of Moldova 2017 is highlighted by initiated reforms aimed at stabilizing monetary conditions, strengthening the banking sector and improving the national legislative and regulatory framework in order to prevent repeat offenses leading to bank fraud in 2012-2014 and the financial crisis that followed.

A catalyst for these reforms is the Agreement of the Republic of Moldova with the International Monetary Fund (IMF) concluded on 7 November 2016. During 2017, the competent institutions have successfully fulfilled their commitments to the IMF, which confirmed the first and second positive evaluation of the program in its decisions of 1 May and 20 December 2017. (NBM, 2018)

In this connection, the Republic of Moldova registered an increase in the economy, but also experienced an increase in domestic consumer prices.

We mention that gross domestic product (GDP) has progressed by 4.5% in 2017, supported by the increase in domestic consumption and production in the agrarian sector. Economic growth in the main emigration countries of Moldovan citizens accelerated the volume of remittances, which in turn helped to increase the purchasing power of local consumers. In the second half of the year, we witnessed a revival of activity in the industrial sector and strong export growth. (NBM, 2018)

The average annual rate of change in the consumer price index was 6.6% in 2017, 0.2 pp. higher than in the previous year. Annual consumer price inflation rose from 3% in January to 7.3% in December 2017, driven by rising energy prices, food prices and rising tariffs for regulated services.

However, annual base inflation continued to fluctuate within the target range and averaged 4.8%. At the time of drafting the report, annual consumer price inflation fell to 3.7%, according to April 2018.

Taking into account inflation forecasts, the NBM continued to pursue a policy of lowering the base interest rate in 2017, but at a slower pace than in 2016: from 9.0% at the beginning of 2017 to 6.5 % at the end of the year.

At the same time, in order to sterilize liquidity surplus and to improve the transmission mechanism of monetary policy, the NBM increased the reserve requirement from the attracted funds in moldovan lei from 35% to 40%. The reserve ratio of attracted funds in freely convertible currencies was maintained at 14%.

The monetary policy of the NBM, the prospects of reducing inflation and favorable conditions in the money market led to a significant improvement in the indebtedness of the Ministry of Finance on the domestic capital market. Thus, the average interest rate on state securities was 6.7% in 2017 compared to 15.8% in 2016.

The liquidity surplus in the system was largely conditioned by the increased flow of foreign currency inflows in favor of individuals on the market of Moldova - equivalent to \$ 1.2 billion, up 11.2% over the previous year.

As a result, during 2017, the Moldovan leu strengthened by 14.4% against the US dollar and by 2.3% against the euro. The appreciation of the Moldovan leu against the US dollar is, however, a consequence of the weakening of the US currency against the euro, which went from 1.0454 for 1 euro at the beginning of the year to 1.1935 in December 2017.

To prevent volatility and excessive appreciation of the Moldovan leu, the NBM intervened in the foreign exchange market in the equivalent of \$ 434 million in 2017.

As a result of the NBM interventions, the official reserve assets reached the record level of about \$ 2.8 billion at the end of 2017, which comfortably covers the equivalent of 5.5 months of imports of goods and services.

At the same time, despite the fact that almost 66% (in 2017) of total exports are destined for the EU market as final destination, where transactions take place in the euro, official country statistics are conducted in US dollars. (NBM, 2018)

Simultaneously with measures to stabilize monetary conditions, the NBM has taken vigorous action to strengthen the banking sector. Thus, thematic controls on shareholder transparency and quality have been stepped up, transactions of related party transactions have been stepped up, as well as asset quality assessments.

Of 7 of the 11 licensed banks, complex field controls have already been performed. The controls carried out eliminated the main uncertainties in the sector, and the implementation of remedial measures, including capital retention, significantly increased the resilience of the sector. Capitalization and liquidity of the banking sector rose to 31% and 55%, respectively. The implementation of prudential supervision measures has helped to restore the stability, transparency and credibility of the banking sector inside and outside the country.

For the first time in the last ten years, a quality foreign investor has entered the Moldovan banking market. In November 2016, Banca Transilvania (the second largest commercial bank in Romania by assets) together with the European Bank for Reconstruction and Development (EBRD) announced its intention to acquire 39.2% of shares in BC "VICTORIABANK" S.A.

The transaction took place in January 2018, creating the conditions for the cancellation of intensive supervision in one of three systemic banks operating under the special supervision regime in 2015.

Together with international experts, the NBM has developed a strategy to sell blocked shares in the other two banks to ensure their stability and good governance. The strategy of attracting foreign investors was supported by the Parliament of the Republic of Moldova by amending the Law on the administration and privatization of public property, which entered into force on January 1, 2018.

The legislative amendments envisage the possibility of the state involvement under the prescribed conditions in the purchase and sale of the shares of the banks systemic to quality investors. At the time of drafting the report, an international consortium filed a formal request with the NBM regarding the acquisition of a 41.09% stake in BC "MOLDOVA - AGROINDBANK" S.A.

Also on January 1, 2018 came into force the new Law on Banking Activity adopted on 6 October 2017. It is a major law for the Moldovan banking system, which harmonises the national legislation with the EU Directives and introduces the best international practices in the field of prudential supervision under the generic name "Basel III".

The impact study carried out by the NBM on the basis of the financial statements as at 30 June 2017 confirms that all banks comply with the new prudential requirements. In order to prevent a possible erosion of own funds before the new rules were implemented, the NBM issued to some banks the recommendation not to distribute the profit for 2017.

The aggregate profit of the banking sector for the year 2017 was at the level of about 1.5 billion MDL, higher by 8.6% compared to 2016. The balance of bank loans expressed in MDL continued to decrease, but at a slower pace, reaching the amount of 33.5 billion MDL in December, 2017, 3.7% less than the same period in 2016.

This is explained by the effect of the exchange gap, with about 40% of the volume of credits being denominated in foreign currencies, have depreciated against the MDL. At the same time, the annual volume of new credits extended increased by 8.9% compared to 2016, amounting to 24.5 billion MDL. The increase in new credits in national currency reached about 20% in annual rate.

The positive dynamics of lending was driven by lower average interest rates and increased demand from individuals. The evolution of lending activity will still depend on the revival of demand from the corporate sector. The balance of non-performing loans constituted 18.4%.

At the recommendation of the NBM, licensed banks created additional reserves, ensuring a level of coverage of bad loans of 80% in December 2017. Banks continued to attract deposits, whose balance reached 59.9 billion lei at the end of 2017, 9% rising over the same period in 2016. Fiscal deposits advanced by more than 18% in one year.

The structure of depreciation currencies shows a continuous increase in the confidence of the population and economic agents in the national currency: 57.2% of the deposits in MDL in December 2017 compared to 53.5% in December 2016 and 42.4% in September 2015, in the midst of the financial crisis.

The increased trust of the population in the MDL and the exchange rate stability enabled the NBM to launch in June 2017 the draft introduction of 1 leu and 2 leu metal coins. After an indepth analysis of the circulation of cash in the Republic of Moldova and international practices, the project was extended to the monetary symbols of 5 MDL and 10 MDL. The new metal coins were put into circulation on 28 February 2018. The introduction of metal coins will allow the NBM to generate savings for production costs estimated at around 300 million MDL over a period of 20 years.

It is gratifying that without prejudice to its fundamental objective and its core competencies, the NBM pursues the purpose of optimizing spending. The increase in the reserve requirement from the attracted funds in MDL, from 35% to 40%, had the ultimate objective of diminishing the monetary policy expenditures. At the same time, the significant increase in the balance of certificates issued by NBM had a reverse effect.

Decreases were recorded in foreign currency transactions as a result of the appreciation of the MDL. As a result, the NBM recorded a loss of 95.31 million MDL in 2017, a 64% reduction compared to the losses in 2016. At the end of 2017, the statutory capital of the NBM, amounting to 2.35 billion MDL, represented about 5, 1% of total monetary bonds. (NBM, 2018)

In order to improve decision-making, streamline processes and eliminate potential conflicts of interest, the NBM reorganized in 2017 a number of departments in line with best international practices. In parallel, the number of managerial posts has been reduced by 4% compared to 2016 and a strategy has been launched to reduce the number of posts in support areas for core functions. With the assistance of a foreign consultancy company, the leader in the global market, the reform of the human resources management system was launched.

The efforts of the NBM have enjoyed political support from the Parliament and the Government and have resulted in a substantial reform of the banking regulatory framework, ensuring the independence of the central bank, expanding the diversity of instruments by which the NBM can interfere, setting regulatory and supervisory standards in the sector according to EU directives and Basel III. Banks' own consolidation trend continued in 2018, with the Moldovan banking sector becoming one of the most capitalized sectors in the region. (NBM, 2019)

Regarding the non-bank market participants, we mention that they had a six-month deadline to comply with the provisions of the Law on Non-Banking Credit Organizations and the requirements set by the NCFM, including on adjusting the minimum amount of the share capital (in the first year minimum of 100,000 MDL) and the disclosure of the ownership structure of the shareholders and the actual beneficiaries. The deadline expired on 30 March 2019. (NCFM, 2019)

It should be noted that according to the law, NCFM was given supervisory powers of non-bank lending organizations; respectively activities related to this sector are validated only with NCFM authorization.

Around 10 non-bank lending entities voluntarily ceased their activity and filed the set of documents, at the same time about 30% of the former microfinance and leasing companies did not comply with the new requirements, did not submit the necessary documents to be registered in the Register of National Commission of the Financial Market. Therefore, the corresponding entities will be sanctioned, including administrative and criminal.

It is necessary to note that the legislation sets the deadline - January 1, 2021, until the non-bank lending organizations are to redimension the minimum amount of the share capital, this amount being increased up to 300 thousand MDL. (NCFM, 2019)

The problematic aspects of the financial market in the Republic of Moldova refer to the low level of information transparency, including the quality of data disclosed by securities issuers, which prevents investors from taking their decisions, also the origin and transparency of the shareholders in the banking sector and insurance, as well as corporate governance issues that are caused by a number of litigation and vulnerabilities related to the cancellation, issuance and sale of holdings held in breach of the requirements regarding the quality of shareholders in the capital of banks and insurance companies. (NCFM, 2018)

At the same time, if we analyze NCFM data, on January 1, current assets held by non-bank lending organizations exceeded the amount of 7.5 billion MDL, increasing by 38% compared to the same period of 2017. It also increased and the loan and financial leasing portfolio, which amounted to more than 6.4 billion MDL, having a percentage increase of 40%, compared to 1 January 2018. The average value of a loan amounted to 14.2 thousand MDL.

In this context, the NCFM certifies the increase of the financial stability of the non-bank credit sector, due to the continuous increase of the own capital, which as of 31.12.2018 amounted to 2.4 billion. MDL. (NCFM, 2019)

The International Monetary Fund, the World Bank, the European Commission and the European Bank for Reconstruction and Development are the NCFM development partners in the field of strengthening the regulatory and supervisory capacities of the non-bank financial market in Moldova, providing continuous support in the stringent aspects of organizing and operating the market concerned and its professional participants, and in addressing the challenges posed by the globalization of financial markets.

NCFM also benefits from advisory and technical support from the Federal Government of the United States of America, the Government of Great Britain, the German Federal Government and other donors in achieving the strategic objectives and actions of the NCFM in the short and medium term.

With reference to the NBM, we mention that it will continue to cooperate with the Government of the Republic of Moldova, the central and local public administration bodies, including the National Bureau of Statistics, the National Commission for the Financial Market, the National Agency for Energy Regulation, the National Regulatory Agency for Communications Electronic and Information Technology, State Hydrometeorological Service of the Republic of Moldova, as well as with the international financial institutions in order to promote monetary policy.

This collaboration involves the permanent exchange of information on the change of regulated prices, the fiscal-fiscal policy strategy, as well as other measures that could have an effect on the national economy and especially on the evolution of inflation.

The institutions operating on the financial market in the Republic of Moldova are determined to continue strengthening and transparency of the financial sector, but also to promote reforms in the monetary policy, financial stability, payment systems, improvement of the quality of the national currency and others.

A key objective of the reforms would be to increase external communication and financial education through media, web-based publications and social networking, which would be an important leap in financial market consolidation, which becomes more secure and credible.

4. Conclusion

We believe that the effectiveness of financial policy can be judged on the basis of the results of the activities carried out by the competent financial institutions in order to achieve the following objectives:

- aligning the banking and non-banking legislation of the Republic of Moldova to international standards;
- ensuring dissipation and financial education of the population;
- ensuring cooperation within a mechanism of specialized financial institutions and bodies;
- the operability of solving the differences between the levels of the financial system of the Republic of Moldova;
- increasing the control of the financial capital and its efficient use;
- prevention and risk management;
- promoting financial stability by applying the new macro-prudential management tools;
- international and inter-institutional cooperation with other state authorities. (GRM, 2018)

In our opinion, the application of the previously proposed instruments and methods will help to improve the situation of the Republic of Moldova by:

- diversifying international relations;
- appropriate changes in legislation;
- undertaking anti-corruption measures;
- reducing inflation and more fully implementing market-oriented reforms;
- regulation of financial markets;
- eliminating barriers to the flow of capital;
- solving issues related to political instability;
- coordination of fiscal and monetary policies;
- the development of primary and secondary markets;
- the development and maintenance of an efficient market for state securities.

After a period of radical changes in the financial sector in recent years, financial market actors will devote themselves to the dissemination and deepening of their effects in the financial-banking system in order to improve the transmission of monetary policy, to promote the modernization and healthy growth of the financial and banking sector and to increase its contribution to the sustainable economic development of the Republic of Moldova.

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The Impact of IFRS 16 on Transparency of Financial Statements

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Abstract. The main mission of the International Accounting Standard Board is that by unique accounting rules ensure a transparency, accountability, efficiency and comparability of financial information's from the financial statements which are crucial for stability of financial markets. With the aim of consistent and reliable financial statements International Accounting Standard Board has adopted a new International Financial Reporting Standard 16 – Leases. By this new standard they want to eliminate the effect called off-balance sheet financing. The effect off-balanced sheet financing was manifested in the incomplete presentation of financial statements. Because of incomplete financial statements the external users (investors, suppliers and others) could not see the complete liabilities arising from the lease, which leads to misperceptions of company financial position. The new International Financial Reporting Standard 16-Leases introduces a unique lease accounting model which require that all assets deriving from lease and related liabilities should be presented in the balanced sheet. Presenting all assets and related liabilities resulting from lease in the balance sheet would impact and other financial statement what lead to increasing transparency of financial statements.

Key words: IFRS 16, transparency, financial statements

1. Introduction

The International Accounting Standard Board have mission to create common accounting language by the International Financial Reporting Standards which should ensure consistency, transparency and comparability of financial statements. To ensure that International Financial Reporting Standards define the methods how companies should maintain and report their accounts, defining types of transactions and other events with financial impact. The one of the most debating transactions was a lease because of their impact on financial statements. Application of International accounting standard IAS17 – Lease was created a distorted presentation of financial statements because of hidden items which resulting from the off balance sheet financing. Specifically for operating lease, IAS17 has enabled the lessee to report only the value of short term liabilities or operating costs arising from the lease (Žager & Sever Mališ, 2018) until the long term liabilities presented as off balance sheet financing. Because of that the financial statements weren't confidential and transparent. In order to avoid above mentioned the International Accounting Standard Board introducing a new International Financial Reporting Standard 16 - Leases which replaced International Accounting Standard 17 – Leases. The application of the International Financial Reporting Standard 16 - Leases has started 1st January 2019. The IFRS 16 - Leases has introduced a new way of lease recognition on the lessee side by equating operating and financial leases. The new way of leases recognition on the lessee side, demand that all assets and arising liabilities should be presented in the balance sheet. The IFRS 16 provides a single leases accounting model on the lessee side what lead to reliable and transparent financial statements.

2. International Accounting Standard 17 - Leases

International Accounting Standard 17 – Leases was applied from 1st January 1999 until 1st January 2019. The objective of IAS 17 - Leases is to prescribe, for lessees and lessors, the appropriate accounting policies and disclosures to apply in relation to leases (Deloitte). IAS17 classified two types of leases (Business Media Group, 2002):

- Financial lease
- Operating lease

A lease is classified as a financial lease if it transfers substantially all the risks and rewards incident to ownership. All other leases are classified as operating leases. The differences between these types of leases are evident in the accounting treatment of leases on the lessee side. On the lessee side finance lease should be recorded under the accounting system as assets and arising liabilities in the balance sheet, until the operating lease doesn't need to be completely recorded under accounting system. For operating lease, only the value of short term liabilities or operating costs arising from the lease should be record in the balance sheet until the long term liabilities presented as "off balance sheet financing". The following table present lease effects on the lessee side.

Table 1 Lease effects on the lessee side

IAS17 - Lease	Financial lease	Operating lease
Financial statements	Assets and arising liabilities	Short term liabilities or operating costs
Non – transparent	_	Long term liabilities

Because of so callled "off balance sheet financing" the financial statements are incompleted and non-transparent and external users dont have confidence in the financial statemnts. To avoid these unwanted effect of operating lease and eliminate distrust of external users the International Accounting Standard Board has adopted a new International Financial Reporting Standard 16 – Leases.

3. International Financial Reporting Standard 16 – Leases

International Accounting Standard Board on 1st January 2016 adopted a new International Financial Reporting Standard 16 – Lease, which is effective for periods beginning on or after 1st January 2019. With this new standard the IASB have intention to increase transparency of financial statements by faithfully and completely recording the total lease transactions. The most significant change raised with the adoption of the new IFRS16 – Lease is to equalize the accounting treatment of operating and financial leases on the lessee side, while on the lessor side retains existing accounting treatments of leases which is equal with directions of IAS17 – Lease. Whether it is a finance or operating lease the lessee have to recognise lease as a right-of-use asset and completely report it in balance sheet. The lessee has obligatory to record a right-of-use asset on the base of asset costs which include (Cirkveni Filipovič, 2018):

- the initial value amount of the lease obligation
- all lease payments made on or before the lease beginning, decreased for lease discounts received

- all initial direct costs incurred by the lessee
- the estimated costs of assembling and bringing assets in working condition

Based on the above mentioned, it can be concluded that lessee in the balance sheet will record a right-of-use asset based on the present value of the resulting lease obligations. A new way of lease recording avoids off-balance sheet financing and hidden items, what increases transparency and confidentiality of the financial statements. The following table present lease effects on the lessee side.

Table 2 Lease effects on the lessee side

IFRS16 - Lease	Financial lease = Operating lease
Financial statements	Assets = present value of the resulting lease liabilities

The new IFRS 16 - Lease requires that most leases be accounted completely on the lessees balance sheets, with exceptions of short term lease and low value lease. The new IFRS16 - Lease does not require a company to capitalise leases of low-value assets and short term lease.

3.1 The IFRS16 – Lease impact on Balance sheet

The new lease regulatory framework requires that, regardless of the type of lease, the lessee in the balance sheet should record a right-of-use asset and all resulting short and long-term liabilities. The mentioned activity leads to the changing of Balance Sheets through the increasing value of the assets and resulting liabilities. Because of that the users of financial statements have complete insight into the company's overall liabilities what was not possible during applying of IAS17 – Lease when the long-term liabilities were show as off balance sheet financing. The following table present lease impacts on Balance sheet on the lessee side.

Table 3 Lease impacts on Balance sheet on the lessee side

BALANCE SHEET		
INCREASING ASSETS	INCREASING current liabilities	
by recording lease as right-of-use asset	INCREASING long term liabilities	

The inclusion of all lease transactions increases the balance sheet transparency, which will allow all users of the financial statements to have an insight into entire lease obligations without any hidden items.

3.2 The IFRS16 – Lease impact on Income statement

Regarding the income statement the new regulator frame of lease by the IFRS16 – Lease will cause changes in recording the costs. With the application of IAS17 - Lease the costs of operating lease were treated as rental costs and were recorded as operating expenditures. The new IFRS16 – Lease requires that the costs of operating lease should be separate and treat as amortization costs and interest costs. Amortization costs are recognized as operating expenditures while interest costs are recognized as financial expenditures.

The following table present lease impacts on Income statement on the lessee side.

Table 3 Lease impacts on Income statement on the lessee side

INCOME STATEMENT			
Amortization costs Recording as Operational expenditure			
Interests costs	Recording as Financial expenditures		

This method of recording lease costs affects the cost structure by providing a more detailed insight of the lease costs and also increases operating profit due to the recording of interest cost as financial expenditures.

3.3 The IFRS16 – Lease impact on Cash flow statement

The new way lease treatment by the IFRS16 – Lease affect the structure of the cash flow in the Cash flow statement. During application of IAS17 – Lease the lease payments were recorded in the cash flow statement completely as operational activities. The implementation of new IFRS16 – Lease demand separation of lease payments on repayment of the lease principal and payment of the interests, what cause a changing of cash flow structure. The following table present lease impacts on Cash flow statement on the lessee side.

Table 4 Lease impacts on Cash flow statement on the lessee side

CASH FLOW STATEMENT			
Repayment of the lease principal Recording as Financial activities			
Payment of the interests	Recording as Operational activities		

This cash flow separation will decrease the operational outflows and therefore increase the operational cash flow, while will increase the financial outflows and therefore decrease the financial cash flow, but the net cash flow on the end will be the same. Reclassification of the cash flow will give more precise insight in the operational cash flow and company solvency.

4. Conclusion

The application of the new IFRS 16 - Lease has eliminated the long-standing problem of financial reporting, known as off-balance sheet financing and company hidden items which resulting from operating lease. Because of off-balance sheet financing and resulting company hidden items the external users of financial statements did not have complete insight into the company's business operations, which raised a certain doubts about the reliability and accuracy of the financial statements. In order to avoid this International Accounting Standard Board was adopted a new IFRS - 16 Lease, which eliminated the observed shortcomings in the recording of leases, which contributed to the increasing transparency of the financial statements. Therefore, it can be conclude that IFRS16 - Lease provides reliable and transparent financial statements.

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Application of Benford's Law in Forensic Accounting

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Abstract. Forensic accountants in their work - primarily in detecting fraud - use various investigative and analytical techniques to identify indicators of fraud and potential fraud areas. Different forms of digital analysis are used in forensic investigations, and one of the forms of digital analysis that has gained significant application in the field of auditing as well as in the field of forensic accounting is Benford's law. With this law, forensics narrow the search area for fraud and detect areas of potential irregularities in financial statements. Benford's law or the law of the first digit is based on the fact that certain numbers appear more often than others in different datasets. For example, number 1 has the highest likelihood of appearing in the first digit position, while number 9 has the least chance of appearing as the first digit. By analyzing the various datasets that accompany the Benford distribution, forensic experts identify anomalies and deviations from Benford's law and provide guidance on areas where more detailed forensic investigations are required. In this paper, the authors give a practical example of the application of the Benford's law in fraud detection and outline the main advantages and disadvantages of this form of digital analysis in the field of forensic accounting.

Key words: Benford's law, frauds, forensics

1. Introduction

Benford's law or the first digit law is based on the fact that distribution of leading digits in different datasets follows a logarithmic function. According to this law, digit 1 will appear as a leading digit in most cases, as much as 30%, digit two will appear as a leading digit in about 18% of cases. The lowest probability of occurrence in the first digit place has digit 9, which is a leading digit in about 4 % of cases. It is apparent that lower digits are more likely to appear in the first digit place than higher ones. This law has experienced applications in various fields of science because most real-life data are expected to follow the Benford distribution. Development of computer techniques and the introduction of various forms of digital analysis in auditing and forensic accounting established Benford's law as a useful and effective tool for fraud detection. Specifically, using this law, forensic accountants narrow down the search area for frauds and detect areas of potential accounting anomalies. In this paper, the authors present the basic features of Benford's law and its application in forensic accounting, and demonstrate the application of this law in order to detect potential irregularities and fraud in accounting data.

2. Development of Benford's law

Simon Newcomb, an astronomer and physicist, published the first paper in 1881 on today well-known Benford's law. He noted that logarithmic tables are much more worn out on the first pages than on the back pages. This observation suggested that in different datasets lower digits (1 or 2) are more likely to appear as leading digits while higher digits (e.g. 8 or 9) are

less frequent. Newcomb did not sufficiently theoretically argue or empirically verify his observations and his work went unnoticed. Years later, Frank Benford also dealt with the phenomenon of the appearance of certain digits in particular numerical positions and studied logarithmic tables the same way as Newcomb did. Benford came to the same conclusions in his analyzes as Newcomb: the first pages of the logarithmic tables are much more worn out than the last pages which means that more numbers start with lower digits. Benford, in contrast to Newcomb, conducted a much more detailed empirical analysis and collected data for over 20.000 observations on different datasets such as river lengths, baseball statistics, atomic element weights, numbers appearing in various articles etc (Durtschi, Hillison, Pacini 2004, p. 20). Based on conducted analysis, Benford concluded that in different datasets the number 1 appears at a position of first digit in most cases. It is followed by number 2, while number 9 appears in the first digit position in the lowest number of cases. Following his observations, Benford defined formulas for calculating the likelihood of occurring different digits at certain number positions (see: Nigrini, 2012, p. 5). The likelihood of appearing digits (0 through 9) in the first four number positions are presented in Table 1.

Table 1: Frequency of occurrence of digits in certain number position according to Benford law

Digit	First	Second	Third	Fourth
0		0,11968	0,10178	0,10018
1	0,30103	0,11389	0,10138	0,10014
2	0,17609	0,10882	0,10097	0,10010
3	0,12494	0,10433	0,10057	0,10006
4	0,09691	0,10031	0,10018	0,10002
5	0,07918	0,09668	0,09979	0,09998
6	0,06695	0,09337	0,09940	0,09994
7	0,05799	0,09035	0,09902	0,09990
8	0,05115	0,08757	0,09864	0,09986
9	0,04576	0,08500	0,09827	0,09982

Source: Nigrini, (1996), p. 74.

The probability of number 1 appearing at the first digit position is highest and amounts 30%, while the lowest probability of occurrence at the first digit position, about 4%, has number 9. When looking at the second digit position, the highest probability of occurrence has number 0, about 12%, while number 9 again has the lowest probability of occurrence, about 9%. In forensic accounting and auditing, first, second and first two digits tests are usually performed in order to identify anomalies and deviations from Benford's law. Nigrini points out that testing the first two digits results in a smaller sample and provides more information than testing the first and second digits only (Nigrini, 2012, p. 87). So, the first step in applying Benfod's law is to analyze the compatibility of real data with Benford's distribution and to analyze the deviations. In the second step, the statistical significance of the deviation is analyzed and for this purpose the following statistical tests are most commonly used: z-value, hi-square test, mean absolute deviation (further in text: MAD) and Kolmogorov-Smirnoff test (Nigrini, 2012, p. 146-160). If the analysis shows significant deviations from the Benford's distribution, additional forensic tests should be conducted in order to identify specific irregularities and possible fraud.

3. Application of the Benford's law in forensic accounting

Benford's law has been applied in different areas since most numbers in real life are expected to follow Benford's distribution. However, it should be noted that this law is not applicable to all sets of numbers and that before applying the law it should be checked that the data follow

the Benford distribution. Nigrini (2011, p. 97) states that data should represent the sizes of facts or events (examples: populations of town and cities, the flow rates of rivers, sizes of heavenly bodies, market value of companies, company's revenues, company's sales etc..). Furthermore, Benford's analysis is not efficient in the case of numbers assigned or generated by a specific algorithm such as bank accounts, invoice numbers, telephone numbers, postcodes, etc. Also, this law is not applicable to datasets that have built-in a minimum or maximum (exception is built-in minimum of zero which is acceptable) nor for information generated by human thinking. For example, prices are often defined for the purpose of achieving certain psychological or marketing effects (e.g. pricing by principle x,99) and as such will not follow the Benford distribution. The law is applicable to numerical distributions that result from a mathematical combination of two different data sets - for example, by multiplying price and quantity. Since most accounting data is the result of certain mathematical processes and combinations of numbers, the law is applicable to most accounting data. For example, accounts receivable are the result of a product of sales price and quantity, accounts payable and different cost invoices are also a combination of certain numbers and are suitable for analysis. Table 2 shows examples where Benford analysis is effective or ineffective.

Tablica 2: When Benford Analysis Is or Is Not Likely Useful

When Benford Analysis Is Likely Useful	Examples
Sets of numbers that result from mathematical	Accounts receivable (number sold * price)
combination of numbers – result comes from	Accounts payable (number bought * price)
two distributions	
Transaction level data – No need to sample	Disbursements, sales, expenses
On large data sets – The more observations, the	Full year's transactions
better	
Accounts that appear to conform – When the	Most sets of accounting numbers
mean of a set of numbers is greater than the	
median and the skewness is positive	
When Benford Analysis Is Not Likely Useful	Examples
Data set is comprised of assigned numbers	Check numbers, invoice numbers, zip codes
Numbers that are influenced by human thought	Prices set at psychological thresholds (1.99\$),
	ATM withdrawals
Accounts with a large number of firm specific	An account specifically set up to record 100\$
numbers	refunds
Accounts with a built in minimum or maximum	Set of assets that must meet a threshold to be
	recorded
Where no transaction is recorded	Thefts, kickbacks, contract rigging

Source: Durtschi, Hillison, Pacini, (2004), p. 24.

When conducting Benford's analysis, the sample size must be also considered. As a general rule, Benford's law applies to a sample of at least 1.000 observations. Although the law may also apply to smaller samples, Nigrini suggests that the law does not apply to samples with less than 300 observations (Nigrini, 2011, p. 99). Certainly, when analyzing data, it should be borne in mind that a larger sample results in a more accurate analysis and that it is better to carry out the analysis on the whole population and not just on a specific sample. In the case of fewer samples greater deviations from the Benford distribution should be allowed in the analysis. Benford's law is a very significant tool for fraud fighting in the areas of forensic accounting and fraud detection, as it allows forensic accountants to spot certain accounting anomalies. Specifically, forensic accountants use various forms of digital analysis in their work, and by Benford's law they analyse whether a particular data set (accounts receivable/accounts payable, cost data, salaries, etc.) follows Benford's distribution. Benford's analysis

can detect irregularities in various areas: insurance claims, irregularities in tax returns, in health insurance claims, etc.

Papic, Vudrić and Jerin (2017, p. 165) outline the main advantages of applying Benford's law in forensic accounting:

- o the calculation is simple,
- o items that may have been manipulated are identified,
- o it is very difficult to manipulate numbers in the financial statements and achieve that numbers continue to follow Benford's law,
- o auditor / forensic accountant has the discretion right to choose the reports and period of analysis.

It should be noted that the possibilities for use of Benford's law in the field of forensics are quite wide, however, before applying the law, it is necessary to make sure that the prerequisites for its implementation are met. If analysed data do not follow the Benford distribution and significant deviations from the law are observed in the analysis, these deviations may indicate intentional manipulation of the accounting numbers. It should be noted that this analysis identifies deviations rather than specific manipulations, and the forensic expert should conduct a more detailed analysis and additional forensic tests to determine the reasons for deviations and possible manipulation.

4. A practical example of the application of the Benford's law

The practical application of the Benford'a law is illustrated by the example of company named A Ltd. which performs its primary activity in the field of tourism. For the purposes of analysis, data from the business books of the company for the year 2018 have been taken. Accounts receivable as well as accounts payable were analysed and the analysis was performed in Excell. The application of the Benford's law is shown for first digit and the results are shown below.

4.1. Analysis of accounts payable

The analysis was conducted on a sample of 1.344 company invoices in the period from 01.01.2018 to 31.12.2018. During that period, 1.362 invoices were recorded however, invoices with a negative sign were eliminated from the analysis and in the end the sample consists of 1.344 invoices. Table 1 and Figure 1 show the results of Benford's first digit analysis.

Table 3: First digit analysis – accounts payable

Digit	Frequency	Observed probability	Benford probability
1	367	27,31	30,10
2	238	17,71	17,61
3	211	15,70	12,49
4	134	9,97	9,69
5	138	10,27	7,92
6	80	5,95	6,69
7	75	5,58	5,80
8	56	4,17	5,12
9	45	3,35	4,58

Source: Author's calculation

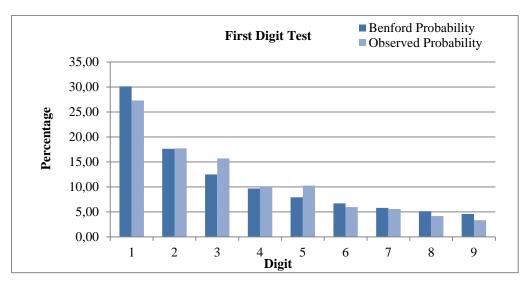


Figure 1. First digit distribution – accounts payable

The graphical representation of the data indicates that the actual data were different from the Benford distribution and that further analysis is required. The largest deviation was observed on digit 3, which appeared more times in the first place than predicted by the Benford distribution. Thereafter, deviations were observed on digit 1 and digit 5. Digit 1 appeared in a fewer number of cases in the first place than predicted by Benford's law, while digit 5 appeared in the first place more times than predicted. Therefore, the graphical representation of the data indicates a deviation from Benford's law, that is, the observed frequencies deviate from the expected ones. The question that arises is whether these differences are significant and whether they require more detailed forensic examinations. In order to determine the significance of the deviation, various statistical tests are applied such as Z-statistic, Chi-square test, Kolmogorov-Smirnoff test and mean absolute deviation (MAD). Chi-square test and MAD were performed for the purposes of this paper. The Chi-square test analyses how much the actual frequencies deviate from the expected frequencies, in this case from the Benford distribution. The null hypothesis, which states that the digits follow the Benford distribution is tested. The calculated Chi-square is compared with the table values and the null hypothesis is accepted or rejected. In this example, the Chisquare cutoffs are 15.507 at a significance level of 5% and 20.090 at a significance level of 1%. The calculated Chi-square is 32.040 which means that it exceeds the limit values and therefore the null hypothesis cannot be accepted and it is concluded that the observed distribution does not follow the Benford distribution.

The MAD analysis also measures the difference between the actual and the expected frequencies for each digit, however, the number of observations is not required to calculate the MAD. This test is recommended by Nigrini in conducting forensic research and analysing deviations from the Benford distribution. A higher average absolute deviation indicates the larger difference between the actual and expected (Benford) frequencies, and the conclusion on the significance of the deviation is established by comparing the actual and critical values. The critical values for different MAD values are shown in the following table.

Table 4: Critical values and conclusions for various MAD values – first digit

Digits	Range	Conclusion
First digits	0.000 to 0.006	Close conformity
	0.006 to 0.012	Acceptable conformity
	0.012 to 0.015	Marginally acceptable conformity
	Above 0.015	Nonconformity

Source: Nigrini, (2012), p. 160.

In the observed case, the MAD value is 1.32, indicating incompatibility with the Benford distribution and signaling to the forensic expert that further research is needed to determine the causes of the differences. Specifically, data where differences from the Benford distribution are significant indicate red flags or a possible risk of fraud. It should be noted that testing only the first digits provides a general insight into possible anomalies and may result in the need for a detailed review of a large number of accounts and inefficient analysis. In this case, for example, statistical tests at the first digit level showed a mismatch with Benford's distribution and in further analysis the forensic accountant should look more closely at accounts beginning with digits 3, 1 and 5, which is 53.27% of total accounts. Such further examination of accounts is not practical and results in a large amount of work. Therefore, in the audit and also in forensic accounting, it is preferable to analyse the first two digits, since such analysis will narrow the scope of testing and result in a smaller sample for further research. Once the Benford primary tests have been conducted and possible anomalies identified, suspicious data can be further examined individually to determine whether there is a potential fraud.

4.2. Analysis of accounts receivable

The sample of accounts receivable consisted of 459 company invoices from 01.01.2018 to 31.12.2018. During this period, a total of 502 accounts were recorded, however after the elimination of accounts with a negative sign 459 accounts were included in the analysis. The results are presented below.

Table 4: Fi	rst digit	analysis -	accounts	receivable
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Digit	Frequency	Observed probability	Benford probability
1	146	31,81	30,10
2	84	18,30	17,61
3	43	9,37	12,49
4	51	11,11	9,69
5	31	6,75	7,92
6	30	6,54	6,69
7	26	5,66	5,80
8	23	5,01	5,12
9	25	5,45	4,58

Source: Author's calculation

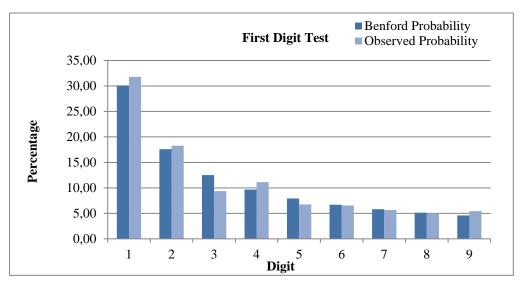


Figure 2. First digit distribution – accounts receivable

As it can be seen from Figure 2 data mostly fit into the Benford distribution. Significant differences can be observed on the digits 3, 4 and 1. The number 3 appeared in a smaller number of cases than predicted by Benford's law as first digit, and the opposite case is with the numbers 4 and 1. More specifically, the Benford distribution predicts that digit 3 will be in the first digit position in 12.49% of cases, and in this example, number 3 was the leading digit in 9.37% cases. On the sample of accounts receivable certain differences and deviations from Benford distribution exist and their statistical significance was tested using Chi-square test and MAD. In the case of statistical analysis of differences of distribution of accounts receivable from the Benford distribution the limit values (for eight degrees of freedom) for Chi-square are 15.507 at the significance level of 5% and 20.090 at the significance level of 1%. The calculated Chi-square amounts 6.701 which means that the null hypothesis can be accepted or the observed distribution follows the Benford distribution. The calculated MAD value for the sample of accounts receivable amounts 1.04, indicating a mismatch with the Benford distribution since it exceeds the critical value of 0.015. The analysis of accounts receivable indicated that two different statistical tests pointed to different conclusions, and in this case the decision of conducting further forensic analysis of accounts receivable is a matter of professional judgment of the forensic accountant.

5. Conclusion

Benford's law is often used in forensic accounting since it is easy to use and allows the detection of suspicious items and red flags which direct further forensic analysis. Specifically, when manipulating financial data, that data is unlikely to follow Benford's distribution, and forensics can narrow the search field by using a relatively simple and rapid digital analysis technique. Certainly, when applying this analysis, the benefits and limitations of the Benford analysis should be taken into account, as well as the prerequisites that must be met before conducting the analysis. In the framework of this paper, the authors presented the basic features of the Benford's law and demonstrated the practical application of this law in the field of forensic accounting. Analysis of the first digit at the sample of accounts payable showed a mismatch with the Benford distribution, which gave forensics a signal to perform further tests within Benford's analysis (testing the second digit and testing the first two digits) to obtain more specific results and narrow the scope for finding irregularities. The analysis of accounts receivable also showed minor deviations from the Benford distribution and the need for additional testing. At the end it should be pointed that Benford's law can be useful in detecting deviations from the Benford distribution and detecting certain anomalies but for more detailed conclusions and fraud detection, further and more detailed forensic analysis is required.

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Accounting and Legal Aspects of Leasing

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Abstract. The lease is becoming an important factor in the renovation and modernization of fixed capital in business. In order to create a data base on leasing, the System of National Accounts, the National Accounting Standard on leasing have been implemented, while adjusting the accounting system to international standards. However, in practice, inconsistencies arise both from an administrative and organizational nature, as well as from a technical one while carrying out leasing operations.

The topicality of the current subject is further enhanced by the new legal framework governing the leasing relations, which, unlike the previous ones, have introduced a favourable regime for all participants in the leasing operations. The leasing institution is an opportunity for local economic operators to take an industrious position on the market, especially in the light of the aspirations of the Republic of Moldova for European Integration, on the one hand, to offer leased competitive products, and, on the other hand, to use it as an achievement form of own production.

Keywords: leasing, leasing contract, financial leasing, operational leasing, National Accounting Standardю

1. Introduction

During the transition to market economy, the small and medium-sized enterprises, sooner or later, will have the dilemma of solving a complex problem - finding a secure source of financing.

Attracting credit sources with an acceptable interest rate is current for investment aimed at expanding and modernizing the production process. In comparison to large entities, small and medium-sized companies hardly obtain long-term loans due to a lack of sufficient insurance. As a result of limiting access to bank credit, small and medium-sized enterprises find themselves at a disadvantage compared to large firms. High bank rates constitute additional obstacles for small and medium-sized businesses in obtaining and reimbursing loans. Under these circumstances, the most effective method of investment policy for the purposes of small and medium enterprises can serve leasing.

Despite the fact that leasing is a relatively new legal institution and social phenomenon for the Republic of Moldova, the practice of leasing operations is expanding and has already shaped the legal and organizational forms necessary for the activity of subjects on the leasing market. In particular, this occurred as a result of the adoption of the legal framework on leasing: 1) Civil Code of the Republic of Moldova No. 1107 of 06.06.2002; 2) Law of the Republic of Moldova on leasing No 59-XVI of 28.04.2005.

The lease can and must become the main factor in the renovation and modernization of fixed capital in business. In order to create a data base on leasing, the System of National Accounts, the National Accounting Standard (NAS) 'Leasing contracts' have been implemented, while adjusting the accounting system to international standards. However, in practice, inconsistencies arise both from an administrative and organizational nature, as well as from a technical one while carrying out leasing operations.

2. Legal aspects of leasing

The lease is the contract according to which the lessor assigns to the lessee, against a payment or series of payments, the right to use the asset for an agreed period of time.

Depending on the degree of distribution between the lessor and the lessee of the risks and benefits related to the ownership of the assets transferred in the lease, two types of leasing are defined: financial and operational.

The lease type is determined at the beginning of the lease term on the basis of the contractual terms and must be the same for the lessee and the lessor. When classifying the lease, it is necessary to give priority to the content over the form, i.e. to take into account the economic essence of the contract rather than its legal form.

In the literature of the Republic of Moldova, leasing is like a legal report where, as an obligated party in the contract, together with the lessor and lessee, is also the seller of the good, which is not a real part of the contract, but a compulsory part of the leasing report. However, this is not a qualifying feature of the contract, since the legal concept itself (Article 1314(1) Civil Code of the Republic of Moldova) allows the contractual relationship to be established with the participation of two subjects. The fact that the legislator omits the seller's figure from the notion of leasing is an essential change in the concept of leasing in the Republic of Moldova and its removal from the legal essence of a loan report. The lessee is not contractually related to the seller of the good, but is endowed by law (Articles 1319, 1320, 1321 Civil Code of the Republic of Moldova) with a number of rights and obligations to him. Under a lease, the lessor undertakes, at the lessee's request, to ensure the temporary possession and use of a good. This obligation derives from the content of the lease report. The supply and use of such goods is to be ensured by buying the goods from the seller, which is part of the leasing relationship. An active role in the lease obligation lies with the lessee. That is, he determines the seller or the property, which is to be procured by the lessor. The lessor is relieved of all liability for the choice of the seller or the good, respectively. Exception to this rule may be the case where, by contract, such an obligation incubates the lessor.

We do not agree with the view that the lessor's production of the good to be transmitted to the lessee under a lease is rather a contract of employment, given that, under the provisions of Article 1314(1), the defining elements of the lease are to ensure the use and possession of a good and to pay periodic payments (leasing rates.) Furthermore, that paragraph expressly provides that the good may be purchased or produced by the lessor. In regard to the contract of employment, it follows from the provisions of Articles 1352 and 1353 of the Civil Code, this is a translated property contract, whereas in the case of a lease the lessee has the option of acquiring the good, therefore, the transfer of ownership of the property that is the subject of the lease is neither a defining element nor a binding element for the lease.

The parties to the lease are the lessor and the lessee. The lessor is the natural or legal person who is engaged in the business of entrepreneurship and, under the terms of the lease, transmits, at the lessee's request, for a specified period, the right to exercise and use a property the owner of which is the owner, with or without transmission of ownership of the property upon expiry of the contract (Article 5(a) Leasing Act No 59 of 2005). The following characteristics of the lessor shall be dissimilar: a) it is a natural or legal person; b) is engaged in entrepreneurial activity; c) owns the item leased in ownership.

The lessee is the natural or legal person who receives the property specified in the contract for a specified period of time in return for payment of the lease instalments. The lessee has an active role in the lease report because he chose the seller or the good to be purchased by the lessor. If the lessee is a natural person who is not an entrepreneur, the leasing relationships are subject to consumer protection legislation (Article 5(b) Leasing Act).

The seller of the good is also the subject of the lease report. The seller (supplier) may be the producing enterprise or another trader who sells a good to the lessor for it to be temporarily transferred to the lessee.

The object of a lease may be any movable or immovable property, except: a) goods which are taken out of the civil use or whose circulation is limited by law; b) agricultural land; c) consumable goods and d) items of intellectual property which cannot be assigned (Article 4(2) Lumbrance Act; Art. 925 Civil Code). Therefore, the object of leasing can be very different goods, such as machinery, housing, land, computers, cars, sea-going vessels, aircraft, etc.

The lease price is expressed in leasing rates (recurring payments). The amount of the leasing rates and the frequency of their payment shall be determined by mutual agreement between the Parties. To regret, the legislation of the Republic of Moldova does not determine how leasing rates are to be determined, what expenses or amounts they should contain and what is the limit of this spending. If the lease does not specify at what intervals the lease instalments are to be paid, the total annual amount shall be divided into 12 equal instalments, each to be paid in the first decade of the month.

Leasing rates may be determined in the form of: a) uniform payments, which shall be paid periodically throughout the life of the contract; b) decreasing payments, in which initially the lease payments are large and then the amount is reduced. This form is frequently applied in the event that the lessor has purchased the lease item from a bank loan account. In the first period of the contract, lease payments are high because the amount of credit taken from the bank is high and the interest included in these payments is higher. With the repayment of the loan, interest is also reduced, which results in a decrease in the size of the leasing rates; c) gradual payments because small quotations are initially paid but gradually increased as the benefits from the use of the good are obtained. This way of paying leasing rates is recommended for entrepreneurs who have started a business with little money.

Shape. The lease must be made in writing (Article 1317 (1) Civil code). The written form serves as an ad probationem condition. That is, all the requirements laid down in the Civil Code regarding the conclusion, modification and termination of legal acts (Article 210) must be complied with.

The lease can be concluded not only in the form of a document signed by the parties, but also by exchange of letters, telegram, telephone and so on, which will be signed by the sender (bidder) and will contain the essential clauses of the future contract. Essential terms of the contract are those provisions without which the contract cannot be considered valid. Thus, any lease must contain: a) the price of the good; b) the total amount, number and maturity of instalments; c) final payment and methods for calculating it in the event of termination of the contract (Article 1317 Civil Code).

The financial lease shall provide for compliance with at least one of the following conditions:

- a) at the expiry of the lease term, the ownership of the leased asset changes to the lessee;
- b) the term of the lease constitutes at least 75% of the economic life of the leased asset;
- c) the sum of the minimum lease payments is at least 90% of the fair value of the asset leased.

Unfortunately, the leasing practiced in the Republic of Moldova is not a real one, in the sense that leasing companies apply the legal construction of the contract of sale and purchase with payment of the instalment price, to which they add an exaggerated interest. In this respect, the beneficiaries do not note any distinction between taking a bank loan or making use of the leasing operation, because the interest rate in both cases is the same.

Leasing is most frequently used by small and medium-sized enterprises that have difficulty accessing long-term loans. As they do not have securities, they cannot obtain credit from financial institutions, so the only alternative for them remains leasing.

We consider that the definitions of financial and operational leasing provided in Article 4 of the lease Act are inadequately formulated and recommend that they be amended as follows: 'Financial leasing — a lease operation in which the risks and benefits of ownership of the property are transferred to the lessee', i.e. 'Operational leasing — a lease operation in which the risks and benefits of ownership of the property are not transferred to the lessee'. We also recommend excluding other forms of leasing, such as: Barter leasing, compensation and lease-back, because in practice these forms cannot be applied.

3. Leasing accounting

The asset received in a financial lease is measured at input cost that includes:

- > the principal (repayable amount of the asset);
- > the residual amount guaranteed;
- > costs directly attributable to the receipt of the lease asset (e.g. costs related to lease, transport, road insurance, preparation of the asset for the predetermined use), which are borne by the lessee under the terms of the contract.

The insurance premium related to the asset leased (except the cost of road insurance), which according to the terms of the contract is borne by the lessee, is allocated at current costs/expenses depending on the destination and place of use of the item. If insurance costs exceed the prescribed materiality threshold and relate to two or more management periods, they may be accounted for as anticipated expenses with subsequent settlement at current costs and/or expenses in the manner prescribed by the lessee's accounting policies.

For example, an entity has received a financial lease of a technology machine and has incurred the following costs:

- related to machinery transport services, provided by a third entity for the amount of lei 5 000;
- annual insurance premium of lei 45 000 paid in November of the management period.

Those costs do not exceed the materiality threshold set by the entity in its accounting policies.

In the example, the lessee accounts for:

transport costs of lei 6 000:

	Debit 121 'Tangible assets in course of execution'	lei 5 000
	Credit 544 'Other current liabilities'	lei 5 000
*	insurance premium of lei 45 000	
	Debit 714 'Other operational activity expenditure'	lei 45 000
	Credit 544 'Other current liabilities'	lei 45 000

When receiving the financial lease asset, the lessee shall determine the minimum lease payments and establishes: the useful life of the asset, which may not exceed the term of the lease and the method for calculating the depreciation of the asset.

The lease payments that are made by the lessee during the lease term include: the principal parts (reduction of the repayable amount of the asset received in the lease) and the lease interest.

Payments on the repayable amount of the asset received in the lease shall be accounted for as payment periods occur as:

Debt 421 'Long-term commercial debt'

Credit 521 'Current commercial liabilities'

Lease interest is calculated over the lease term as payment periods occur, using the method set out in the lease and is recorded as:

Debit 714 'Other operational activity expenditure'

Credit 521 'Current commercial liabilities'

The lessee shall record the contingent rent on the basis of the accrual account as the current expense of the period in which it was incurred.

Example: In accordance with the contractual conditions, the lessee who has received a commercially rented room for financial use is obliged to pay, at the end of each month, the leasing rates and the payment of a contingent rent of 4% of the monthly sales revenue. In the first month of the lease term, the lessee found sales revenues amounting to lei 75 000.

Based on the example data, the lessee records contingent rent expenses in the amount of lei 3 000 (lei 75 000 x 0,04):

Debit 714 'Other operational activity expenditure'	lei 3 000
Credit 521 'Current commercial liabilities'	lei 3 000

The useful life of the asset is determined by the lessee at the beginning of the lease term. If the contractual terms do not provide that at the expiry of the lease term ownership of the asset goes to the lessee, the useful life of the asset shall be equal to the lesser of the term of the lease term and the useful life fixed for its similar assets.

Depreciation of leased asset is calculated by the lessee in each management period under the NAS 'Intangible and tangible assets' using the method accepted in accounting policies for similar own assets. The calculated depreciation shall be recorded in each management period as current costs/expenses according to the destination and place of use of the leased asset.

Assets transferred under operational leasing shall be reflected on the lessor's balance sheet.

The initial direct costs related to the negotiation and conclusion of the operational lease (e.g. lease search fees, valuation services, and legal) that are borne by the lessor under the terms of the contract are found to be current expenditure. If these costs exceed the pre-specified materiality threshold and relate to two or more management periods, they may be accounted for as anticipated expenditure on subsequent settlement within the lease term at current costs and/or expenses in the manner prescribed by the lessor's accounting policies.

Operational lease payments received or receivable under the contractual terms shall be recognized as current income during the lease term under the accrual accounting on a systematic basis set out in the lessor's accounting policies.

Example: An entity has operationally leased a technology equipment for 2 years. According to the contract concluded, the lessor receives at the beginning of each quarter an advance payment of lei 72 000 for the lessee's use of the equipment in the next 3 months. Under the lessor's accounting policies, income from the transfer of operating leases is recognized in equal parts over the lease term.

The lessor shall account for:

***** at the beginning of each quarter:

- the advances received amounting to lei 72 000:	
Debit 242 'Current accounts in national currency'	lei 72 000
Credit 523 'Current advances'	lei 72 000

***** *monthly:*

- recognized operating lease income in the amount of lei 24 000 (lei 72 000 / 3 months)

6 1 1 6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	,
Debit 231 'Claims related to revenue from use by third parties	
of the assets of the entity'	lei 24 000
Article 612 'Other revenues from operational activity'	lei 24 000
at the same time the simultaneous decrease in the amount of lei 24 000 of cu	rrent debts:
Debit 523 'Current received advances'	lei 24 000
Credit 231 'Claims on third-party use revenue	
of the assets of the entity'	lei 24 000

Depreciation of assets leased in operation is calculated by the lessor in accordance with the requirements of the NAS 'Intangible and tangible assets' using the method accepted in accounting policies. The calculated depreciation shall be recorded as the simultaneous increase in current expenditure and the depreciation of fixed tangible assets.

Impairment of assets transferred to operational leases shall be accounted for under the NAS "Impairment of assets".

The subsequent costs of repairing and restoring the assets transferred to operational leasing borne by the lessor shall be recorded as current charges or capitalized in the manner prescribed by the NAS 'Intangible and tangible assets'.

4. Conclusions

Leasing practiced in the Republic of Moldova differs both conceptually and as legal-civil construction from the economic-legal leasing phenomenon in most Western countries, because leasing companies apply in principle the legal construction of the contract of sale-purchase in instalments, to which they unfortunately add an excessive interest. For this reason, the beneficiaries do not see any distinction between taking out a bank loan or making use of the leasing operation, because the interest rate in both cases is roughly the same.

The legal and economic aspects analysed in the thesis reveal the following advantages of the lease:

- the method of payment in the leasing report constitutes an advantage by saving equity in the initial phase, and the payment of an advance is not compulsory;
- contributes to the promotion and development of exports, with the supplier being able to carry out, in addition to traditional and leasing exports; attracting new customers is achieved through the promotional role of the lease, by the fact that a particular piece of equipment is first leased in order to convince the customer of its return, and in the event of a positive result, it can purchase the equipment (experimental leasing);
- ensures that additional gains are obtained from the resale or resale of machinery and equipment which has been returned after the expiry of the lease period.

As a form of acquisition of ownership, the lease has advantages for the lessor because it retains ownership of the goods and equipment in question and can only be privatized once the customer has proved his ability to pay, and has even depreciated part of the value of the good, as well as for clients, in this economic-legal operation, there can be attracted capable managers who, without capital, could not have done such economic affairs on their own.

The lease also has certain limits, both for the customer and the supplier. Within the disadvantages of leasing, we mention:

- is effective, only in conditions where the object of the lease can be exploited throughout the rental period;
- it is often more expensive than buying credit, and the option of such an operation is only justified if the sums released can be invested in other highly profitable areas;
- the operation becomes genuinely profitable in limited situations (in particular, financial leasing):
- for the lessor, there is a risk that after the first rental, no other users may be found.

From a tax point of view, the use of leasing as a means of acquiring ownership cannot attract a particular interest, except in those countries where, from a tax point of view, the lessee of the financial leasing contract is not regarded as the owner, therefore, leasing rates would be seen as expenses, not as a reinvestment of capital, which is not the case with the Republic of Moldova. The rates paid to the lessor other than the financial leasing and the depreciation of the machinery may be deducted entirely from the taxable profit of the enterprise as current expenses.

Leasing operations have both disadvantages and advantages, but they must not be offset either in one sense or in another, but must be seen as complex, extremely useful operations in our view.

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Accounting and Legal Aspects of Tax Evasion

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Abstract. From scientific and professional point of view, tax evasion is multidisciplinary problem that significantly deprives countries of budgetary resources. Preventive action to reduce its incidence has crossed national borders and, in modern times, concerted efforts are being taken to combat it at supranational and global level. It is considered to be the most intense activity aimed at reducing tax liability, given that it involves unlawful acts which imply criminal liability. Unlike tax avoidance which is based on more sophisticated activities of exploiting legal loopholes, tax evasion transactions are generally less complex. In context of companies' business activities, the field of tax evasion is intrinsically interrelated to manipulations in accounting records. Therefore, in addition to the conceptual definition of tax evasion, its modalities and the relevant legal regulations that seek to discourage it, this paper will also provide an overview of accounting manipulations that are in function of tax evasion.

Key words: Accounting Manipulation, Criminal Law, Financial Statement Fraud, Tax Evasion

1. Introduction

Effective tax income collection is among the most important governmental activities (Raczkowski, 2015) that may have an impact on stimulating the economic development and increasing the ability to provide public goods (Kong and Wang, 2014). But, throughout the history countries have been facing undesirable patterns of behaviour such as tax evasion, which is almost as old as the world – "Greek philosopher Plato stated that *in a country with an income tax, an honourable man will pay a higher tax than a dishonest man, even though they have earned the same income*" (Kesner-Škreb, 1995). In this regard, inventiveness of tax evaders through time can be exemplified by following cases – "during the third century, many wealthy Romans buried their jewelry or stocks of gold coin to evade the luxury tax and homeowners in eighteenth-century England temporarily bricked up their fireplaces to escape notice of the hearth tax collector" (Webber and Wildavsky, 1986, p. 141, in Slemrod, 2007, p. 25). Difficulties in studying tax evasion emerge from the facts that "there is no single source of information capturing all of it" and that "the key source used so far in rich countries are stratified random audits" (Alstadsæter, Johannesen and Zucman, 2019, p. 1).

There are two types of tax gaps in literature – as a macroeconomic concept, tax gap is the discrepancy between the amount of taxes owed and the amount of taxes filed in accordance with tax provisions (Weigel, Hessing and Elffers, 1987) which is measured to gain insight into the extent of tax non-compliance and to understand its causes – e. g. errors, tax avoidance and tax evasion (HMRC, 2019). Tax administration in a country should strive "to improve business processes, methods and procedures in order to reduce the tax gap" (Terzić, 2017, p. 52). From microeconomic aspect, book-tax gap is "difference between income reported to capital markets and tax authorities" (Desai and Dharmapala, 2009, p. 537) by a company and

it is used as a measure of corporate tax evasion (Kourdoumpalou, 2017) and tax avoidance (Taylor and Richardson, 2012; Desai and Dharmapala, 2005, in Bennedsen and Zeume, 2018). "The measured book-tax gap can – apart from deterministic differences between tax and financial accounting – be attributed to either downward managing of taxable income (tax sheltering/avoidance) or over-reporting of financial income (earnings management)" (Desai and Dharmapala, 2009, in Evers, Meier and Finke, 2016, p. 3). It is important to highlight the distinction between corporate tax evasion, "tax reporting behavior that would, if discovered, be subject to civil or criminal sanctions" (Crocker and Slemrod, 2005, p. 3) and would "create a negative mentality among investors that leads to reduction in corporate stock prices" and, on the other side, tax avoidance which can be defined as "legal, but unethical transactions in order to avoid taxes" (Hammer, 2017, p. 10) that "do not have general effect on investors because they are considered as legal activity" (Blaufus et al., 2019, in Salehi, Tarighi and Shahri 2020, p. 3).

Primary focus of this paper is tax evasion at the level of individual company. For instance, corporate tax evasion, besides aforementioned repercussions for national finances, may be the cause of unfair market competition (Kourdoumpalou, 2017). Before modern accounting scandals, companies had been using various accounting methods in order to boost their income despite the repercussions such as increased tax liability (Mills and Newberry, 2001, Erickson et al., 2004, in Kourdoumpalou, 2017). But fact-finding processes following the occurrence of aforementioned "high-profile cases of corporate accounting fraud and tax evasion ... which spawned an extensive debate regarding changes in tax rules and the enforcement of existing tax law" (Crocker and Slemrod, 2005, p. 3) showed that simultaneous increase in income and avoiding tax payment are not necessarily incompatible (Slemrod, 2004; Desai, 2005; Desai and Dharmapala, 2009, in Kourdoumpalou, 2017).

2. Conceptual definition and modalities of tax evasion

Tax evasion implies "unlawfully avoiding tax liability by directly breaching the law with aim of not paying taxes or paying lower amount of taxes" (Kapetanović, 2009, p. 104) and is a fundamental issue for the development of an economy, since it directly affects the state budget and market competition (Kourdoumpalou, 2017). "Complete tax evasion implies the non-reporting of generated income, while partial tax evasion only partial reporting of generated income" (Kapetanović, 2009, p. 104).

There are various forms of tax evasion (Kesner-Škreb, 1995): keeping two sets of books, undeclared work, compensation in kind, undeclared tips if they are subject to taxation and difficulties of detecting payments for goods and services made in cash. The most common types of taxes susceptible to tax evasion are (Matković, 2013, p. 162): value added tax – "failure to issue invoices for taxable transactions", income tax – undeclared work and payment of salaries in cash and corporate tax – "creating fictitious costs in order to reduce the tax base".

3. Criminal and misdemeanour aspects of tax evasion

Criminal and misdemeanour provisions are stipulated in Croatian legal system to destimulate unlawful non-payment of tax liabilities. Given the difference in the gravity of sanctions for criminal offences and misdemeanours in the context of tax evasion, it is necessary to clearly identify their distinctive characteristics. An important factor in this assessment is the existence of a intent to pay a lower amount of tax, but it should also "take into account all the circumstances which show the taxpayer's overall attitude to the calculation, filing and payment of tax liabilities" (Matković, 2013, p. 164). For instance, "if a person miscalculated

depreciation and thereby reduced the income tax liability, this does not imply that the tax evasion was committed" (Matković, 2013, p. 162).

Criminal Code (OG 125/11, 144/12, 56/15, 61/15, 101/17, 118/18, 126/19)

Tax or Customs Duty Evasion

Article 256

"(1) Whoever, with the aim that he or she or another person¹ evade paying in full or in part a tax or customs duty, provides false or incomplete information on income, items or other facts of relevance for determining the amount of tax or customs duty payable or whoever, in the case of mandatory declaration, fails, with the same aim, to declare his or her income, items or other facts of relevance to the determination of tax or customs duty payable, which results in a reduction of the tax or customs duty payable by an amount exceeding twenty thousand kuna or to its non-determination in the said amount

shall be punished by imprisonment from six months to five years.

- (2) The same punishment as referred to in paragraph 1 of this Article shall be inflicted on whoever uses a tax relief or customs privilege in an amount exceeding twenty thousand kuna in breach of the conditions under which he or she obtained it.
- (3) If the criminal offence referred to in paragraph 1 or 2 of this Article leads to a reduction in or non-determination of a considerable tax or customs liability,

the perpetrator shall be punished by imprisonment from one to ten years.

(4) The provisions of paragraphs 1 through 3 of this Article shall also be applied to the perpetrator who reduces European Union funds by committing the acts described therein."

Source: Official Gazette of the Republic of Croatia – Narodne novine (2011). Criminal Code, available at: https://narodne-novine.nn.hr/

Article 256 of the Criminal Code specifies the criminal offence of Tax or Customs Duty Evasion, which can be accomplished in two ways – by providing false or incomplete information on income, items or other facts of relevance for determining the amount of tax payable, or by not declaring them. Key prerequisites required for a particular action to be considered tax evasion are the reduction or non-determination of the tax liability, that is, fiscal repercussions for the country and that the tax evasion exceeds 20.000,00 HRK (Criminal Code, Art. 256 para. 2). If the amount of evaded tax is lower than the aforementioned limit, the misdemeanour provisions of the General Tax Code shall be applied (Turković et al., 2013).

4. Accounting manipulation in the function of tax evasion

Manipulation of financial statements can be conducted either with aim of increasing or decreasing financial result. Given that "incentives to report high quality accounting numbers may vary significantly across firms" (Zimmermann and Goncharov, 2006, p. 3), the primary focus is on the differentiation of companies by their stock exchange listing status because "private and public firms are affected by the market pressure for high-quality accounting earnings to a different extent" (Zimmermann and Goncharov, 2006, p. 2).² Certain researchers

¹ The term "person" in Art. 265 para. 1 refers to both natural and legal persons (Turković et al., 2013).

² "Investors prefer to trade in shares of firms reporting accounting data of high quality that is suitable for valuation and/or monitoring", while "firms without a listing status usually have a concentrated ownership and communicate information via private channels – firm's performance is assessed through private communication rather than the analysis of accounting information" (Zimmermann and Goncharov, 2006, p. 3).

have found a negative relation between company size and tax evasion (Giles, 1998; Kanellopoulos, 2002, in Kourdoumpalou, 2017) and negative relation between company size and occurrence of corporate fraud (Persons, 1995, in Kourdoumpalou, 2017). Taking into account previous remarks, fraudulent increases in business result are primarily in the interest of companies whose financing depends on their financial performance, such as listed companies, while fraudulent decrease in operating results is in the interest of private companies. Therefore, from the aspect of tax evasion, manipulations that result in fraudulent decrease of financial result are relevant.

4.1 Classification of accounting manipulation methods

Financial statement manipulation methods which are used to decrease profits and, consequentially, tax liability can be classified in following categories: fraudulent income reduction, fraudulent cost increase and aggressive revaluation (Belak, 2017). Further elaboration of first two categories is provided in two following sub-chapters (4.1.1 and 4.1.2).

4.1.1 Fraudulent reduction of income

The most common methods of fraudulent income reductions imply shifting income to deferred income for the purpose of reducing profits – usually income from services that are provided for a longer time, avoiding income recognition and hiding cash from sales – commonly refers to tax evasion in private companies, decrease in income at the expense of an increase in revaluation reserves – contrary to the rules of profession and temporary because revaluation is recognized as retained earnings in the following period, decrease in income at the expense of an increase in liabilities – contrary to the rules of the profession usually made by companies with a low amount of long-term liabilities, and agreement with "friendly" companies that implies not sending invoices in the current but in the subsequent financial year – very difficult to detect because there are no injured parties (Belak, 2017).

4.1.2 Fraudulent increase of costs

The most common methods of fraudulent cost increases are improper recognition of personal expenses as business expenses – natural person uses the property of a company for personal needs, arbitrary and subjective reduction of asset's useful life to increase costs, big bath accounting – accelerated write-off of assets (mostly intangible assets, fixed assets, trade receivables and inventories) which are generally not tax-deductible, excess provisions, increase in costs accompanied by increase in fraudulent liabilities, and increase in costs accompanied by increase in fraudulent revaluation reserves (Belak, 2017).

5. Conclusion

Given that its existence is embedded in distant past of economic activities, there is long history of efforts taken by national and supranational authorities in order to eradicate or destimulate tax evasion, since it directly affects the development of an economy. Besides more effective audits, countries curtail tax evasion by stipulating criminal provisions in their legal systems. For instance, Croatian Criminal Code stipulates the criminal offence of Tax or Customs Duty Evasion, which can be accomplished in two ways – by providing false or incomplete information on income, items or other facts of relevance for determining the amount of tax payable, or by not declaring them. In context of companies' business activities, the field of tax evasion is intrinsically interrelated to manipulation in accounting records which can be done with aim of increasing or decreasing financial result. Financial statement manipulation methods which are used to decrease tax liability can be classified as fraudulent income reduction, fraudulent cost increase and aggressive revaluation.

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Review of Audit Committee Development in the Republic of Croatia

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Abstract. Audit committee has long been a part of corporate structures in large companies worldwide. Despite often being the subject of strong criticism (especially in times of major accounting scandals), it has become an indispensable internal oversight mechanism of contemporary corporations. Unlike the situation globally, its appearance in the Republic of Croatia is of recent date and has been related to the strengthening of corporate governance mechanisms in the last decade and a half, with the aim of gaining a greater level of stakeholders' confidence (especially regarding investors and lenders). Given that the strengthening of corporate governance through non-binding recommendations incorporated in corporate governance codes ("soft law") in underdeveloped capital markets does not generally achieve desired effects at the speed characteristic for statutory provisions, in this paper particular emphasis is placed on the legislative activities taken in order to improve position of the audit committee from its introduction until today and the effects of legal interventions on its acceptance in business practice.

Key words: Audit Act, Audit Committee, Corporate Governance Code, Croatia

1. Introduction

Despite often being the subject of strong criticism, audit committee has long been a part of corporate structures in large companies worldwide and it has become an indispensable internal oversight mechanism of contemporary corporations. "The history of audit committee development internationally ... has been driven by concerns about the credibility of financial reporting, particularly in relation to the issue of auditor independence" (Spira, 1998, p. 30). Although it had been introduced at the New York Stock Exchange following the McKesson and Robbins fraud in the 1930s, it wasn't until the enactment of Sarbanes-Oxley Act and other related regulations that the role of audit committee became more important in corporate governance system (Mo, Shi and Wang, 2013).

Due to, among other reasons, certain limitations inherent to audit committee such as periodicity of meetings, usage of second-hand information and insufficient knowledge of company's activities (DeZoort et al., 2002), "waves of financial irregularities" had happened (NACD, 2000, p. vii, in DeZoort et al., 2002, p. 41) and stimulated "regulation of the audit committee function in a number of areas, including independence, composition, expertise, disclosure of activities, discussion of financial reporting quality, and materiality assessment" (e. g., BRC, 1999; Sarbanes-Oxley, 2002; SEC, 1999a; SEC, 1999b, in DeZoort et al., 2002, p. 41).

Unlike the development of audit committee globally, its appearance in the Republic of Croatia is of recent date and has been related to the strengthening of corporate governance mechanisms in the last decade and a half, with the aim of gaining a greater level of stakeholders' confidence.

The activities of the Audit Committee in the Republic of Croatia are regulated in particular by the provisions of the Audit Act and the Corporate Governance Code (in further text: Code). It should be noted that there is a significant difference in the obligation to apply these documents. Specifically, the provisions of the Act oblige their addressees, while the provisions of the Code, as a soft law source, have no such legal force. "If a company does not comply with a Code provision, it must: explain in what way the company does not comply with the Code provision and the reason why, with reference to the company's specific circumstances; describe the actions it has taken instead of complying with a Code provision to make sure it meets the objective set out in the relevant Code Principle; and if the company intends to comply with the Code provision in the future, specify when it will start doing so." (Croatian Financial Services Supervisory Agency, 2019, p. 9).

In terms of legislative activity, the most important years for establishing the audit profession in the Republic of Croatia are 1992 - when the first Audit Act was passed, 2005 and 2017 - the years in which new Audit Acts were also enacted. The first Code, drafted in 2007 by the Croatian Financial Services Supervisory Agency and the Zagreb Stock Exchange, was revised in 2010, while at the end of 2019 the new Code was adopted (HANFA, n. d. - b).

2. Regulation of audit committee in Croatian legal system

The audit profession in the Republic of Croatia was initially regulated by the provisions of the Audit Act (OG 90/1992) and, partly, by the provisions of the Accounting Act (OG 90/1992) which entered into force on 1st January 1993. The aforementioned Audit Act expired in December 2005 due to the adoption of the Audit Act (OG 146/2005). In addition to the fact that this act has contributed to significant evolution of the audit profession in the Republic of Croatia, it is also important from the viewpoint of corporate governance, as it introduces the obligation to establish an audit committee for public interest entities (Official Gazette, 2005, Art. 27 para. 1).

It was also stipulated that "at least one member of the audit committee must be an expert in the area of accounting and/or auditing" (Official Gazette, 2005, Art. 27 para. 4). The audit committee's tasks were as follows (Official Gazette, 2005, Art. 28): "monitoring the financial reporting process, monitoring the effectiveness of internal control systems, internal auditing, and risk management system, overseeing the audit of annual financial and consolidated reports, monitoring the independence of statutory auditors or audit firm, in particular contracts regarding provision of additional services, making recommendations to the general assembly on the selection of statutory auditor or audit firm, discussing the plans and annual report of the internal audit and on significant issues relating to this area". The provisions of that act established two-way relationship between the audit committee and the statutory auditor, so "the statutory auditor or the audit firm must report to the audit committee on key matters arising from the audit, and particularly on the significant internal control weaknesses in relation to the financial reporting process" (Official Gazette, 2005, Art. 29).

The Act Amending and Supplementing the Audit Act (OG 139/2008) introduced provisions under which the statutory auditor or audit firm must submit certain reports to the audit committee regarding his independence (Official Gazette, 2008, Art. 26a para. 1). Also, maximum period of auditor's tenure was stipulated (Official Gazette, 2008, Art. 26a para. 2), as well as two-year cooling-off period before company can rehire their auditor after reaching aforementioned maximum (Official Gazette, 2008, Art. 26a para. 3).

Table 1 Review of essential Croatian laws in an audit of financial reports

Official Gazzette	Legislation	Period	
NN 90/1992	Audit Act	Before the introduction of audit committee	
NN 146/2005	Audit Act		
NN 139/2008	Act Amending and Supplementing the Audit Act	After the introduction of	
NN 144/2012	Act Amending and Supplementing the Audit Act	audit committee	
NN 127/2017	Audit Act		

Source: Official Gazette of the Republic of Croatia - Narodne novine, available at: https://narodne-novine.nn.hr/

Act Amending and Supplementing the Audit Act (OG 144/2012) did not modify or introduce new articles related to the audit committee.

From January 1st, 2018, the Audit Act (OG 127/2017) entered in force and introduced changes in terms of empowering the audit committee and strengthening it's position in the corporate structure. It has been stipulated that "the audit committee must have a minimum of three members" (Official Gazette 2017, Art. 65, para. 3) and "may be a independent committee or supervisory board's sub-committee" (Official Gazette 2017, Art. 65 para. 1), "audit committee's members as a whole must have knowledge about the sector in which the auditee operates" (Official Gazette 2017, Art. 65 para. 5), "the majority of the audit committee's members must be independent in relation to the auditee" (Official Gazette 2017, Art. 65 para. 6) and also, the necessity of audit committee's independence and autonomy while conducting its activities has been addressed (Official Gazette 2017, Art. 65, para. 8 and para. 9).

Under existing provisions, its tasks are as follows: "informing supervisory board or non-executive members in board of directors on outcome of statutory audit and explaining the contribution of statutory audit to the integrity of financial reporting and explaining the role of audit committee in that process, monitoring the financial reporting process and submitting recommendations or proposals to ensure its integrity, in terms of financial reporting monitoring the effectiveness of internal quality control system and risk management system and, where applicable, internal audit, without violating its independence, monitoring the statutory audit of annual accounts and annual consolidated accounts, testing and monitoring the independence of the audit firm, and particularly the suitability of providing non-audit services, responsibility for audit firm selection process and suggesting the audit firm to appoint" (Official Gazette 2017, Art. 66).

3. Establishment of audit committees in companies listed on the Croatian Stock Exchange

Taking into account the availability of information provided by Croatian Financial Services Supervisory Agency (HANFA) in their Annual reports on corporate governance, the period from 2009 to 2018 has been analysed. There was a constant increase in percentage of companies listed on the Zagreb Stock Exchange with established audit committee (with exception of 2014).

Table 2 Percentange of companies listed on the Zagreb Stock Exchange with established audit committee

Year	Percentage	Year	Percentage
2009.	32 %	2014.	53 %
2010.	38 %	2015.	60 %
2011.	45 %	2016.	69 %
2012.	47 %	2017.	73 %
2013.	57 %	2018.	77 %

Source: Croatian Financial Services Supervisory Agency – HANFA (n. d. - a). Annual report on corporate governance. Retrieved March 9th, 2020, from https://www.hanfa.hr/publikacije/godisnji-izvjestaj-o-korporativnom-upravljanju/

This indicator improved by 45 p. p. from 2009 (when it was 32 %) to 2018 (when it reached 77 %). According to legislative actions which have been in force since 2018, it is expected that this number will continue to improve in future.

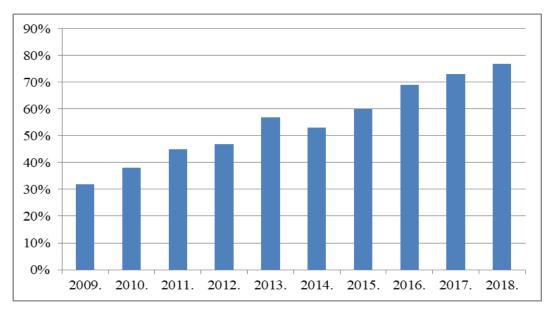


Figure 1 Percentange of companies listed on the Zagreb Stock Exchange with established audit committee

Source: Croatian Financial Services Supervisory Agency – HANFA (n. d. - a). Annual report on corporate governance. Retrieved March 9th, 2020, from https://www.hanfa.hr/publikacije/godisnji-izvjestaj-o-korporativnom-upravljanju/

In order to conduct analysis of audit committee's characteristics, data from annual questionnaires of Corporate governance code for years 2012, 2016 and 2018 was gathered (table 3). Sample comprises 59 companies listed on Zagreb Stock Exchange that have published annual questionnaires of Code of corporate governance for aforementioned years. Questions were related to (1) the fact of having established audit committee for given year,

(2) majority of independent members in audit committee, (3) monitoring the integrity of financial information, (4) evaluation of internal control system quality and risk management, (5) monitoring the independence and objectivity of statutory auditor, (6) monitoring the type and quantity of non-audit services provided by audit firm, and (7) consideration of statutory auditor's effectiveness.

Table 3 Percentage of companies with established audit committee at the Zagreb Stock Exchange

Question/Year	2018	2016	2012	2018 (%)	2016 (%)	2012 (%)
Established audit committee	48	41	35	-	-	-
Majority of independent members	22	18	18	46%	44%	51%
Monitoring the integrity of financial information	48	42	34	100%	100%	97%
Evaluation of internal control system quality and risk management	47	41	33	98%	100%	94%
Monitoring the independence and objectivity of statutory auditor	46	39	31	96%	95%	89%
Monitoring the type and quantity of non-audit services provided by audit firm	28	25	16	58%	61%	46%
Consideration of statutory auditor's effectiveness	44	41	32	92%	100%	91%

Source: Authors' creation; Zagreb Stock Exchange (ZSE): Annual questionnaires of Code of corporate governance 2012, 2016 and 2018, available at: https://www.zse.hr/ [accessed on March 6th, 2020].

It is evident that absolute values have increased over years for all observed categories. This was expected because the number of established audit committees has been increasing during the analysed period. Therefore, it is advisable to analyse relative values for these categories. Changes in relative values did not have the equivalent intensity nor direction. For instance, proportion of companies with majority of independent members decreased from 2012 to 2018, while proportion of companies that monitor the independence and objectivity of statutory auditor has increased over same period.

4. Conclusion

Often doubted and controversial, the concept of audit committee has been present for decades and has undergone process of development stimulated by legislative actions. Corporate governance in Republic of Croatia is characterized by its ongoing development and convergence to the global trends. Audit committee is one among corporate mechanisms which

follows mentioned trend. This statement is corroborated by information on constant rise in percentage of companies with established audit committee on the Zagreb Stock Exchange (with exception of 2014). Analysis of audit committee's characteristics has shown that absolute values have increased over years for all of these companies. This was expected because number of established audit committees has increased over years. Changes of relative values did not have the equivalent intensity nor direction – proportion of companies with majority of independent members decreased from 2012 to 2018, while proportion of companies that monitor the independence and objectivity of statutory auditor has increased over same period. With regard to recent legislative changes and the new Code of corporate governance, it is expected that the percentage of companies with established audit committee on the Zagreb Stock Exchange will continue to rise in future and that the importance and role of audit committee is going to be improved.

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CIET Split 2020 Track 2

Tourism, Trade and Entrepreneurship

July Drop Phenomenon in Croatian Tourism

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Abstract. After the cooling of touristic growth in the early 1990s driven by war activities and political imbalances, Croatian tourism recovered to the top of the list of most visited countries by international tourist arrivals per capita, and despite being one of the smallest countries it is in TOP 10 European countries by tourist nights in Europe.

Today tourism is the most important industry in Croatia delivering almost 20 percent of GDP, thus its volatility represents high financial risk for final performance of Croatian economy. Having this in mind, it is important to analyse every historical slowdown and explain its context and outcome on Croatian touristic results.

It is obvious and already proven that seasonal variations are determined by numerous variables, from country-specific to geopolitical ones, so this article through the analysis of local historical movements and industry-specific variables explores the background of the July drop phenomenon (i.e. "srpanjska rupa"), as a term already introduced in Croatia in 2014.

Keywords: July drop, tourism, phenomenon, Croatia

1. Introduction and context

Croatia is a small open economy with the service sector delivering the majority of country's GDP and employing more than two-thirds of its workforce according to the Croatian Employment Service (2018), boosted by tourism as the most important component of the Croatian economic system in general.

After the political changes in CEE, Croatian economy declined during the process of transition to a market based economy in the 1990s followed by losing some markets traditionally important for the local companies, with severe impact on the local touristic industry as well. An additional driver for the economic downturn were war activities until the late-1990s, deteriorating touristic performance in this period. After the war, the economy surged lifting real wages and generally improving almost all economic indicators. Touristic performance was correlated with political and economic stabilization in the country and region.

A new negative economic cycle started in 2008 when Croatia experienced six years of economic recession in a raw. The turning point and upward trajectory started at the third quarter of 2014, delivering an average growth of 2,9 percent during 2015-2019 (Croatian National Bank, 2020). As touristic results are strongly correlated with political situations in the country and general economic performance of major outbound tourist markets, as elaborated by Galičić (2015), Croatian tourism rose even in the period of long lasting recession in the country, with exception of 2009, keeping an upswing of touristic indicators until today and hitting record high results in 2019.

Having in mind positive historical results, a solid future outlook and huge importance for the national economy, the Croatian government recognized tourism as a key sector and launched various development measures in order to boost tourism growth, however still not enough to achieve balanced all-year elevated performance.

At the moment of writing this document, the most important advantages of Croatian tourism are an attractive coastline and architecture, mild climate and stable political situation in the country followed by the proximity of the most important European markets. On the other hand, the main disadvantages are a still underdeveloped tourism offer, extremely seasonal character and lack of high-quality hotels in some areas mostly determined by administrative barriers for new investment projects.

Croatia's tourism model can be described as a mass-market one, however there has been a movement in the direction of higher-value-added tourism, started in the region of Istria, where progressive hotel owners promoted high-quality gastronomy and other aspects of sustainable tourism development.

When it comes to overall market position of Croatian tourism, the focus is on the Mediterranean tourism market and the position of Croatia compared to its peers on this market. By the number of international arrivals, the largest market share among the Mediterranean competitive destinations was occupied by France, Italy and Spain, while Croatia takes the upper-middle position on the market according to UNWTO (2019). With more than 18 million arrivals followed by almost 90 million tourist nights in 2019 as reported by Croatian Bureau of Statistics (2019) generating more than 11 billion USD according to UNWTO, tourism is comprising a significant share of Croatian GDP.

Still, more than 80% of tourist nights are registered during the four peak summer months according to Croatian Bureau of Statistics (2019), with hotels, restaurants and stores producing almost all of the revenue during this short, intensive period (J. McCormick & T. Omrčen, 2015).

As published by Eurostat, Croatia is ranked 7th in EU regarding nights spent by non-residents at tourist accommodation establishments in 2018. Often tourist arrivals are evaluated as well, where Croatia is ranked 14th among European countries by number of international tourist arrivals. According to this report, the average number of nights spent per arrival in collective tourist accommodations by total and by non-resident type of tourist in EU is 3,4. In regard to nights spent per arrival, leading countries in Europe are Cyprus with 6,1, Malta 5,4 and Croatia with 5 nights spent per arrival.

The goal of this document is to analyse historical movements important for tourism in Croatia, with special focus on the July drop phenomenon (*i.e.*, "srpanjska rupa"), as a term introduced in Croatia in 2014, especially in the local politics and media. The real impact and the background of July drop in Croatian tourism was never fully explained and documented, so this document tends to disclose irrelevance of this phenomenon specific for one short period of time, especially its outcome on the general touristic performance in Croatia over the last 15 years, with no intention to investigate why it was introduced at the time. Due to specificity of tourism in Croatia, the focus is mostly on July touristic delivery compared to other peak months, with August as the most significant one, in order to show that the term of July touristic drop was specific for one short period of time and that its regular usage in Croatia has no real background having in mind the results and trend in recent years.

As results on a daily basis are not available for such a long period, at least not in a way in which this paper plans to analyse delivered results, data was collected on a monthly basis for the period 2005-2018 with focus on nights spent rather than arrivals due to specificity of the local touristic model and type of guests in Croatia.

2. Seasonality in the tourism industry

The seasonality phenomenon is known in different scientific areas, such as medicine, agriculture, biology and economy. When it comes to economy, there are several areas where seasonality has a

huge influence such as sales, employment or production. People conducting any kind of business need to know how their business is performing within a certain time frame, what would be normal seasonal patterns in the related area, how to manage their business and in the end how to compare it with competitors. Tourism is an industry where seasonality has normally a determining impact on the whole business. In some specific areas seasonality has a lower impact, but in most countries and regions, it is a dominant factor.

There are many breakdown seasonality models published so far. Lee, Bergin-Seers, Galloway, O'Mahony & McMurray (2008) made an overview of the Butler and Mao (1997) model when it comes to influencing factors of seasonality, divided in demand and supply factors:

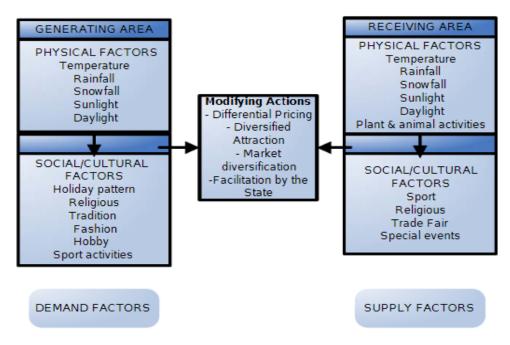


Figure 1. Factors of seasonality in tourism

Normally, it is considered as an advantage to have a tourism industry with lower seasonality. European countries in general have higher seasonal oscillations, while countries with lower oscillations are mostly positioned on other continents, with Asia as the best example.

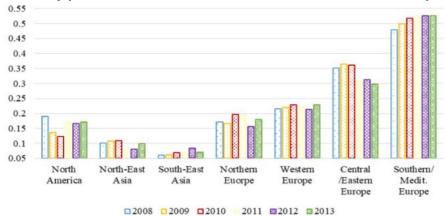


Figure 2. Global demand and seasonality by regions, 2008-2013, Monthly Concentration,

Source: Juan Antonio Duro, JudithTurrión-Prats (2019), Tourism seasonality worldwide

Baum & Lundtorp (2001) described different seasonality patterns. For example, in Austria usually there is a two-peak mountain in August and February, with China delivering flat results throughout the year, however in most cases, especially in Europe, a single peak month is noted most often in August.

As visible on the illustration below, almost all EU regions noted highest results in summer season. The most important reasons are twofold, school vacation and climate conditions. It is recognised that there is less seasonality in large metropolitan areas compared to less populated coastal areas.

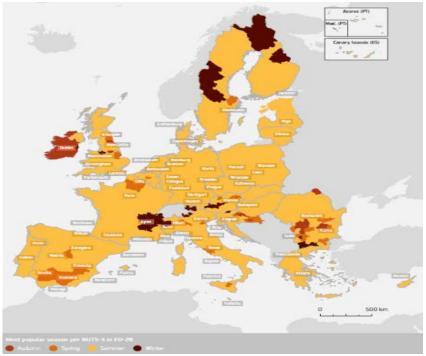


Figure 3. Most popular season per NUTS-3 (Nomenclature of territorial units for statistics, level 3) in the EU in 2011

Source: Eurostat, 2020, Tourism, https://ec.europa.eu/eurostat/statistics-explained/index.php/Tourism_statistics Inside EU there are two countries standing out with largest seasonality, Croatia and Greece. The illustration below shows different grades of seasonality as per NUTS region, with the Croatian coastline as one of the most intensive seasonal-marked regions within EU.

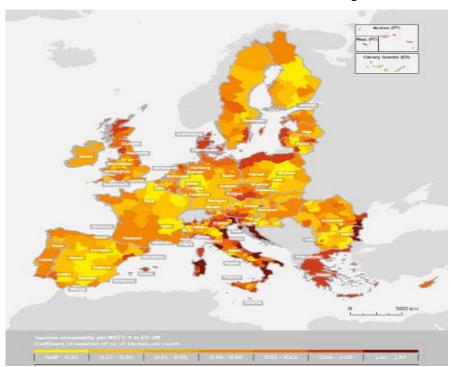


Figure 4. Tourism seasonality per NUTS-3 (Nomenclature of territorial units for statistics, level 3) in the EU in 2011

Source: Eurostat, 2020, Tourism, https://ec.europa.eu/eurostat/statistics-explained/index.php/Tourism_statistics

3. Overview of seasonality in Croatian tourism and significance of July performance for the final outcome

Generally, Croatian tourism has surged higher than EU average since 2005. From 2005 to 2018, total nights spent at touristic accommodation establishments jumped from 50,1 million nights in 2005 to 89,7 million nights in 2018, representing an exceptional increase of almost 88%. In regarded period, only in 2009 a slowdown was noted caused by global economic crisis. Compared with results in other EU countries, Croatia noted a 29 percentage points higher growth in nights spent from 2005 to 2018.

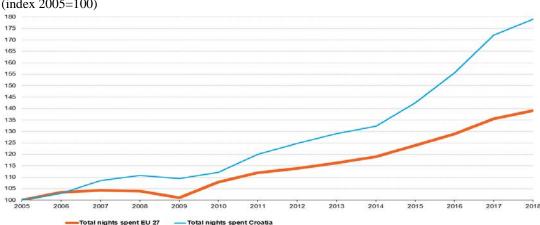


Chart 1. Trend in nights spent at EU-27 tourist accommodation establishments, EU-27 vs Croatia, 2005-2018 (index 2005=100)

Source: data compilation Eurostat & Croatian Bureau of Statistics

It is crucial to perform regular analysis of volatility in tourism especially for countries with strong seasonality, with Croatia as one of the best examples in the world.

The majority of nights spent in Croatia are related to two peak months, July and August. As presented in Table 1 in both peak months there is more than double number of nights spent in each of those two months compared to the number of nights spent in any other month.

2005 2006 2010 2011 2012 2013 0,3 Feb 0,3 Mar 0,6 Apr 1,1 May 3,0 Jun 5,8 14,8 Jul 16,8 Aug 5,5 Sep Oct 1,4 0.4 Nov Dec 0.3 Jul/Total 29,5% 29.4% 31,0% 30,0% 30,8% 29,6% 29.5% 29,0% 32,1% Aug/Total 33.4% 32.1% 31,4% 33.1% 33,7% 33.6% 33.0% 33,0% 33.9% 33.2% 32.7% p.p Aug-Jul 3.9% 2.7% 4.0% 4.0% Total 50.1

Table 1. Nights spent at tourist accommodation establishments, Croatia, monthly (in mil. nights)

Source: data compilation from Croatian Bureau of Statistics

Combined, those two months deliver around 60% of overall nights in average. It is also visible that during the observed period in each year there are more nights spent in August than in July. In average, in August there are about 10% (or three percentage points) more nights spent than in July,

coming to the following ranking of the four peak-months in Croatia: August, July, June and September.

According to presented figures, it can be concluded that the difference between August and July varies from just 0,4 percentage points in 2008 and up to 6,1 percentage points in 2014. Generally, the July-August spread is relatively balanced with the exception of three years: 2014 (peak at 6,1%) followed by the years before and after 2014 (4% and 4,7%, respectively). During these three years, and especially in 2014, the July drop phenomenon was introduced in Croatia as a term when evaluating poor July delivery when it comes to tourist nights. However, it is obvious from the figures presented above that such a spread hasn't been noticed ever before nor after. Moreover, during the last couple of years, a downward trend in July-August spread was noted, ending in only 1,8% and 1,3% in 2017 and 2018, respectively. Having this in mind, it can be concluded that the July drop phenomenon does not exist in Croatian tourism anymore, especially not during recent years (Chart 2).

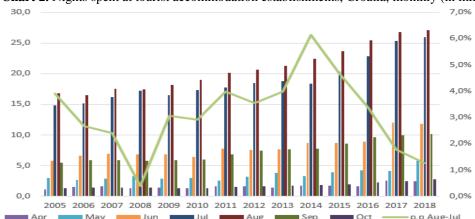


Chart 2. Nights spent at tourist accommodation establishments, Croatia, monthly (in mil. nights)

Source: data compilation from Croatian Bureau of Statistics

4. Conclusion

The goal of this paper is to show that the term "July drop phenomenon" introduced in Croatia in 2014 to describe a somewhat weaker July performance comparing to other peak touristic months is not as relevant as it has been presented during recent years in the country. In the context of general financial result of the four most intensive months, the July drop phenomenon as such can be characterised as not relevant, as its performance was in line with usual and expected movements of touristic results in Croatia, especially in the pre-2014 and post-2014 period. This is obvious when observing both, 2015-2018 data but also performance before 2014 when the spread between the peak months was relatively constant. A somewhat higher August-July spread indeed occurred in 2014 when this term was introduced in Croatia, however, having in mind the specific local touristic offer, it has to be taken into account that it is not realistic to expect fully flat results when it comes to volatility of the four most intensive touristic months. Higher volatility and outcome deviance can be expected especially in years with slower growth, as it was the case with 2014 in Croatia when there was a slower increase in booked nights spent comparing to the years before and after.

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Flagships and Pop-up Stores as Contemporary Retail Trends

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Abstract. Today's shopping, besides the very act of shopping itself also increasingly realizes an experience. Today's buyers when shopping prefer a comfortable environment where they can spend their free time and value for their money. The advancement of technology has greatly influenced retail. E-commerce is taking an even growing share of retail; automatic cash registers are used, mobile apps, new payment trends, QR codes and others.

As one of the modern retail forms during the recent years on the retail market, flagship and popup stores appear. The flagship stores with their interdisciplinary approach when designing the interior of the sale place using modern architectural solutions, the focus is on the conception of trade as the leading point of sale place that customers want to visit as a sort of destination. Some of the flagship stores have also become tourist destinations, and more of them on the one place are attracting tourists on a daily basis (e.g., Fifth Avenue in New York). Pop-up stores shortly introduce themselves to customers on a specific location with the purpose of creating a surprise.

In the paper some of the current retail trends and the concept of flagships and pop-up stores are outlined and also examples of these stores in the word and in the Republic of Croatia are explored.

Keywords: modern retail format, flagship stores, pop-up stores, retail trends

1. Introduction

The development of technology has contributed to completely new and contemporary trends in retail trade, for which can now be said with gained experience that they are not a replacement for traditional forms of retail, but rather an upgrade to meet the needs of consumers, and also of product manufacturers and service providers. In every possible way the retailers try to meet customer needs, facilitate and speed up their shopping, offer as many supplementary services as possible, make their shopping enjoyable and turn shopping into an event. Retails implement new ways of presenting products, promoting sales, selecting purchases, payment methods and new retail forms. Because of all the said above, there has been changes in retail formats. Two new retail concepts have emerged during the recent years in the retail market, namely flagships and pop-up stores which seek to capture consumer attention and to give their customers a sense of glamour. Further retail development is highly dependent on technological advancements and potential changes in consumer habits. In the paper some of the current retail

trends are outlined, the concept of flagships and pop-up stores, and it explores examples of these retail concepts in the world and in the Republic of Croatia.

2. Modern trends in retail

Under the influence of development of technology and the increasing practical application and implementation of technological solutions in the everyday life of an individual also come changes in retail trends. Modern retail trends are shaped largely by the increasing availability of broadband Internet to both households and individuals through fourth-generation mobile networks and, more recently, the fifth generation, which is still in a test phase, but is likely to become operational in practical applications very soon. Personal computers are no longer a fact from the future, but they are giving way to mobile phones, which are becoming a central access point for information from all areas of the business, education and entertainment spectrum of interest of the average person. When taking into account these social trends, the notion of modern trends in retail trends means terms that define today's retail, such as: e-sales, automatic cash registers, mobile application usage, QR codes, new payment trends, virtual glasses shopping, social media sales etc.

With the development of the Internet and the World Wide Web, as a result, comes the emergence and very rapid development of e-commerce. E-commerce is the process of buying, selling, or exchanging products, services or information through a publicly available computer network, the Internet, and offers a large reduction in cost and time of transactions (Panian, 2000). "E-commerce represents the maintenance of business connections and the sale of information, services and products via the computer telecommunications networks" (Ružić et al., 2014: 478). Just as the concept of trade itself implies the exchange of certain goods, so does e-commerce imply the exchange of particular goods, but this exchange does not take place in a particular physical space, a retail object, but it takes place in a virtual space of the Internet or in the space of computer networks. Moving the store process from retail objects to the virtual space of the Internet has brought numerous benefits for all participants involved in the store process. Merchants sell their products and services through e-commerce and they receive an incomparably larger market space and potential customers than what was the case in classic retail sales. Buyers who are buying through e-commerce enjoy incomparably greater comfort by purchasing goods from their own home, office or another optional place from where not too long ago shopping has not even been considered, let alone was the whole buying process executed. In order for e-commerce to work, they also had to monitor the development of logistics capacities, both warehouse and delivery, in the form of fast parcel deliveries to end customers. The e-commerce process brings not only unquestionable benefits for the participants in the process, but there are also some difficulties in the form of concerns about online payment security, personal information safety and the security of delivery of the purchased product or service. It can be said that there exists a gap between the consumer's perception of the quality of service and the actual delivery of the service (Anić et al., 2013). Other authors also agree with the above mentioned, and they emphasize the necessity of investing in consumer education in Croatia in order to create a positive perception of online shopping (Babić et al., 2011). In accordance to the study published at Zagreb Ecommerce Day 2019 for Croatia in 2017 (The survey was conducted by the Heureka Group, the owner of the Cheapest.hr portal and sMinda), with all the difficulties that e-commerce is facing, the value of the e-commerce market was € 0,4 billion for 2017, with a growth rate of 20% per year, with the significant increases in growth rates that are expected in the coming years. It can be said that today's e-commerce still resembles a list of products with basic product characteristics accompanied by a few product photos, unlike classic stores that give the customer a multidimensional shopping experience (emotional experience, sensation, smell, suggestive influence of the seller, etc.). It is in this

field that there is greatest room for advancement of e-commerce in the future to make the online shopping experience equally enjoyable, if not more enjoyable than classic purchasing in-store shopping.

Leading global e-retailers today are Amazon, Aliexpress, Ebay, etc. The revenues they generate in the global marketplace are measured in the hundreds of billions of dollars. Global e-marketers have a mutual characteristic of solely selling other people's products, that is, they are mediating between manufacturers and consumers. The growth and development of global e-merchants has also led to an increase in positive consumer perceptions of Internet commerce, thus they have indirectly contributed to the emergence of a large number of smaller e-commerce retailers. Today, there is an interesting Yellow Click platform in the Republic of Croatia developed by the Croatian Post. This is an online store that offers, among other things, food products of domestic family run farms that can be purchased online via the Internet which greatly facilitates the domestic producers' journey towards the buyers of their products.

It is important to emphasise that the crucial role in the purchasing decision is still played by the price of the product, regardless by which channel the buyer buys the product.

The trend of introducing automatic cash registers has been present globally for the last fifteen years, and during the last few years it has also appeared with merchants present in the Republic of Croatia. In 2004, German retailer Real introduced the automatic cash registers in 40 of its stores (Deutcshe Welle, 2020). In the Republic of Croatia, the first retail chain to introduce automatic cash registers was the Slovenian Mercator, followed shortly after by the local Konzum retail chain.

The main objective of introducing automatic cash registers in retail outlets was to accelerate the payment process of selected products without subjective influence of cashier employees on the payment process itself. The very process of introducing automatic cash registers initially has encountered many difficulties; in the first place it encountered resistance from employees who saw them as a threat to their jobs, as well as distrust of older customers in such technological solutions. Automatic cash registers can only offer the ability to pay by card, which is another drawback. During the application period, significant benefits of automatic cash registers have been found in customers who buy only a few items and pay with a card, thus significantly saving their time spent at the cash register. Automatic cash registers show their advantage in the largest sales formats and with the younger population of customers, while in smaller sales outlets still overcome classic cash registers formats with sales staff. Today in the Republic of Croatia, it is very rare to find outlets that have implemented automatic cash registers.

Continued development of cash registers is moving in the direction of RFID technology, which is becoming a leader for stores (Segetlija et al., 2011). Radio frequency identification (RFID) technology could very quickly replace barcodes on products, and product identification will be done wirelessly (Dunković et al., 2010). In the warehouse business environment RFID technology has found its application in practice.

The QR (Quick Response) code is a type of a matrix barcode that was originally developed for use in the automotive industry. Due to its easy readability and the ability to store large amounts of data, it quickly found application and became popular outside the auto industry. The QR code consists of black modules arranged in a square placed on a white background. Coded information can consist of any kind of information. Toyota's Denso Wave subsidiary has created the QR code in 1994. Today, the most popular is a two-dimensional bar code that can be read by any smartphone equipped with camera and Internet access that has previously installed a QR code reader. QR codes have numerous practical applications in modern commerce (Megastore, 2019).

The advancement of the capabilities of smartphones, which by its potentials have become equal to PCs, has contributed to the exponential development of e-commerce enhancement potential. The development of smartphones is accompanied by the development of mobile applications for the same, which gives a wide range of practical applications for mobile phones, and such applications are most certainly leading in e-commerce. All leading online stores have upgraded their services that they were developing and they are still developing mobile smartphone applications that facilitate access to their services through the use of smartphones that are increasingly taking primacy in front of classic PCs. The development of card payment and online payment services such as PayPal has contributed to the rapid growth of e-commerce through increasingly popular social networks such as Facebook and Instagram. Today, there are mobile commerce apps that use VR glasses as an upgrade for us to create the impression of being in front of the product and also being able to virtually pick it up or find ourselves on some of the tourist destinations we want to make an arrangement for, which eases for them making a purchase decision. It is important to note that today all banks have their own mobile smartphone applications that facilitate online payments.

One of the trends in retail is to create experience in retail units by combining them with the classic sales methods. Marketers are choosing to add value to their product and to create a story about their brands that will enable them to build long-term relationships with their customers (Chi, 2018). The concept of shopping with a limited inventory consists of customers being able to go to a retail unit, see a product, try it out (e.g. a mattress) and do the online shopping. The well-known American chain of luxury department stores, Nordstrom has introduced this concept of retail into its business. In the specialized store, it offers the opportunity to try out products, but without the ability to make purchases throughout the website itself. In the store there is also a personal stylist who offers advice to buyers, all with the aim of finding the right style and solution for the customers. As a part of the store, an additional tailoring service, manicures and refreshments (Thomas, 2017) are available to customers.

Merchants have become well aware that knowing about customers' needs and wants and building relationships with them are imperative in today's trading business. Stores can showcase their new technology solutions, and customers will decide what to accept, so technology solutions must be in line with consumer preferences. Predicting and listening to consumers' desires is a fundamental driver of contemporary retailing (Muller, Singh, 2006).

3. Flagship and pop-up concepts as retail formats

Kotler in his work "How to Create, Conquer and Manage Markets", considers that "the central purpose of marketing is to manage demand, with the capabilities necessary to manage the level, timely occurrence and composition of demand" (Kotler, 2006: 9). An analysis of retail development leads to the realisation that the new retail forms are constantly emerging and competing with the existing ones. Retail life has been shortened, so the new retail forms need less time to reach maturity and to become challenging against the old ones. The fact is that together with the advent of the new forms of retail, the previous forms have not disappeared, but they are developing side by side (Brčić-Stipčević, Renko, 2007).

During the recent years, two new retail concepts for flagship and pop-up stores have emerged in the retail market to attract customer's attention.

Flagship stores first appeared in the 1970s and have since evolved significantly in their form and function (Kozinets et al., 2002).

The term "flagship" is derived from the Navy, where the strongest and most famous armed ships that represent the mightiest ships in the fleet are called by that name. In trade, the term "flagship" stands for a store that has advantages: it is the largest and is located in the most attractive location, with the best selection of products; the store is specially designed to focus

on specific products, creating a comfortable atmosphere. The flagship store stands out with these characteristics as a unique separate sales unit (Farfan, 2019). The goal of flagship stores is to promote the brand image and to raise the concept of sales to the highest level. With the help of contemporary interior design, we can maximize decoration of the store itself, where potential customers will feel comfortable.

Very often in such stores, the concepts are adapted to the brand depending on what it represents. Common to flagship stores is that they create positive feelings for customers (pleasure, entertainment, luxury, playfulness) by passing it on to their consumers, who then identify with the product and culture of the brand itself (Kozinets, 2002).

Flagship stores are not made to make a profit, but to represent the company and brand in the best possible way. Flagship stores can be used to test the market, to make repositions of brand or test a new product, and use the high value of public relations activities (Shopworks, 2017).

What characterises the store's flagship is the modern design of its space; from product to display, innovative solutions for product positioning in the store and lighting, original interior designs all with a touch of luxury to attract customers.

However, the use of flagship stores as a business concept has its downsides and risks. All about the flagship stores requires considerable investment because of the interior design and modern concept.

Flagship stores may confuse customers with their appearance; unlike other stores in their retail chain, customers may be disappointed with the appearance of other stores if they get used to the flagship stores because they may be accustomed to such higher standard. It may happen that such a concept of a store simply does not work, for example, by the poor flow of customers through the store or because of the alienation of customers due to lack of clarity when the customers move around the store's area (Shopworks, 2017). Flagship stores have a strong visual impact on the material uncovering of luxury brand and offer its customers a high standard of service with the impression "the language of the flagship" with a variety of internal factors that create the impression of luxury (Arrigo, 2015). The four basic elements that define flagship stores are (Manlow, Nobbs, 2013):

- flagship stores are a means of establishing a brand's particular heritage and identity
- flagship stores allow a brand to position itself as a luxury brand in terms of its identity and with respect to other brands through the store architecture, design and location
- flagship stores are means by which the width of a brand's offering may be displayed
- means of providing a branded customer experience within which customers determine their own relationship to the brand.

With its dimension "place and location" flagship stores can be viewed from two points of view: micro and macro standpoints. From a macro standpoint, flagship stores are located in the world metropolitan areas, and from a micro standpoint they are situated between streets with customer access (Arrigo, 2015). Luxury flagship store models are situated in specific streets where they have priority and prestige due to the buildings in which they are located (Moore, Doherty, research that conducted 2013. 2007). A topic "The role of the flagship store location in luxury branding" (Arrigo, 2015) has shown that: "a certain density of luxury flagship stores exists inside the major worldwide capitals; luxury flagship stores are agglomerated in particular shopping streets or districts and by the presence and proximity of many luxury flagship stores in the same area a luxury sense of place is developed; the generated luxury sense of place is able to improve the luxury brand positioning of retailers having flagship stores there".

Flagship stores also bear some criticisms for their concept of sales. Some of them are: flagship does not target a new market segment, there are no successful features that could be applicable in other stores in the chain, it's not enough to attract more buyers than e-sales, it is not making

enough profit, managers believe that there is something "Too big to fail" i.e. in any retail industry the products are generally the same as in other brand stores and therefore do not offer exclusivity (Routes to finance, 2020). The key factors that make the world's most successful flagship stores are (Shopworks, 2017):

- usually the largest store in a retailer's chain
- situated in a prestigious location or high footfall area
- stocks the chain complete range of merchandise
- experimental, inspirational or opulent often all three
- world class design execution and attention to detail
- visual and experiential embodiment of the brand.

Pop-up stores have started to appear since 2008: Uniqlo store opened its pop-up store for a period of two months in Paris; Azzaro shop opened their pop-ups in 2010 for ten weeks in Riyadh; Louis Vuitton in 2008 for four months at the Museum of Contemporary Arts in Los Angeles (Picot-Coupey, 2014). As a form of marketing communication, pop-up store is a retail concept that is introduced to consumers during a short period with the aim of creating a surprise effect.

Pop-up stores are based on short-term presentations at a particular location and for creating a surprise effect, thus forming positive customer relationships. Their main goal is not to sell products but to attract attention, create interaction with consumers and to gain attention (Klein, 2016). The forerunners of pop-up stores are - trade fairs, markets, places of sale of second-hand goods, etc., and in such places socialisation was created, therefore it encouraged sale. Often, the form of pop-up retail space is housed in various variants of mobile homes, buses, trucks, containers, but in such a way that they create a unique space.

A pop-up shop is an attractive retail space for small and large brands, and can last from one day to six months. As such it may have a purpose like a stock sale, but more often it is used as a marketing tool to attract brand attention during a very short time. For a pop-up shop the most important features are: selection of location, space and duration. Pop-up should be a special event that gives its visitors an emotional experience (Sanchez, 2019). Pop-up stores are best suited for selling fashion brands. Some of the reasons for the aforementioned are (Alexander et al., 2018):

- driving novelty through retail "experiences"
- building brand awareness and expouse, augmenting brand image and promoting the retail brand
- testing new products
- building community and relationship with internal and external stakeholders
- responding to volatile economic conditions and transactional.

There are various forms of pop-up shops in retail practice. Some of them are (Alexander et al., 2018):

- guerrilla store raise brand awareness
- nomad store (mobile) test market
- temporary online store limited and collaborative
- temporary outdoor store reach target market and exclusivity
- concept brand store raise brand awareness
- community store reinforce customer relationships
- test store test new markets and products
- sustainable store promote sustainability
- collaborative pop-up store collaboration and exclusivity
- shop-sharing reinforce customer relationships and build community

- digital pop-up – limited and collaborative.

There are three key motivations for the choice of pop-up store:

- understanding consumer preferences and testing the market potential, result which reinforces the findings that pop-up stores are a means to test a new market (Surchi, 2011)
- managing efficiently the international brand image, finding that supports the view that pop-up stores are an appropriate mode to disseminate brands internationally (Surchi, 2011)
- developing relationship networks with various stakeholders in the internationalisation process (Bianchi, 2006).

4. Application of flagship and pop-up concepts in retail practice

Flagship stores are used when the sale of various products took place, but are most commonly used by high fashion and high street fashion brands. Some of them are located in the world's metropolises close to each other and over time these areas have become tourist destinations e.g. Fifth Avenue in New York, Broadway Soho in New York or Oxford street in London. The most numerous flagship stores are located in: New York, London, Miami, Berlin, Washington, Dubai, Rome, Paris, and many are located in China. Figure 1 shows the number of flagship stores in China.

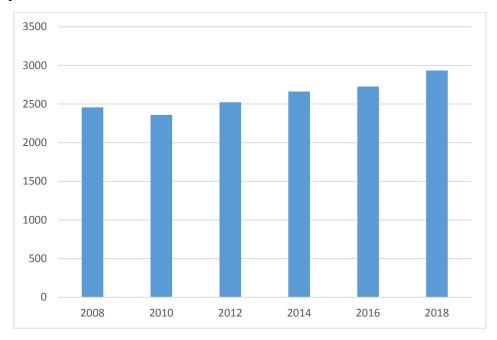


Figure 1 Number of flagship stores in China (Statista, 16.02.2020.)

There are many examples of existing flagship stores in worldwide metropolises:

- Primark in Madrid covers an area of 133,000 square meters encompassing the four floors, neon lighting, designed in the style of an art museum, with the projection of short duration fashion films, with light shows... are just some of the examples of the design of this space housed in a historic building (EchoChamber, 2020)
- Lego flagship in Berlin; 658 square meters, with its design and bright colours that encourage play; 950,000 of cubes were used to create the model in the shop, the space is inspired by the Berlin Street Graphite Scene (Ixtenso, 2017); Lego also has its flagship stores in Amsterdam in addition to Berlin, Copenhagen, New York, London, Singapore, Shanghai, Beijing

- Ikea flagship in Stockholm; opened in 1965 is by far the largest Ikea store in the world, it was the first to introduce the concept of a restaurant and playroom for children as a part of the store
- Samsung flagship in Singapore; opened in 2006, represents an interactive space with terminals and displays; Samsung has more flagship stores in Frankfurt, Seoul, London, and New York
- Powell's Bookstore in Portland; it's located on 6300 square meters, known as the "coolest" bookstore in the world; it consists of nine differently coloured rooms with about 3500 different book sections
- Prada flagship in Milan is located in the Vittorio Emanuele gallery and it was opened in 2013; the luxurious interior reflects its brand on 5,000 square meters; Prada has a number of flagship stores for example in Tokyo, London, Paris, New York, etc.
- Apple flagship store in New York is located in Fifth Avenue and it was renovated in 2019: the idea behind the interior design is to give visitors the feeling of being outdoors what was achieved with the use of plants and custom lighting; the store is open 24/7 (Curbed, 2020)
- Victoria Secret flagship store in New York is the largest flagship store in New York, it's located and occupies the four floors in Fifth Avenue and the space is conceptualised as a museum with a retrospective of its products from the past; there are also its flagships in New York and London
- Louis Vuitton flagship store in Paris was opened in 2017, with a simple interior that reflects the luxury of the brand, there is also a special space for VIP visitors who provide discretion and intimacy; there are stores of this brand in Osaka, Tokyo, London, Singapore, New York, etc.
- Nike Flagship store is located in Fifth Avenue in New York, dubbed the "House of Innovation NYC/000" it is located on five floors, with specifically designed departments for men, women and children it gives its visitors a special experience in a contemporary designed space (Nike, 2020)
- Adidas flagship store in Berlin is located in a simply decorated interior where many of the local artist contributed to the store; other stores are located in Paris, London, Moscow, Shanghai, Seoul, New York (Retail Designer Blog, 2020)
- Giorgo Armani flagship store in Milan; in its simple and luxurious interior it provides its visitors with other services, for instance, make up; it's the largest Armani's flagship store in the world located on four floors; others are located in London, New York and Hong Kong.

From all the above mentioned it follows that each large brand that holds up to its reputation in several world capitals has established its flagship stores in which it displays all forms of brands in luxury designed interiors. In the Republic of Croatia there are several flagship stores such as Yamamay in Zagreb offering underwear and accompanying assortment, the furniture store Harvey Norman, shoe store Hogl Store in Zagreb, fashion house LuLu Couture in Zagreb and the flagship footwear store Borovo from Osijek.

Pop-up concepts are used as a surprise factor for the customers, and some examples are:

- As an interesting example of the exterior of a pop-up shop that holds the attention of customers stood out the Adidas sports footwear and clothing brand, which made its pop-up shop in the form of a large sneaker box, in which Adidas would otherwise package its sneakers (Tan, 2013)
- Samsung pop-up store in Hong Kong offers to their visitors an experience where they can participate and play with new technical developments and devices, and the store was designed as a relax area, with an innovative, artistic and interactive approach to customers (Retail in Asia, 2020)
- Bark Shop Live; located in Soho New York, invites pet owners to bring their pets with them and to visit the store that provides a comfortable interior together with a pleasant shopping experience

- Birchbox, USA has opened several pop-up stores in the US where customers could try decorative cosmetic products. After that initial surprise phase they launched a new brand and opened their first store in the US
- Penguin, USA has opened a pop-up book store for the occasion of Women's Day in London, offering discounts to customers and attractive book titles (Shopify, 2020)
- Collector Square, Paris; a pop- up store that contributed to the company's revenue and sales by selling vintage high-fashion garments
- Facebook Caffe, London; a pop-up that uses promotion selling activities by offering free drinks to convince its users of extant privacy and service improvements
- Fila has opened pop-up stores in several locations in the world's metropolises for some segments of athletes and also for their other customers to attract them with their new products (Insider Trends, 2020), etc.

There are numerous areas for the purpose of application of pop-up stores for all kinds of different product ranges. Some examples of pop-up stores in the Republic of Croatia are: Croatian Perfume House, Sportina, Espadrij l'originale, Douglas Perfumery, Chanel, Samsung, Baby Land, Vartex, Lee Cooper and others.

5. Conclusion

Adoption of new technologies in retail business and concentrating on new retail forms represents the future of retail that will lead to the competitiveness of the retailer in the market and adding value for the consumers. For many marketers, the application of the flagship and pop-up concepts represents the future and a big part of their business strategy. As a leading flagship retail chain, flagship stores have no financial potential but to promote their brands, they enhanced sales and by implications of marketing they positioned their business. Some flagship stores have also become tourist destinations over time (such as the Fifth Avenue in New York or Vittorio Emanuele Gallery in Milan). Flagship stores are best suited for the promotion of high fashion, which is why all of the metropolitan centres of the world have such examples of flagship stores. When choosing top destinations in the centres of the world's metropolitan areas, with their top-notch interior accomplished design and creating a unique sales concept, flagship stores have their place in the future of retail. Pop-up stores aim for a surprise to the customer together with their short-lived existence and sudden appearance they enhance brand sales and are therefore, best suited for new product lines. Like flagships, pop-up shops are best suited to sell well-known clothing brands (or those who are planning to become one), although there are a wide range of products and services existing that can be presented to their customers in this way. In the Republic of Croatia, the application of the concept of flagship and pop-up retail is in its inception. It is difficult to predict what the new trends will be and will occur in the future, but only those merchants will survive who can best adapt to their customers and towards new trends in society.

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SWOT Analysis of Health Tourism Development in Dalmatia

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Abstract. Treatment of health disorders and civilization and age-related diseases is expensive. During last year the tourism sector in Croatia was growing and especially in Dalmatia. More and more people worldwide are travelling for leisure and other purposes, also life expectation and health costs are increasing. To achieve a solid level of quality on the one hand but also to reduce healthcare costs on the other hand, a modern lifestyle puts more focus on prevention, personal responsibility and on achieving and preserving a desirable level of vitality. Vitality is a goal which has to be adopted in strategic planning of the tourism, health and labour market. This paper explores the possibility of applying SWOT analysis in the field of health tourism. Health tourism, as one of the most promising specialized forms of tourism, is attracting enormous attention and is considered one of the most important economic activities for the development of the destination. The introductory part analyses the concepts, trends and experiences of domestic and international examples. Subsequently, an analysis of service quality measurement was conducted and some of the most useful theoretical models were presented. The results of the paper represent a contribution to the formulation of the supply in health tourism, as a progress in this field could lead to less seasonality in total tourism figures.

Keyword: Health tourism, SWOT, vitality, Dalmatia

1. Introduction

Health is one of the oldest, the most lasting and one of the strongest motives of tourism trips. Tourism has always, in all its forms, conducted a health function (Alfred D, 2004, 209). The change of physical and social environment, which is the result of tourism, has a healing effect (Kušen E, 2011, 59). That is why it is of special importance to recognize that health tourism is becoming an important pillar in the modern concept of healthy and active living and aging (Čavlek N, Bartoluci M, Prebežac D, Kesar O, 2011, 355).

Until the development of modern medicine, nature has been the only source of treatment giving elements for health maintenance, its improvement, as well as for recovery after some illnesses and rehabilitation. Series of studies have shown that only destination and drugs are not factors that give appropriate support for health recovery. Various rehabilitation programmes as a part of a systematic approach to this issue should be introduced. Each destination is to have comparable parameters, the climate ones as well as rehabilitation parameters, because without the possibility of comparison the competitiveness of a destination for medical tourism cannot be set (Banić A, 2016, 175). The impacts of the mild Mediterranean climate, aerosol as well as the position of the island itself have always been undeniable basis of the health tourism.

Due to development of the pharmaceutical industry, natural healing factors are significantly less used in official medicine, but their value is as ever more recognized by tourism, which is offered primarily through health tourism. Health tourism is a synergy between the medical and tourism industry with purpose of improving health and quality of life. The medical part of the offer of health spa tourism include, under medical supervision, professional and controlled use of natural healing factors and physical therapy in order to treat, improve, rehabilitate and preserve health (Vrkljan S, Hendija Z, 2016, 55).

Besides a long tradition in health tourism, the Dalmatia health tourism offer is characterized by a skilled workforce, good quality of medical and health services, price competitiveness, proximity to major emitting markets, favourable climate and natural wealth with a number of healing factors. Croatia also has a wealth of natural therapeutic factors at numerous unused locations (Ivanišević G, 2011, 40).

2. Literature review

2.1. The area of Dalmatia

Over the last few decades, tourism became a major economic sector in Croatia and a dominant one in Dalmatia. The country is recognized as one of the most attractive destinations in the Mediterranean. Dalmatia Health Tourism primarily consists of medical, dental, cosmetic, surgical, implant, ophthalmic, anaesthesiologic procedures and treatments, as well as rehabilitation.

The demand for health services from abroad in Dalmatia is increasing year by year. Health tourism is a product mix which consists of already established good positioning in tourism in combination with improvable healthcare. At the same time, health tourism proved to be excellent for promoting and strengthening the economic development of the region, but also as a good means of improving employment in the Dalmatia County.

Dalmatia has many attractive destinations and facilities for tourists, and also top dental, medical and tourism professionals. The aim of the Dalmatia health tourism is to strengthen its position as a member of the international health tourism services market and to improve health tourism services.

In recent decades, health tourism has developed as a strong trend, parallel with another global megatrend - the growing popularity of health awareness (Cook S, 2008, 3). The vision is to make Dalmatia recognizable by offering health services and tourist attractions. While the mission is to improve the quality of health and tourism offer, Dalmatia is promoted as a destination of health and an attractive tourist destination to come to from abroad for medical-specialist procedures and rehabilitation.

2.2. Health tourism

The forerunner to the United Nations World Tourism Organization Health tourism, known as the International Union of Tourist Organizations (IUTO), offered one of the first definitions of health tourism as "the provision of health facilities utilizing the natural resources of the country, in particular mineral water and climate" (IUTO, 1973, 7).

Goodrich and Goodrich (1987, 217) were one of the first researchers who tried to define health tourism in terms of a narrower concept of health-care tourism as "the attempt on the part of a tourist facility (e.g. hotel) or destination (e.g. Baden, Switzerland) to attract tourists by deliberately promoting its healthcare services and facilities, in addition to its regular tourist amenities."

As the concept of health tourism evolved, the World Tourism Organization included the following aspects into its definition: medical care, sickness and well-being, rehabilitation and

recuperation (WTO, 2019, 217-222). Even though the concept of health tourism is widespread, there is still no consensus among scientists and experts regarding this notion.

On the topic of defining and conceptualising health tourism, Smith and Puczkó's definition is most widely accepted. According to these authors, health tourism "comprises those forms of tourism which are centrally focused on physical health, but which also improve mental and spiritual well-being and increase the capacity of individuals to satisfy their own needs and function better in their environment and society" (Smith M, Puczkó L, 2014, 206).

Following this concept, health tourism can be divided into three interconnected subsectors - medical, wellness and spa tourism. Medical tourism involves people travelling for the sole purpose of undergoing medical treatments, interventions or therapies. In other words, curing illnesses is the core of the medical tourism subsector. On the other hand, wellness tourism emphasises prevention and personal well-being. Spa tourism, as a means for healing, relaxing or beautifying the body, is located in a sort of middle ground between health and wellness tourism (Hodžić S, Paleka H, 2018, 3).

Health spa tourism services are provided in special hospitals for medical rehabilitation and health resorts and include controlled use of natural healing factors and physical therapy under medical supervision in order to improve and preserve health. Health tourism is a service industry and therefore labour-intensive industry in which human resources are one of the key factors of business success.

In health resorts and special hospitals, the medical personnel are medical specialists (physicians), nurses and medical technicians and physiotherapists, occupational therapists, and others. Non-medical personnel usually include housekeeping and technical staff, food and beverage staff, receptionists, sales and marketing staff, administrative staff, wellness staff, etc. Generally, the higher total numbers of employees provide better service, thus ensuring greater satisfaction of health tourists resulting in greater consumption, meaning better financial business performance of health resorts and special hospitals (Vrkljan S, Grazio S, 2017, 682.).

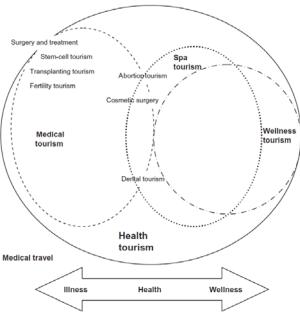


Figure 1 Interrelatedness of health, spa, wellness and medical tourism domains. Source: Adapted from Hall (2011, p. 8).

3. Methodology

The research method in this study has been done in a combined descriptive-qualitative approach and analytical method by observing and exploring the potential of the Dalmatia region to provide input in the planning and designing strategy for development of health tourism in Dalmatia. To analyze data of Dalmatia health tourism development, SWOT (Strengths, Weaknesses, Opportunities, and Threats) analytical method has been used. SWOT analysis is the most used tool for the analysis of internal and external environment which enables systematic approach and gives support when solving certain complex, mostly strategic situations (Kotler P, 1988, 29).

Identification of SWOTs is important because they can inform the later steps in planning to achieve the objective. In the process of analysis, the priorities in the field of tourism are:

- Improving the quality of the existing offer;
- Human resource development;
- Branding Dalmatia as a health tourism destination;
- Defining tourist offers and products and proper promotion and presentation
- Achieving the best financial outcome
- Optimising resources through less seasonality

In this research, the degree of relevance or desirability for these strategic options is based on the assessment of its relations to SWOT factors as criteria. This refers to desirability of further engagement of resources in greater part for the purposes of health tourism. Programs following such strategic prioritization should include projects closely connected to main elements of description and corresponding resources.

4. Results and discussion

4.1. Tourism potential of Dalmatia

The growth in tourism turnover in recent years confirms that Dalmatia is on the path towards making tourism an active generator of its economic development. In order to increase the economic benefits of tourism, it is essential to adopt and implement a tourism strategy focussed on sustainable development. Health tourism is such a form of tourism which will create added value to all those who engage in tourism trade.

The correct positioning on a dynamic and competitive health tourism market is conditioned by monitoring modern trends which serve to identify demand, new market potentials, areas of possible investment, and infrastructural requirements. In recent years, on the demand side of the market, there has been a growing trend of tourists seeking specific types of tourism.

Dalmatia still did not utilise the vast potential for health tourism development based on its natural healing remedies, like marine aerosol of the Adriatic coast and beneficial influence of its mild climate. Despite many barriers and limitations, the health tourism potential is widely recognised and perceived as a vital niche in attracting new tourists and achieving significant financial results.

Analysis of secondary data points to a lack of quantitative research on health tourism in Dalmatia. In order to achieve strategic planning and brand building of health tourism as an export product, studies of this type are essential. It is also necessary to solve the problem of term definitions in health tourism. Without the standardisation of terminology, collecting data of different states data is not viable.

Health tourism is a valuable asset that must be maintained and protected, so the aim of this strategy is to create a framework designed for the development of a high quality, modern, and innovative health tourism supply which will increase the competitiveness of Dalmatia tourism in markets where there is demand and which have capital waiting to be invested. Its ultimate goal is to put Dalmatia on the tourist map as one of the market leaders in this field.

4.2. SWOT Analysis

This method enables the inclusion of qualitative and quantitative goals and factors with possibility to establish a hierarchy of goals and the bearer or a group for decision making; based on this, one can choose an alternative solution which is considered to be the most favourable one (Fabac I, Zver R.O., 2011, 206). However, it should be noted that SWOT analysis factors have a distinctive feature, which is the fact that the potential success of a particular strategy or desirability of a strategic situation is reduced proportionally to the size of the factors/criteria of internal weaknesses and external threats.

The study reveals information on strengths and weaknesses for the development of health tourism in Dalmatia. The complexity of deciding may be in the fact that, in order to decide, one has to take into account a great number of factors which these decisions depend upon, i.e. which influences a certain outcome of this decision.

Table 1: SWOT Analysis of health tourism in Dalmatia

Strengths:

- regarded as a destination worth visiting for treatment as well as health and physical condition maintenance
- high level of medical services
- safe destination attractive for tourists and rich in heritage site
- perceived as an interesting destination on the world health tourism map
- a well-established tradition of medical services
- offering considerably cheaper services compared with Western Europe and the USA
- high level of medical services and access to highly qualified specialists (medical tourism)
- abundant natural resources with thermal waters, seacoasts, mountains, forests, herbs and plants
- excellent climatic conditions throughout the whole year
- preserved environment proximity to major emitting markets

Weaknesses:

- an unused potential of EU market
- weak cooperation within health tourism establishments
- not recognised as spa tourism destination for foreign tourists
- lack of planned and consistently implemented promotion
- the absence of a well-defined marketing strategy
- need for public-private partnerships (medical tourism)
- a low number of agencies involved in the promotion of health tourism
- old fashioned facilities
- lack of grouping in the sector
- capacities and their availability shortage of health-care workers

Opportunities

- emerging demand for complexed health tourism products
- The EU Directive 2011/24/EU on the application of patients' rights in cross-border healthcare
- the demographical situation of the ageing society
- an attractive market for foreign tourists at healing resorts
- accessibility of information about health services
- investments (especially in spa and wellness
- seasonality reduction labour intensive sector
- global lifestyle trends
- the growing interest for a destination among Western Europeans
- natural prerequisites (thermal water springs) for the development of wellness programs and health tourism
- potential for building sports infrastructure (golf courses, tennis courts, football fields, bicycle tracks) improving the level of expertise

Source: According to author of this study

Threats:

- strong global competition
- lack of information, legislation and statistics
- increased quantity decreased quality
- high level of skills required could mean that the sector struggles to find enough employees
- dependency on the Italian market for medical tourism (currently dominant part)
- loss and degradation of natural resources
- lack of financial resources and new investment opportunities
- migration of professionals
- intense growth and development of international competition
- possible stagnation of demand for tourism due to global economic crisis

When SWOT recognizes and forms strategic factors, as Table 1 shows, one elaborates general strategies with the goal to activate the area of strength, bypass the weaknesses and threats, and exploit opportunities. For specific strategic situations, strengths or weaknesses factors may be of varying importance. Therefore, the procedure of SWOT group's evaluation as criteria that have a potential impact on the success of particular strategies is justified (Fabac I, Zver R.O., 2011, 205).

4.3. Discussions

From the results of our research, it can be concluded that special hospitals for medical rehabilitation and health resorts, which employ more physicians and medical personnel, are achieving better financial business performance. There are no reliable statistical indicators that can be used to determine the exact revenue share of health tourism in the total revenue of Croatian tourism. Estimates show a minimum share. Bartoluci and Birkić (Bartoluci M, Birkić D, 2011, 53), for instance, state that health tourism participates with only 1% in the total tourism revenue of the Republic of Croatia.

While there is an absolute shortage of staff (especially physicians), this is substantially exacerbated by inequitable deployment. This leads to problems in both the quality (when lower categories of staff are expected to perform functions of higher categories of staff) and efficiency (when higher categories of staff are expected to perform functions of lower categories of staff) (Daviaud E, Chopra M, 2008, 46). The reason for this can be found in high labour costs. Staff costs typically account for around 70% of district health expenditure (Bach S, 2000). Managers have to ensure an optimal allocation of staff at all levels in order to provide quality and efficient services that will result in highly profitable business. Improving the level of expertise at all levels should be encouraged, which is a prerequisite for long-term sustainability of competitiveness of health spa tourism providers.

One part of service providers in health tourism are strongly turning towards wellness tourism as an additional or even main offer, seeking the possibility of increasing profitability. This is confirmed by experiences from Austria, Hungary, Slovenia and other countries. The question is whether it is the best strategy for growth and development of health resorts and special hospitals in Croatia and other similar countries that are relatively young and insufficiently exploited tourist destinations that have the wealth of natural healing factors and can provide high-quality and competitive medical service (Vrkljan S, Grazio S, 2017, 686).

The Global Wellness Institute (Global Tourism Industry, 2013) estimates that wellness tourism accounts for 71%, thermal spa tourism resorts for 21%, and medical tourism for 8% of total revenue of health tourism. Wellness tends to become a complete health concept in that it implies movement, physical exercise, healthy food, relaxation and managing stress, aiming at achieving satisfaction and pleasure (Andrijašević M, Bartoluci M, 2014, 125), and tends to become a mass-scale form of tourism in the 21st century (Bartoluci M, Birkić D, 2011, 53).

The report of the European Public Health Alliance (EPHA) (European Public Health Alliance, 2015, 6) on cross-border healthcare explicitly states the relation between inequalities of access to healthcare services and the EU Directive on patient rights implementation: 'The Directive requires Member States to reimburse citizens to the value that care would have cost at home an essential provision for protecting the financial sustainability and viability of national health systems but this immediately disadvantages patients from poorer countries with less-developed health systems. Health services are provided for substantially less money in Croatia, for example, than in Sweden. Thus, a Croatian patient would have to cover a considerable difference in cost in treatment out of their own pocket, whilst patients from wealthier Member States are free to travel almost anywhere else for their care without

contributing to the costs themselves. Another side effect is that wealthier governments are effectively gaining if the treatment is less expensive abroad' (Mainil T, 2017, 27).

This SWOT analysis indicates that although there are significant challenges for developing health tourism in Croatia, there are also considerable potentials. The area is rich in natural resources, has excellent climate conditions throughout the whole year and even has a recognized tradition of the medical and spa sector. According to many opportunities that this analysis emphasized, it is only a matter of time before Croatia manages to improve its offer, promote new products, and place itself firmly on the map of European or even global health tourism.

Tourism plays a significant role in Dalmatia - creating jobs and providing employment. Estimating the total size of the health tourism sector, in general, is difficult because of limited and fragmented data. Besides, the overlapping definition by different sources is a big obstacle as well. These issues should be in focus for further scientific research. Health tourism may not be the leading type of tourism when measured by the number of tourists, but it is still considered as one of the most finance-consuming market segments due to the high cost of services included.

Dalmatia with a recognized tradition, high-quality workforce and excellence in providing numerous health tourism services has a strong foundation for the development of health tourism and all its subsectors. Although the potential is undeniable, there is still less specific and meaningful support in terms of strategic and financial backing on part of the Croatian government. However, further development of the entire health tourism sector requires primarily coordination for gathering reliable data, as well as building cooperation and networking among institutions interested in sending and hosting tourists. Access to the European Union has created favorable conditions and served as a sound basis for new directions of the health tourism development in Dalmatia.

Some of the factors that could improve further development of health tourism in Dalmatia would be:

- the use of opportunities linked to ageing trends
- extension and differentiation of the health tourism products
- the continuous use of the European Union funds
- promoting the usage of EU Directive 2011/24/EU on the application of patients' rights in cross-border healthcare
- implementation of new marketing techniques
- development of scientific activity that would support sustainable development of the health tourism sector

5. Conclusions

Medical tourism in Croatia has the potential to become one of the driving forces of the country's tourism sector, and experts agree that Croatia could easily be one of the top ten global players in this lucrative industry within 10 years.

Strategic planning in tourism as an economic sector is significant both on state and regional level, and tourism often has a significant role in regional development, thus the problem of sustainable tourism and economy development was studied in many European countries (Kauppila, P. Saarinen J, Leinonen R, 2009, 424-435).

Nowadays, healthcare has become a global market, with emerging, developing and developed nations competing for health tourists. As a result of this, health tourism plays a vital role in the development of sustainable tourism, placing value on environmental quality, reducing

seasonality, adjusting supply to specific customer demands, and financial growth of individual institutions providing health tourism services (Hodžić S, Paleka H, 2018, 2).

It is known that tourism is a labor-intensive industry. Human resources in the health sector reform aim to improve the quality of services and patient satisfaction. (Nica E., 2013, 76.). In health tourism, the reputation of medical staff, especially physicians, will be important or almost critical. The share of employees with university qualifications is 10%, out of which only 2% non-medical employees have university education in health spa providers in the Republic of Croatia (Trdina D, 2010, 324).

The question is whether it is the best strategy for growth and development of health resorts tourism in Dalmatia which are relatively insufficiently exploited tourist destinations that have a wealth of natural healing factors and can provide high-quality and competitive medical service. To answer this question, we assumed, contrary to the foregoing, that these service providers would be more successful if their medical offer was better, if they were employing more physicians and medical personnel, and had a higher proportion of them in the total number of employees.

Apart from economic effects, there are many other benefits of health spa tourism for the national economy. Seasonal employment is less pronounced because health resorts and special hospitals remain open all year round and require continuity in the employment of professional human resources.

Tourists that stay in a health resort or a special hospital for medical rehabilitation remain longer in order to achieve a preventive or rehabilitation treatment, unlike the stay of leisure "sun and sea" tourists. It could be said for tourist demand of health services that it is less flexible than some other forms of tourism demand due to its connection to human health, which is one of the rare categories in which people do not accept compromises. Thanks to the EU Directive 2011/24/EU on the application of patients' rights in cross-border healthcare it is possible for EU citizens to have their health insurance cover the costs of some medical and health spa services. Considering only these advantages, it is clear why the growth and development of this segment is desirable in all destinations that are naturally predisposed for its development, especially those with high seasonality.

SWOT factors would surely bring a more precise evaluation of desirability of strategies. The next question is the inclusion of experts. The modern theory of strategic deciding assigns growing attention to questions of assumptions, beliefs and understanding of strategists regarding certain key topics (Salaman G, 2002, 179-185). Thus further efforts on strategic shaping should be directed to complementary analyses and inclusion of a greater number of experts of various relevant profiles.

In Dalmatia, the health tourism sector has great potential. Besides that, increasing the share of health tourism may lessen tourism seasonality, increase labor quality as well as ensure sustainability. Access to European Union Fonds has created favorable conditions for new directions of health tourism development in Dalmatia.

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International Trade as a Foundation of The European Union's Identity in the Globalization Context

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Abstract. The belief based on the fact that within the international society the economic integration leads to peace and economic prosperity has led to the founding of the European community, today the European Union. Therefore, trade is a fundamental part of the European Union's identity. A globally integrated economy continues to benefit large, small and medium-sized European businesses, and to the benefit of European citizens, workers and consumers. But world trade must be proactively designed and managed to ensure that it is fair, that it projects values and that it remains firmly anchored in a rules-based system. Based on the actions of the European Union, it aims to lead a transparent and responsible trade policy, which will benefit all citizens and which offer modern solutions for the realities of today's economy, in a context of technological evolution. We also want to mention that the European Union is considered an example of the benefits of trade, globalization and economic openness, as it is one of the main players in world trade. In the debate launched in the White Paper on the future of Europe, it shows how trade policy can contribute to capitalizing on globalization and can guarantee a fair distribution of trade benefits, in line with EU principles of solidarity and sustainability, as international trade policy represents today an exclusive competence. Currently, the benefits of globalization and international trade are being questioned. Respectively, the EU's new "Trade for All" strategy addresses a number of issues, is more effective, transparent.

Key words: Globalization, international trade, European Union, policies, strategies.

1. Introduction

The benefits of international trade and globalization, the economic openness, the evolution and progress of states' policies aimed at peace, prosperity and economic prosperity are widely discussed in international society.

The international trade and globalization are the two phenomena that influence the business cycles and labor markets and expand the range of options available to consumers. International trade is also a central driving force underlying globalization, a process of integration among countries and individuals. According to the economic theory, as technological development reduces the transaction costs, there develops cross-border trade and investments. This forecast is available for the European Union (EU) both within its own market and beyond its borders. (Comisia Europeana, 2019)

Both theoretically and practically, trade must be proactively designed and managed to ensure that it is fair, that it projects values and that it remains firmly anchored to a rules-based system.

The European Union aims to pursue a transparent and accountable trade policy out of which all citizens benefit and offer modern solutions to the realities of today's economy, in a context of technological evolution. This conclusion lies in all EU legal tools and mechanisms. At the same time, the international context, where the EU unfolds its trade policy, is constantly changing: there is a growing number of actions challenging the rules-based multilateral trading system, which may also constitute a recruitment of protectionism. At the same time, many trading partners, small and large players, on the trade stage, demonstrate the attachment to a fair and open international trade.

2. New approaches and benefits of the international trade in terms of progressive trade policy to capitalize on the opportunities offered by globalization

Here we need to describe the role of the tools, authorities and mechanisms operated by EU in order to determine their essence. In this way, the 2015 "Trade for All" strategy strengthens the role of EU trade policy, being the first to help promoting growth, job creation and investment. The strategy also calls for the revitalization of the World Trade Organization (WTO) by giving it a central role in drafting and enforcing the rules. Taking a more targeted approach instead of the current "single commitment" approach, whereby all points should be agreed, and creating a "two-layer" mechanism to allow some WTO members to move forward on a particular issue, while allowing other members later to join this group. (Comisia Europeana, 2017)

The European Commission plays a special role in ensuring that EU trade policy evolves towards achieving the Union's overall economic and political objectives by increasing the coherence between trade policy and other EU internal and external policies.

For example, trade policy contributes to an integrated process of developing the 2030 Agenda for Sustainable Development, focusing not only on economic but also on social and environmental issues, as well as recognizing the role of international trade as one of the pillars of the European Strategy 2020, which aims for a greener and more competitive European Union. Trade policy is an exclusive power of the EU - therefore only the EU and not the Member States individually can legislate on trade and conclude international trade agreements.

International trade was one of the first sectors in which Member States agreed to delegate their sovereignty. Therefore, the EU, acting as a single entity, negotiates both bilateral and multilateral trade agreements on behalf of all Member States. As data from the WTO Dispute Settlement System show, the EU has demonstrated a remarkable ability to defend its own interests in international trade disputes. (Comisia Europeana, 2017)

The EU has also used international trade tools to promote its own values and policies and has sought to extend its own regulatory practices to the rest of the world. Indeed, "promoting European values", including human rights, sustainable development, good governance and respect for the environment, is one of the three pillars of the EU's trade strategy, entitled "Trade for All".

The "Trade for All" strategy emphasizes the importance of a forward-looking negotiating program that will shape globalization, in particular through the revitalization of the multilateral trading system and the progress of bilateral relations. (Trade for all, 2015)

Today, the EU is more globalized than ever when it comes to trade. However, the benefits of international trade and globalization for the EU go beyond strict economic limits: economic integration through trade also promotes peace and stability, as the European project itself has successfully demonstrated for decades. The international trade allows the EU to establish relations with other countries and create alliances around the world.

The EU's active involvement in the WTO allows it to pursue multilateralism and international cooperation through a system that is based on rules rather than power. At the same time, EU trade policy seeks to encourage the economic development, for example by giving developing countries preferential access to the EU market. The EU also uses its trade policy as a lever to promote core values in the third countries, with the aim of helping to improve people's living conditions. (European Commission, 2014)

This does not mean that international trade and globalization lack disadvantages. In terms of undesirable effects, the trade can lead to regional inequalities, such as lower wages, as the production moves to countries that offer an advantage in this regard. As the resources are relocated to more productive enterprises within an economy, it is expected that more efficiency will generate net profit in welfare. However, these benefits are not always equally distributed.

Changes in production have led to job losses, especially in the manufacturing industry. However, the earnings generated by trade and jobs relocation undoubtedly, compensate the overall effects of the reallocation of trade-related workers.

The effects of trade on the environment depend, inter alia, on the measured variables on the environment and the level of economic development of the given country (European Commission, 2017). In our opinion, trade liberalization without a mitigating regulation can also undermine the protection of personal data.

The EU plays an important role in managing the social, political and economic aspects of globalization. First, it has an exclusive competence for the management of trade relations and the negotiation of trade agreements with the third countries.

Secondly, it is essential for addressing unfair trade practices of the third countries and for promoting international rules in this area, for example by reforming the WTO. This contributes, for example, to protecting European businesses from the influx of undervalued goods into the European market and to ensuring fair competitive conditions at international level. (European Commission, 2019)

The EU's competences in the field of international trade are defined by the EU Treaties. Pursuant to Article 3 (1) of the Treaty on Functioning of the European Union (TFEU), the EU has exclusive competence in the field of Customs Union and international trade policy.

The EU's exclusive competence in international trade is the direct result of the establishment of the Customs Union at the start of the EU, which led to the abolition of intra-Community borders for trading goods and the establishment of a common customs tariff (Article 28 TFEU) for trading with countries outside EU. This common customs tariff required Member States to adopt a common trade policy, which was later transformed into a comprehensive EU trade policy.

The Lisbon Treaty has also strengthened the role of the European Parliament, turning it into a co-ordinator, the equal to the Council, in matters of trade and investment.

The treaty also gave the Parliament a more active role in negotiating and ratifying international trade agreements, its approval being currently mandatory. However, some aspects of trade policy remain within the competence of the Member States. (Cartea albă, 2017)

3. The benefits of trade, approaches, discussions, perspectives.

Although the legal mechanisms and tools are working, they have a good breadth and they have all built a new approach to trade, although within the EU heated debates on the benefits of international trade are going on, a full position and a word to say for European citizens.

In this regard, we cannot overlook the results of a Eurobarometer survey, which shows that 60% of Europeans believe that they personally benefit from international trade, a 16 percentage points higher than 10 years ago years, when the last survey on this issue was conducted. It also showed that 71% of respondents believe that the EU is more effective in defending the trade interests of their countries than in cases where they act on their own. (Eurobarometrul, 2019)

Analyzing these data, we concluded that European citizens are far from being indifferent to the fate of the EU and this is demonstrated by the answers according to criteria, objectives and priorities, for example: 54% of respondents suggest that the main priority of EU trade policy should be the job creation in the EU.

Defending EU's environmental and health standards has also become important for Europeans, with half of respondents considering it a priority, a 20-percentage point over the year 2010. More than half of Europeans acknowledge that at the same time the EU trade policy has already taken into account the social, environmental and human rights influence, both in the EU and globally.

The wide evolution of processes and phenomena in the international society has imposed on Europeans a more advanced degree of awareness, accountability, maturity, which makes them feel the need of progress and evolution. The need of for international trade rules speaks of the fact that almost three quarters of Europeans agree that we need them.

As for trade's advantages: 54% of respondents consider the international trade to be beneficial for them and that this benefit materializes in a wider range of products, while 36% consider that reducing prices is the most important benefit.

One aspect and opinion that seems to be objective has to do with fairness in international trade, as a third of those surveyed consider it naive to expect other countries to comply with the trade rules. More than half of respondents believe that the EU should increase import duties for non-EU countries or companies that do not comply with international trade rules.

But here we also want to mention that, what is the meaning of the tendency of some states that still today aspire to integrate, to a change through the concluded preferential Agreements, established reforms, connected, unified norms? Confidence remains the key factor in the process of integration into Europe.

However, going back to survey's results, we deduce that they confirm a good agreement between the priorities set by EU citizens and those set out in the EU's "Trade for All" strategy.

As a result, if we analyze and compare the efficiency of the initiation and entry into force of EU trade agreements with the third parties, we find that some agreements are of major importance, for example those with Canada and Japan. International trade currently supports over 36 million jobs in the EU, 5 million more than in 2014 (United Nation, 2015).

Increased emphasis has been placed on transparency and sustainable development, as the protection of the environment and workers' rights has become a cornerstone of EU trade policy. Unilateral protectionist measures have increased the need for the EU to intervene and defend Europeans against unfair and illegal trade measures imposed by others. There are currently over 130 EU trade defense measures in force, which help protect more than 343,000 jobs in Europe. (Non paper, 2018)

On international market where the EU unfolds its trade policy is constantly changing. There appear new phenomena, processes that test the EU trade system. Some aspire to integrate, for example the Republic of Moldova, which has demonstrated its commitment by concluding the Association Agreement in Brussels in 2014, others are testing its relations (UK with the EU following the Brexit), which is in fact a controversial issue, especially related to future trade relations.

For the Republic of Moldova, this partnership is the lifeline, promoting long-term competitiveness, strengthening resilience in the vision of some people and damaging sovereignty in the vision of others.

The Moldova-EU Association Agreement establishes a new legal framework for advancing the relations between the Republic of Moldova and the EU towards a qualitatively higher level, the one of political association and economic integration with the EU. Thus, the Association Agreement (AA) is based on an innovative and ambitious approach, including the creation of a Deep and Comprehensive Free Trade Area - DCFTA.

Trade relations between the Republic of Moldova and the EU are carried out on a preferential basis, according to the provisions of the DCFTA, which is a component part of the Association Agreement.

DCFTA has been in effect since September 2014. Since then, trade has grown steadily. In 2018, the general trade grew by 14% and the trade balance remained positive for the EU. The international trade of the Republic of Moldova, based on free trade agreements, provides for the cancellation of the import customs duty for most goods and their gradual reduction for products that are an exception to the free trade regime.

The exceptions are stipulated in each agreement, thus, the economic agent that imports goods from several countries, in some cases will pay the customs duty on import, and in others will be exempted from this duty, according to the preferential trade regime.

The free trade area refers to exemptions only from customs duties, and has no impact on the application of other types of customs payments, namely VAT or excise duties. As for the customs procedure fee, currently charged for each customs declaration, it will be repealed in the future, instead a tariff for customs clearance will be implemented outside the official Customs working hours or in places other than Customs.

In this context, referring to the perspective of developing trade in Moldova, we conclude the following: it is certain that exports out of country depend on the reforms in the country. Diversification of markets and products will lead to increased exports. The structural reforms of the business climate are more important for maintaining foreign direct investments and innovation than, for example, fiscal incentives. Customs and export licensing procedures have a negative impact on productivity; each day of waiting for goods to be cleared means reduced productivity.

The Republic of Moldova needs a new approach to trade by reviving the trade policy, trade strategy, by modeling and capitalizing a negotiation program aimed at obtaining the benefits of trade, the trade system and the progress of international relations.

The fact that an Association Agreement is signed and reforms are introduced does not mean that the opportunities offered by this process for the Republic of Moldova are capitalized. It follows a difficult path, full of approaches, but in order to pursue its economic interests along with the EU we need to implement the principles of: cooperation, diplomacy, transparency, efficiency and values.

4. Conclusions

Currently, the EU-27 format forms the largest trading block in the world. This fact remains undeniable as it gives it a strong position in international trade. The EU's strong position is due to the fact that it has the share of Member States, i.e. it increases its bargaining power with third countries.

In this context, we would like to conclude that international trade offers and will offer a multitude of economic benefits for both consumers and economic entities. According to the

European Commission, more than 40 million jobs and more than 600,000 small and medium-sized enterprises (SMEs) in the EU depend on exports (European Commission, 2019).

In order to regulate international trade, the EU has concluded more than 70 trade agreements with countries around the world, covering a share of almost 45% of world's GDP. From 2018, the Council approaches a new architecture of trade agreements.

- As a result, current trade negotiation processes among the EU and the third countries include: Japan a Free Trade Agreement (FTA) which entered into force on 1 February 2019; the negotiating directives were adopted in 2012 and the agreement was ratified at the end of 2018;
- Singapore ALS broken down signed on October 19, 2018, the entry into force being scheduled for 2019; the negotiating directives were adopted in ASEAN, the Association of Southeast Asian Nations, in 2007;
- Vietnam ALS broken down signed on June 30, 2019; the negotiating directives were adopted in ASEAN in 2007;
- Mexico the text for the modernization of the EU-Mexico Global Agreement is to be finalized by the end of 2018; the negotiating directives were adopted in 1999;
- MERCOSUR on 28 June 2019, negotiations on a trade agreement, part of the Association Agreement, with the South American trade block comprising Argentina, Brazil, Paraguay and Uruguay were completed; the negotiating directives were adopted in 1999;
- Chile negotiations for the modernization of the existing FTA are ongoing; the negotiating directives were adopted in 2017;
- Australia and New Zealand FTA negotiations are ongoing; the negotiating directives were adopted in 2018.

Although the global trade growth slowed and protectionism increased in 2019, EU preferential trade agreements continued to have trade facilitation effects, according to the European Commission's report (European Commission, 2014).

Beyond total or partial tariff reductions, the agreements continue to contribute to the development of a rules-based trading system and have improved market access for EU products and investments in partner countries. They also contribute to economic diversification and growth in developing partner countries.

In our opinion, the European Union has to maintain a rules-based trade system, pursue a resilient, proactive trade policy, promote a progressive values-based trade agenda to ensure the prosperity and sustainable development of the economy.

Whatever we say, it is certain: the benefits of international trade and globalization are obvious, economic integrity through trade promotes peace and stability, undoubted values for our society.

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CIET Split 2020 Track 3

Electrical Engineering, Information Technology and Mechanical Engineering

The Numerical Modelling of Experimental Device for Measuring Thermal Conductivity of Metals

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Abstract. In order to identify the operating parameters of experimental device for measuring thermal conductivity of metals, the numerical modelling approach has been applied. The numerical modelling is performed by implementing the finite element method for transient heat flow and employing the Python programming language. The test specimens for measuring thermal conductivity of metals were cylindrical in shape. The heat transfer of interest considers the conduction through test specimen and thermal insulation, and the convection to surrounding air and cooling water. Radiative heat transfer was neglected due to the specific design of experimental device and the temperature levels achieved between the forehead of test specimen and cooling water. Number of numerical simulations have been performed in order to analyse the effect of two different metals (steel and copper) on thermal conductivity values. Furthermore, the analysis included the power of heat source (warm forehead) and the intensity of heat transfer from the specimen cold forehead (heat sink). The presented numerical analysis produced valuable data that will play important role in defining the final concept and design of the experimental device for measuring thermal conductivity od metals.

Key words: thermal conductivity, finite element method, Python programming

1. Introduction

As a part of laboratory educational activities, devoted to implementation of practical sciences, the experimental device for measuring thermal conductivity of metals will be constructed. Other authors have also researched and constructed similar devices for measuring thermal conductivity of different materials [1], ceramic coatings [2], insulating materials [3], etc. Although such apparatus could be easily purchased, the "in-house" designed and constructed experimental device will give students better insights on theories and practices applied during the development and especially during the utilisation of experimental device. Numbers of specific requirements have been defined in order to optimise design and to construct the device to be as simple as possible. These are out of the scope of this paper. However, in this paper attention is given on the performance of experimental device in measuring thermal conductivity of metals. In order to identify the operating parameters of experimental device the numerical modelling approach has been applied. This has included the implementation of a finite element method for transient heat flow [4], and the development of "in-house" numerical code employing the Python programming language [5]. The generated numerical results on thermal conductivity of steel and copper are presented, as well as the influence of operating parameters on the numerical results. Finally, the analyses have indicated the time duration of numerical experiment for attaining the satisfactorily precision of the results. The overall duration time of measurement of thermal conductivity is very important as the time for the experiment will be limited.

2. Physical Model

The experimental device for measuring thermal conductivity of metals was designed as cylindrical chamber having 50 mm thick layer of thermal insulation, shielded by 1 mm thick SAE 304 stainless steel (Figure 1). As thermal insulation a calcium silicate ($\lambda = 0.07 \text{ W/(m·K)}$) @ 200°C) was selected. The test specimens for measuring thermal conductivity of metals were cylindrical in shape, 50 mm in diameter and 100 mm in length.

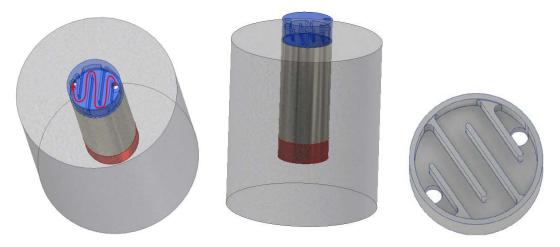


Figure 1 Experimental device for measuring thermal conductivity of metals – design

As a heat source, an electric resistance heater was located at the warm forehead of the test specimen. The heater was assumed as cylindrical in shape, with uniform heat distribution. The power of heater could be regulated from 0 to 100 W. A cooling chamber was attached at the cold forehead (heat sink). The cooling chamber was made of aluminium, and it was designed as a heat exchanger with fins to increase the heat exchange between the cooling water and the specimen cold forehead (Figure 1). In order to maintain the controllable circulation of water, the system was equipped with the circulation pump with the variable flow. The circulating water was in the direct contact with the specimen forehead. So as to avoid the conductive heat transfer, the gap of 1 mm was constructed between the fins of the cooling chamber and the cold forehead.

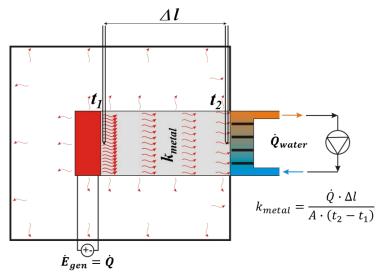


Figure 2 Experimental device for measuring thermal conductivity of metals – concept

The temperature difference between two foreheads (t_1-t_2) will be measured at the distance Δl , which is nearly the length of the test specimen (Figure 2). Since the test specimen is surrounded by the thick layer of thermal insulation, the heat generated by electric resistance heater (E_{gen}) will mainly flow along the specimen length. Some of the heat will be lost, for heating the thermal insulation and due to the heat flow though the thermal insulation. Since the heat will be continuously removed from the cold forehead (Q_{water}) , after some time the heat transfer will reach nearly steady-state. At that point, when the temperature difference (t_1-t_2) remains nearly constant, the value of thermal conductivity (k_{metal}) could be finally quantified. Radiative heat transfer was neglected due to the specific design of experimental device, and the temperature levels achieved between the cold forehead of specimen and the cooling water.

3. Numerical Model

Numerical model was developed based on the geometry of the physical model. The numerical grid was defined within the 2D area of numerical analysis, which was represented by one half of the longitudinal section (Figure 3), having dimensions 160×75 mm. The numerical grid was uniform, comprised of 16×12 cells, each cell 10 mm in length and 6,25 mm in height. The additional analysis, as it will be later presented, have included the sensitivity of numerical results on grid density. In that case the numerical grid was comprised of 32×24 cells, where cells had dimension of $5\times3,125$ mm.

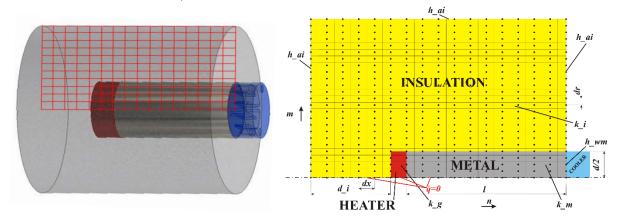


Figure 3 Numerical geometry; Numerical grid and nods - illustration

Although the numerical grid was two-dimensional, the calculation of heat flows has included the cross section area of the physical model along the symmetry axis. The heat transfer considered the conduction through the test specimen and the thermal insulation. The following conduction coefficients were used:

- electric heater (k_g = 100 W/mK)
- metal specimen (steel k_ms = 52 W/mK, copper k_mc = 394 W/mK)
- thermal insulation (k i = 0.07 W/mK)

The above vales were considered as constants. This assumption could be considered as the simplification of numerical model, which to some extent affects the numerical results. However, due to the specific purpose of this numerical model, the inaccuracies of results are considered insignificant. The boundary conditions have included the convection heat flow between the thermal insulation wall and the surrounding air, where coefficient $h_ai = 6$ W/m²K was used (see Figure 3). The convection heat flow between the cold forehead and cooling water was dependent on the value of coefficient h_a , which was varied from 2000 to $10000 \text{ W/m}^2\text{K}$.

Heat balance for each numerical cell (i, j) was based on the conductive (q_k) and convective heat transfer (q_h) from/to adjacent numerical cell and the internally generated heat (q_{heater}) (Figure 4). The heat flow perpendicular to the symmetry line was assumed zero.

The equation for Fourier's law of two-dimensional heat conduction with heat generation could be written as [4]:

$$\frac{\partial}{\partial x} \left(k \frac{\partial T}{\partial x} \right) + \frac{\partial}{\partial y} \left(k \frac{\partial T}{\partial y} \right) + \dot{e}_{gen} = \rho c \frac{\partial T}{\partial t}$$
 (1)

where k is the thermal conductivity of the material, $\frac{\partial T}{\partial x}$ is the temperature gradient, \dot{e}_{gen} is the rate of heat generation, ρ is the density of the material, c is the specific heat capacity of the material, while $\frac{\partial T}{\partial t}$ is the rate of change of the temperature.

The general relation for Newton's law of heat convection could be written as [4]:

$$\dot{Q}_{conv} = hA_s (T_s - T_{\infty})$$
 (2)

where h is the convection heat transfer coefficient, A_s is the heat transfer surface area, T_s is the temperature of the surface, while T_{∞} is the temperature of the fluid sufficiently far from the surface.

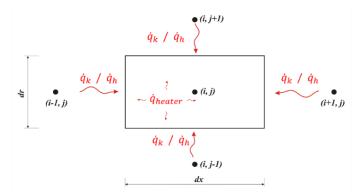


Figure 4 Numerical cell – heat balance

The governing equations have included the heat balance (Eq. 3, 4 and 5) of each cell where the sum of conductive and convective heat transfer, together with the internally generated heat, give the rate of total energy change. The calculations were time dependent, where each iteration have considered the calculations of physical values at the specific time step.

$$\sum \dot{Q}_{k} + \sum \dot{Q}_{h} + \sum \dot{E}_{gen} = \frac{\Delta E_{el}}{\Delta t}$$
 (3)

$$\sum \left(k_{el} \cdot \frac{T_{i\pm 1,j} - T_{i,j}}{dx} \cdot A_i \right) + \sum \left(k_{el} \cdot \frac{T_{i,j\pm 1} - T_{i,j}}{dr} \cdot A_i \right) + \sum \left(h \cdot (T_{fluid} - T_{i,j}) \cdot A_i \right) + \sum \dot{e}_{gen} \cdot V_{el} = \rho_{el} \cdot C_{p,el} \cdot V_{el} \cdot \frac{T_{i,j}^{t+\Delta t} - T_{i,j}^{t}}{\Delta t}$$
 (4)

$$T_{i,j}^{t+\Delta t} = T_{i,j}^{t} + \frac{\sum \left(k_{el} \cdot \frac{T_{i\pm 1,j} \cdot T_{i,j}}{dx} \cdot A_i\right) + \sum \left(k_{el} \cdot \frac{T_{i,j\pm 1} \cdot T_{i,j}}{dr} \cdot A_i\right) + \sum \left(h \cdot (T_{fluid} \cdot T_{i,j}) \cdot A_i\right) + \sum \dot{e}_{gen} \cdot V_{el}}{\rho_{el} \cdot C_{p,el} \cdot V_{el}} \cdot \Delta t \tag{5}$$

Due to the convergence issues, each time step was selected as 1/1000 seconds, while the duration of simulation was limited to 1800 seconds (30 minutes). The duration of 30 minutes was set as the acceptable duration time of real laboratory exercise. The results generated after 30 minutes of numerical simulation were compared with the standard values of thermal conductivity. The sensitivity of calculated thermal conductivity and temperature difference of specimen foreheads was additionally analysed as a function of the electric heater power (varied from 20 to 100 W) and the convection heat transfer coefficient (varied from 2000 to 10000 W/m²K).

4. Experimental results

The numerical simulations have been undertaken in order to evaluate the validity of experimental device for measuring thermal conductivity od metals. The resulting values of thermal conductivity for steel and copper were compared with the standard values for the specific temperature range. As it was already mentioned, the maximum time of numerical simulations was limited to 1800 s. The example of program-generated graphs, in case of numerical simulation for steel specimen, when power of electric heater was 100 W and the value of convection heat flow coefficient at 2000 W/m²K, are presented in Figure 5. The first graph shows the values of numerically calculated thermal conductivity of steel as a function of time, which slowly converges to its standard value of 52 W/mK. Second and fourth graphs show the increase in temperature difference of warm and cold foreheads during the time of numerical experiment. In this case, the temperature difference reaches some 91.91°C, while warm and cold foreheads had temperatures of 135,11°C and 43,20°C respectively. As it could be seen from the graphs, at 1800 s the rate of change of temperature curves is reduced, almost reaching steady-state values. Finally, the third graph shows the heat flows, where initially the heat generated by the electric heater was used for warming up the steel specimen and surrounding thermal insulation. At the end of the experiment, at 1800 s, the steel specimen heat input reached some 97,32 W, while the heat output some 91,04 W. The results suggest the existence of heat losses to surrounding air, which finally have as a result a little higher value of calculated thermal conductivity if compared with the standard value.

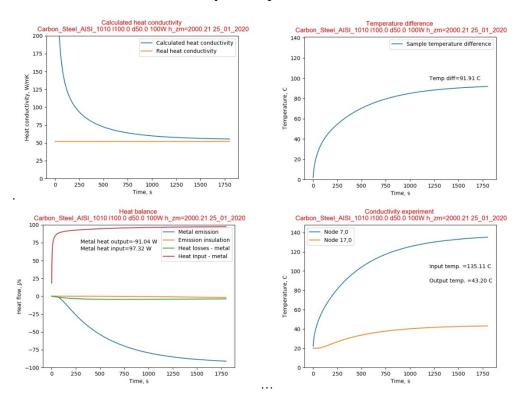


Figure 5 The example of program generated graphs – thermal conductivity, temperature and heat flow as time dependent values

As the numerical analysis have included the calculation of thermal conductivity of two different materials (steel and copper), different power of electric heater (from 20 to 100 W), and the variation of convection heat transfer coefficient (from 2000 to 10000 W/m²K), it was convenient to show results as surface plots. The representation of results has been performed using the Design-Expert software [6].

The deviation of calculated thermal conductivity as a function of the electric heater power and the convection heat transfer coefficient is shown in Figure 6. The left graph corresponds to steel specimen, while the right graph to copper specimen. It could be seen that the deviation of thermal conductivity for steel has varied from 2,2 to 3,4 W/mK as convection heat transfer coefficient has been reduced from 10000 to 2000 W/m²K respectively. This suggests that higher values of convection heat transfer have as a result more accurate value of calculated thermal conductivity.

In the real case, the experimental device for measuring thermal conductivity of metals should have a possibility of regulating the volume flow of cooling water in order to attain the value of convection heat transfer coefficient of 10000 W/m²K or higher. The influence of the power of electric heater on the deviation of thermal conductivity showed to be almost insignificant. In case of copper specimen (Figure 6, right graph), the deviation of thermal conductivity has varied from 2,7 to 6 W/mK as convection heat transfer coefficient has been reduced from 10000 to 2000 W/m²K respectively. Again, the power of electric heater showed to be of low significance on the deviation of thermal conductivity.

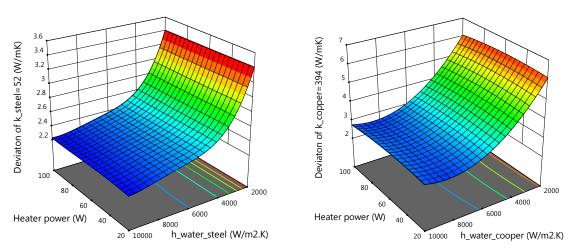


Figure 6 Deviation of calculated thermal conductivity (in W/mK) as a function of heater power and convection heat transfer coefficient (steel vs copper)

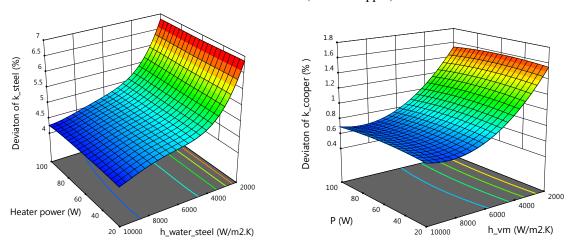


Figure 7 Deviation of calculated thermal conductivity (in %) as a function of heater power and convection heat transfer coefficient (steel vs copper)

As thermal conductivity of steel (52 W/mK) and copper (394 W/mK) differ significantly, the analysis has also included relative values, showing the deviation in percentages. In this case, as shown in Figure 7, the deviation of thermal conductivity for steel specimen has varied from 4,25 to 6,8%, while for copper specimen from 0,67 to 1,52%. This suggests that materials

with higher values of thermal conductivity (heat conductors) are less sensitive on the intensity of heat removal from the cold forehead.

Although showed to be insignificant when analysing the values of deviation of thermal conductivity, the power of electric heater has had effect on the temperature difference between two foreheads of the specimen, as shown in Figure 8. In case of steel specimen (left graph), the temperature difference has varied from 19 to 95°C as power of electric heater has been increased from 20 to 100 W respectively. The coefficient of convection heat transfer had no effect on the temperature difference, for both, steel and copper specimens. In case of copper specimen (right graph), the temperature difference has varied from 2,5 to 12,8°C as power of electric heater has been increased from 20 to 100 W respectively.

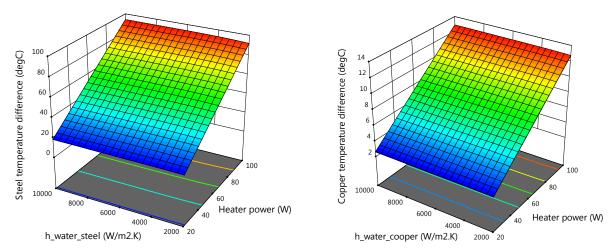


Figure 8 Temperature difference of specimen foreheads as a function of heater power and convection heat transfer coefficient (steel vs copper)

These observations suggest that in case of materials with higher values of thermal conductivity, the electric heater should have higher power as this will generate higher temperature difference between the specimen foreheads. This is especially important for real model as the temperature difference will be measured with temperature probes. Due to the precision of temperature probes, higher temperature difference between the specimen foreheads will be less sensitive to probes accuracy.

5. Conclusions

The presented numerical analysis showed to be very useful tool in analysing the performance of experimental device for measuring thermal conductivity of metals. The analysis has identified the most important operating parameters and their values, and has produced other valuable data that will play important role in defining the final concept of the experimental device. The accuracy of the presented numerical values has been already examined by redefining the density of existing numerical grid (192 cells), where number of numerical cells has been increased two times in both directions (x, r), having in total 768 cells. The time step has remained the same as before, 1/1000 seconds.

As it could be seen from Figures 9 and 10, in case of steel and cooper, the values of calculated heat conductivity have slightly improved by refining the numerical grid. The heat conductivity of steel has improved from 55,41 to 55,14 W/mK, becoming slightly closer to the targeted value of 52 W/mK. The same applies to copper, where calculated value of heat conductivity has improved from 400,39 to 399,45 W/mK, being also slightly nearer to the targeted value of 394 W/mK. Further analysis has included the variation of grid density and the time step of numerical simulations. This has also proved to be of insignificant effect on the values of numerical results.

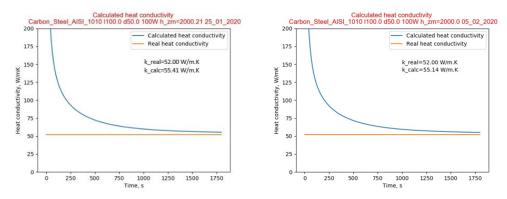


Figure 9 Calculated value of heat conductivity for steel (192 cells vs 768 cells)

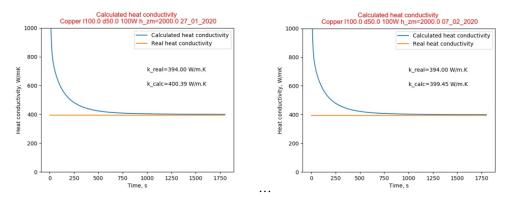


Figure 10 Calculated value of heat conductivity for copper (192 cells vs 768 cells)

Finally, the future work will include the construction of the experimental device for measuring thermal conductivity of metals. Once constructed the device will be experimented and analysed, where collected data will be used for validation and further development of numerical tool presented in this paper.

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Plastic Products Design: Today's Challenges from the Aspect of Environmental Protection

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Abstract. Today, in the technical application, synthetic polymer materials are largely represented due to the many advantages of its properties. Polymers are becoming more and more in use as construction materials in various areas (for example in the construction of parts of transport vehicles, manufacturing of various products in general mechanical engineering, electrical engineering, households, etc.). However, in addition to all these advantages, we must not forget today's limitation of natural resources, as well as the importance of waste management, and also the possibilities and availability of recycling processes of individual materials, both metals and plastics.

Every country in the world strives to protect nature and preserve the environment, and also in the Republic of Croatia has made a significant step forward in that field, especially because the obligation of Republic of Croatia to join to the European Union (EU) was to harmonize our legislation with EU legislation, and it is undoubtedly that legal solutions will continue to develop and improve.

Considering that the Republic of Croatia has opted for the adoption of guidelines for sustainable development, which include the provision of economic development but also the protection of natural resources, additional efforts must be made to meet the interests of the economy while at the same time respecting the laws related to environmental protection.

Therefore, in this paper, attempts are made to reconcile the contradictory goals and give answers to the questions of how to produce plastics and thereby be competitive on the market, while also respecting the laws with an emphasis on preservation and environmental protection.

Key words: polimers, structural engineering, recycling, environmental preservation

1. Introduction

Considering the current limitations of natural resources, and therefore the need for sustainable product development, great consideration should be given to the possibility of recycling, both metal and plastic (polymer) materials. Furthermore, the main factors influencing a favorable decision will be discussed in order to satisfy technical and economic aspects of a particular polymer product. It's a huge responsibility of the designer himself who task is to design a functional product, with an appropriate design, with optimum material choice, not necessarily the cheapest, but the material that best fits the desired function with its properties. Of course, attention should be paid to the possibility of recycling the material from which the product is designed. Today, we strive for light products, or products of reduced mass, and for the same reasons, polymer material has found a great use in various fields, including structural engineering. In the field of structural engineering, various elements for joining construction parts from polymer materials, such as screws and snap rings, different types of springs and hinges are made. Polymer elements for joining the structural components can also be used in

combination with metal parts to achieve higher strength and load-bearing capacity (e.g., clamping of the metal shaft and polymer hub or clamping of the polymer sleeve and metal housing). In addition to joining elements, polymers have been found satisfactory application for the manufacturing elements such bearings, gears, belt transmission (polymer belt and pulley), wheels, clutches, etc.

The automotive industry is increasingly turning to the fitting of components (and bodywork) of polymer composites, carbon and other synthetic materials, which has so far been used only for luxury cars, because these materials are extremely expensive. Polymeric materials have proven to be durable, and the justification for their use is increasing, except the reduction of a cars mass, they also allow maintaining a high level of safety.

Given the limited natural resources from which structural materials (metals and polymers) are derived, polymer materials can certainly be favored due to the significantly lower energy consumption of the semi-finished product (up to 10 times less energy consumption in relation to metals). During the final machining process by particle separation, the energy consumption is again on the side of the polymeric materials, because they can be processed with higher cutting depths, which save up to 40% in relation to metal materials [1].

When selecting a polymer material for structural purposes, it is necessary to match the numerously properties of the material with the structural requirements and with the influence of external factors (especially in exploitation), taking into account material behavior at elevated and lowered temperatures, aggressive media, the influence of moisture (especially affects at polyamides), type and load duration, deformation rate, thermal stability (the ability to keeping the desired shape at elevated temperature), and with all the above, to make the economic choice justification.

The polymer materials, or their properties, are very specific regard to other structural materials, the metals particular. Except for the materials themselves, manufacturing production and processes by which polymer materials are molded into the final product (usually in only one operation) are specific, which greatly affects to the material properties of the finished polymer product.

The development of polymer materials is extremely dynamic, which is another additional challenge for the constructor, who constantly needs to keep up with new materials coming to the market, and to be in contact with manufacturers and suppliers in order to be able to choose the right polymer material for their structural purpose. Commercial databases (on-line available) and catalog systems of manufacturers and suppliers, with their corresponding polymer properties, are also of great help.

By designing a polymer product, it is necessary to explore all the possibilities that will ultimately lead to the desired, technically and economically acceptable product. Therefore, in the construction phase, it is necessary to take into account the type of material, the amount of spent material (with less waste), the maximum functionality (which involves the integration of parts with as few parts as possible, and where it is possible, to avoid using metal parts - the same material of the finished product also makes it easier to prepare for recycling).

2. Environmental protection

The development of technology enables the application of different types of polymeric materials in the production of plastic products. The problematic group are certainly one-use products, after which the same products are discarded, with insufficient care being taken to dispose of them. However, there is a growing awareness of the adverse effects on the environment of inadequate disposal of plastic waste. In order to solve this problem, legislation and guidelines for sustainable development were adopted.

A legal branch was also developed as part of the national and international legal system (Figure 1) called *Environmental Law*, whose normative values and solutions serve to help protect and preserve the environment, and to sustainable development of society.

Environmental law implies all legal norms relating to the protection and rational management of the environment, the planning of actions to balance the natural and man-made elements of the environment and the prevention of adverse environmental impacts.

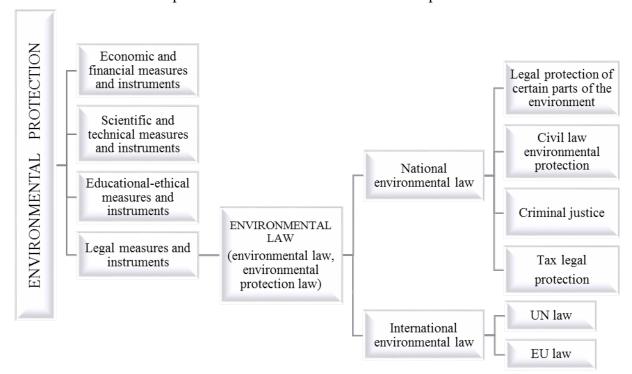


Figure 1 Division of legal system with regard to environmental protection [2]

The basic principles of environmental law can be divided into the principles of prevention, causality, cooperation and the principle of general compensation [2]. It is important to know the principles, especially for the creation of legal norms, since they constitute guidelines for work aimed at a specific goal. Each country has defined principles regarding environmental rights, and these are derived from its constitution. For example, the Republic of Croatia has accepted the principle of prevention as one of the basic principles of environmental protection, and it is the same part of the Environmental Protection Act of 2013.

The Constitution of the Republic of Croatia also establishes certain ecological standards: the right to a healthy life, the obligation of the state to ensure the right of citizens to a healthy environment, the obligation of all social entities to protect nature and the human environment, the possibility of limiting entrepreneurial freedom and property rights for the protection of nature, the human environment and human health. The right to a healthy environment belongs to the human rights of the third generation, also referred as the "rights of the people" and "the rights of solidarity".

The Declaration on Environmental Protection in the Republic of Croatia (NN 34/92) was adopted in 1992 at a session of the Council in the Parliament of the Republic of Croatia and refers to ensuring balanced ecological and economic development with the aim of permanently preserving the national heritage for the future generations and the implementation of the constitutional right of the citizens of the Republic of Croatia to a healthy and dignified life, in a preserved environment.

We are aware that the development of new technologies, increases an environmental pollution, because the impact of technology on that has been neglected, because it sought

exclusively to make civilizational progress through technical progress without thinking about the possible adverse on environmental effects. The problems of global warming have confronted us with reality, and today we are looking at the environment from a different angle, and we are increasingly turning to the introduction of guidelines for improving the newly emerged state, while it's not too late. Again, with the use of new technologies, it is possible to anticipate the positive and negative aspects of development, and to provide a systematic measures that will minimize the adverse impact of technological change on the environment. Changes in existing technologies need to be introduced, and new technologies will change the relationship from man to the nature, reducing energy consumption in production and exploitation, reducing consumption of non-renewable resources, using artificial raw materials and biomaterials, optical fibers, using micro electric power, etc.

3. Recycling and sustainable development of polymers

Plastic recycling is a plastic processing for the plastic that had already been in use. Before recycling, the plastic is grouped according to the resin identification code or symbol (made of three arrows - clockwise to form a triangle which numerical designation is located within) which is used as the identification code.

The rate of reuse as well as recycling of waste plastics is very low (compared to other materials in use), while the rate of disposal and incineration of plastic waste is steadily increasing leading to an increase in CO₂ emissions. According to Table 1 [3,4], division and clarification of the individual groups of plastics for recycling, is given.

PTE or PET - Polyethylene terephthalate

This group of plastics is the most commonly used type of plastic, usually intended for single use only, but reuse is not recommended due to bacterial contamination. This group of plastics is easily recyclable to provide materials for new PET bottles or polyester fibers that are further used in textile production.

HDPE – *High-density polyethylene*

This group of plastics is considered to be the safest type of plastic and is reusable for the same reason, and therefore is the most commonly recycled. It is recycled for the production of bottles, grocery boxes, agricultural pipes etc.

PVC or V – Polyvinyl chloride

Belongs to a group of plastics that is rarely recycled because it releases a toxic chemical compounds when heated. In the case of recycling, pipes, fences, and non-food bottles are produced.

LDPE – Low-density polyethylene

Recyclable plastic, although the recycling of this type of plastic is implemented to a lesser extent, it is very safe to use. It is recycled for the production of plastic bags, various containers, bottles, tubes and laboratory equipment.

PP – *Polypropylene*

Wide use plastics that are recyclable but also implemented to a lesser extent. It is recycled to produce various parts for vehicles and industrial fibers.

PS – Polystyrene

A widespread type of recyclable plastic, however, it releases styrene, which is harmful and dangerous to health when heated. It is recycled into various office equipment, boxes, insulation boards.

Other (BPA, polikarbonat, LEXAN...)

All other plastics which are not covered by the aforementioned groups belong to this group. Since this group also includes multi-layer materials (laminates), which can consist of different types of plastic materials, the recycling process itself is somewhat more complex (and thus not cost-effective) and there is no general rule for recycling for this group.

Table 1 provides an overview of all seven previously mentioned groups, with associated symbols and examples of common usage.

The recycling symbols (arrows in the triangle) according to D7611 standard, which relate to the Standard Practice for Coding Plastics Manufactured Articles for Resin Identification, an American Standardization Organization (*American Section of the International Association for Testing Materials – ASTM*) [4], has decided replace them with an equilateral triangle sign.

After adopting the above, the Republic of Croatia, will be apply the symbols to the right (symbols from the new group) according to Table 1.

Table 1 Plastic products labeling and plastics identification [3,4]

LABEL	TERM	THE MOST APPLIED EXAMPLE	SYMBOL	NEW SIMBOL
PET	Polyethylene terephthalate	bottles for soft drinks, thermal insulation boards	PETE	PETE PET
PE-HD or HDPE	High-density polyethylene	bottles for detergents, shampoos, milk etc.	L2 HDPE	HDPE PE-HE
PVC or V	Polyvinyl chloride	oil bottles, water pipes, window frames	٨	3 <u>03</u> PVC
PE-LD or LDPE	Low-density polyethylene	food containers, shopping bags, plugs	LDPE	LDPE PE-LD
PP	Polypropylene	yogurt cups, drinking straws	<u>چ</u> ے	5 <u>05</u> PP
PS	Polystyrene	food utensils, cutlery	6 5	6 PS PS
Other (multilayer materials)	Other plastics	all plastic items not specified in categories 1-6	OTHER	OTHER OT

The production and plastics use, as well as its recycling, should be taken seriously, bearing in mind that the plastic degradation process in the nature takes up to 500 years. According to [5], we distinguish two basic divisions of recovery (recycling) of polymeric materials: material and energy recovery.

Material recovery is further divided into mechanical and chemical recycling, whereby in mechanical recycling polymers are separated and sorted from mixed waste, and the given recycled material is further processed or used for the production of new products, while chemical recycling is carried out by depolymerization on monomers or partial degradation to other valuable raw materials.

During energy recovery, the combustion property of the waste is utilized and by this process the polymers are converted into electricity by utilizing the heat generated.

Compared to other commonly used materials in the industry, such as metal or glass, plastic recycling poses additional challenges because polymer materials need to be almost of the

same composition to be mixed, which is not the case for metals where different alloys can be melt in one phase (e.g., different aluminum alloys).

In addition to the limitations posed by low mixing entropy, another important limitation is the large amount of additives to plastics (fillers, reinforcements), as well as the addition of large quantities of colors. The high viscosity of the polymer makes it impossible to remove the additives economically, while in processes that are more cost-effective or cheaper is a high possibility of damaging the polymer material. Additives are less represented in food and beverage packaging and thus the recycling process for the same plastic is more common.

Therefore, manufacturers of plastic products should take into account, already at the design stage of the product, of the recycling possibility or reusing the product, while excluding the addition of additives that complicate the recycling process and affect on the quality and value of the recycled plastic.

Construction parts made of polymer materials (belts and pulleys, gears, springs, various elements for joining, etc.) tend to last and are not intended for one-time or short use. Of course, they have a service life and should be properly disposed them after cease to function. The automotive and aviation industry, in addition to furniture and electronics factories, are large source of plastic waste that needs to be recycled upon termination. There is considerable space left for advancement and improvement in the presence of various chemicals which, as an integral part of the polymeric material, make the recycling process difficult. It therefore strives for environmentally acceptable design while keeping the primary function of the product.

Products are rarely made from only one type of polymer material and it is desirable, already at the design stage, to determine the compatibility of the used materials, in order to simplify the preparation for the recycling process, i.e. to provide quality recycled material. It is especially important to ensure good conditions for the recycling of products manufactured in mass or large-scale production. Figure 2 [6], shows the compatibility of the basic polymer materials that are in use.

		Addition												
В		PE	PVC	PS	PC	ЬР	PA	POM	SAN	ABS	PBTP	PETP	PMMA	
a s	PE	•	0	0	0	lacksquare	\circ	0	0	0	0	0	0	
3 i	PVC	0	lacksquare	0	0	\circ	0	\circ	lacksquare	$lue{}$	0	\circ	lacksquare	
c	P\$	0	0	•	0	0	0	0	0	0	0	\circ	0	
	PC	0	•	0	lacksquare	0	0	0	lacksquare	lacksquare	•	lacksquare		
m	PP	•	0	0	0	lacksquare	0	\circ	0	\circ	0	0	0	
l a l t	PA	0	0	•	0	0	•	0	0	0	0	O	0	
ا د ا و	POM	0	0	0	0	0	0	•	0	0	•	0	0	a compatible
r	SAN	0	•	0	•	0	0	0	lacksquare	lacksquare	0	0	•	₽ 00 % 1 .001
i	ABS	0	Θ	О	lacksquare	0	0	lacksquare	0	lacksquare	•	O		Oimited compatible
a	PBTP	0	0	0	•	0	•	0	0	•		0	0	_ compatibile in small
	PETP	0	0	0	•	0	O	0	0	0	0	•	0	amounts
	РММА	0	•	O	•	0	0	O	•	•	0	0	•	_ not compatible

Figure 2 Compatibility of polymer materials [6]

For successful waste management, it is necessary to apply the recycling process of polymer materials, but also to strive for energy recovery in power plants, which are certainly the best solution for the disposal of large quantities of waste, which is still on low level due to the

costs they incur. Sustainability of development is possible if consider the importance of power plants for waste, and on that way reduce the accumulation of waste at landfills, thereby actually losing the energy that can be used. If waste management is not optimal, even the collected plastic waste can end up in the environment.

The recycling process can be completely rounded off, which is also being implemented (e.g. the separation and recycling of packaging waste, whose product is a polymer material in granules, which is transformed into new products by further production process according to market needs). The waste material generated during the recovery or recycling process can be further used as a raw material for the production of synthetic diesel, which in its characteristics fully corresponds to the properties of the Eurodiesel available at gas stations. Increasing the recycling of plastic also reduces the import of fossil fuels.

Innovations are the key factor in transforming the value chain of plastics, such as innovative solutions for advanced sorting, chemical recycling and improved polymer design that can have a powerful effect. It seeks to develop innovative materials that are fully biodegradable in seawater and freshwater that are not harmful to the environment and ecosystems. The most plastics that are labeled as biodegradable generally decompose under special conditions that are not always present in the natural environment and therefore continue to be damaging to ecosystems, and because of that a separate system for well-functioning organic waste is required. The impact of biodegradable materials on health and the environment is still in the research phase [7].

Increasing the level of plastics recycling can be achieved by improving the production and design of plastics and plastic products. Moreover, with better organization of the circular economy, there is no need to fear the loss of jobs, the tendency is to modernize and expand plastic recycling centers, and to build new facilities for sorting and recycling plastic waste.

When we talking about sustainable development, it is considered that the position of people in the social community is improved in terms of reduced poverty and greater equality, and improved economy without compromising the environment but treating it responsibly. Sustainable development should provide equal natural conditions necessary for life for everyone, such as drinking water and non-polluted air, while natural, non-renewable resources (which are not inexhaustible) should be used to some extent to prevent their complete exhaustion.

It is also not desirable to exhaust natural renewable resources (overfishing, felling of trees) but to provide time for natural renewal.

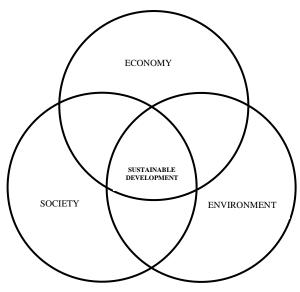


Figure 3 Elements of sustainable development [8]

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The goal of sustainable development is to meet the needs of the present without compromising the future of next generations. Problems should be resolved "now", not left them to the future generations. The elements of sustainable development can include the economic, environmental and socio-cultural principles [8] that need to be developed as a whole (Figure 3), not as each principle separately.

4. Conclusion

Of course, it's not to our goal to stop the plastics production, or products made of different polymer materials. Plastics is an innovative material that enables us to solve problems that we are also facing today, from reducing CO₂ emissions due to the use of these materials in the automotive and aerospace industries, thereby achieving less mass which is leading to reduced fuel consumption. The huge progress has also been made in the field of medical implantology, respectively the bone implants made of polymers [9] by 3D printing using biodegradable composites.

However, it is necessary to constantly develop the awareness of all stakeholders in the life cycle of plastic use, from manufacturers to consumers, and ultimately recycling centers, which is recognized by the European Commission and also adopted in 2015 as an action plan [10] for the circular economy (COM (2015 614 final)) committed to developing a strategy to meet the challenges that plastic brings. With this strategy, Europe can serve as a good example of how to bring awareness to stakeholders globally.

Keeping in mind of the design and production of plastics and plastic products, it enables its continued use, through reuse, recycling or production of fuels, making this innovative material sustainable with reduced pollution and negative impact on living organisms and the environment in general.

In addition to the reuse and recycling, it can contribute to the reduction of CO₂ emissions by developing new bio-based plastic materials or carbon dioxide-based materials that retain the same properties, while reducing the environmental impact. From the foregoing, it is evident that the production, processing and recycling of plastics is a huge challenge, however, with the joint efforts of all stakeholders in a circular economy strategy, it is possible to ensure a healthier life and a safer environment while remaining competitive in the market by developing new, innovative materials and processing operations, as also the modernization of recycling facilities.

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Dizajn plastičnih proizvoda: izazovi današnjice s aspekta zaštite okoliša

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Sažetak. Danas, u tehničkoj primjeni, uvelike su zastupljeni sintetički polimerni materijali zahvaljujući mnogobrojnim povoljnim svojstvima. Polimeri su tako sve više u upotrebi kao konstrukcijski materijali u različitim područjima, primjerice u konstrukciji dijelova prijevoznih sredstava, izrade raznih proizvoda u općem strojarstvu, elektrotehnici, kućanstvu itd. Međutim, uz sve navedene prednosti, ne smije se izgubiti iz vida današnja ograničenost prirodnih resursa, kao ni važnost gospodarenja otpadom, te mogućnosti i dostupnosti postupaka recikliranja pojedinog materijala, kako metala tako i plastike.

Svaka zemlja na svijetu teži zaštiti prirode i očuvanju okoliša, te je tako i u Republici Hrvatskoj (RH) učinjen značajan iskorak u tom području, samim time što je i obveza Republike Hrvatske za pristupanje Europskoj uniji (EU) bila usklađivanje našeg zakonodavstva sa zakonodavstvom EU, te je nedvojbeno da će se zakonska rješenja nastaviti razvijati i usavršavati.

S obzirom da se RH opredijelila za prihvaćanje smjernica održivog razvoja koje obuhvaćaju osiguranje gospodarskog razvoja ali isto tako i zaštitu prirodnih resursa, potrebno je uložiti dodatne napore kako bi se zadovoljili interesi gospodarstva, a ujedno i poštivali zakoni vezani uz zaštitu okoliša.

Stoga se u ovom radu pokušavaju pomiriti oprečni ciljevi i dati odgovori na pitanja kako proizvoditi plastiku i pri tome biti konkurentan na tržištu, a ujedno poštivati zakone s naglaskom na očuvanje i zaštitu okoliša.

Ključne riječi: polimeri, konstrukcijsko strojarstvo, recikliranje, očuvanje okoliša

1. Uvod

S obzirom na današnju ograničenost prirodnih resursa, a samim time i potrebe održivog razvoja proizvoda, uvelike treba voditi računa o mogućnosti recikliranja istih, kako metalnih tako i plastičnih odnosno polimernih materijala. Nadalje će biti govora o glavnim čimbenicima koji utječu na donošenje povoljne odluke kako bi se zadovoljili tehnički i ekonomski aspekti određenog polimernog proizvoda. Velika je odgovornost samog konstruktora čiji je zadatak oblikovati funkcionalan proizvod, s odgovarajućim dizajnom, uz odabir optimalnog materijala, ne nužno najjeftinijeg, već materijala koji svojim svojstvima najbolje odgovara traženoj funkciji. Dakako, pozornost treba posvetiti mogućnosti recikliranja materijala od kojega je oblikovan proizvod. Danas težimo što lakšim proizvodima, odnosno proizvodima smanjene mase, te je iz istih razloga polimerni materijal pronašao veliku primjenu u različitim područjima, između ostalog i u konstrukcijskom strojarstvu. U području konstrukcijskog strojarstva, od polimernih materijala, izrađuju se različiti elementi za spajanje dijelova konstrukcija poput vijčanih i uskočnih spojeva, različitih vrsta opruga, šarki i sl. Polimerni elementi za spajanje dijelova konstrukcija se isto tako mogu koristiti i u kombinaciji s metalnim dijelovima radi postizanja veće čvrstoće i nosivosti (npr. stezni spoj

metalnog vratila i polimerne glavine ili stezni spoj polimerne čahure i metalnog kućišta). Osim za elemente za spajanje, polimeri su pronašli zadovoljavajuću primjenu za izradu ležajeva, zupčanika, remenskog prijenosa (polimerni remen i remenica), kotača, spojki itd.

Automobilska industrija sve više je okrenuta ugradnji dijelova, (i karoserije) od polimernih kompozita, karbona i drugih sintetičkih materijala, što je do sada bio slučaj pretežito za luksuzne automobile jer su ti materijali izrazito skupi. Polimerni materijali su se pokazali izdržljivima, te je opravdanost njihova korištenja sve veća jer osim smanjenja mase automobila omogućavaju i zadržavanje visoke razine sigurnosti.

S obzirom na ograničenost prirodnih resursa iz kojih se konstrukcijski materijali (metali i polimeri) dobivaju, polimernim materijalima se svakako može dati prednost zbog znatno manjeg utroška količine energije u procesu dobivanja poluproizvoda (i do 10 puta manji utrošak energije u odnosu na metale). Prilikom završne, strojne obrade odvajanjem čestica utrošak količine energije je ponovno na strani polimernih materijala, jer je iste moguće obrađivati s većim dubinama rezanja čime se postižu uštede i do 40 % u odnosu na metalne materijale [1].

Prilikom odabira polimernog materijala za konstrukcijsku namjenu potrebno je uskladiti mnogobrojna svojstva materijala s konstrukcijskim zahtjevima, te utjecajem vanjskih čimbenika (posebice u eksploataciji) uzimajući u obzir ponašanje materijala pri povišenim i sniženim temperaturama, agresivnim medijima, utjecaju vlage (posebice utječe na poliamide), vrsti i trajanju opterećenja, brzini deformiranja, toplinskoj postojanosti (sposobnost zadržavanja željenog oblika pri povišenoj temperaturi), te uz sve navedeno ostvariti ekonomsku opravdanost izbora.

Polimerni materijali, odnosno njihova svojstva, su vrlo specifična u odnosu na druge konstrukcijske materijale, posebice metale. Osim samih materijala, specifični su i proizvodni postupci i procesi kojima se polimerni materijali oblikuju u konačni proizvod, najčešće u samo jednoj operaciji, što uvelike utječe na svojstva materijala gotovog polimernog proizvoda.

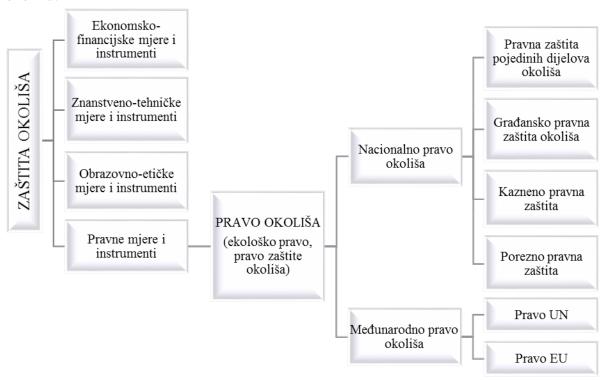
Razvoj polimernih materijala izrazito je dinamičan, što predstavlja još jedan dodatni napor, odnosno izazov za konstruktora koji konstantno treba pratiti nove materijale koji dolaze na tržište, te biti u kontaktu s proizvođačima i dobavljačima kako bi mogao odabrati odgovarajući polimerni materijal za svoju konstrukcijsku namjenu. Pri tome svakako velika pomoć su i komercijalne baze podataka, te kataloški sustavi proizvođača i dobavljača, s pripadajućim svojstvima polimera, dostupni *on-line*.

Prilikom oblikovanja polimernog proizvoda potrebno je istražiti sve mogućnosti koje će u konačnici dovesti do željenog, tehnički i ekonomski prihvatljivog proizvoda. Stoga je potrebno već u fazi konstruiranja voditi računa o vrsti materijala, količini utrošenog materijala (uz što manje otpada), maksimalnoj funkcionalnosti (što podrazumijeva integraciju dijelova pri čemu treba težiti što manjem broju dijelova i gdje je moguće izbjegavanje korištenja dijelova od metala – istovrsnost materijala gotovog proizvoda omogućava i jednostavniji postupak pripreme za recikliranje).

2. Zaštita okoliša

Razvojem tehnologije omogućena je primjena različitih vrsta polimernih materijala pri proizvodnji proizvoda od plastike. Problematična skupina svakako su proizvodi čija je namjena jednokratno korištenje nakon čega se isti proizvodi odbacuju, pri čemu se nedovoljno vodi računa o njihovom zbrinjavanju. Međutim, sve više raste svijest o štetnim posljedicama na okoliš zbog neadekvatnog zbrinjavanja plastičnog otpada te su s ciljem rješavanja tog problema doneseni i zakonski propisi i smjernice održivog razvoja.

Razvijena je i pravna grana kao dio nacionalnog i međunarodnog pravnog sustava (slika 1.) pod nazivom *Pravo okoliša* čije normativne vrijednosti i rješenja služe kao pomoć u zaštiti i očuvanju okoliša, te održivom razvoju društva. Pravo okoliša podrazumijeva sve pravne norme koje se odnose na zaštitu i racionalno gospodarenje okolišem, planiranje radnji za uravnoteženje prirodnih i umjetnih elemenata okoliša i sprječavanje štetnih utjecaja na okolinu.



Slika 1. Podjela pravnog sustava s obzirom na zaštitu okoliša [2]

Osnovna načela prava okoliša moguće je podijeliti na načela: preventivnosti, uzročnosti, kooperacije i načelo opće naknade [2]. Načela je važno poznavati, posebice za stvaranje pravnih normi jer ista predstavljaju smjernice za rad usmjeren ka određenom cilju. Svaka zemlja ima definirana načela vezana uz prava okoliša, a ista proizlaze iz njezina ustava. Primjerice, Republika Hrvatska (RH) je prihvatila načelo preventivnosti kao jedno od osnovnih načela zaštite okoliša, te je ista dio *Zakona o zaštiti okoliša* iz 2013.godine.

Ustav RH utvrđuje i određene ekološke norme: pravo na zdrav život, obvezu države za osiguranje prava građana na zdrav okoliš, obvezu svih društvenih subjekata za zaštitom prirode i ljudskog okoliša, mogućnost ograničenja poduzetničke slobode i vlasničkih prava radi zaštite prirode, ljudskog okoliša i zdravlja ljudi. Pravo na zdrav okoliš pripada u ljudska prava treće generacije, i nazivaju se još i "pravima naroda" i "pravima solidarnosti".

Deklaracija o zaštiti okoliša u Republici Hrvatskoj (NN 34/92) donijeta je 1992. godine na sjednici vijeća u Saboru RH a odnosi se na osiguravanje uravnoteženog ekološkog i gospodarskog razvitka s ciljem trajnog očuvanja nacionalne baštine za d i buduće generacije i provedbe ustavnog prava državljana RH na zdrav i dostojanstven život, u očuvanom okolišu.

Svjesni smo da je s razvojem novih tehnologija povećano zagađenje okoliša jer se utjecaj tehnologije na isti zanemario, iz razloga što se težilo isključivo civilizacijskom napretku kroz tehnički progres bez promišljanja o mogućim štetnim posljedicama na okoliš. Problemi globalnog zatopljenja suočili su nas sa stvarnošću, i danas na okoliš gledamo iz drugog ugla, a sve smo više okrenuti uvođenjem smjernica za poboljšanje novonastalog stanja, dok još nije

prekasno. Ponovno, uz upotrebu novih tehnologija, moguće je predvidjeti pozitivne i negativne aspekte razvitka, te u tom smislu osigurati sustavne mjere kojima će se nepovoljan utjecaj tehnoloških promjena na okoliš svesti na najmanju moguću mjeru. Potrebno je uvesti promjene u postojeće tehnologije, te uvođenjem novih tehnologija promijeniti odnos čovjeka prema prirodi, smanjenjem potrošnje energije u proizvodnji i eksploataciji, smanjenjem potrošnje neobnovljivih resursa, upotrebom umjetnih sirovina i biomaterijala, optičkih vlakana, korištenjem mikroelektornike itd.

3. Recikliranje i održivi razvoj polimera

Recikliranje plastike je proces prerade plastike koja je već bila u upotrebi. Prije recikliranja plastika se grupira prema identifikacijskom kodu smole, odnosno prema simbolu (sačinjenom od tri strelice usmjerene u smjeru kazaljke na satu čineći trokut unutar kojeg se nalazi brojčana oznaka) koji se koristi kao identifikacijski kod.

Stopa ponovne upotrebe, kao i recikliranje otpadne plastike vrlo je niska (u odnosu na ostale materijale koji su u upotrebi), dok je stopa odlaganja i spaljivanja plastičnog otpada u stalnom porastu što dovodi do povećanja emisije CO₂. U nastavku je dana podjela i pojašnjenje pojedinih skupina plastike za recikliranje, prema tablici 1 [3,4].

PTE ili PET - eng. Polyethylene terephthalate (polietilen teraftalat)

Ova skupina plastike podrazumijeva najčešće korištenu vrstu plastike, u pravilu namijenjenu za jednokratnu upotrebu, s tim da se višekratna upotreba ne preporučuje zbog bakterijske kontaminacije. Ovu skupinu plastike je moguće lako reciklirati pri čemu se dobivaju materijali za nove PET boce ili poliesterska vlakna koja se dalje koriste za proizvodnju tekstila.

HDPE – eng. High-density polyethylene (polietilen visoke gustoće)

Ova skupina plastike smatra se najsigurnijom vrstom plastike te je iz istog razloga višekratno primjenjiva, a samim time se i najčešće reciklira. Reciklira se za proizvodnju boca, kutija za namirnice, poljoprivrednih cijevi i dr.

PVC ili V – eng. Polyvinyl chloride (polivinil klorid)

Pripada skupini plastike koja se rijetko reciklira jer prilikom zagrijavanja otpušta toksične kemijske spojeve. U slučaju reciklaže, od istih se proizvode cijevi, ograde, te boce koje se ne koriste u prehrani.

LDPE – eng. Low-density polyethylene (polietilen niske gustoće)

Plastika koju je moguće reciklirati, iako se reciklaža ove vrste plastike provodi u manjoj mjeri, te vrlo sigurna za upotrebu. Reciklira se za proizvodnju plastičnih vrećica, raznih kontejnera, raznih boca, cijevi i laboratorijske opreme.

PP – eng. Polypropylene (polipropilen)

Plastika široke primjene koju je moguće reciklirati, ali koja se također provodi u manjoj mjeri. Reciklira se za proizvodnju raznih dijelova za vozila i industrijska vlakna.

PS – eng. Polystyrene (polistiren)

Široko rasprostranjena vrsta plastike koju je moguće reciklirati, međutim prilikom zagrijavanja ista otpušta stiren koji je štetan i opasan po zdravlje. Reciklira se u raznu uredsku opremu, kutije, izolacijske ploče.

Ostalo (BPA, polikarbonat, LEXAN...)

Ovoj skupini pripada sva ostala plastika koja nije obuhvaćena prethodno navedenim skupinama. S obzirom da ovoj skupini pripadaju i višeslojni materijali (laminati) koji se mogu

sastojati od različitih vrsta plastičnih materijala sam proces recikliranja je nešto složeniji (samim time i troškovno neisplativ) te za ovu skupinu još uvijek ne postoji generalno pravilo o recikliranju.

U tablici 1. dan je prikaz svih sedam prethodno navedenih skupina, s pripadajućim simbolima i primjerima najčešće primjene. Navedene simbole recikliranja (strelice u trokutu) prema standardu D7611, a koji se odnose na standardnu praksu za označavanje plastičnih proizvoda i identifikaciju plastike (eng. Standard Practice for Coding Plastics Manufactured Articles for Resin Identification) [4], američka organizacija za standardiziranje – ASTM, odlučila je zamijeniti ih znakom s jednakostraničnim trokutom. Nakon usvajanja istog RH će primjenjivati simbole desno, iz nove skupine simbola prema tablici 1.

Tablica 1. Označavanje plastičnih proizvoda i identifikacija plastike [3,4]

OZNAKA	NAZIV	PRIMJER NAJČEŠĆE PRIMJENE	SIMBOL	NOVI SIMBOL
PET	Poli(etilen- teraftalat)	boce za bezalkoholna pića, termoizolacijske ploče	PETE	PETE PET
PE-HD ili HDPE	polietilen visoke gustoće	boce za deterdžente, šampone, mlijeko	LDPE HDPE	HDPE PE-HE
PVC ili V	poli(vinil-klorid)	Boce ulja, cijevi za vodu, prozorski okviri	٨	V PVC
PE-LD ili LDPE	polietilen niske gustoće	posude za hranu, vrećice za kupovinu, čepovi	LDPE	LDPE PE-LD
PP	polipropilen	čašice od jogurta, slamke za piće	25 <u>)</u>	5 <u>05</u> PP
PS	polistiren	posude za hranu, pribor za jelo	<u>6</u> 5	6 PS PS
Ostalo (višeslojni materijali)	ostala plastika	svi plastični predmeti koji nisu specificirani u kategorijama 1-6	OTHER	OTHER 07

Proizvodnji i upotrebi plastike, kao i njezinom recikliranju treba pristupiti ozbiljno, imajući u vidu da proces razgradnje plastike u prirodi traje i do 500 godina. Prema [5] razlikujemo dvije osnovne podjele oporabe (recikliranja) polimernih materijala: materijalna i energijska oporaba. Materijalna oporaba nadalje se dijeli na mehaničko i kemijsko recikliranje, pri čemu se kod mehaničkog recikliranja polimeri odvajaju i razvrstavaju iz miješanog otpada, a dobiveni reciklat se dalje prerađuje odnosno upotrebljava za proizvodnju novih proizvoda, dok se kod kemijskog recikliranja vrši depolimerizacija na monomere ili djelomična degradacija na druge vrijedne sirovine. Prilikom energijske oporabe, iskorištava se svojstvo gorivosti otpada i tim se postupkom polimeri pretvaraju u električnu energiju iskorištavanjem nastale topline.

U odnosu na ostale često korištene materijale u industriji, poput metala ili stakla, recikliranje plastike predstavlja dodatne izazove budući da polimerni materijali trebaju biti gotovo istog sastava da bi se mogli miješati, što nije slučaj kod metala gdje se različite legure mogu rastaliti u jednoj fazi (npr. različite aluminijske legure).

Osim ograničenja koje predstavlja niska entropija miješanja, još jedno bitno ograničenje je i velika količina dodataka plastici, odnosno aditiva (punila, ojačala) kao i dodatak velikih

količina boja. Visoka viskoznost polimera onemogućava ekonomično uklanjanje dodataka, dok pri procesima koji su troškovno isplativiji, odnosno jeftiniji, postoji velika mogućnost oštećivanja polimernog materijala. Dodaci su manje zastupljeni u ambalaži hrane i pića te je samim time i proces recikliranja iste plastike češće zastupljen.

Stoga bi proizvođači plastičnih proizvoda trebali voditi računa, već u fazi oblikovanja proizvoda, o mogućnosti recikliranja ili ponovne upotrebe proizvoda, i pri tome isključiti dodavanje aditiva koji otežavaju postupak recikliranja te utječu na kvalitetu i vrijednost reciklirane plastike.

Konstrukcijski dijelovi izrađeni od polimernih materijala (remeni i remenice, zupčanici, opruge, različiti elementi za spajanje i sl.) imaju tendenciju trajanja i nisu predviđeni za jednokratno ili kratko korištenje. Dakako i njihov vijek ima rok trajanja, te ih po prestanku funkcije također treba propisno zbrinuti. Automobilska i avionska industrija, uz tvornice namještaja i elektronike, su veliki izvor plastičnog otpada kojeg je po prestanku funkcije potrebno reciklirati, a gdje je ostavljen znatan prostor za napredovanje i usavršavanje po pitanju prisutnosti različitih kemikalija koje kao sastavni dio polimernog materijala otežavaju reciklažni postupak. Teži se dakle ekološko prihvatljivom dizajnu uz zadržavanje primarne funkcije proizvoda.

Proizvodi se rijetko proizvode od samo jedne vrste polimernog materijala te je poželjno, već u fazi oblikovanja, odrediti kompatibilnost korištenih materijala, kako bi se priprema za postupak recikliranja pojednostavila, odnosno omogućio kvalitetan reciklirani materijal. Posebice je važno osigurati dobre preduvjete za recikliranje proizvoda koji se proizvode u masovnoj ili velikoserijskoj proizvodnji. Slika 2. [6] prikazuje kompatibilnost osnovnih korištenih polimernih materijala.

			Dodatak											
	Važni umjetni konstrukcijski materijali	띪	PVC	PS	PC	РР	PA	POM	SAN	ABS	PBTP	PETP	PMMA	
	PE	•	0	0	0	•	0	0	0	0	0	0	0	
	PVC	0	left	0	0	0	0	\circ	lacksquare	$lue{}$	0	\circ	lacksquare	
	P\$	0	0	•	\circ	0	0	0	\circ	О	0	0	0	
<u>_</u>	PC	0	O	0		0	0	0	lacksquare	lacksquare	lacksquare	lacksquare		
eriji	PP	•	0	0	0	•	0	0	0	\circ	\circ	0	0	
mat	PA	0	0	•	0	0	•	0	0	О	lacksquare	•	0	
Osnovni materijal	POM	0	0	0	0	0	0	lacksquare	O	0	•	0	0	- spojiv
) Suc	SAN	0	•	0	•	0	0	0	lacksquare	lacksquare	0	0	•	•
١٥	ABS	0	0	\circ	•	0	0	lacksquare	0		•	O	•	ograničena spojivost
	PBTP	0	0	0	•	0	•	0	0	•		0	0	- spojiv u malim
	PETP	0	0	•	•	0	O	0	0	0	0	•	0	količinama
	РММА	0	•	•	•	0	0	•	•	•	0	Ö	•	O - nije spojiv

Slika 2. Kompatibilnost polimernih materijala [6]

Za uspješno gospodarenje otpadom nužno je primjenjivati postupak recikliranja polimernih materijala, ali i težiti energijskoj oporabi u energanama koje su svakako najbolje rješenje za zbrinjavanje velike količine otpada, što je još uvijek na niskoj razini zbog troškova koje iste nose. Održivost razvoja moguća je ukoliko se uvidi važnost energana na otpad, i na taj način smanji gomilanje otpada na odlagalištima, čime se zapravo gubi energija koju je moguće iskoristiti. Ukoliko gospodarenje otpadom nije optimalno, čak i prikupljeni plastični otpad može završiti u okolišu.

Proces recikliranja moguće je, a što se danas i provodi, u potpunosti zaokružiti, primjerice odvajanjem i recikliranjem otpadne ambalaže čiji je proizvod polimerni materijal u granulama koji se daljnjim postupkom proizvodnje pretvara u nove proizvode prema potrebama tržišta. Otpadni materijal koji nastaje prilikom postupka oporabe odnosno recikliranja moguće je nadalje koristiti kao sirovinu za proizvodnju sintetičkog diesela koji svojim karakteristikama u potpunosti odgovara svojstvima eurodiesela dostupnog na benzinskim crpkama. Povećanjem recikliranja plastike smanjuje se i uvoz fosilnih goriva.

Inovacije su ključni čimbenik za preobrazbu vrijednosnog lanca plastike poput inovativnih rješenja za napredno razvrstavanje, kemijsko recikliranje i poboljšan dizajn polimera koji mogu imati snažan učinak. Teži se razvoju inovativnih materijala potpuno biološko razgradljivih u morskoj i slatkoj vodi koji nisu štetni za okoliš i ekosustave. Većina plastike koja je označena kao biorazgradljiva uglavnom se razgrađuje u posebnim uvjetima koji nisu uvijek prisutni u prirodnom okolišu te se stoga i dalje šteti ekosustavima, stoga je nužan sustav za odvojeno prikupljanje organskog otpada koji dobro funkcionira. Utjecaj biorazgradljivih materijala na zdravlje i okoliš još uvijek je u fazi istraživanja [7].

Povećanje razine recikliranja plastike moguće je postići poboljšanjem načina proizvodnje i dizajna plastike i plastičnih proizvoda. Nadasve, s boljom organizacijom kružnog gospodarstva ne treba strahovati od gubitka radnih mjesta, težnja je osuvremenjivanje i proširivanje centara za recikliranje plastike, te gradnja novih postrojenja za razvrstavanje i recikliranje plastičnog otpada.

Kada govorimo o razvoju koji je održiv, smatra se da je položaj ljudi u društvenoj zajednici poboljšan u smislu smanjene stope siromaštva i veće jednakosti, te unaprijeđeno gospodarstvo i privreda, odnosno ekonomija, a da se pri tome okoliš ne ugrožava već se s istim odgovorno postupa. Održivi razvoj treba osigurati svima jednake prirodne uvijete neophodne za život, poput pitke vode i zraka koji nije zagađen, dok prirodne neobnovljive resurse koji nisu neiscrpni treba koristiti u određenoj mjeri kako ne bi došlo do njihovog potpunog iscrpljenja. Također prirodne obnovljive resurse nije poželjno iscrpljivati (prekomjeran izlov ribe, sječa drveća) već osigurati vrijeme za prirodno obnavljanje.

Cilj održivog razvoja je zadovoljiti potrebe sadašnjice a pri tome ne ugroziti budućnost narednih generacija. Problemi se trebaju rješavati "sada", nikako ne ostavljati budućim generacijama. U elemente održivog razvoja možemo uvrstiti ekonomska, ekološka i sociokulturna načela [8] koja je potrebno razvijati u cjelini (slika 3.), ne kao svako načelo zasebno.



Slika 3. Elementi održivog razvoja [8]

4. Zaključak

Dakako, cilj nije prestanak proizvodnje plastike, odnosno proizvoda od različitih polimernih materijala, jer plastika je inovativan materijal kojim je omogućeno rješavanje niza problema s kojima smo također danas suočeni, od smanjenja emisije CO₂ zbog korištenja navedenih materijala u automobilskoj i zrakoplovnoj industriji čime se postiže manja masa što dovodi do smanjene potrošnje goriva. Veliki napredak ostvaren je i u području medicinske implantologije, odnosno implantata kostiju izrađenih od polimera [9] metodom 3D ispisa pri čemu su korišteni biorazgradivi kompoziti.

Međutim, nužno je neprestano razvijati svijest svih dionika životnog ciklusa upotrebe plastike, od proizvođača sve do potrošača, te u konačnici reciklažnih centara, što je uvidjela i Europska komisija te je 2015. godine donijet akcijski plan [10] za kružno gospodarstvo (COM(2015 614 final) koji obvezuje na izradu strategije za suočavanje s izazovima koje plastika donosi. Tom strategijom Europa može poslužiti kao dobar primjer kako osvijestiti dionike i na globalnoj razini.

Vodeći računa o dizajnu i proizvodnji plastike i plastičnih proizvoda, omogućava s daljnje korištenje iste, kroz ponovnu uporabu, recikliranje ili dobivanje goriva čime taj inovativni materijal postaje održiv uz smanjeno onečišćenje i negativan utjecaj na žive organizme i okoliš općenito. Pridonijeti smanjenju emisije CO₂, može se osim ponovnom uporabom i recikliranjem, razvojem novih plastičnih materijala na biološkoj osnovi ili razvojem materijala proizvedenih iz ugljikova dioksida, koji pri tome zadržavaju jednaka svojstva, pri čemu su negativni utjecaji na okoliš smanjeni.

Iz ranije navedenog vidljivo je da proizvodnja, prerada i recikliranje plastike predstavlja veliki izazov, međutim uz zajedničke napore svih dionika prema strategiji kružnog gospodarstva, moguće je osigurati zdraviji život i sigurniji okoliš, a pri tome ostati konkurentan na tržištu razvijanjem novih, inovativnih materijala i postupaka prerade, te modernizaciji reciklažnih postrojenja.

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Photogrammetry: Node System Manipulation for Generating Low Density Mesh

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Abstract. Photogrammetry is the combination of technology, science and art with purpose to use photos for measurements, 3D modeling and texturing. The basic process consists of taking series of pictures and aligning them in photo scan software to generate a point cloud. From the point cloud the high density mesh is generated which can produce textures. After creating the model, geometric surface is quite relatively dense and decimation of the 3D model can be a challenging job. The study conducted in this paper focuses on if it were possible to change the basic process and topology of the 3D model through the node system by using different types of filters with goal to achieve relatively low density mesh without losing too many high frequency details.

Key words: photogrammetry, meshroom, 3D modeling, texturing, scanning

1. Introduction

In today's world 3D printers are inevitable part of the industry, school and home. Having a 3D printer at home or school provides a space for various ideas, makes education more fun or just simply facilitates domestic necessities. However, in unhappy situations like arising pandemics, it proved to be the hidden treasure for generating parts of personal protective equipment and many other medical necessities. All of the hardware would be obsolete if there was not one good 3D model of the object which can be replicated by 3D printer. The 3D model would not be of good use if it was time consuming, with lots of vertices, or just too expensive to compute. A lot of work, research and experiments were performed during the last three decades, trying to divulge what was the best and fastest method to generate low density mesh from the original 3D model. The resulting mesh would still need to preserve visual satisfaction while obtaining low number of vertices. This paper proposes the new method with node manipulation, where visual quality of generated 3D model as well as speed are equally important.

This paper is compiled as follows: Section one: Introduction, Section two: Previous Research and development, Section three: The inevitable mesh, Section four: Algorithm, Section five: Results and discussion, Section six: Algorithm upgrade and Conclusion.

2. Previous Research and Development

According to Wang *et.al.* [1], methods for mesh simplification can be divided in three main categories: vertex decimation, vertex clustering and iterative edge contraction. Methods for vertex decimation are usually time-efficient and can preserve positions but cannot guarantee the boundary errors. Those methods consists of the following steps: defining vertices that satisfy distance or angle criterion, after which proceeds the removal of the loop triangles

around specified vertices and finishing with the triangulation of the resulting holes [2, 3, 4, 5, 6, 7, 8].

Methods of vertex clustering use the original model divided into clusters by grid structures and then compute a new vertex to represent each cluster [1]. These methods result in timeefficiency and high data reduction rate, but on the other hand very low quality of simplified mesh cannot preserve more prominent features [3, 9, 10]. Edge contraction methods iteratively collapse edges into new vertices [1, 3, 11, 12]. The difference between these methods is how they choose an edge to contract. The state of the art Quadric error metric (QEM) algorithm is distinguished by high computational efficiency and can produce highquality simplification models [1, 5, 12]. The weakness of QEM method lies in the measurement based only on the Euclidian distance between a certain vertex and its planes that meet at this vertex. It does not consider the geometric characters of the neighbouring triangles. This is why QEM-based methods preserve geometric features only to a certain degree [13, 1]. Kinect is a good device for capturing 2D/3D data due to his depth sensing cameras [14]. Liu et.al. [15] have proposed an extension to the Kinect Fusion algorithm which allows creating simplified 3D models with high quality RGB textures. Their 2D texturing method is able to maintain a high-level texture quality despite the degree of model simplification. Novel approach for a tradeoff between visual quality and speed are presented in algorithms such as SESIMP [16], QSlim [3] and FMLOD [17]. SESIMP is based on halfedge collapse, i.e. on a measure of geometric fidelity that exploits local normal field variation of a surface. The only drawback is that it is only applicable for the situations where approximation is needed to have vertices which form the subset of the original vertices.

3. The Inevitable Mesh

For realistic view of 3D object it is inevitable to have three-dimensional finite elements all over that object. Usually, the finite elements are represented as *tris* or *quads*. Keeping in mind that representing 3D object as *vertices* is not a precise review of the object but merely it's approximation, decision on which finite element to use comes down to which ever suites the best for the model. Once, the decision was made, the next step is making decision on how low poly one wants to go? This is the point where tradeoff between visual quality of the 3D model and the speed of the algorithm comes to expression.

3.1. Generating Mesh from Images

The goal of this paper is to compare differences between *MeshResampling* and *MeshDecimate* nodes in Meshroom. Meshroom is a free, open-source 3D Reconstruction Software based on the AliceVision framework [18].

3.2. MeshResampling node

The goal of MeshResampling node is to reduce number of faces while trying to keep overall shape, volume and boundaries. User can specify fixed minimum and maximum number of vertices. MeshResampling node can be seen in figure 1.

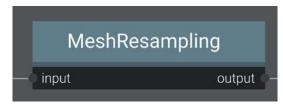


Figure 1 MeshResampling node

3.3. MeshDecimate node

As in the previous subsection, the key of the MeshDecimate node is to simplify the mesh by reducing the vertex count without changing the visual appearance of the model. MeshDecimate node can be seen in figure 2.

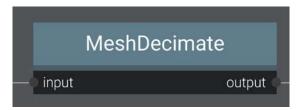


Figure 2 MeshDecimate node

As can be seen in both of these cases, MeshResample and MeshDecimate nodes are trying to preserve overall shape of the model. However, how much exactly of the model is preserved by either of the nodes still needs to be affirmed.

4. Algorithm

For dataset, *Buddha statue* [19] images are used, which are downloaded directly from Alicevision. Data set consists of 67 images, all of 2736 x 1540 pixels each. The algorithm proceeds as follows:

• Generate mesh from images

This step is really simple. One just needs to place all images into Meshroom and start the process. Meshing node creates mesh from Structure from Motion (SfM) data. All steps of the process need to complete. Meshing node can be seen in figure 3.

• Resampling/Decimating the generated mesh

When original mesh is finished, the output Meshing node needs to be taken as the input for MeshResampling or MeshDecimating nodes.



Figure 3 Meshing node creates a mesh from Structure from Motion (SfM) data

Meshing node is originally connected to MeshFiltering and then to Texturing, as shown in figure 4.

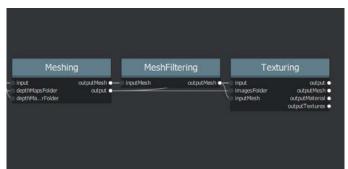


Figure 4 Meshing node is originally connected to MeshFiltering and then to Texturing

The core of this research is to take out the MeshFilter node and instead connect MeshResampling or MeshDecimate node, like shown in figure 5.

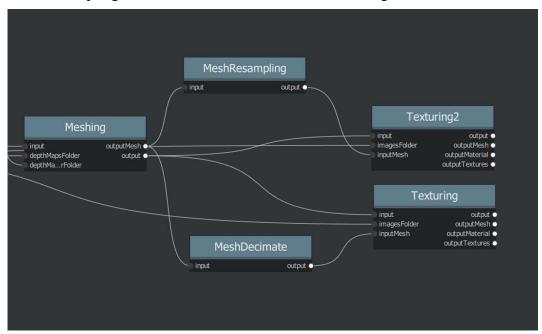


Figure 5 Meshing node is connected to MeshResampling or MeshDecimate node

This process needs to be done seven times to get 3D model for each simplification factor value. Otherwise, they can be connected all at once so that one does not need to repeat seven times the procedure. The resulting node system looks like in figure 6.

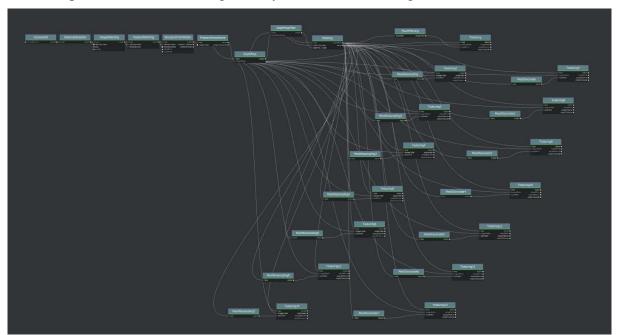


Figure 6 Node group for all eight different simplification factor values

5. Results and Discussion

The algorithm presented above was compared to results obtained by *Blender program* [20]. Blender program also has Decimate, and one of the way to validate results was to compare results gained by Meshroom and by Blender. Blender was also used for 3D model display.

For comparison, eight values for MeshResampling and MeshDecimate were taken. Original mesh consisted of 615292 vertices. The following simplification factors were used: {0.5, 0.25, 0.1, 0.05, 0.01, 0.005, 0.005*(fixed vertices), 0.0005}. The results for Vertex output with different simplification factors can be seen in table 1.

 Table 1 Vertex output for different simplification factors

Vertex output (original mesh) = 615292	Simplification factor											
vertices	0.5	0.25	0.1	0.05	0.01	0.005	0.005*	0.0005				
MeshResampling	316467	154214	61729	30815	6152	3053	493	303				
MeshDecimate	307646	153823	61529	30764	6140	3076	500	307				
Blender Decimate	307757	153984	61709	30931	6256	3151	500	336				

^{*} Fixed 500 vertices

Times to complete expressed in seconds, including the saving time is listed in table 2.

Table 2 Output times for different simplification factors

Time to complete (seconds) Including saving time	Simplification factor										
	0.5	0.25	0.1	0.05	0.01	0.005	0.005*	0.0005			
MeshResampling	43.42	21.27	13.72	9.68	7.43	6.32	7.22	6.74			
MeshDecimate	16.44	19.24	22.13	22.70	23.96	23.09	24.43	22.54			
Blender Decimate	17.14	24.41	20.98	21.78	32.86	22.32	22.32	22.48			

^{*} Fixed 500 vertices

Elapsed time and vertex count in blender were calculated using a simple python script:

```
import bpy
import time
sampling_factors = [0.5, 0.25, 0.1, 0.05, 0.01, 0.005, 0.0005]
start_time = time.time()
bpy.ops.object.modifier_add(type='DECIMATE')
bpy.context.object.modifiers["Decimate"].ratio = sampling_factors[4]
bpy.ops.object.modifier_apply(apply_as='DATA', modifier="Decimate")
elapsed_time = time.time() - start_time
print(f"time for factor {sampling_factors[4]} = {elapsed_time}")
print(f"number of vertices is {len(bpy.context.object.data.vertices)}")
```

The Blender original mesh and python script applied can be seen in figure 7.

The most important are the two last simplification factors (0.005 and 0.0005) which unveil the truly best method for preserving the shape and outline of 3D model in the lower end of the vertex count.

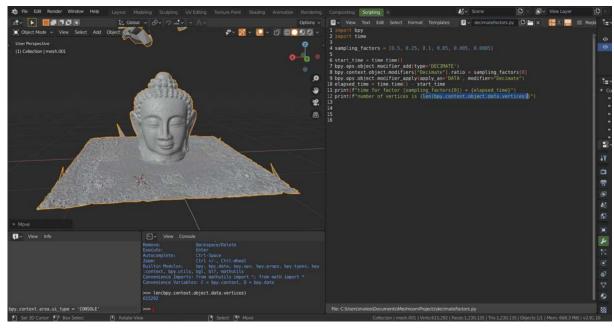


Figure 7 Blender original mesh and applied python script

5.1. Meshroom – results

This section demonstrates resulting images of Meshroom program. The original meshroom model is in figure 8.

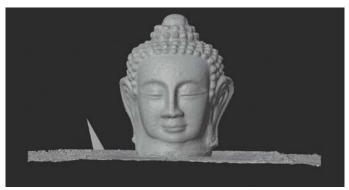


Figure 8 Original meshroom 3D model

Figure 9 shows results of the two last sampling factors for MeshResampling, while figure 10 shows results for MeshDecimate.

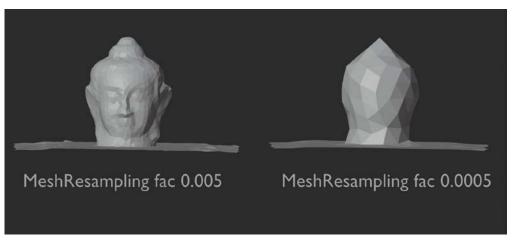


Figure 9 Results for MeshResampling factors

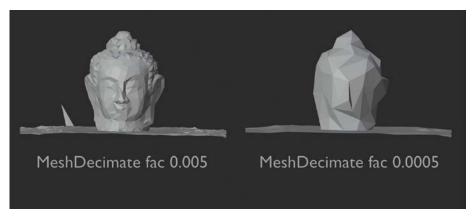


Figure 10 Results for MeshDecimate factors

For additional comparison results with Blender Decimate modifier were also acquired, and are presented in figure 11.



Figure 11 Blender Decimate modifier with two last factors

Generating graph of time dependence on vertex count gives the result on graph in figure 12.

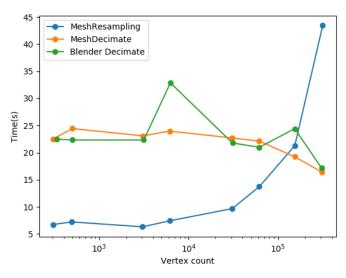


Figure 12 Time dependence on vertex count

It is clearly visible that MeshResampling method has some difficulties regarding high vertex count whereas it has best performances in lower regions, both in time and model topology output. MeshDecimate and Blender Decimate modifier have both good time performances in low poly and high poly regions. However, in regions with lower vertex count they are usually too destructive, so their performance is much better when it is necessary to remove many redundant high frequency vertices from a model.

In figure 13 comparison of models generated from both methods can be seen. Right part of model is MeshResampling result, while left is MeshDecimate.

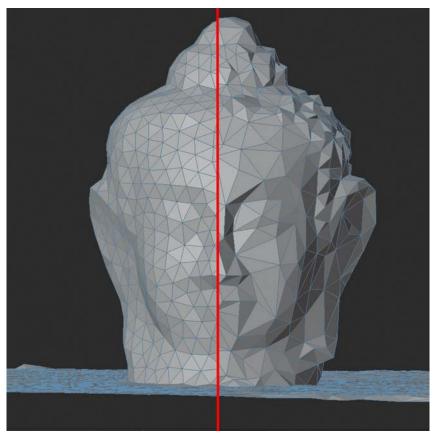


Figure 13 MeshResampling versus MeshDecimate result count

Besides visual inspection of the model there is one thing that can be done in Blender to compare models to original. Their volume can be measured to see which of the models is closer to original mesh, as shown in table 3.

 Table 3
 Volume of 3D model depending on simplification factor

3D model	Simplification factor	Volume m^3		
Original mesh		0.987465		
Blender model	0.005	0.422639		
Blender model	0.0005	0.4419018		
Mesh Resampling	0.005	0.9136954		
Mesh Resampling	0.0005	0.8750103		
Mesh Decimate model	0.005	0.998508		
Mesh Decimate model	0.0005	1.023327		

As can be observed, MeshResampling is always trying to remain inside model boundaries, since that is what it is meant for. Creating somewhat better topology in respect of model silhouette and it will have some smoothing while creating the mesh. On the other hand, Mesh Decimate exceeds original model size since it's job is just reducing polygons without taking silhouette too much into the account. That is also visible from visual inspection especially if the two models are overlapped.

Mesh decimate model goes slightly over the original model on some places, as can be seen in figure 14.



Figure 14 Overlap of the two models

6. Algorithm Upgrade and Conclusion

From all these results pops up a question: What if our mesh was really large and we wanted to have a nicer topology with higher polygon count in a model? What if we use MeshDecimate in high poly region and after that MeshResampling in lower end of vertex count?

In Meshroom it would mean connecting nodes in series, like in figure 15 where one should be careful about simplification factors for each node since a final mesh of around 3k vertices is targeted.

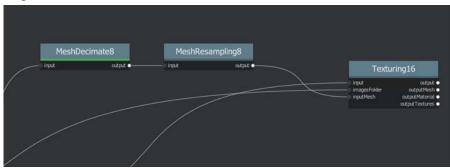


Figure 15 Serial connection of the nodes



Figure 16 Final result after serial connection of MeshDecimate and MeshResampling nodes

If input mesh has 615292 vertices, setting MeshDecimate factor to 0.5 would result in 307646 vertices, which is a solid input for MeshResampling. Furthermore, MeshResampling factor is set to 0.01 to get a final mesh of around 3k vertices in the end. After running the process, final mesh looks like in figure 16.

As can be seen, topology is better compared to only using MeshDecimate node.

 Table 4 Volume of 3D model depending on simplification factor

MeshResampling	0.01	0.0125	0.0165	0.025	0.05
MeshDecimate	0.5	0.4	0.3	0.2	0.1
Time to complete (sec)	27.40	28.6	29.11	29.97	31.2
	18.95	19.33	19.77	20.39	20.61
	19.08	19.62	19.92	20.19	20.54
Average time (sec)	21.81	22.51	22.93	23.51	24.12
Total vertices	3051	3049	3021	3058	3055

Taking into consideration that average time of execution for MeshDecimate according to table 4 is 25.85 seconds, using both nodes in series would give faster output, together with better model topology. In this case, if we take average time of nodes in series, it would be 2 seconds faster, which in high poly region would mean a great deal.

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Increasing the Power Supply of the Island Drvenik Veli

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Abstract. From the practical experience, the electrical power grid in the coastal areas quickly shows sensitivity due to various disturbances. This paper analyses the investment in a 20(10) kV submarine power cable between the island Šolta and Drvenik Veli, in order to increase the power supply. To avoid as many weak spots in the electrical power grid as possible specialized application was used to analyse the current and future situation. Due to the increased power consumption, especially during summer months because of increase in the tourism season, for which some of the existing cables, will no longer be able to provide secure power supply and reliability, it is necessary to lay a new submarine power cable to increase power supply. The substation (SS) 35/10 kV Marina is radially connected, and as a vital object of the subarea of Marina the N-1 criteria is not satisfied. The paper also provides data for reliability indices such as SAIFI (System Average Interference Duration Index), and CAIDI (Customer Average Interference Duration Index) which shows how statistics of operational events contribute to distribution network optimization, and how proper network planning can increase availability of the electrical power grid. Two scenarios were considered and analysed. The first scenario shows the current network state of, which contains a 10 kV model network powered by the substation 35/10 kV Marina. The second scenario shows the future network state after the submarine power cable between the island of Solta and Drvenik Veli is activated, and its benefits to the electrical power grid. After the construction of the SS 20(10)/0.4 kV Drvenik Veli 6 (Krknjaši) on the island Drvenik Veli there is a possibility to connect SS 20(10)/0.4 kV Maslinica 2 (which is located on the island of Šolta) with SS 20(10)/0.4 kV Drvenik Veli 6 (Krknjaši) with a submarine power cable. An overview of technical challenges of planned preparations and construction procedure of the submarine power cable is also shown. Furthermore, with this connection, a two sided and more reliable power supply to the island group Drvenik Veli and Drvenik Mali would be possible, as well to a good part of Vinišće, and Marina, which would fulfil the n-1 criteria and increase the power supply of these areas.

Key words: Submarine power cable, XLPE, reliable power supply, N-1 criteria

1. Introduction

The existing electrical network of the coastal areas of Trogir, Marina and Vinišće as well as the island group Drvenik Mali and Drvenik Veli in conceptual terms are radially resolved. The 10 kV outgoing network feeder Vinišće is also radially connected with 10 kV power line whose conductors are Al-Fe type with a cross section of 25 mm2. Power supply to the island Drvenik Veli is made by an old submarine power cable type IPZO 3x35 mm2 (Paper insulated with semi - hard compound impregnated, separate lead sheathed power cable armoured with steel galvanized wire and anti - corrosive protection) from the cable substation Vinišće 8 towards the substation 20(10) kV Drvenik Veli 4 with a total length of 3400 m. The

island Drvenik Mali is connected via an old submarine power cable type IPZO 3x35 mm2 from the cable substation Drvenik Veli 2 towards the cable substation Drvenik Mali 2. In order to increase the power supply and reliability of the island group Drvenik, in 2008 a new submarine power cable type XHE 46/24-V 3x120/16 mm2 was laid to achieve a connection between substation 20(10)/0.4 kV Vinišće 16 and substation 20(10)/0.4 kV Drvenik Mali 3.

The main development branch of these places is tourism. It is expected that the consumption will increase if the development plans are fully realized.



Figure 1 Geographical overview of the 10 kV outgoing network feeder Vinišće

The 10 kV electric network of the entire area is designed according to spatial settlement and hamlets in which substations 20(10)/0.4 kV are located. The areas are supplied by a 10 kV power line, which route is along the main roads, but also partly through inaccessible terrains on the stretch of Vinišće and the islands of Drvenik Veli and Drvenik Mali.

Very frequent failures of the mentioned 10 kV outgoing network feeder Vinišće are caused due to the deterioration of the existing network parts, as well as frequent atmospheric discharges in the winter months.

2. Description of the existing submarine power cables

An overview of existing submarine power cables is shown in table:

Table 1. Overview of existing submarine power cables

Line and route length	Cable insulation, conductor cross section and material	Year of laying	Rated power
Vinišće – Drvenik Veli, cable length is 3187 m	IPZO, 3C 3x35 mm ² , Cu (submarine section)	1966	2.5 MVA
Drvenik Veli 4 – Drvenik Mali 2, cable length is 2183 m	IPZO, 3C 3x35 mm ² , Cu (submarine section)	1966	2.5 MVA

Drvenik Mali 3 – Vinišće 16, cable length is 2815 m XHE 46/24- V 3x120/16 mm², 3C XHE 49-A 3x(1x185 mm²), 1C (underground section)	2008	6.92 MVA
--	------	----------

Since the submarine power cable is powered from the landside by a 10 kV power line (Al-Fe 25/4 mm2), the specified maximum load of the submarine power cable is defined by the permissible current of the overhead power line (Al-Fe 25/4 mm2) which is 125 A. Most of these cables consist of two land sections and a middle submarine section. These cable parts are also mixed with power lines and cable substation. The lengths of land sections of cables vary from 0,1 km till 1 km length. Figure 2. Show cable substation Vinišće 8.



Figure 2. Photograph of the cable substation Vinišće 8

The cable substation is a building made of concrete, which contains cable oil plant, cable sealing ends, surge arresters, and voltage instruments.



Figure 3. View of the SS 20(10)/0.4 kV Drvenik Veli, i.e. submarine cable outlet on Drvenik Veli

Existing cables are protected on landing points by means of prefabricated concrete blocks, which consist of two parts. The lower one laid before the cable laying and upper cover, and protecting the cables up to a sea depth of about 8 m.

3. Reliability indices

According to the definition [1], the reliability of the power supply is the ability of network to ensure continuity of the power supply over a period, as indicated by the indicators of the number and duration of the interruption of power supply. An interruption of power supply defines a condition where there is no voltage at the point of the end user for more than 1.5 seconds. An interruption of power supply can be short for up to 3 minutes or long lasting over 3 minutes.

The reliability index shows the quality of delivered electricity over a period through the number of interruptions, duration of interruption, or total duration of all interruptions in the delivery of electricity. The purpose of the reliability analysis is to obtain indicators for unplanned interruptions at the 10 kV outgoing network feeder Vinišće.

In the paper, several indices are shown:

- ➤ SAIDI (System Average Interruption Duration Index), indicating the duration that energy is not supplied to a customer in a year (min/customer and year),
- ➤ SAIFI (System Average Interruption Frequency Index) revealing the number of times in a year energy is not delivered to a customer (frequency/customer and year),
- ➤ CAIDI (Customer Average Interruption Duration Index), representing the average time required to restore service to the average customer per interruption (min).

Colours in Table 2 shows the fulfilment of certain criteria. It is indicated in red if none of the criteria is met.

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Table 7. Reliability	v criteria tor MN	distribution network	nlanning nrocess
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Standards	Type of network	SAIDI	SAIFI	
Standard 1	Urban area with predominantly cable network	120	2	
Standard 2	Suburban areas and larger settlements	240	4	
Standard 3 Overhead lines in outlying areas		360	8	
Ad	ditional global criteria	_	ing state if better than dard	

Table 3. Historical indicator of the reliability of the outgoing network feeder Vinišće

	Year	SAIFI	SAIDI	CAIDI
kV	2011	2,47	1 178,99	477,32
	2012	7	3120	445,71
35/10 će	2013	1	630	630
∞	2014	1	395	395
S, Marina VP Vini	2015	4	1962	450
Z S	2016	2,02	687,42	338,82
	Average	3,25	1,527	491,68

Table 3 shows the details of unplanned (forced) interruption. Forced interruptions from 2011 to 2016 were considered. Reliability indicators are presented in this paper were the data was gathered from using DISPO reports. The duty station promptly recorded information on each power failure on MV and LV network such as cause of the failure, number of areas (substations) affected by the failure and undelivered electricity during the failure. In 2012 indicators SAIFI and SAIDI were high due to poor conditions of the power lines, which requires reconstruction, as well as lack of network automation in depth. In addition, there is no backup power supply direction.

4. Power flow analysis

A 10 kV network model powered by the substation 35/10 kV Marina was formed on the basis of known technical parameters of the electrical power grid with practiced switching state. With a total load which approximately fits to the measured peak loads of the individual outgoing network feeder. The model also includes 35/10 kV and 20(10)/0.4 kV transformations, and consumer hubs that are equivalent on the low voltage side of the 20(10)/0.4 kV transformation. Figure 4 shows the power flow calculation on the existing network state.

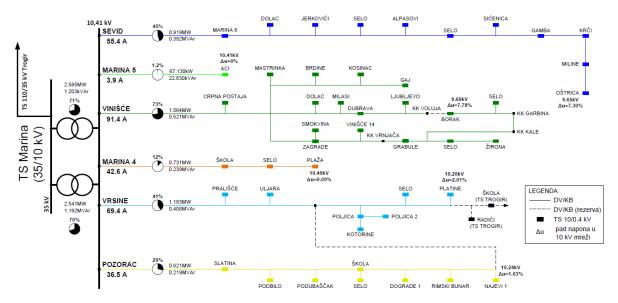


Figure 4. Review of the power flow and voltage conditions on the existing state of the SS 35/10 kV Marina

The results show that the 10 kV outgoing network feeder Vinišće is the most overloaded, while the load of other network feeders is below 50 %. Voltage conditions of distant substations are favorable except for two cases where voltage conditions are at permissible limit.

Table 4. Results of 10 kV	outgoing network	feeders in	substation 3	5/10 kV Marina

Outgoing network feeder	Total load [A]
Vrsine	69
Marina 4	42,6
Vinišće	91,2
Sevid	55,8
Pozorac	39
Marina 5	3,9

Voltage drops are related to the outgoing network feeders Vinišće and Sevid whose amount is to 7.78 % and 7.30 % respectively. Voltage drops are expressed relative to voltage of the 10 kV busbar. In addition to the mentioned problems above on the outgoing network feeder from the calculation, we can conclude that the following deficiencies were noted in the 10 kV network:

- on relatively long 10 kV line the voltage drops are greatly increased as the load on the outgoing network feeder increases,
- insufficiently selective protection is applied,
- since the network is radial there is no possibility of a backup power supply, so therefore, there is no flexibility in operation, and thus any malfunction on the electrical network causes the power supply of the supply area behind the fault to be interrupted. In this situation, the most vulnerable are the islands of Drvenik Mali and Drvenik Veli.

Considering all the above growth trends, we can assume that the peak load, which is now present on the outgoing network feeder, Vinišće will increase several times. Therefore, it is necessary to anticipate the construction of new power facilities in the development plans. The consumption of the island of Šolta is supplied from the substation 35/10 kV Grohote, which is partly made with underground, cables of various cross sections and partly with overhead power lines type Al-Fe 3x35 mm². Total installed power of substation Grohote is 2 x 4 MVA.

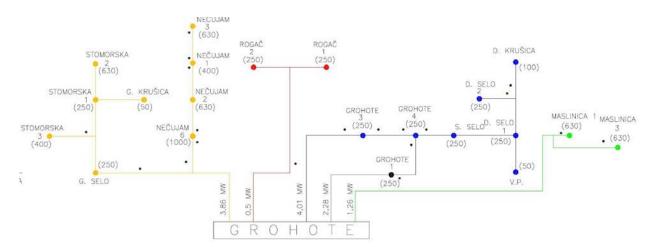


Figure 5. Block scheme of substation 35/10 kV Grohote with total loads on the outgoing network feeders

The existing consumption of the island of Šolta supplies 21 20(10)/0.4 kV substations with a total installed power of 7850 kVA. From figure 3, it is noted that the 10 kV outgoing network feeder Maslinca is underloaded which supplies two 20 (10)/0.4 substations with a total installed power of 1.26 MVA. The substations are powered by 12/20 (24kV) NA2XS (F) 2Y (XHE 49-A) 1X185 RM/25 mm² 1C power cables. The maximum measured peak load in 2017 was 43.2 A.

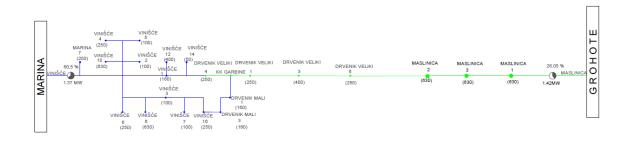


Figure 6. Review of the power flow after the submarine cable is active

5. Technical description of the planned preparation and construction procedure of the planned submarine power cable

Especially considering the reliability, the 20(10) kV electrical power grid requires the possibility of a two-sided power supply, of course, depending on the stage of development, the sensitivity of the consumer and the placement of the network is overhead or underground. Power factors generally define the macro locations of power facilities, including power submarine cables. However, the micro location of the power submarine cable is the result of a number of prerequisites that must be fulfilled and consolidated in the final defined route. In our case, it is a construction of a submarine power cable between the islands of Šolta and Drvenik Veli, with the aim of increasing power supply and reliability of the islands Drvenik Veli and Drvenik Mali, as well as some part of the 10 kV outgoing network feeder Vinišće.

Some prerequisites and requirements are shown below:

- power requirements of spatial plans,
- requests from the port authorities,
- appreciations of infrastructure corridors,
- requirements arising from years of experience in the selection and laying submarine power cables.

Submarine power cable routes generally consist of one longer submarine section and two shorter terrestrial sections that fit the intended route into the existing electrical power grid. The selection and determination of the cable route must be carried out by an on-site inspection, taking into account all relevant factors, primarily the location of the existing cable corridor, and the existing submarine and underground installations present on the route. Certainly, a hydrographic survey of the undersea with included oceanography, geology, magnetometry and bathymetry of the sea should be made.

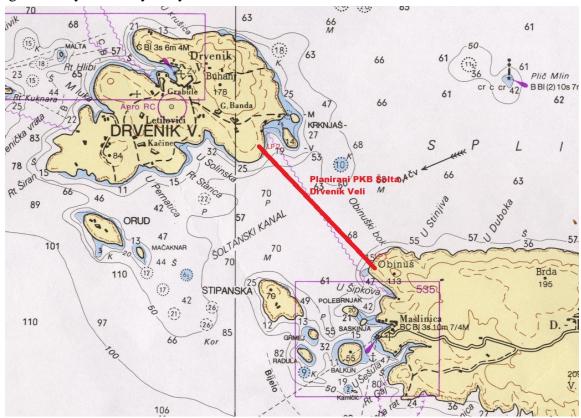


Figure 6. Planned route of the submarine power cable 20(10) kV

The starting point of the cable route would be at Cape Obinuški Bok (island of Šolta, 1500 m northwest of Maslinica). A transition joint-on would be made on the planned 1C 20(10) kV cable from SS 20(10)/0.4 kV Maslinica 2.

The end point of the submarine section of the cable route ends on the south-eastern coast of the island of Drvenik Veli, at Cape Gornja Banda west of the island Drvenik Veli (Krknjaši). This would connect the land cable to the nearby SS 20(10)/0.4 kV Drvenik Veli 6.

Technical details of the planned submarine power cable are as follows:

- mode of operation of MV network in SS 35/10 kV Marina is isolated
- earth fault current is 47.16 A,
- maximum short circuit current at 10 kV busbars in the SS 35/10 kV Marina is 4 kA.
- tripping time of the relay protection is 1 s.

The planned cable is a MV three-core (3C) submarine power cable. Modern medium-voltage submarine cables (\leq 52 kV) are usually designed as (3C) cables with XLPE insulation. Depending on the specifications, submarine medium-voltage cables can be produced with or without a metallic sheath. The low electric stress in extruded medium voltage cables allows for a cable design without total lock-out of water. The armoring losses in 3C cables are significantly lower than in 1C cables because the magnetic fields from the three conductor currents cancel each other to a large extent. The lower losses in a 3C cable may allow a smaller conductor to achieve the required ampacity.

The total length of the submarine route between the islands is 4300 m. For this section the following (standard) submarine power cable type used in HEP DSO Ltd., is XHE 46/24 - V, $3\times120/16 \text{ mm}^2$, 12/20/24 kV with rated current of 400 A.

 $\begin{array}{lll} \mbox{Rated voltage } (\mbox{U}_0/\mbox{U}) & 12/20 \ \mbox{kV} \\ \mbox{Maximum system voltage} & 24 \ \mbox{kV} \\ \mbox{Rated impulse with stand voltage} & 125 \ \mbox{kV} \\ \mbox{Rated current} & 400 \ \mbox{A} \\ \end{array}$

Conductor copper, class 2, 120 mm²
Insulation XLPE, 5.5 mm, watertight

Inner sheath HD-PE, 1.8 mm
Outer sheath HD-PE, 3.6 mm

Armour galvanized steel wires

Total cable weight (with drum) 11800 kg
Length of packing 900 m

The coastal protection is planned to be carried out on the islands Drvenik Veli and Šolta by a drilling machine and by drawing one PEHD pipe Ø 180 mm. The drilling is done by a threading machine. Consequently, the cable then has the highest quality protection and there are no visible excavation marks on the coast. On the submarine section, cable laying will be done by boat laying. The cable is freely laid on the bottom into the muddy sediment by its weight or lies freely on the hard bottom. At the end, the submarine power cable is pulled apart and laid on the sea surface by means of airbags. After the airbags are being lowered to the seabed, the cable is routed through a coastal protection pipe by using a wire.

6. Conclusion

System reliability is an important segment of planning and optimization of distribution systems. Systematically and economically justified investment in network automatization and new supply directions significantly increases the ability of the distribution network to

continue delivering electricity to all consumers, and as well in emergency operating states. With this investment regular maintenance and monitoring and replacement of network elements can further enhance reliability.

Considering the accelerated development of tourism in the next 20 years on the relatively underdeveloped islands of Drvenik Veli Mali, and the island of Šolta, as well as the inability to simply "close" the loop of the outgoing network feeder Vinišće it is logical to conclude that this submarine connection is very necessary.

In the next 10-year, HEP DSO Ltd. plans to make numerous replacements of old submarine power cables and the construction of new ones is likely to be one of the topics to be taken into consideration. Analyses presented in the paper will become an indispensable segment of any development plans. As the required standard by the customers is on the increase, sensitivity of the consumables themselves is increasing and the unavailability of electricity will become very expensive and unacceptable in very short periods, which will pose a great challenge to the distribution system operator maintaining and upgrading the network.

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Implementation of SaaS Solution in Cadastral Offices - a Case Study

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Abstract. This paper presents the case study research of a new SaaS based information system implemented in the State Geodetic Administration's Cadastral offices in the Republic of Croatia. The main aim is to provide an overview of the effects of implementation project.

Effects of the transition to the new information system were analysed by defining expectations from the implementation project, collecting relevant measurable parameters from experts, and performing an evaluation. An overview of new functionalities is given, such as reallocation of work between offices, the integration of the Digital Archive System and merging with public service of the state administration, which have increased the availability of services and accelerated document issuance. In conclusion, significant improvements and savings were achieved in the areas of security, equipment cost, scheduling and monitoring activities, introduction of digital signature, expediting the issuance of official records, time spent on generating reports and performing cashier operations. Certain processes, such as processing user requests, remain to be improved, while some novel issues have arisen, such as significantly increased telecommunications costs and disparate numbering schemes on land parcels have temporarily worsened. Overall, the project can be considered a success, however there is a strong need for further improvements, such as simplifying the map entry process, which is one of the main activities of the cadastre, as well as faster adoption of new technologies, as the system, already based on a decade-old platform, risks losing pace with the rapid advances in web technologies.

Key words: Information system, Cadastre, SaaS, administration, success factors

1. Introduction

Work of Cadastre involves processing and presentation of substantial amounts of graphic and textual information. Benefits of computer data processing became clear and the introduction of information technology into the cadastre began as early as 1980s, with other public services, following suit, such as the Courts Land Registry Departments. Recently, due to the growing economic activities in Croatia, as well as involvement of Republic of Croatia in the process of accession to the European Union, there is a growing need to introduce a comprehensive common information system which unites and accelerates business processes of Cadastre and Land registry service. Implementation of the new Joint information system (JIS) was lengthy and complex, involving various external entities in addition to Cadastre and Land Registry.

JIS is based on SaaS technology, enabling the 112 cadastral offices throughout Croatia to benefit from new functionalities, harmonized business processes in all cadastral offices and created, as well as creating the conditions for connection with the information systems of other government services.

The process of introducing major changes in an organization as rigid as state administration has been a major challenge from organizational, technical, and staffing point of view. After four years of using the system, new opportunities and ideas for its improvement are continuously explored, resulting in introduction of new functionalities. Realistic assessment of achieved benefits are only possible after a period of use of the new system, after the new way of work has settled, and users are exploiting all its benefits.

This paper consists of four parts. The first part describes the pre-computerization situation and the motivators for entering the project. The second part describes the process of implementing a new information system with the main steps and participants in the project. Metrics for evaluating implementation performance are discussed in the third part, while fourth part describes the process of gathering information on project outcomes from stakeholders and evaluation results.

1.1. Cadastre

Cadastral Offices in the Republic of Croatia are part of the State Geodetic Administration. Their scope of work and organization are prescribed by the Decree on the Internal Organization of the State Geodetic Administration [1]. Among the most important cadastral affairs are, inter alia, maintaining official records of land parcels and buildings, keeping records of holders of rights to them, issuing data from official records, reviewing and verifying acts that change official data, maintaining digital cadastral plans and register of spatial units.

1.2. Software as a service

Software as a service (SaaS) is a web-based model of software delivery that allows any device with an internet connection to access data using a web browser. Servers, databases, and application code are hosted by software vendors which reduces hardware requirements, on-premise IT security budgets and risk of security breaches. SaaS systems are highly dependable on internet connection bandwidth and stability which nowadays are available in most urban and industrial areas with business activity [4].

The advantages of SaaS systems are: independence of local machine's operating system, centralized system update and implementation of patches without affecting the user business process, scalability, adding and reducing new users to the system, high availability of systems from different locations and elimination of the need for investment in data storage [5].

SaaS systems are typically financed by a subscription model as opposed to on-premise software, which is usually purchased through a perpetual license. Therefore, the SaaS vendors are fully responsible for keeping service operation at the highest possible level [6].

2. Initial status of the cadastre office information system

Prior to the implementation of JIS, two mutually independent information systems were used in the cadastral offices in the Republic of Croatia to maintain cadastral databases and run office operations. In the territory of the Republic of Croatia, there were two suppliers of applications

for running the office business and the text section of the cadastral database, each serving half of the offices.

Both systems had client-server architecture, with a server in each office there was a server running the application and database, independently of the other offices (Figure 1). Backup of data had to be done daily, while replication of data from the office to the State Surveying and Mapping Authority was carried out every few days, causing a delay in information availability from the central server.

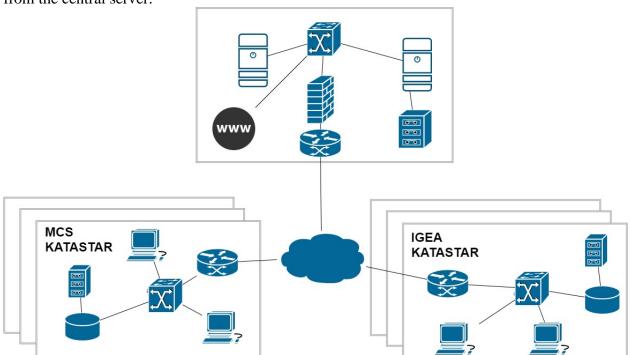


Figure 1 Information system architecture prior to the implementation of SaaS

The most significant issues with the described processes are:

Server failure. In the event of a physical failure on a local server in one of the cadastral offices, normal operation of the office was disabled until the physical server was repaired or replaced at the site. In the case of offices on the islands, this meant a break in the office operation for several days.

Slow release of official records. Due to the lack of a suitable software solution that would satisfy the need to monitor the history of changes in the digital cadastral plan, the graphic part of cadastral database was not maintained in digital form, which made it impossible to release data from official records online. Issuing of official data to parties was unacceptably slow, especially in larger offices, where it was necessary to wait for several days to issue cadastral plan extracts.

Uneven workload distribution of offices. As offices in major cities had significantly greater demand from the public, they were overloaded with work, while other offices, in smaller cities, were underutilized. As one office could not access documents of the other, it was not possible to redistribute work from offices with greater backlog to less burdened offices.

Time-consuming reporting. In order to produce reports on the current status of cases processed, cash flow or workload of individual employees, it was necessary to manually collect and compile data from different sources and information systems, which required between few hours and few days, depending on the complexity of report.

Inability to ensure traceability of performed actions. Review and validation of land parcels and geodetic studies was conducted in steps, some of which were done manually and not visible in

the existing information system. Most critical step, prone to abuse, was manually entering shape of land plots into the GIS software without any automated logging mechanism.

3. Motivation to introduce JIS as SaaS solution

Given the need to remedy the situation in the Croatian land administration system, which traces its roots back to the 19th century, the strategic goal of the State Geodetic Administration and the Ministry of Justice has become the introduction of the Joint Land Registry and Cadastre Information System, which would bring together two significant records in one place. : cadastral records of the position, form and surface of land parcels with their respective owners, as well as land and book records of owners and mortgages entered.

Shortening response time. The development of economic, agricultural and tourist activities has increased the number of cadastre requests as well as their complexity. In order to shorten the response time and to monitor the status of cases, it is necessary to efficiently manage circulation of documents, by introducing a comprehensive information system, that will integrate all business processes in a fast, secure and reliable manner.

By integrating the landowner's business into the new information system, cadastral staff will be given instant access to ownership data, thus ending the need for the physical delivery of documentation. On the other hand, courts will immediately have results of cadastral proceedings by accessing the same information system.

Digital delivery of documents between departments, as opposed to the present method of delivering written documents by mail or couriers, is expected to have a significant impact on speeding up the procedures and reducing cost.

Citizens' access to official documents online. The development of information technology makes it easy and fast to issue various certificates and extracts from official state records online. As a prerequisite for the public disclosure of data and their immediate availability to citizens, it is necessary to ensure their continuous updating and storage to the central repository.

Maintaining a digital cadastral plan. Business processes for maintaining cadastral plans that are carried out manually or using manual tools (Auto Cad), without a central record of changes in handling through the information system, must be performed using professional tools. In this way, the process will be significantly accelerated, and the traceability of changes will be enabled, which will reduce the possibility of abuse. The new information system will have all the information on the area and persons registered as holders of land parcels in one place.

Job redistribution among offices. The inclusion of all offices in a single information system will allow the reallocation of jobs in such a way that the jobs of the overloaded offices are reallocated to those offices that at that moment have less workload, which will result in reducing backlogs and increasing the overall efficiency of the system.

Better management of the cadastre business. Implementing the new system will shorten the process of compiling case reports from hours to minutes. Prerequisites will be created for the introduction of new digital services, such as the Digital Elaboration System, which would eliminate the need to submit paper versions of documents for review and verification, the integration of the Digital Archive system in which digital documents will be automatically saved after completion of the procedure and thus become immediately available to registered users. As the cadastral offices also carry out the cashier's business of collecting material costs for the preparation of certain types of statements, it is necessary to ensure efficient management and control over working with cash and to facilitate the process of issuing invoices to users.

4. Implementation of JIS

The establishment of the JIS was defined for the first time by amendments to the Land Registry Act of 2007. [2] In the same year, its development and establishment were contracted. The

scheduled implementation completion dates have been defined and have been changed several times. Two pilot sites have been set up whose cadastral offices and land registry departments have started running in a new system physically housed in the APIS IT datacentre. Working groups have been set up to manage the JIS implementation project composed of employees of the State Geodetic Administration and the Ministry of Justice and the City Office for Cadastre and Geodetic Affairs of the City of Zagreb.

During the implementation of the project, a technical solution of the system was defined which enables communication with various other state registers such as OIB database, spatial unit register, State Geodetic Administration Geoportal, State Geodetic Administration and Ministry of Justice digital archives systems and e-citizen system. Business processes and a common database have been developed and defined. It is planned to merge 120 databases of the State Geodetic Administration and 109 databases of municipal courts and databases of the City Office for Cadastre and Geodetic Affairs of the City of Zagreb. A unique data model has been created to replace the different models in the previously distributed databases.

Because JIS is defined as a SaaS system that is integrated into the APIS IT datacentre, it was necessary to upgrade existing Internet data connections from each office to increase the need for data transfer outside the office LAN networks compared to previous systems where most traffic occurred. locally between client computers and the local server. This upgrade, for objective organizational and logistical reasons, has delayed the migration process to the new system for more than half a year.

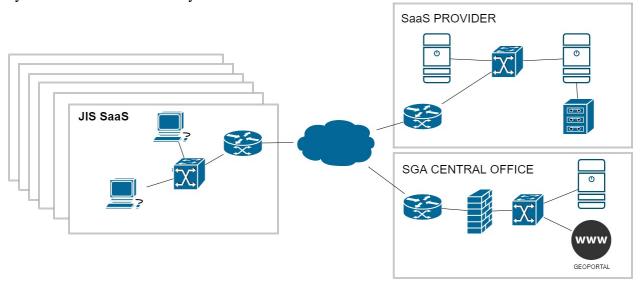


Figure 2 Architecture of JIS SaaS system

The process of data migration was performed for each office separately in such a way that the data for each cadastral office and the land registry department of the same local jurisdiction were migrated in pairs. Migration controls were carried out before being put into production to avoid any data loss. The quality controls of digitized cadastral plans have also been previously implemented and implemented in the new database. The migration of data from individual cadastral offices to JIS was conducted in groups of several offices at a time. Previously, test environments were set up for each group in which the employees of individual offices were able to practice working in the new system. An e-learning system was also set up through which employees were familiarized with individual JIS modules and received basic training in working in the new system.

The full implementation of JIS for the entire territory of the Republic of Croatia was completed in November 2016. [3] After completion of the implementation process, periodically updates

and introductions of new system functionalities are made. For the implementation of the JIS coordination and management process, a permanent three-level governance structure has been set up to make changes decisions and guide the further development of the system.

5. Results

The aim of the analysis is to compare operation of JIS against the earlier on-site system. A survey was conducted among the officers of the Split Regional Cadastral Office. As three years have passed since the implementation of JIS, it is assumed that the period of user adaptation to the new system is over and the system is used efficiently. Had the assessment been done shortly after introduction of new system, initial difficulties with start of use of any new system would cloud the objectivity of results. Also, since the JIS system has matured significantly during the three years' period, with additional functionalities implemented and business processed visibly improved, the functional advantages of JIS as a SaaS solution over the previous solution come to the fore.

Parameters for comparison of two systems were defined, which include the expected benefits of implementation, i.e. those system capabilities that are most important for the normal running of business processes in cadastral offices:

- Data security and failure recovery
- The duration of the processing of applications and the issuance of official records
- Connectivity with other systems of state administration
- Maintaining digital cadastral plans
- Work reassignment
- Statistical processing

5.1. Data security and failure recovery

Location of storage, backup procedures and backup equipment reliability are crucial factors for data security and the ability to recover data in case of a failure. The storage of data at the location of each cadastral office poses a potential risk in terms of restrictions on access to the servers on which the data is stored. Also, there is a risk of irregular backups in individual locations. The cost of supporting a system distributed in more than a hundred locations is also significant. On the other hand, by keeping all data in one centralized location, specifically equipped solely to store data under controlled conditions, the security level is significantly increased.

5.2. The duration of the processing of applications and the issuance of official records

The time required to process clients' requests and to issue documentation is important in several respects. Primarily, by users of cadastral services, citizens who need various statements and certificates, and other entities that use cadastral data to produce various other documents. On the other hand, shortening the time increases the efficiency of cadastral offices and reduces the possibility of creating work delays.

5.3. Connectivity with other systems of state administration

Connecting the information systems of different state administration services enables the development of online services through which all data on certain entities can be obtained in one place. This eliminates the need for seeking information between individual services in citizen proceedings and significantly shortens the time of the proceedings themselves. Connectivity is one of the basic prerequisites for making public services accessible and obtaining documentation from official records online.

5.4. Maintaining digital cadastral plans

Digital cadastral plan, graphical representation of the position and shape of land parcels and structures built on them, is one of the most important cadastral records. Processes related to it, such as maintenance, making changes and issuing official statements related to cadastral plan, are critical in terms of importance, sensitivity, and security.

It is of critical importance that these processes are executed quickly and efficiently, ensuring traceability of all actions performed, thus limiting the risk of abuses. The information system that oversees this process must limit the ability to manipulate data by logging date and person that enters or changes any information.

5.5. Work reassignment

In order to maintain satisfactory level of service to the clients, it is often necessary to redistribute work from offices that are overloaded to the offices (often in smaller cities) that have less work. In addition to levelling demand, work reassignment can speed up procedures and prevent delays caused by several reasons, such as sick leave of employees or vacations.

5.6. Statistical processing

Cadastral offices regularly generate various statistics, such as number of cases received, work in progress, or number of cases completed. Statistics are usually done at the level of a regional office with responsibility for multiple cities, so it is necessary to collect and process data for different offices from different cities. Making data for all offices available in one place significantly shortens the time and resources required to analyse the data. Also, multiplication of work is avoided, so instead of having people in each office process and submit data to the regional office, and then have a person make a summary report, the whole job can be done by one person in the regional office.

The survey was conducted among cadastral office officials in Split. The criteria listed in Table 1 were evaluated, with ratings ranging from 0 (completely unsatisfactory) to 10 (completely satisfactory). 10 employees of the Split Regional Cadastral Office were interviewed who used both systems.

Table 1. System ratings by individual parameters

Nr.	Parameter	On-site system	JIS SaaS
1	Data security and failure recovery	5	9
2	The duration of the processing of applications and the issuance of official records	4	8
3	Connectivity with other systems of state administration	3	9
4	Maintaining digital cadastral plans	0	6
5	Job reassignment	0	10
6	Statistical processing	5	9

Comparison of two systems according to the conducted research is shown graphically in Figure 1.

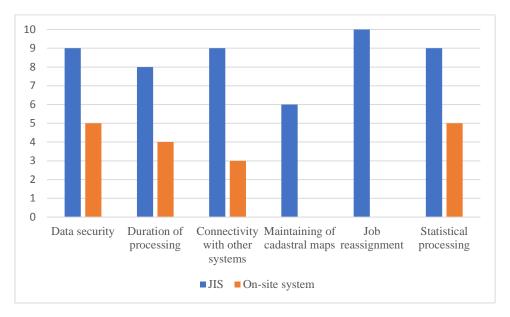


Figure 3 Graphical comparison of the JIS and the earlier On-site system

Compared to expectations before the implementation of JIS, the realized benefits are not uniform across all parameters.

Significant improvements were achieved in terms of data security and reducing risks of data loss due to a human error, technical failure, or natural disaster.

Response time for issuing of official records, such as cadastral plan statements, has been shortened by orders of magnitude, on average two working days to a few minutes. A possibility to issue certain documents using the E-Government portal is also available now, so for certain extracts it is no longer necessary to come to the cadastral office.

JIS also met expectations on connectivity to other systems such as the OIB system, the State Geodetic Administration's digital archive system.

The new system performed worst in the scope of digital cadastral plans management, especially in the first period of use of the graphical editor. There were frequent complaints about inadequate user interface, frequent interruptions in communication, inability to correct unintentional errors, and slow system response.

In terms of job redeployment, JIS has fully met its expectations, enabling users from an office to be assigned work from any other office, thus optimizing workload to the maximum.

Reporting has also improved by orders of magnitude, because in a matter of minutes detailed analysis are made, and reports that previously took several hours, with the involvement of a significantly larger number of employees, are now generated instantly.

6. Conclusion

The conducted research shows that the implementation of JIS as a SaaS solution into a large and complex system of state administration has made considerable progress in terms of security, efficiency and enabling of new system functionalities. Although in areas like maintenance of

digital cadastral plans the implementation was at a lower level than expected, further improvements are expected in subsequent system upgrades, which are now centralized and easy to propagate. Certain improvements, such as linking double particle numbering and printing data to envelopes for mailing, have already been implemented.

The implementation of a comprehensive information system in a country-wide civil service organization, involving many offices, has proven to be a time-consuming and complicated process that requires careful planning of each step, considering the many details that often came to light at during the implementation process itself. The problems encountered in the implementation process led to significant extensions of the project implementation timeline.

Finally, JIS provides a good foundation for further upgrading and supporting a stable and efficient information system that can meet the current and future needs. Improvements, both in terms of functionalities and implementation of new technologies as they become available, must be planned and performed on a perpetual basis, as that is the only was of assuring that the system will keep up with the growing demands of modern society.

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Hybrid Winch Drive

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Abstract. In this paper, a Hybrid winch drive will be explained. It will be explained why electric motor is not the best option when Active Heave Compensation is considered. Basic configuration of the drive will be presented, each of components will be explained and the role they play in this hybrid drive. Main advantages and disadvantages will be explained. It will be shown where this hybrid system could be implemented and why it presents a more power-efficient solution.

It will be explained how this system could use energy of the waves and store it.

Keywords: hybrid system, accumulating energy, optimal energy usage.

1. Introduction

Reduction in CO2 emissions and higher energy efficiency currently present two main objectives and continuously drive the development of new concepts and ideas. Various operations at sea require special cranes and winches. Winches are used for operations such as towing, fishing, under water work. Some of these operations require winches that help retain certain position or tension value constant. Due to the nature of the waves, any operation at sea is accompanied by dynamic change in position. This change in position depends on the sea state, the size and the shape of the vessel. As mentioned the nature of the change is dynamic. Therefore any attempt to cancel that change also needs to be applied in a dynamic spectrum. Winch needs to perform two main actions. Classic towing of the cargo and actively compensate any movement of the targeted object (cargo). Certain challenges arise when the system is powered, for example with an electric motor (EM) that is operating most of its operation in the nominal range. The peak power requirements, linked with amplitude motions of the cargo, exceed the nominal values and motors tend to work in poorer energy efficient regime. Electric motor powered systems offer efficiency of ~ 80% If a hydraulic system is considered, greater loses are present. Piping, various valves, pump and engine each present certain loss in the system. Hydraulic system has the efficiency~ 60%. Each one of these solutions, electric and hydraulic, poses a certain advantage. For current solutions, where winches are driven with electric motors, there is no efficient way of storing the power from the unwinding actions of the winch. This is where hydraulics can fill the gap, store and utilize that free energy.

2. Electric motor (EM) as drive unit for Active Heave Compensation

Winch, which is intended for active compensation also, needs to perform two actions. Electric motor (EM) (induction motor), driven with variable frequency drive (VFD), is responsible for main operations, towing of the cargo for example. These operations are usually performed within nominal regime of the EM. When actively compensating free motions of desired object, peak loads tend to be higher than nominal. This means that the EM will have to work in overload. EM has the ability to deliver higher torque than the nominal value. Higher torque generates more heat, if the EM constantly performs these overload actions periodically, there is no time for the EM to cool down. These Active Compensation actions are performed in a way that the engine constantly operates in on/off mode. Every start draws large amounts of electricity. Amount of energy that is needed to accelerate (with no load) is approximately the amount equal to energy lost. If load is added, energy

loses are greater. Efficiency of EM is depended on the imposed load and the rpm. Due to the dynamics of compensation and periods of change, EM does not have time to develop rated rpm. for optimal efficiency. It constantly varies between low values of the rpm. Frequent start stop actions, overload operations and lower rpm. all indicate that the EM even with VFD (variable frequency drive) will not operate in its intended optimal area. It will operate with significant energy losses and it is questionable will it be able to follow the dynamics of imposed compensation.

3. Energy Accumulation in Active Movement Compensation Operations

As stated in previous chapter, winch for Active Heave Compensation perform two actions. Towing-pulling of selected object, are powered by EM. These work regimes are suitable for EM controlled with VFD. Operations of ensuring constant position or tension are actions which are performed in dynamic spectrum. This motion can be approximated like a simple harmonic motion. Position and velocity can be obtained according to

$$x_{(t)} = A * \sin\left(\frac{2 * \pi}{T} * t\right) [m]$$
(1)

$$v_{(t)} = \left(\frac{2*\pi}{T}*t\right)A*\cos\left(\frac{2*\pi}{T}*t\right) \ [m/s] \tag{2}$$

where:

A (m) -maximum amplitude

T (s) -time period of one cycle

t (s) -duration of the motion

Expressions 1 and 2 describe harmonic motions. If we presume a constant value of load on the winch, velocity parameter determines the behaviour of the power curve. Energy distribution is as such that there are periods when energy can be stored. These periods occur when unwinding actions are being performed. Winch needs to release a certain length of rope to ensure for example constant position of cargo. Model of a winch operation in described dynamics (active motion compensation) can be approximated with a graph Power P (kW) vs time t (s) (Fig. 1).

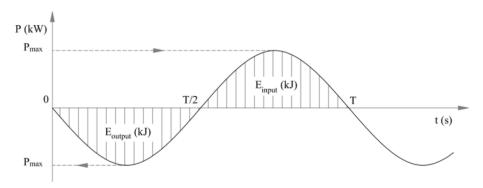


Figure 1 Power (kW) vs time (s) graph for active motion compensation [1]

 P_{max} is the maximum power requirement with constant pulling force and can be calculated using 3.

$$P_{max} = F * A * \frac{2 * \pi}{T} \tag{3}$$

where:

 P_{max} -maximum power requirement

F(kN) -winch pulling force

A (m) -ship amplitude on heavy seas

T (s) -winch winding and release cycle

As shown in Figure 1, Power (kW) vs time (s) curve is a sin wave function. E_{output} (kJ) is the energy that could be retrieved and accumulated. This energy could be harnessed from the unwinding actions of the winch. E_{input} (kJ) is the amount of energy that we need to input for pulling actions. In theory these two areas are equal, and amount of energy should be equal. This suggests that the amount of energy used equals the amount of energy accumulated. In reality these amounts differ because efficiency coefficients affect these two actions (pulling and releasing) differently. It is shown in [1] that the amount of the energy regenerated in to the system is lower than the energy we put in to the system. Amount of energy that can be regenerated is depended on the entire system and the operation conditions and state of the sea. This amount is somewhere between 30-50% of the energy we put in to the system.

As mentioned in 1st.chapter there is no efficient way of storing energy and using it for unwinding actions, when electric driven winches are considered in active compensation movements (small cycle periods). EM controlled with VFD and active front end (AFD) drives are convenient to store energy when pulling and releasing of the cargo is performed in longer periods of time. Electric batteries, as an option, cannot handle the needed speed of the discharge. Frequent rate of discharge is another issue that eliminates electric batteries as an option. Hydraulic accumulators (HA) are capable to deliver large quantities of energy (oil flow) in short bursts of time, also they are able to accumulate and to store energy. Frequent rate of discharge is not an issue when HA is considered. Simple configuration allows them to store energy and release it on demand with practically no limiting operating cycles (maintenance is required and eventual replacement after certain periods of time). As mentioned, electric driven winches in normal working regimes, offer better energy efficiency than hydraulic systems. Hydraulics offers the ability to accumulate power, and to use it on demand.

4. Hybrid Winch Drive (HWD) Configuration

Hybrid Winch Drive (HWD), consisting of EM and hydraulic motor-pumps (HMP), offers a way to utilize best aspects of both solutions. Figure 2 displays basic HWD configuration and its components.

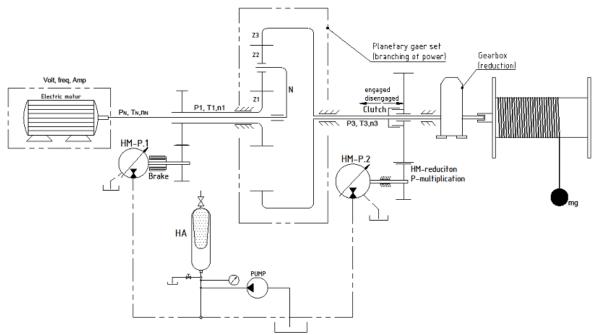


Figure 2 Hybrid Winch Drive (HWD) configuration

EM shaft is connected with the planet carrier (PC). This presents the main power source. Planetary gear set (PGS) plays a role in reduction and multiplication. It is also responsible for

power distribution across the system. Another role of the PGS is to fill the speed gap between hydraulic motor pump 1 (HM-P1) and the EM. The sun gear is connected to HM-P1 with one set of helical gears, ratio between them is 1. This could be altered for given criteria. Ring gear of the PGS is connected to the output shaft trough a gearbox. Rpm. relationship between PGS components can be obtained according to

$$n_3 = \frac{n_N(Z_1 + Z_3) - n_1 * Z_1}{Z_3} \tag{4}$$

where:

 n_3 - rpm. for the ring gear

 n_N - rpm. for the planet carrier

 Z_1 - teeth number for the sun gear

 Z_3 - teeth number for the ring gear

This configuration enables great speed difference to be utilized in favour of energy accumulation. Sun gear, as mentioned, is connected with an HM-P1. HM-P1 is a part of a hydraulic system consisting of:

- Hydraulic Motor Pump-1 HM-P1
- Hydraulic Accumulator HA
- Pump
- Hydraulic Motor Pump 2 HM-P2

Hydraulic system is responsible for the dynamic operations of compensation and for the energy regeneration. HM-P1 acts as a pump (P) and hydraulic motor (HM). HM-P2 operates in the same manner. HM-P2 is connected to the ring gear shaft with a set of helical gears and a coupling. Ratio between them is greater than 1. When HM-P2 is performing as a P, the gear set is in multiplication mode. HM-P2 speed of rotation is multiplied enabling higher oil flow and so faster accumulation of energy in the HA. When HM-P2 is acting like a HM, the gear set is in reduction mode. HM-P2 speed of rotation is reduced and torque is increased. By increasing torque HM-P2 is adding torque (energy) to the ring gear shaft which turns the winch drum. Engage-Disengage option is added, with a coupling, for disengaging the HM-P2 if the situation requires doing so. A pump is added to the system to ensure adequate pressure in the HA if needed.

4.1. HWD in Main Pulling Actions

When normal operations are performed, classic pulling, EM drives the system. EM revs up and forces the sun gear with it. This is the phase where EM could drive the winch and use the sun gear, which is connected with HM-P1, to power the HM-P1 to act as a P. While HM-P1 is in P mode, all the energy is stored in the hydraulic accumulator (HA). After the accumulator reaches its maximum pressure, oil flow could be bypassed to the HM-P2, which now acts as a HM, helping the EM in performing the classic pulling operations. The EM drives the HM-P1 which in turn drives the HM-P2, and pressurises the HA. HM-P2, powered by HM-P1 helps the EM perform the basic operations. For this reason it is possible to include a smaller EM in the system than it would be the case if the EM operated alone.

4.2. HWD in Active Motion Compensation (AMC) Operation

AMC operations are, as mentioned, performed in a dynamic spectrum. EM could start the motion, rev up the HM-P1, and start the energy accumulating process in the HA. EM could run long enough for the system to ensure enough energy to perform these alternating operations, ensure enough energy in the HA. If the HA is filled (fully pressurised) by actions explained in

section 4.1 or with a pump (P), then there is energy in the system that can be used to start the AMC operations. EM does not have to run, the AMC operation could be, theoretically, performed by energy accumulated in the HA.

If E_{input} is needed, the energy is released from the HA. HA delivers necessary oil flow and powers the HM-P2, which now acts as a HM. HM-P2 is connected to the ring gear shaft and drives the winch drum. Since the ring gear is powered by HM-P2, the ring gear forces the sun gear to rotate. The EM is stationary and the planet carrier is also stationary. Depending on the ratio *i* between the ring gear and sun gear, speed of the sun gear is determined. Sun gear, driven by the ring gear, is powering the HM-P1 which now directs a certain amount of oil flow to the HA and by doing so helps the system in performing the AMC operations. If the HA cannot take in the oil flow delivered by the HM-P2, this can be monitored by simple pressure indicator, oil flow can be bypassed to assist the HM-P2 performing the HM operation. As stated in chapter 4. the ratio between sun gear and the HM-P1 gear is 1. This can be altered and certain ratios can be set so the speed difference can deliver more "flow" manipulation.

When the E_{output} action is performed, cycle now enters the "unwinding phase" where the wire/rope is released and energy is regenerated. E_{output} is being harnessed and HM-P2 now acts as a pump and pressurises the HA. HM-P2 rotation is multiplied and the oil flow increased. In theory amount of energy E_{input} and E_{output} should be equal but the amount of E_{output} is lower due to the efficiency and system losses. Pump (P) has the task to refill the HA when needed. Unwinding the winch turns the HM-P2 and also the HM-P1 trough the ring gear. HM-P1 also acts as a pump and pressurises the HA for the certain amount. Every unwinding operation, energy can be regenerated.

Cycle repeats as shown in Figure 1. Presuming that the HA is filled. E_{input} is delivered from the HA. Oil flow from the HA powers the HM-P2 (operates in HM mode) and drives the winch drum, pulling the wire/rope. The ring gear, being connected to the drum, turns and forces the sun gear to turn. The sun gear powers the HM-P1 which acts as a P and pressurising HA to certain value. Oil flow (if the HA is under high enough pressure) from the HM-P1 could be bypassed to the HM-P2 to increase its power. After the Pulling action is done, the unwinding E_{output} operation starts and the wire/rope is released. This turns the HM-P2 which now acts as a P and directing the oil flow to the HA. All the energy (losses are present) from the unwinding action is "stored" in the HA. Ring gear turns with the drum and drives the sun gear. Sun gear drives the HM-P1 which works as a P additionally filling the HA.

Oil flow restrictions, non-return valves and bypasses between HM-P1 and HM-P2 will have to be installed. Reverse flow needs to be disabled between HM-P1 and HM-P2 to ensure the system from blocking and eventual damage to the hydraulic components.

Depending on the load of the system, HA capacity and the HM-P (1-2) set performance, different regenerating efficiency can be accomplished. HM-P (1-2) are variable displacement pumps-motors. Variable displacement HM-P allows more torque, pressure and oil flow manipulation for different load magnitudes and speed.

5. Conclusion

Active Heave Compensation (AHC) presents a constant challenge for any action taken at sea. Rough seas, calm seas, all require some level of compensation, if the operation is sensitive to relative motion. Current solutions using a winch apply either a full hydraulic system or electric motor driven systems. Hydraulic and electric driven systems differ in energy efficiency.

This paper presents a new approach to handling AHC operations. Using a Hybrid Winch Drive it is possible to regenerate certain amount of energy back in to the system. Combining electric and hydraulic drive enables the system to utilize the advantages of both solutions, higher

efficiency, when performing main operations and the ability to harness the work done by waves with the hydraulics.

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Optimization of Thin-walled Beams with Mono-symmetric I-section Subjected to Torsion

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Abstract. A thin-walled beam with mono-symmetric I-cross-section fixed at its ends and loaded by the uniformly distributed torsion loads $m_{\rm P}$ is considered in this paper. The thin-walled beam is subjected to torsion with influence of shear and also to bending due to shear in the plane orthogonal to the plane of symmetry. The beam has small ratio length of the beam and length of the middle line. Because of that the shear influence especially on the angle of torsion, but also on the normal stresses in longitudinal direction, is significant. So, in this paper the normal stress and the angle of torsion we will calculate with the influence of shear. All geometrical properties of mono-symmetric I cross-section needed for calculation of the normal and shear stresses and the angle of torsion are given in numerical and graphical outputs. The optimization of the beam's cross-section dimensions is done using MS Excel Solver GRG Nonlinear algorithm. The goal is the smallest mass of the beam and two criteria: strength and rigidity criteria were taken into consideration. For so obtained optimal cross-section the values of maximum normal stresses as well as the maximum value of the total angle of torsion for all types of materials according to the both criteria are given.

Key words: thin-walled beam, open cross-section, optimization, torsion with influence of shear

1. Introduction

Thin-walled beams with open cross-section are often parts of modern metal construction. Such constructions are very light and because of that cheaper when compared with alternative structures.

The main goal of this paper is to find optimal dimensions of the beam with given loading and shape of the cross-section. The thin-walled beam considered in this paper is fixed at its ends and loaded by uniformly distributed torsion loads as is shown in Fig 1a.

The cross-section of the thin-walled beam is I-section with one axes of symmetry and the middle line of its contour is given in Fig 1.b. The point T is centroid and point P the principal pole of the thin-walled cross-section [1]. The location of these points on cross-section's middle line are shown in Fig 1.c.

All data of the cross-section are changed in some intervals. Using Excel solver GRG which is an algorithm for problems of nonlinear programming we obtained the cross-section with optimal dimensions according to the two criteria: strength and rigidity criteria.

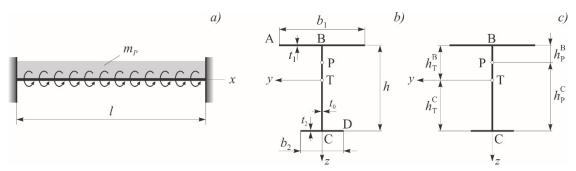


Figure 1 a) a beam fixed at its ends and loaded by uniformly distributed torsion moments, b) the middle line of the cross-section, c) location of the centroid and principal pole

The influence of shear, both on the normal stress and on the angle of torsion is also taken into consideration because of the small ratio l/h - length of the beam over length of the middle line.

The beam has the cross-section with one axis of symmetry and because of that the beam will be subjected to *torsion with influence of shear* and in addition to *bending due to shear* in the plane orthogonal to the plane of symmetry.

Then, the normal stress could be computed according to the formula (1); the shear stress according to (2) and (3) and the angle of torsion according to the formula (4) [1], [2], [3]

$$\sigma_{x} = \frac{B}{I_{\omega}} \cdot \omega + m_{P} \cdot \frac{E \cdot \kappa_{\omega\omega}}{G \cdot I_{P}} \cdot \omega - m_{P} \cdot \frac{E}{G \cdot I_{\omega}} \cdot \int_{0}^{s_{\omega}} \frac{S_{\omega}^{*}}{t} \, ds + m_{P} \cdot \frac{E \cdot \kappa_{y\omega}}{G \cdot W_{P}} \cdot y, \qquad (1)$$

where E is the modulus of elasticity and G is the shear modulus which are addicted on material of the beam.

The total shear stress can be calculated as

$$\tau = \tau_{ts} + \tau_{\varphi}, \tag{2}$$

where

$$\tau_{ts} = \frac{M_t}{I_t} \cdot t \; ; \quad \tau_{\omega} = \frac{M_{\omega} \cdot S_{\omega}^*}{I_{\omega} \cdot t} \; . \tag{3}$$

$$\alpha = \alpha_{\rm t} + \alpha_{\rm ad} \,. \tag{4}$$

In equations (1) and (3) the bimoment B, the moment of pure torsion M_t (Saint-Venant's moment) and the warping moment M_{ω} are the internal forces which can be obtained according to (5) [1], [2], [3]

$$B = -E \cdot I_{\omega} \cdot \frac{\mathrm{d}^{2} \alpha}{\mathrm{d}x^{2}}, \ M_{t} = G \cdot I_{t} \cdot \frac{\mathrm{d} \alpha}{\mathrm{d}x}, \ M_{\omega} = -E \cdot I_{\omega} \cdot \frac{\mathrm{d}^{3} \alpha}{\mathrm{d}x^{3}}$$
 (5)

where the angle of torsion α_t is a solution of differential equation

$$\frac{\mathrm{d}^4 \alpha}{\mathrm{d}x^4} - \frac{k^2}{l^2} \cdot \frac{\mathrm{d}^2 \alpha}{\mathrm{d}x^2} = \frac{m_{\mathrm{p}}}{E \cdot I_{\omega}},\tag{6}$$

where k is as follows) [1]

$$k = l \cdot \sqrt{\frac{G \cdot I_t}{E \cdot I_{\omega}}}, \tag{7}$$

In equation (4) the second term is the additional angle of torsion due to shear and given by the formula (8) [2], [3]

$$\alpha_{\rm ad} = \frac{B - B_{\rm A}}{G \cdot I_p} \cdot \kappa_{\omega\omega} \tag{8}$$

In equations (1), (3), (5) and (8) geometrical properties are defined as follows

$$I_{\rm t} = \frac{1}{3} \int_{L} t^3 ds \,, \quad I_{\omega} = \int_{A} \omega^2 dA \,, \quad I_{\rm P} = \int_{A} h_{\rm P}^2 dA \,, \quad W_{\rm P} = \frac{I_{\rm P}}{h_0}$$
 (9)

and shear factors according to

$$\kappa_{\omega\omega} = \frac{I_{\rm P}}{I_{\omega}^2} \int_{L} \left(\frac{S_{\omega}^*}{t}\right)^2 dA, \quad \kappa_{y\omega} = \frac{W_{\rm P}}{I_{\omega}I_{z}} \int_{A} \frac{S_{z}^* S_{\omega}^*}{t^2} dA. \tag{10}$$

Here $S_z^* = S_z^*(s_y) = S_z^*(s_y^*)$ is the moment of the cut-off portion of cross-section area with respect to the z-axes, $S_\omega^* = S_\omega^*(s) = S_\omega^*(s^*)$ is the sectorial moment of the cut-off portion of the cross-section area.

2. Geometrical properties of cross-section

Expressions for all geometrical properties of given mono symmetric I-cross-section needed for calculating normal and total shear stress as well as the angle of torsion according to equations (1), (3), (4) and (8) are given in parametric form as follows [3]

$$\begin{split} &A_{\rm l} = b_{\rm l} \cdot t_{\rm l}, \quad A_{\rm 2} = b_{\rm 2} \cdot t_{\rm 2}, \quad A_{\rm 0} = h \cdot t_{\rm 0}, \\ &\lambda = A_{\rm 2}/A_{\rm l}, \quad \psi = A_{\rm 0}/A_{\rm l}, \quad \mu = h_{\rm T}^{\rm C}/h_{\rm T}^{\rm B}, \\ &\eta = b_{\rm 2}/b_{\rm l}, \quad \varphi = h_{\rm F}^{\rm B}/h, \quad \rho = b_{\rm l}/h, \quad h_{\rm 0} = h_{\rm P}^{\rm B}, \\ &h_{\rm T}^{\rm B} = h \cdot \frac{2\lambda + \psi}{2\left(1 + \lambda + \psi\right)}, \quad h_{\rm T}^{\rm C} = h \cdot \frac{2 + \psi}{2 \cdot \left(1 + \lambda + \psi\right)}, \\ &h_{\rm P}^{\rm B} = h \cdot \frac{\lambda \cdot \eta^2}{1 + \lambda \cdot \eta^2}, \quad h_{\rm P}^{\rm C} = h \cdot \frac{1}{1 + \lambda \cdot \eta^2}, \\ &A = A_{\rm l} \cdot \left(1 + \lambda + \psi\right), \quad I_{\omega} = A_{\rm l} \cdot h^4 \cdot \frac{\lambda \cdot \eta^2 \cdot \rho^2}{12 \cdot \left(1 + \lambda \cdot \eta^2\right)}, \quad I_{\rm P} = A_{\rm l} \cdot h^2 \cdot \frac{\lambda \cdot \left(1 + \lambda \cdot \eta^4\right)}{\left(1 + \lambda \cdot \eta^2\right)^2}, \\ &I_{\rm t} = \frac{1}{3} \cdot A_{\rm l} \cdot t_{\rm l}^2 \cdot \frac{\eta^2 + \lambda^3 + \eta^2 \cdot \psi^3 \cdot \rho^2}{\eta^2}, \quad W_{\rm P} = \frac{I_{\rm P}}{h_0} = A_{\rm l} \cdot h \cdot \frac{1 + \lambda \cdot \eta^4}{\eta^2 \left(1 + \lambda \cdot \eta^4\right)}, \\ &\kappa_{\omega\omega} = \frac{6 \cdot \left(1 + \lambda\right) \cdot \left(1 + \lambda \cdot \eta^4\right)}{5 \cdot \left(1 + \lambda \cdot \eta^2\right)^2}, \quad \kappa_{\omega y} = \frac{6 \cdot \left(1 - \eta^2\right) \cdot \left(1 + \lambda \cdot \eta^4\right)}{5 \cdot \eta^2 \cdot \left(1 + \lambda \cdot \eta^2\right)^2}. \end{split}$$

Also, the positive and negative coordinates s_y and s_α over the cross-section contour are done in Fig 2.a and Fig 2.b. Distribution of coordinate y and principal sectorial coordinate ω over cross-section contour are presented in Fig 3.a. and Fig 3.b.

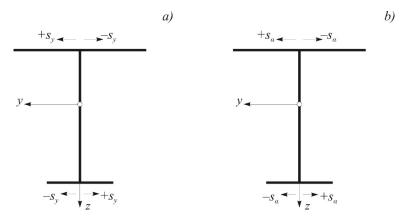


Fig. 2 a) positive and negative coordinate s_y over cross-section contour; b) positive and negative coordinate s_α over cross-section contour

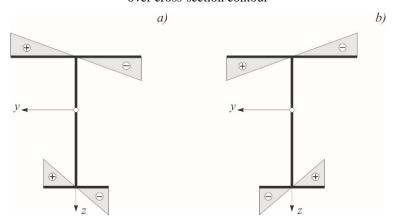


Fig. 3 a) distribution of coordinate y over cross-section contour; b) distribution of principal sectorial coordinate ω over cross-section contour;

Distributions of S_z^* , S_ω^* and $\int_0^{s_a} \left(S_\omega^*/t\right) \cdot ds$ over the cross-section contour are presented in Fig 4.a., 4.b. and 34c.

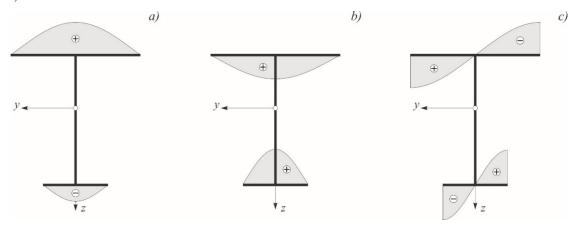


Fig. 4 a) distribution of S_{ω}^* ; b) distribution of S_{ω}^* ; c) distribution of $\int_{0}^{s_{\alpha}} \left(S_{\omega}^*/t\right) \cdot \mathrm{d}s$

Analytical expressions of S_z^* , S_ω^* and $\int_0^{s_a} \left(S_\omega^*/t\right) \cdot \mathrm{d}s$ for top and bottom flange of the cross-section are as follows

• top flange

$$-b_1/2 \le s_y \le b_1/2$$
, $-b_1/2 \le s_\alpha \le b_1/2$

$$S_{z}^{*} = \frac{1}{2}t_{1}\left(\frac{b_{1}^{2}}{4} - s_{y}^{2}\right), \quad S_{\omega}^{*} = \frac{h_{P}^{B}}{2} \cdot t_{1} \cdot \left(\frac{b_{1}^{2}}{4} - s_{\alpha}^{2}\right), \quad \int_{0}^{s_{\alpha}} \frac{S_{\omega}^{*}}{t} ds = \frac{1}{2} \cdot h_{P}^{B} \cdot s_{\alpha} \cdot \left(\frac{b_{1}^{2}}{4} - \frac{s_{\alpha}^{2}}{3}\right)$$
(11)

bottom flange

$$-b_2/2 \le s_y \le b_2/2$$
, $-b_2/2 \le s_\alpha \le b_2/2$

$$S_{z}^{*} = -\frac{1}{2}t_{2}\left(\frac{b_{2}^{2}}{4} - s_{y}^{2}\right), \quad S_{\omega}^{*} = \frac{h_{P}^{C}}{2} \cdot t_{2} \cdot \left(\frac{b_{2}^{2}}{4} - s_{\alpha}^{2}\right), \quad \int_{0}^{s_{\alpha}} \frac{S_{\omega}^{*}}{t} ds = \frac{1}{2} \cdot h_{P}^{C} \cdot s_{\alpha} \cdot \left(\frac{b_{2}^{2}}{4} - \frac{s_{\alpha}^{2}}{3}\right) \quad (12)$$

3. Materials of the beam

Young's modulus of elasticity E and shear modulus G that were mentioned in previous formulas depend on the material of the bars. Four different materials of the beam are used in this paper: three types of structural steel S235, S275, S335 and aluminum alloy EN AW - 6060. Values of Young's and shear modulus as well as allowable stress of these materials are given in Tab 1.

Table 1 Values of Young's and shear modulus as well as allowable stress of the beam's materials

Material of the beam	E GPA	<i>G</i> GPA	$\sigma_{ m allow}$ MPa
S235	210	80	157
S275	210	80	183
S335	210	80	223
EN AW- 6060	69,5	26,1	93

4. The angle of torsion and internal forces

General solution of Eq. (6) is

$$\alpha = C_0 + C_1 \cdot x + C_2 \cdot \operatorname{sh} \frac{k}{l} x + C_3 \cdot \operatorname{ch} \frac{k}{l} x. \tag{13}$$

Integration constants in Eq. (13) are obtained according to the boundary conditions [1], [4]

$$\alpha(0) = 0; \quad \frac{\mathrm{d}\alpha}{\mathrm{d}x}(0) = 0; \quad \alpha(l) = 0; \quad \frac{\mathrm{d}\alpha}{\mathrm{d}x}(l) = 0 \tag{14}$$

For the given beam loaded by uniformly distributed torsion moments and fixed at its ends having in mind boundary conditions (14) the angle of torsion α as solution of differential equation (6) may be written as follows [1]

$$\alpha_{t} = \frac{m_{p} \cdot l^{4}}{2 \cdot E \cdot I_{\omega} \cdot k^{2}} \cdot \left\{ \frac{x}{l} - \left(\frac{x}{l}\right)^{2} - \frac{2}{\chi \cdot k^{2}} \cdot \left[1 - \psi_{1} \cdot \cosh k \left(\frac{1}{2} - \frac{x}{l}\right) \right] \right\}, \tag{15}$$

where ψ_1 and χ are

$$\psi_1 = \frac{1}{\cosh\frac{k}{2}}, \quad \chi = \frac{2 \cdot \psi_1}{k} \cdot \sinh\frac{k}{2}. \tag{16}$$

According to equations (5) internal forces can be written as follows

$$B = \frac{m_{\rm P} \cdot l^2}{k^2} \cdot \left[1 - \frac{\psi_1}{\chi} \cdot \cosh k \left(\frac{1}{2} - \frac{x}{l} \right) \right],\tag{17}$$

$$M_{t} = \frac{m_{p} \cdot l}{2} \cdot \left[1 - 2 \cdot \frac{x}{l} - 2 \cdot \frac{\psi_{1}}{\chi \cdot k} \cdot \sinh k \left(\frac{1}{2} - \frac{x}{l} \right) \right], \tag{18}$$

$$M_{\omega} = \frac{m_{\rm P} \cdot l \cdot \psi_1}{\chi \cdot k} \cdot \sinh k \left(\frac{1}{2} - \frac{x}{l}\right). \tag{19}$$

The maximum value of the bimoment is at ends and is equal to

$$B_{\text{max}} = B_{\text{A}} = \frac{m_{\text{P}} \cdot l^2}{k^2} \cdot \left(1 - \frac{\psi_1}{\chi} \cdot \cosh \frac{k}{2}\right). \tag{20}$$

The maximum value for the angle of torsion is in the middle of the beam i.e. for x/l = 1/2

$$\alpha_{\text{max}} = \frac{m_{\text{p}} \cdot l^4}{2 \cdot E \cdot I_{\omega} \cdot k^2} \cdot \left[\frac{1}{4} - \frac{2}{\chi \cdot k^2} \cdot (1 - \psi_1) \right] + \frac{B - B_{\text{A}}}{G \cdot I_{p}} \cdot \kappa_{\omega\omega}, \tag{21}$$

where B is the bimoment in the middle of the beam

$$B = \frac{m_{\rm p} \cdot l^2}{k^2} \cdot \left(1 - \frac{\psi_1}{\chi}\right). \tag{22}$$

5. Criteria of strength and rigidity

The maximum values of the normal stress according to the criterion of strength must be

$$\sigma_{\max} \le \sigma_{\text{allow}}$$
, (23)

where the maximum normal stress could be at point A or D (Fig 1.b) and according to (1), (11) and (12), (20) and having in mind

$$y_{A} = b_{1}/2; \quad y_{D} = -b_{2}/2; \quad \omega_{A} = h_{P}^{B} \cdot b_{1}/2; \quad \omega_{D} = h_{P}^{C} \cdot b_{2}/2;$$

$$\begin{pmatrix} s_{\alpha} & S_{\omega}^{*} \\ \int_{0}^{s_{\alpha}} \frac{S_{\omega}^{*}}{t} \cdot ds \end{pmatrix}_{A} = \frac{h_{P}^{B} \cdot b_{1}^{3}}{24}; \quad \begin{pmatrix} s_{\alpha} & S_{\omega}^{*} \\ \int_{0}^{s_{\alpha}} \frac{S_{\omega}^{*}}{t} \cdot ds \end{pmatrix}_{C} = \frac{h_{P}^{C} \cdot b_{2}^{3}}{24};$$

may be written as

$$\sigma_{\text{max,A}} = \frac{B_{\text{A}}}{I_{\omega}} \cdot \frac{h_{\text{P}}^{\text{B}} \cdot b_{1}}{2} + m_{\text{P}} \cdot \frac{E \cdot \kappa_{\omega\omega}}{G \cdot I_{\text{P}}} \cdot \frac{h_{\text{P}}^{\text{B}} \cdot b_{1}}{2} - m_{\text{P}} \cdot \frac{E}{G \cdot I_{\omega}} \cdot \frac{h_{\text{P}}^{\text{B}} \cdot b_{1}^{3}}{24} + m_{\text{P}} \cdot \frac{E \cdot \kappa_{y\omega}}{G \cdot W_{\text{P}}} \cdot \frac{b_{1}}{2}, \quad (24)$$

$$\sigma_{\text{max,D}} = \frac{B_{\text{A}}}{I_{\text{m}}} \cdot \frac{h_{\text{P}}^{\text{C}} \cdot b_2}{2} + m_{\text{P}} \cdot \frac{E \cdot \kappa_{\omega\omega}}{G \cdot I_{\text{P}}} \cdot \frac{h_{\text{P}}^{\text{C}} \cdot b_2}{2} - m_{\text{P}} \cdot \frac{E}{G \cdot I_{\omega}} \cdot \frac{h_{\text{P}}^{\text{C}} \cdot b_2^3}{24} + m_{\text{P}} \cdot \frac{E \cdot \kappa_{y\omega}}{G \cdot W_{\text{P}}} \cdot \left(-\frac{b_2}{2}\right), \quad (25)$$

The maximum values of the total angle of torsion according to the criterion of rigidity must be

$$\alpha_{\max} \le \alpha_{\text{allow}},$$
 (26)

where α_{max} is calculated according to (21).

The allowable stress $\sigma_{
m allow}$ and allowable angle of torsion $lpha_{
m allow}$ are given data.

6. Optimization of the cross-section dimensions

The optimization of the considered beam cross-section dimensions is the nonlinear programming problem, where the objective function is the mass of the beam (i.e. its cross-section area *A*):

$$m = \rho \cdot L \cdot A$$

where m is the mass of the beam, ρ is beam material density and L is its length.

This objective function has to be minimized with decision variables (cross-section dimensions):

$$h, b_1, b_2, t_0, t_1 \text{ and } t_2.$$

Constraints are:

- due to strength criterion (where $\sigma_{\rm max,A}$ and $\sigma_{\rm max,D}$ are given by Eqs 22 and 23)

$$\left|\sigma_{\text{max,A}}\right| - \sigma_{allow} \le 0, \quad \left|\sigma_{\text{max,D}}\right| - \sigma_{allow} \le 0$$

- due to rigidity criterion (α_{max} is given by Eq. 19)

$$\left|\alpha_{\max}\right| - \alpha_{\text{allow}} \le 0$$

- due to cross-section geometry (minima and maxima):

$$\begin{aligned} h-0,1\cdot l &\geq 0\,, & h-0,3\cdot l &\leq 0 \\ b_1-0,6\cdot h &\geq 0\,, & b_1-0,9\cdot h &\leq 0 \\ b_2-0,6\cdot b_1 &\geq 0\,, & b_2-0,9\cdot b_1 &\leq 0 \\ t_0-0,05\cdot h &\geq 0\,, & t_0-0,1\cdot h &\leq 0 \\ t_1-0,05\cdot b_1 &\geq 0\,, & t_1-0,1\cdot b_1 &\leq 0 \\ t_2-0,05\cdot b_2 &\geq 0\,, & t_2-0,1\cdot b_2 &\leq 0\,. \end{aligned}$$

Input values are: $l=3 \, \mathrm{m}$, $m_{\mathrm{P}}=10 \, \mathrm{kN} \cdot \mathrm{m/m}$; $\alpha_{\mathrm{allow}}=0.5^{\circ}$ (when the rigidity criterion is prime) or $\alpha_{\mathrm{allow}}=1^{0}$ (strength criterion is prime), and E, G, σ_{allow} according to Tab 1.

A set of variants of the problem are solved using MS Excel Solver GRG (Generalized Reduced Gradient) algorithm. The obtained results are given in Tab 2.

Table 2 Optimal values of the dimensions of the cross-section according to both criteria in millimeters, the smallest mass in kilogram, cost per kilogram and the total cost, both in Euros

	Steel S235		Stee	Steel S275		Steel S335		Aluminum EN AW - 6060	
	Strength criteria	Rigidity criteria							
h	450	460	450	460	451	460	454	560	
b_1	225	276	217	276	198	276	272	335	
b_2	180	220	173	220	158	220	217	268	
t_0	23	23	23	23	23	23	23	28	
t_1	12	14	11	14	10	14	14	17	
t_2	18	22	16	22	15	22	21	26	
m	381	451	363	451	345	451	152	230	
Cost per kilogram	0,82	0,82	0,92	0,92	1,03	1.03	3,50	3,50	
Total cost	312,57	370,02	333,79	415,15	354,85	464,78	533,18	803,52	

7. Normal stresses at points A and D and the angle of torsion in the middle of the beam for steel S235 and aluminum EN AW - 6060

Values for normal stresses at points A and D of the cross-section middle line at fixed ends are presented In Tab 3 according to the strength criteria for structural steel S235 and aluminum EN AW – 6060, where $\sigma_{x,1}$, $\sigma_{x,2}$, $\sigma_{x,3}$ and $\sigma_{x,4}$ are the first, the second, the third and the fourth term according to equation (1) and σ_x is the total normal stress according to the same equation.

The last three terms in equation (1) are due to the shear and one can see that influence of shear on normal stress for ratios l/h = 6,67 (steel) and l/h = 6,61 (aluminum) is negligible.

Table 3 Values of normal stresses at points A and D at fixed ends for structural steel S235 and aluminum EN AW-6060 according to the strength criteria

	Steel S235 $l/h = 6,67$					Alum	inum EN	AW – 600	60 $l/h =$	6,61
	$\sigma_{x,1}$	$\sigma_{x,2}$	$\sigma_{x,3}$	$\sigma_{x,4}$	$\sigma_{_{\chi}}$	$\sigma_{x,1}$	$\sigma_{x,2}$	$\sigma_{x,3}$	$\sigma_{x,4}$	$\sigma_{_{\chi}}$
Point A	-146,4	2,32	-2,43	0,59	-145,9	-89,3	1,99	-2,09	0,52	-88,8
Point D	-152,5	2,42	-1,62	-0,48	-152,1	-93,5	2,09	-1,40	-0,41	-93,2

Tab 4 shows given values for the maximum angle of torsion (in the middle of the beam) according to the rigidity criteria for structural steel S235 and aluminum EN AW – 6060, where α_t , $\alpha_{\rm ad}$ are the first and the second term in equation (4) and α is the total angle of torsion according to the same equation.

The second term in equation (4) is due to the shear and the influence the shear on the total angle of torsion for steel S235 is 7,9 % and for aluminum 11,5 %.

Table 4 Values of the total angle of torsion in the middle of the beam for structural steel S235 and aluminum EN AW - 6060 according to the rigidity criteria

Steel S235 $l/h = 6,67$			Aluminum EN AW – 6060 $l/h = 6,61$		
α_{t}	$lpha_{ m ad}$	α	$\alpha_{_{ m t}}$	$lpha_{ m ad}$	α
0,00394	0,00034	0,00428	0,00386	0,00050	0,00436

8. Conclusion

The thin-walled beam with mono-symmetric I-cross-section subjected to the uniformly distributed moments and fixed at its ends is taken under consideration in this paper.

The optimization of the values of the cross-section's dimensions was done using solver GRG. The goal was the smallest mass of the beam. Four types of materials were taken under consideration and two criteria were used: strength criteria and rigidity criteria.

Although the smallest mass of the beam was obtained for aluminum the better choice for material is steel having in mind the cost.

The influence of shear on the normal stress for all types of the material can be neglected according to the strength criteria.

That same influence on the total angle of torsion is for all types of steel according to the rigidity criteria 7,9 % and for the aluminum 11,5 %.

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Matlab Controlled Wireless Sensor Network

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Abstract. In this paper the Matlab possibility to control Wireless Sensor Network (WSN) based on the Arduino microcontroller is presented. Communication is established using the XBee hardware platform through a router connected wirelessly through coordinator to Personal Computer (PC) as a base station. Matlab software is used to control the network and to graphically present the collected data.

Key words: Matlab, Arduino, WSN, XBee

1. Introduction

Arduino is a widely used open source software and hardware platform used for building electronics projects. The Arduino comes in a variety of different types with different capabilities that provide flexibility in choosing the perfect solution. One of the advantages of Arduino platform is that Arduino supports a large number of communication protocols, both wired and wireless. For wireless communications Arduino supports a large number of protocols, like Wi-Fi, Bluetooth (BLE), Thread, MQTT, GSM/3G/4G/5G, ZigBee, Z-wave, RF, 6LoWPAN, GPRS/3G/LTE, NFC, Lora etc. This diversity makes Arduino suitable for use in IoT projects [1]. ZigBee is an IEEE 802.15.4 based short-range wireless networking standard used for two-way communication between sensors and the control system. ZigBee protocol supports multiple network topologies such as point-to-point, point-to-multipoint and mesh networks. The basic characteristics are low duty cycle that assures low energy consumption, Direct Sequence Spread Spectrum (DSSS), Low latency, up to 65,000 nodes per network, 128-bit AES encryption for secure data connections, collision avoidance, retries and acknowledgements. ZigBee protocol is widely used for wireless communication [2], [3].

MATLAB is a language for technical computing that integrates computation, visualization, and programming in an easy-to-use environment. With MATLAB Support Package for Arduino hardware MATLAB can be used to interactively communicate with an Arduino board. The package enables to acquire data from analog and digital sensors connected to the Arduino board, control other devices with digital and PWM outputs, access peripheral devices and sensors connected over I²C or SPI, communicate with an Arduino board over a USB cable or wirelessly. Results from I/O instructions are obtained immediately, without

compiling, since MATLAB is a high-level interpreted language. This provides users to quickly analyse and visualize data collected from your Arduino.

The aim of this paper is to demonstrate how to set up Arduino and MATLAB to connect them using ZigBee protocol, as shown in Figure 1.

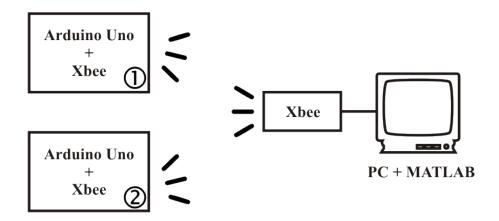


Figure 1 Wireless Sensor Network Alfresco administrator interface

Digi XBee module is connected to the Personal Computer trough a USB port using XBee explorer. Two Arduino Uno boards are equipped with the XBee module and temperature sensor (DHT 11). Matlab is used to provide communication and control of Arduino boards, and for graphical presentation of collected measurements.

There are numerus papers addressing this issue [4], [5]. Unfortunately, it is difficult to find in detail how to adjust the settings of Arduino and Matlab to allow their communication. On MathWorks website, there are only examples how to control remote XBee module (not connected to Arduino) via Matlab [6], [7]. Arduino wireless control provides numerous measurements and control functionalities, which are limited in the case of XBee control only. Software used: Windows 7 Professional, Digi XCTU Version 6.5.0, Arduino Software (IDE) Version 1.8.12, Matlab Version 9.7.0.1247435 (R2019b).

2. Setting up XBee

At https://www.digi.com/xbee there are papers necessary for understanding how to work with XBee. In addition, on this website, Digi XCTU software for configuring XBee modules can be downloaded. At the beginning, while creating XBee network, it is necessary to decide which operating mode for XBee to select. XBee devices can use transparent (AT) or API operating mode to transmit data over the serial interface. A mixture of devices running API mode and transparent mode in a network can be used. Advantages and disadvantages between these two modes are presented in Table 1.

Table 1 Advantages and disadvantages between AT and API operating mode

Transparent operating mode	API operating mode
Advantages:	Advantages:
• Provides a simple interface that makes it easy to get started with XBee devices.	Can set or read the configuration of remote XBee devices in the network.
• Easy for an application to support; what you send is exactly what other modules get, and vice versa.	Can transmit data to one or multiple destinations; this is much faster than transparent mode where the configuration

• Works very well for two-way communication between XBee devices.

- must be updated to establish a new destination.
- Received data includes the sender's address.
- Received data includes transmission details and reasons for success or failure.
- Several advanced features, such as advanced networking diagnostics, and firmware upgrades

Disadvantages:

- Cannot set or read the configuration of remote XBee devices in the network.
- Must first update the configuration to establish a new destination and transmit data.
- Cannot identify the source of received data, as it does not include the sender's address.
- Received data does not include transmission details or the reasons for success or failure.
- Does not offer the advanced features of API mode, including advanced networking diagnostics, and firmware upgrades.

Disadvantages:

- Interface is more complex; data is structured in packets with a specific format.
- More difficult to support; transmissions are structured in packets that need to be parsed (to get data) or created (to transmit data).
- Sent data and received data are not identical; received packets include some control data and extra information.

(source: https://www.digi.com/resources/documentation/Digidocs/90001942-13/concepts/c xbee comparing at api modes.htm?TocPath=How%20XBee%20devices%20work%7CSerial%2 Ocommunication%7C _____2)

It is obvious that transparent operating mode (AT) is simpler to use, but API operating mode provides features that are more advanced. In this paper, XBees (Series 2) are configured to work in transparent mode. XBee connected to PC using XBee explorer, depicted in Figure 2, is set to work as:

• Product family: XB24-ZB.

• Function set: ZigBee Coordinator AT.

• Firmware version: 20A7.

• ID PAN ID: 1234

XBees connected to Arduino are set to work as:

• Product family: XB24-ZB.

• Function set: ZigBee Router AT.

• Firmware version: 22A7.

• ID PAN ID: 1234



Figure 2 XBee exporer

Starting XCTU and clicking the button "Discover radio modules connected to your machine (Ctrl+Shift+D)". When XBee is found, clicking on it in the left pane, settings will be shown in the right pane, as depicted in Figure 3. By clicking the button "Update" and choosing proper operating mode, XBee programming starts. After programming, it is possible to adjust parameters in the right pane.

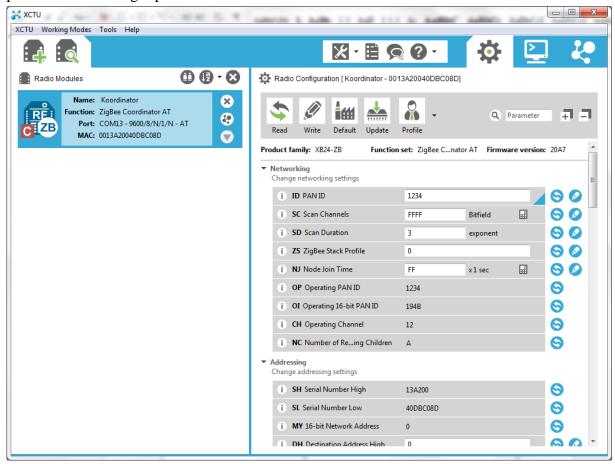
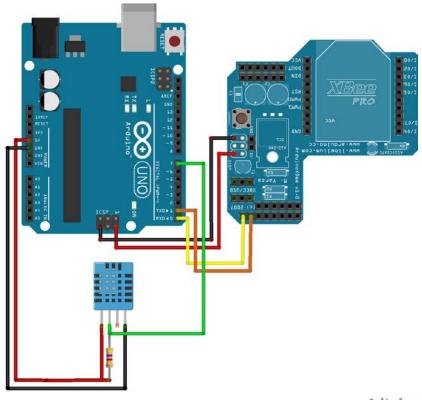


Figure 3 Digi XCTU

3. Setting up Arduino board

Arduino wiring diagram is depicted in Figure 4. DHT11 pin 2 is connected to Arduino Uno digital pin 7. A $10~\text{k}\Omega$ pull-up resistor is needed between the signal line and 5 V to make sure the signal level stays high by default. XBee is connected using XBee Shield v.1.3 (developed with Libelium.com, today deprecated product). It is important to set jumper to XBee position instead to USB. DHT11 specifications are given in Table 2.



fritzing

Figure 4 Wiring diagram/schematics

Table 2 DHT11 specifications

Operating voltage	3.3 – 5.5 V
Operating current	Measuring: 0.3 mA, standby: 60 μA
Humidity measuring range	5 – 95 % RH ± 5 % RH
Temperature measuring range	$-20 - 60 ^{\circ}\text{C} \pm 2 ^{\circ}\text{C}$
Sampling period	> 2 seconds

DHT11 sensor has a low sampling period and narrow operating range, but its advantage is low cost. For purposes of this paper, its characteristics are not important since the goal is to show the XBee communication. If more accurate measurements are needed, DHT22 can be used. Arduino code is very simple and it is depicted in Figure 5.

```
#include "DHT.h"
                                                   //include dht header file
#define DHTPIN 7
                                                   //define pin 7 to take
output
#define DHTTYPE DHT11
                                                   //select dht11 rather
than dht22
DHT dht(DHTPIN, DHTTYPE);
                                                   //function call from dht
header file
unsigned int state = 0;
float t=0;
                                                 //variable for temperature
int LED = 13;
                                                 //LED pin
```

```
void setup()
{
              pinMode(LED, OUTPUT);
                                                 //set LED pin13 as output
              digitalWrite(LED, LOW);
              Serial.begin(9600);
                                                 //baud rate communication
              dht.begin();
                                                  //start communication with
dht11
void loop()
           if(Serial.available() > 0)
                                                //Get the number of bytes
(characters) available for reading from the serial port
              state = Serial.read();
                                                 //Read incoming data
    switch (state)
                                                //select operation which is
to be performed
      case '1':
                                                  //TURN LED ON
                 digitalWrite(LED, HIGH);
                 break;
      case '2':
                                                  //TURN LED OFF
                 digitalWrite(LED, LOW);
                 break;
      case '3':
                                                  //READ TEMPERATURE
                 t = dht.readTemperature();
                                                 // Read temperature from
digital pin 7
                 Serial.println(t);
                                                 //send temperature to XBee
                 break;
      }
```

Figure 5 Arduino code

For testing purposes, the code is made very simple. After receiving "1", Arduino will turn on built in led. When it receives "2", it will turn off led, and after received "3" Arduino sends temperature sensed from DHT11. Generally, instead turning led ON-OFF, Arduino can control any device connected to any digital pin. On the same way, Arduino can read data from any sensor, or more of them, and send data to PC. The second Arduino has the same code. The only difference is that "1" is replaced with "4", "2" with "5", and "3" with "6". Since XBee is set to work in transparent mode (AT), there is no need for XBee library. It is only necessary to connect XBee RX/TX to Arduino RX/TX (digital pin 0/digital pin 1).

4. Testing network

After programming all three XBees and two Arduions, it is possible to check their connectivity using Digi XCTU. XBee coordinator should be plugged to PC. After starting Digi XCTU and discovering coordinator (Figure 2), it is necessary to click on "Discover radio nodes in the same network" and to add XBee connected to Arduino. Next, clicking to "Switch to Console working node (Alt+C)" and to button "Open serial connection with the radio module" network will be ready for communication. Communication can be tested by creating data packets and then sending them to Arduinos. The user can turn ON/OFF Arduino built in led and read data from DHT11 sensors. This procedure is depicted in Figure 6.

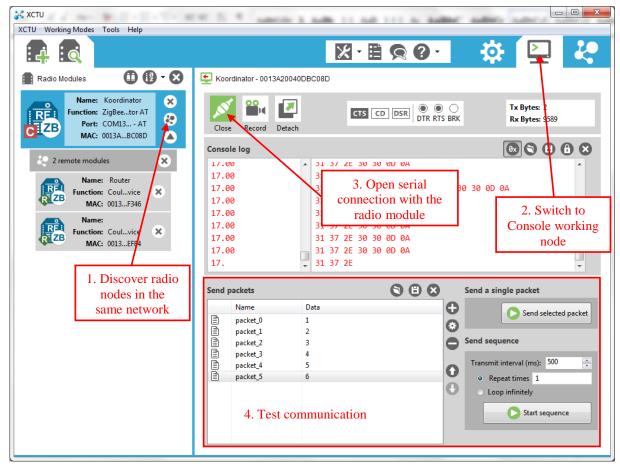


Figure 6 Testing network connectivity

5. Matlab code

In this section Matlab code will be explained.

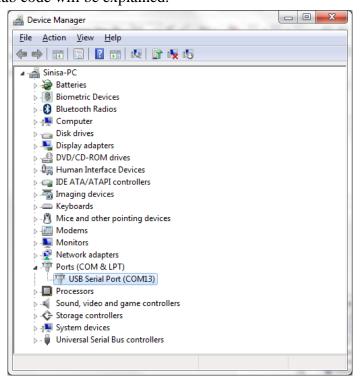


Figure 7 Windows 7 Device Manager

First, it is necessary to plug XBee coordinator to PC using XBee explorer. After the PC installs XBee, using Device Manager it can be found to which serial port the XBee is connected, as depicted on Figure 7.

Parts of the Matlab code are depicted in Figures 8 and 9. Explanation of used Matlab commands is given in Table 3.

```
delete(instrfindall);
clear s;
s = serial('COM13');
set(s,'BaudRate', 9600);
set(s,'DataBits', 8);
set(s,'StopBits', 1);
fopen(s);
fwrite(s,'1');
fclose(s);
```

Figure 8 Matlab code for turn LED ON

```
delete(instrfindall);
clear s;
s = serial('COM13');
set(s,'BaudRate', 9600);
set(s,'DataBits', 8);
set(s,'StopBits', 1);
fopen(s);
fwrite(s,'3');
fscanf(s,'%f')
fclose(s);
```

Figure 9 Matlab code for turn read single data from serial port

Table 3 Matlab commands explanation

Matlab command	Explanation
instrfindall	Get all communication interface objects (serial port objects) from
msumidan	memory to MATLAB workspace.
	Constructs a serial port object associated with port, PORT. If PORT
serial('PORT')	does not exist or is in use, you will not be able to connect the serial port
	object to the device.
	When the serial port object is constructed, the object's Status property is
fopen	closed. Once the object is connected to the serial port with the FOPEN
Topen	function, the Status property is configured to open. Only one serial port
	object may be connected to a serial port at a time.
fwrite	Write binary data to file.
fscanf	Read data from serial port object. Parameter '%f' stands for "Floating-
	point fields"
fclose	Disconnect the serial port object from the serial port.

In case that we want to read more than one data from the serial port, we should put in the Matlab code "s.ReadAsyncMode = 'continuous';" after "fopen".

The same code is for turning led ON and OFF, the only difference is in sending data to Arduino. If Arduino 1 receives "I" the led will turn ON, and when received "2" it will turn it OFF.

Measured time, using *tic/toc* commands, for the program depicted in Figure 8 is 1.57 seconds, and for the program depicted on Figure 9 is 1.93 seconds.



Figure 10 Matlab user interface

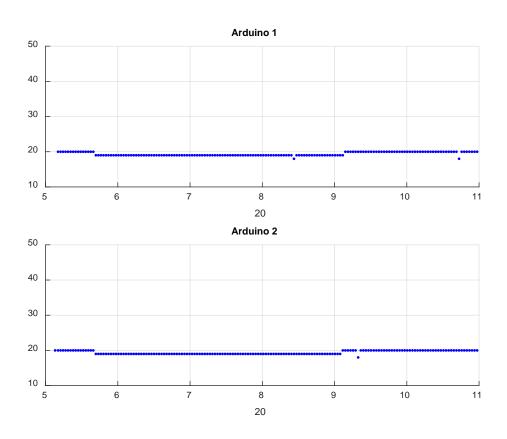


Figure 11 Graphical representation of measured temperatures

For testing purposes, the user interface is made very simple. It is created using Matlab *Guide*. By clicking the ON/OFF switch Matlab starts to measure temperature. Using the Matlab *timer* function, measuring time is set to 5 minutes. With the *clock* function (*hour*, *minute*, *second*) X-axis is set to represent real clock time in *hh:mm* format.

6. Conclusion

Matlab is a powerful tool used for many engineering applications. In this paper it is demonstrated how to use Matlab to control Arduino using ZigBee wireless network. Used Matlab commands are made for previous versions of Matlab and because of compatibility considerations their use is not recommended starting Matlab R2019b. Also, used XBee transparent mode operation is not suitable for use in control application and communication in network is very slow. Despite its shortcomings, the connection method shown is a good starting point for understanding and developing how to connect Matlab to the XBee network. Future work will be focused on working with the new Matlab commands and setting up XBee network in API operating mode.

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Wind Turbine Concept for Educational Purposes

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Abstract. The environmental awareness of modern society is changing regard to the use of electrical sources. Change of climatic conditions, as a consequence of fossil fuel energy use, increases the need for renewable energy research. Consequently, a wind turbine will be installed on the premises of the University Department of Professional Studies at the University of Split, for educational purposes. Based on an annual assessment of energy production and consumption a wind turbine project is developed. This paper explains the main concept of wind turbine operation. The system is controlled manually or remotely by programmable logic controller (PLC) and supervisory control and data acquisition (SCADA), with the possibility to measure and monitor all relevant points in the system. The purpose of this system is to be used to perform laboratory exercises and to educate students of the Department. It also describes the possibility of integrating the system into an internal electric power system.

Key words: wind turbine, wind farm, renewable energy sources, power generation, SCADA

1. Introduction

This paper describes a wind turbine system that will be installed within the University Department of Professional Studies at the University of Split for the purpose of students' education. The first part of the paper gives general overview of wind energy, wind turbine system and the associated generator. Furthermore, the main components of the system, their sizing and installation are explained. Design of the system was based on annual assessment of energy production, consumption and storage.

Second part of the paper describes how the system can be controlled and monitored. It can be done manually (locally) via the control panel or automatically (remotely) via the PLC and SCADA system. The system is designed to enable measurements in all relevant points with the possibility of reading them on the measuring instruments and the computer. Monitoring and processing of measuring data will be also possible through the Internet.

In the last part, we present an overview of the laboratory exercises that will be performed on the system and the possibilities of integrating wind turbine system into the internal power system.

2. Wind turbine overview

Wind speed is a fundamental parameter in order to design wind turbine. Before designing a wind turbine, it is necessary to determine the wind potential of the site due to the interdependence of the wind speed and produced electrical energy. Optimal data are obtained by measuring at a potential location using anemometers over a long period of time. In addition, wind data for a specific location issued by the State Meteorological Institute or software tools can be used to analyze the suitability of an area for the purpose of harnessing wind energy.

The conversion of wind kinetic energy into kinetic energy of shaft rotation is performed through the rotor blades and wind turbine. The optimum degree of aerodynamic conversion is the so-called Betz's limit, which equals 59.3% [1]. When converting energy, in addition to wind speed and air density, the surface described by the rotor blades and their shape should be considered. In practice, additional energy conversion losses are inevitable so modern wind turbines achieve maximum efficiency of 45-50%. Maximum transformed power is determined by the following equation derived by Carl Betz:

$$P_{t,max} = 0.593 * \frac{\rho * v^3}{2} \tag{1}$$

where:

 $P_{t,max}$ - maximum transformed power per unit area

 ρ - air density

v - wind speed

Due to the variable wind speed, the main considerations are based on the achieving maximum efficiency of wind turbine. The wind turbine generator can be driven at a constant or variable speed. With the development of power electronics, synchronous generators are used instead of asynchronous, which can be driven at variable speeds. This approach maximizes the use of wind energy.

Furthermore, with discovery of strong permanent magnets such as neodymium magnets (*Neodymium Iron-Boron*, NdFeB), preference is given to synchronous generators with permanent magnets (*Permanent Magnet Synchronous Generator*, PMSG). These generators are extremely efficient, but their limitation is the constant excitement that cannot be controlled. [2]

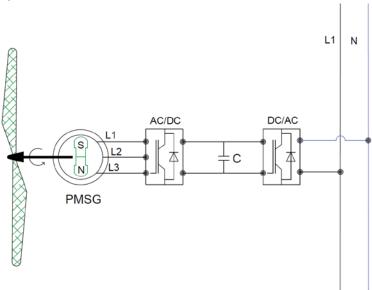


Figure 1 Power grid connection of synchronous generator

The structure of wind turbine based on synchronous generator with permanent magnets is shown in Figure 1. In a design like this, the generator is driven by direct drive without gearbox. This reduces mechanical transmission losses, which simplifies the device itself. On the generator side there is an inverter, which has the task of controlling the torque of the generator in order to maintain optimum power. The second converter controls the power supplied to the power grid. Braking of low-power wind turbines that charge batteries is often performed using a short circuit. [3]

3. Wind turbine design

A wind turbine with a monitoring and control system will be installed at the University Department of Professional Studies at the University of Split. The system will be used for students' education and therefore will be primarily adapted for performing laboratory exercises with the possibility of its integration later into the internal electrical power system.

The first step in design is based on the estimation of electrical energy consumption and production. Consumption shown in Table 1 refers to the system's and consumers' power supplies required to perform laboratory exercises.

Table 1	Estimation	of electrical	energy	consumption
---------	------------	---------------	--------	-------------

Consumer	Power [W]	Units	Hours [h]	Consumption [Wh/day]
Consumer 1	50	1	1	50
Consumer 2	500	1	0,2	100
Consumer 3	20	1	24	480
Total Consumption				630

Next step is to determine the wind potential of the location where the wind turbine will be mounted. Figure 2 shows a preview of the wind rose for the wider Split area, which shows the average wind speed and direction for December 2019. Daily wind speed for the specified area is shown in Figure 3.

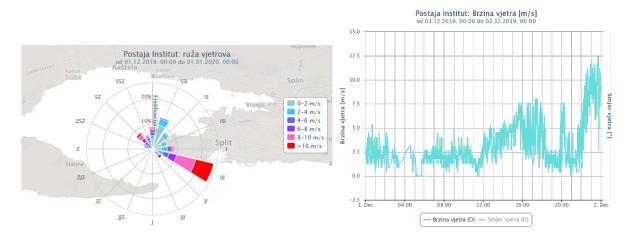


Figure 2 Wind rose – area of Split [4]

Figure 3 Wind speed – area of Split [4]

Graphical curves of selected wind turbine for the power and produced electrical energy in relation to the wind speed are shown in Figure 4 and 5.

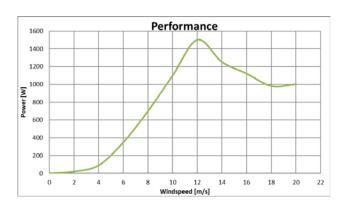


Figure 4 Power vs. Wind speed curve for wind turbine

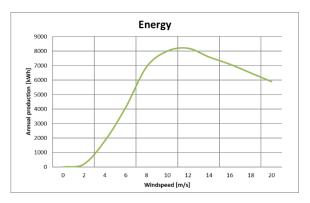


Figure 5 Annual energy produced vs. Wind speed curve

According to the shown curves and analysis of wind data is determined the potential of electrical energy production. *Bplanner* software tool from Bornay was used to calculate an estimation of wind speed and electrical energy production during one-year period at monthly intervals, as shown in Table 2 [5].

Table 2 Average wind speed, produced and consumed electrical energy

Month	Windspeed [m/s]	Wind production [kWh/day]	Consumption [kWh/day]
January	2,88	1,62	0,63
February	3,1	1,99	0,63
March	2,97	1,62	0,63
April	2,98	1,62	0,63
May	2,5	1,01	0,63
June	2,46	1,01	0,63
July	2,42	1,01	0,63
August	2,45	1,01	0,63
September	2,41	1,01	0,63
October	2,72	1,29	0,63
November	2,81	1,62	0,63
December	3,01	1,99	0,63

The ratio of produced and consumed electrical energy chart can be seen in Figure 6. Based on these data, the wind turbine and other components of the system are dimensioned.

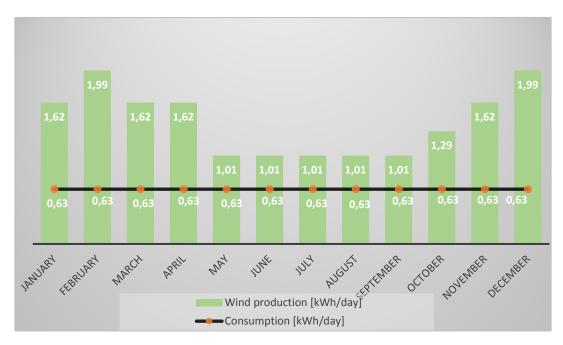


Figure 6 Chart of produced and consumed electrical energy

The wind turbine, as a basic component of the system, is dimensioned so that according to location's wind potential produces an adequate amount of electrical energy. The unit is controlled via a MPPT controller. In our case, the function of the controller is also to optimize the charging of the batteries. Batteries are used as additional storage of energy in order to make the system independent of the power grid. With fully charged batteries, system has autonomy of five days with the possibility that, if there is not enough wind, the batteries can be recharged from power grid. This is provided by a bidirectional converter that can conduct energy in both directions. In the first case it works as a rectifier, while in the second it works as an inverter and supplies 230V AC to consumers. Figure 7 shows the installation of wind turbine system with all the major system components.

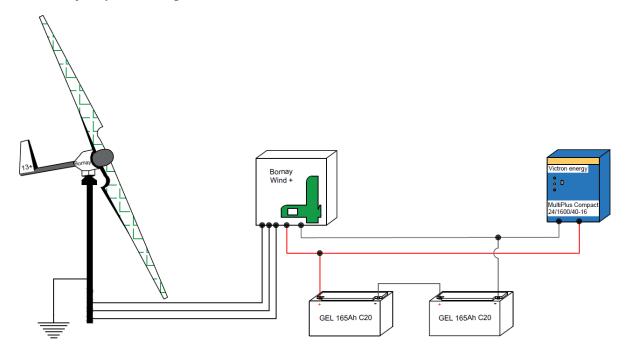


Figure 7 Installation of wind turbine system [6]

Detailed technical specifications of the components can be found in Table 3 [7, 8].

Table 3 Technical specifications of wind turbine main components

Wind turbine		
Nominal power	1500 W	
Nominal voltage	220 V	
Nominal RPM	600	
Alternator type	Three phases permanent magnet	
Number of blades	2	
Diameter	2,86 m	
Wind speed		
Operation range	2-30 m/s	
Turn on	3 m/s	
Nominal power	12 m/s	
Automatic brake system	14 m/s	
Maximum	60 m/s	
Model	Wind 13+	
Controller		
Input voltage	80 - 480 V	
Output voltage	12 V/24 V/48 V	
Maximum power	3000 W	
Maximum braking power	5000 W	
Anemometer input	Yes	
Model	Wind 13+	
Batteries		
Voltage	24 V	
Autonomy	5 days	
Battery capacity	165 Ah C20	
Units	2	
Model	Victron 165 Ah/ 12 V GEL	
Inverter	24 V	
Input voltage	24 V	
Output voltage	230 V	
Frequency	50 Hz	
Inverter power 25 C	1300 W	
Charger	Yes (16 A)	
Model	Phoenix MultiPlus C 24/1600/40-16	

4. Wind turbine monitoring and control

In order to effectively manage the system for the scope of laboratory exercises, the system can be controlled locally through the control cabinet and remotely using the PLC. Energy flows through the system can be fully controlled and measured. Figure 8 shows wind turbine wiring diagram with all major components. The bidirectional converter is connected to the power grid with the contactor KM1. Contactor KM2 enables switching on and off 230V AC consumers connected to the inverter. The MPPT controller, in addition to charging the batteries, is also used to brake the wind turbine by resistor or short circuit and thus to disconnect power from the generator.

For the purpose of analyzing the state of the system, measurements are made at all relevant points. The measuring points and measuring units are shown in Figure 8.

All measured data can be read on the control cabinet's measuring instruments and on the computer using the SCADA system. The status of the system can also be monitored through the Internet, i.e. online.

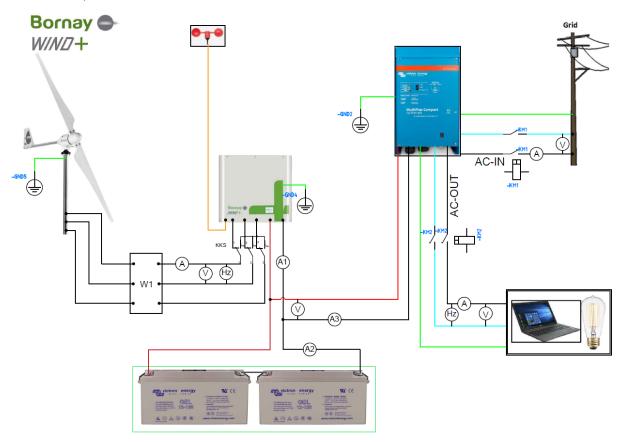


Figure 8 Wind turbine wiring diagram

Figure 9 shows wind turbine wiring diagram for the control part. The control is performed with relays and associated contactors. As shown in Figure 9, relays KA1 and KA2 control the contactors KM1 (AC-Input) and KM2 (AC-Output), and the relay KA4 controls the brake of wind turbine. In order to prevent the brake from being accidentally actuated, an additional brake permit must be issued. This is done by pressing the permit pushbutton that activates relay KA5, which is a precondition for engaging the brake. Once the braking has been activated, the KA5 relay is reset and the whole procedure must be repeated for new braking.

Local control of the system is managed through S_x pushbuttons. By pressing the pushbuttons with NO contact (normally open) appropriate relays and contactors are activated and certain control lines are switched on, e.g. AC-Input, AC-Output, Brake-ON, etc. Pushbuttons with NC contact (normally closed) are used for theirs' disconnection.

Remote control is implemented via digital outputs on the PLC and SCADA system. Through digital outputs, the voltage is applied to the desired relays.

The control mode selection is made on control panel with SA2 switch, which supplies 24V DC voltage to the S_x pushbuttons or the PLC through emergency stop button (ES).

By pressing emergency stop button user can switch off entire system in case of hazardous situation.

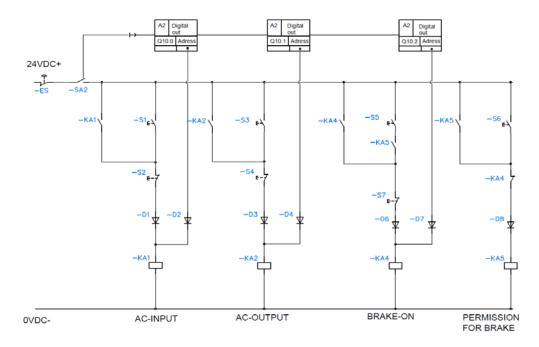


Figure 9 Wind turbine wiring diagram for the control part

Remote control is performed using Siemens S7-1200 PLC with CPU version 1214C which has the possibility of additional connection of up to 8 signal modules and 3 communication modules. PLC management and the SCADA system are implemented using the Siemens TIA Portal v15 platform in which these two functions are integrated, which simplifies the creation of the SCADA application itself. In addition to displaying the measuring data, SCADA also allows remote control of the system via the appropriate buttons. In the upper left of the SCADA, the user can see general system status information such as control mode, PLC power supply status, battery status, emergency stop status or system error status. Errors are recorded through a list of alarms that the user can see with the date and time of their occurrence. All the errors need to be acknowledged by the user.

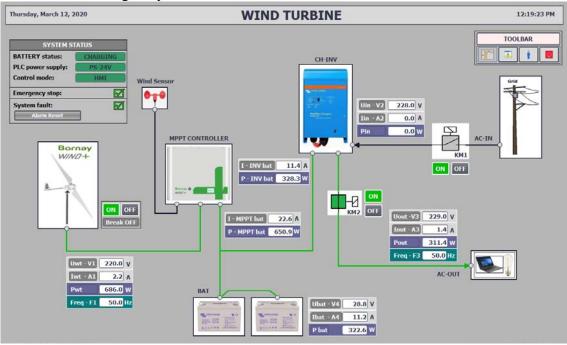


Figure 10 Wind turbine SCADA

Communication between the PLC and SCADA is made over the LAN to allow communication with other parts of the energy system. Wind turbine SCADA graphical interface example is shown in Figure 10.

5. Application of wind turbine in education

The presented wind turbine system is primarily intended for the education of electrical engineering students. Through laboratory exercises students will analyze and study the operation of entire system as well as the individual components of the system. Particular emphasis is given to the conversion of wind energy, as a renewable energy source, into electrical energy and to efficiency of wind turbine. Students will also be introduced to the methods of control in electrical systems and to the preparation and understanding of technical documentation.

With the further development of the power engineering laboratory, it is foreseen that the wind turbine would be integrated into the internal power system, which would consist of a photovoltaic system, a synchronous generator driven by a controllable asynchronous motor and a consumer field. The intention is that all sources can be synchronized and integrated into the system to be able to deliver required power to the consumer field. Management would be also possible locally or remotely via the SCADA system. Figure 11 shows a graphical interface of the SCADA power system with the visualized power flows between individual sources and consumer field.

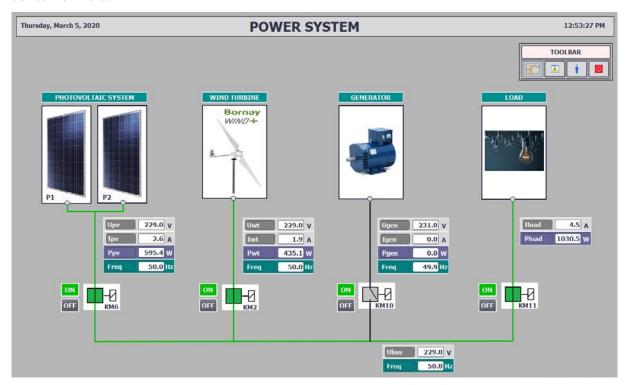


Figure 11 SCADA for Electrical Power System

6. Conclusion

The paper describes a sequence of actions in the design of a wind turbine system, from determining the wind potential for a given location, estimating the consumption and production of electrical energy, dimensioning the system elements to designing the control and monitoring. The intention was to design a system that would allow students to become more familiar with: the use of wind energy, the principle of operation of individual components and entire system,

and the management and monitoring of the system. The wind turbine system is intended to be part of a future internal power system that will be a hybrid type and will integrate solar energy, wind energy and energy produced by a synchronous generator driven by a controllable asynchronous motor. Considering that there is an increasing need for the use of renewable energy sources, we have the opinion that such an equipped laboratory at the University Department of Professional Studies at the University of Split will make a significant contribution to the education of future electrical engineers.

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Acceptance of m-learning at the University Department of Professional Studies at the University of Split

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Abstract. In the 21st century, technology plays a key role in our daily lives and brings new challenges in the field of education. The development of mobile devices and wireless technology enables mlearning, the latest development form of e-learning. Mobile devices such as smartphones, netbooks, or tablets provide higher education institutions with flexible tools to complement existing technologies and the opportunity to learn no matter time and place. The wide availability and relatively low cost of mobile devices opens a wide range of new and exciting learning and teaching opportunities. Since students are highly exposed to mobile technologies it is to be expected that m-learning will have an important role in the development of teaching and learning methods in higher education. However, the effectiveness of m-learning will be based on students' acceptance and satisfaction with this technology. Therefore, the aim of this article is to survey whether students at the University of Professional Studies at the University of Split, Croatia are well equipped for mobile learning; students' habits when using mobile devices, whether they use them, and if so how often they use them for formal and/or non-formal learning, students' opinions on m-learning and what they expect from mobile devices in teaching. The results of this survey will provide a meaningful direction for future development of m-learning at the University of Professional Studies at the University of Split.

Key words: m-learning, mobile technologies, higher education, digital natives

1. Introduction

15-20 years back it was hard to imagine that today people would use their mobile devices for socializing, communication, entertainment, photography, video recording, learning, daily business, etc.

Digital 2020 Global Overview reports [1] show that 4.54 billion people around the world are using the internet at the start of 2020 which is an increase of 7 percent compared to January 2019. There are **3.80 billion social media users** in January 2020, which is increase of more than 9 percent in relation to the beginning of 2019; more than **5.19 billion people** now use **mobile phones**, with user numbers up by 124 million (2.4 percent) over the past year.

The average internet user spends 6 hours and 43 minutes online each day. Assuming that we sleep for 8 hours a day, that means we currently spend more than 40 percent of our waking lives using the internet [1].

According to Digital 2019 Croatia – there are 5.15 million mobile subscribers, 3.79 million internet users and 2.0 million active social media users [2].

It is obvious that digital, mobile, and social media have become a necessary part of everyday life for people all over the world.

As more and more people use mobile technology the question is: *Can we learn more creatively and efficiently with the help of mobile devices*?

Most people today use smartphones whose ability to store and process data, and to connect to the Internet and other devices, enables a much wider application than telecommunications itself. The strong development and production of mobile devices in the last few years has greatly increased the opportunities and the interest of users for mobile learning. As a result, the feasibility of this form of learning is not questionable at all. However, in order to understand how to use mobile devices for the purpose of improving students' learning experience, we must first understand their motivation for using mobile technologies in education.

Therefore, the aim of this article has following goals: to survey whether students at the University of Professional Studies, University of Split, Croatia, are well equipped for mobile learning. Also, students' habits when using mobile devices, whether they use them, and if so, how often they use them for formal and/or non-formal learning, students' opinions on mlearning and what they expect from mobile devices in teaching.

2. M-learning

The rapid development of digital technology completely changes learning, society relations and the exchange of information with young people who access them and know how to use them.

For the first time, e-learning emerged in the late 80s and in the 90s. Today's forms of e-learning include various aspects of the use of information and communication technologies that have increased educational opportunities and opened the door to new teaching methods. Teachers and students have adopted technology as a normal part of their curriculum. Multimedia, graphics, animations, simulations and virtual environments offer students a way to visualize and actively participate in content. Many e-learning platforms have been developed [3]. Numerous examples of remote and virtual labs have been developed [4, 5].

Recent technological advancements have brought about a new generation of learning environments. A growing number of mobile phone users and the increasing availability of other portable and wireless devices are changing the landscape of technology supported learning [6].

Mobile learning was the next logical step in the development of e-learning. "Mobile learning (m-learning) is a recent technology that has been developed rapidly to deliver e-learning using personal mobile devices without posing any restrictions on time and location" [7]. "M-learning can take place in any location, at any time, including traditional learning environments such as classrooms as well as in workplaces, at home, in community locations and in transit" [8].

M-learning uses wireless communication devices to deliver learning materials and a variety of educational content. These materials can take the form of simple text to complex multimedia content with image, audio and video file formats. M-learning is developed by using many platforms, languages, and technologies. Thus, learning can be carried out anywhere, anytime for as long as an institution's networking system can gain access to the wireless coverage [9].

With m-learning students can access documents or document libraries, access quizzes and self-assessment as questions or games, participate in lessons and tutorials, receive lectures archived

or broadcasted live, access to video clips or audio libraries, read asynchronous postings, exhibit student work and participate in virtual learning communities on the go [6].

Mobile devices, particularly smart phones, offer additional benefits and learning opportunities in a learning environment as compared to traditional learning methods [10]. The use of mlearning has a significant positive effect on the effectiveness of learning. It can facilitate ease of learning, cultivate interest in learning, clarify learning, foster self-learning, and overcome learning difficulties [11].

The purpose of mobile learning is not to replace traditional classroom teaching, nor it is intended to convert all learning content into a mobile format, but to consider how mobile devices can be used to enhance the learning experience and to strengthen and coordinate its overall strategy.

Today's students belong to generations that were born into a world where the Internet, social networks and mobile technologies have always existed. They have grown up with technology that gives them easy access to information, making their way of thinking and acquiring information significantly different from previous generations of students.

Since students are highly exposed to mobile technologies it is to be expected that m-learning will have an important role in the development of teaching and learning methods in higher education.

Abu-al-aish, Love [12] stated that m-learning will play an increasingly significant role in the development of teaching and learning methods for higher education. However, the successful implementation of m-learning in higher education will be based on users' acceptance of this technology.

There are several researchers who have studied the acceptance of m-learning by students. Thus, Radovan Vrana [13] finds that while the acceptance of mobile technologies comes with the wide availability of mobile devices in students' working and personal environment, the acceptance and active participation in m-learning requires additional effort on the part of the students by using it more frequently, and on the part of the academic institutions by promoting m-learning and improving it on the basis of research like this one. Blanka Klimova and Petra Poulova [14] state that generally, it thus seems that mobile learning has the potential of helping students learn efficiently if this learning is carefully planned, observed, checked, evaluated and constantly modified by all stakeholders (teachers, students, peers, institutional management or parents). Mohd Shoaib Ansari [15] finds that mobile learning apps can be very useful in the higher education environment. Furthermore, results showed that students had the adequate knowledge and awareness to use mobile technology and the Internet in their educational environment. Al-adwan, et al [16] state that results reveal that students' intentions to adopt mlearning is influenced by several factors that include the relative advantage, complexity, social influence, perceived enjoyment, and the self-management of learning. On the other hand, selfmanagement of learning is considered as a key inhibitor in terms of the adoption of m-learning.

The use of mobile technologies brought certain advantages such as: flexibility, collaboration, motivation, accessibility and portability [17]. M-learning promotes learner-centred and personalized learning approaches by enabling students to interact and engage with educational processes away from traditional learning places such as classrooms and desktop computers [18]. In addition, mobile devices are more easily portable and cheaper than desktops and laptops, which gives m-learning the advantage over other forms of e-learning. Also, some of the standard smartphone applications provide quality support learning in terms of planning, taking notes, recording audio and video, communication, etc.

M-learning certainly has its disadvantages such as: small screens of mobile phones and PDAs, limited storage capacities in PDAs, battery life/charge, lack of common operating system, lack of common hardware platform make it difficult to develop content for all, less robust, still

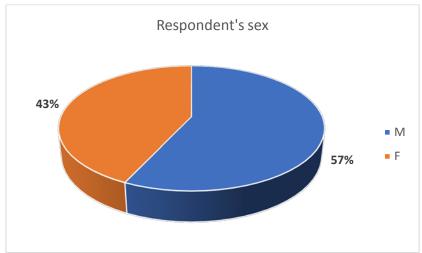
difficult to use moving graphics, limited potential for expansion with some devices, devices can become out of date quickly, wireless bandwidth is limited and may degrade with a larger number of users, difficulties with printing, unless connected to a network [6].

3. Methodology

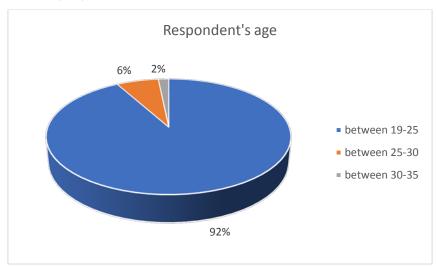
At the beginning of 2020, 309 students of the undergraduate professional study, University Department of Professional Studies at the University of Split, completed an online questionnaire survey in order to find out their attitude towards m-learning. The questionnaire consists of 19 questions divided into 3 sections. The first section focusses on the users' profile such as gender, age, study programmes, year of study and status. The second part covers students' habits when using mobile devices. The third section investigates students' opinion on mobile learning and what they expect from mobile devices in teaching.

4. Data Analysis and Results

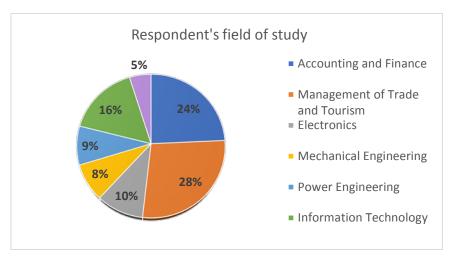
Among the 309 students who completed the survey, 176 were men and 133 women.



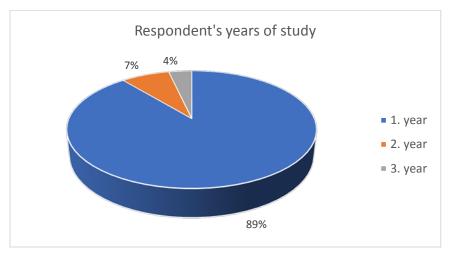
The biggest group of students were between 19-25 years old, 284 (92%). Then 20 (6%) were between 25-30 and 5 (2%) between 30-35.



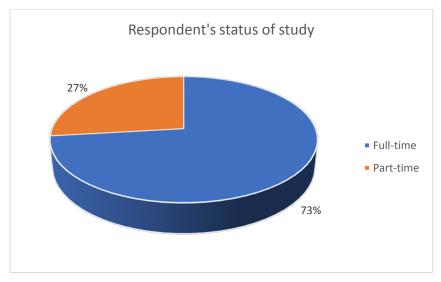
The largest number of students were enrolled in studying Management of Trade and Tourism 85 (28%) and Accounting and Finance 75 (24%), followed by students of Information Technology 50 (16%), Electronics 31 (10%), Power Engineering 27 (9%), Mechanical Engineering 26 (8%) and Business Trade 15 (5%).



Most students were enrolled in 1^{st} year 275 (89%), then 23 (7%) in 2^{nd} year and 11 (4%) in 3^{rd} year.

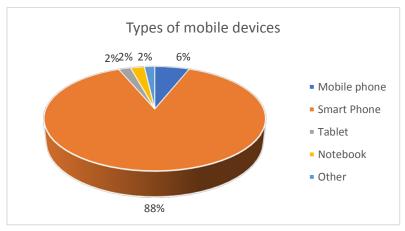


Full-time students made up the big group of 226 (73%) students while there were 83 (27%) part-time students.



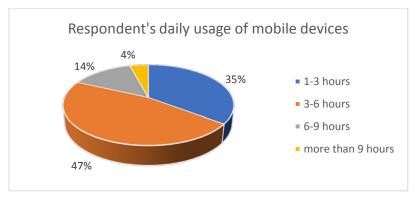
Question: What type of mobile device do you own? (multiple answers permitted)

The research revealed that $291 \ (88\%)$ students owned a smart phone, then $8 \ (2\%)$ owned a notebook, $7 \ (2\%)$ owned a tablet, $6 \ (2\%)$ some other mobile device, while only $20 \ (6\%)$ owned a regular mobile phone.



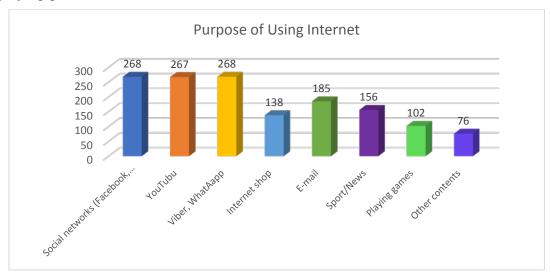
Question: How much time do you spend on mobile devices every day?

Almost 144 (47%) students use mobile devices 3-6 hours per day; 109 (35%) use it for 1-3 hours per day; 43 (14%) use it for 6-9 hours a day and only 13 (4%) use it for more than 9 hours per day.



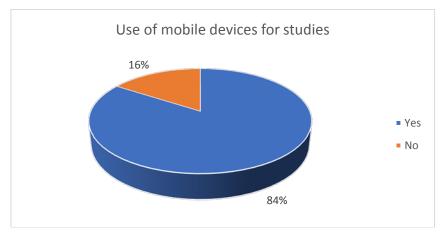
Question: Purpose of using Internet (multiple answers permitted)

The study revealed that most students use the Internet to access social networking 268 (18%), Viber, WhatsApp 268 (18%) and YouTube 267 (18%). There are 185 (13%) students who use the Internet for e-mail, 156 (11%) for sports/news, 138 (9%) for internet shopping, 102 (7%) for playing games, and 76 (5%) for other contents.



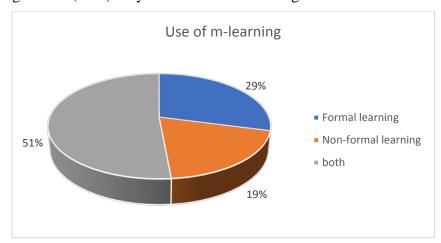
Question: Do you use a mobile device for learning?

Most of the students, 260 (84%) use the mobile device for their studies, while 49 (16%) do not.



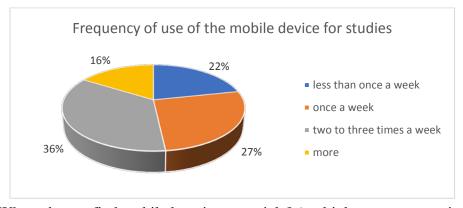
Question: Do you use m-learning for formal or non-formal study?

As far as the use of mobile devices for learning is concerned, 159 (51%) of students use mobile device for formal and non-formal learning, while 90 (29%) of them use mobile device only for formal learning and 60 (19%) only for non-formal learning.



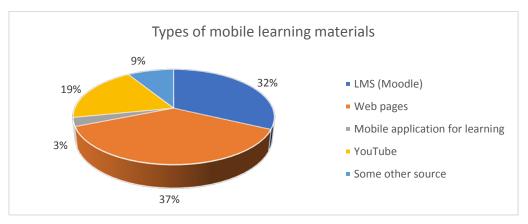
Question: How often do you use a mobile device for learning?

Regarding duration, almost 110 (36%) of students use mobile device for studies two to three times a week, 82 (27%) of them use it once a week; 67 (22%) use it less than once a week while 50 (16%) use it more than three times a week.



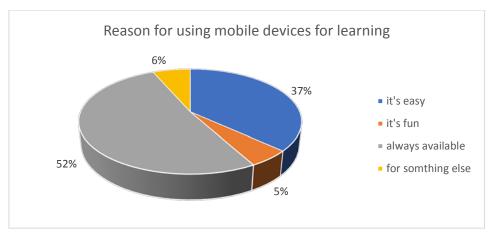
Question: Where do you find mobile learning materials? (multiple answers permitted)

The most popular materials for m-learning are web pages 237 (37%) and online courses created in LMS (Moodle) 206 (32%). Only 19 students (3%) mentioned mobile applications, 124 (19%) use materials for learning from YouTube and 57 (16%) find it from another source.



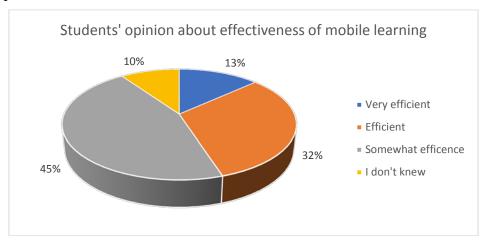
Question: Why do you use mobile devices for learning? (multiple answers permitted)

The most common reason why students use mobile devices for learning is because it is always available 238 (52%), 170 (37%) of them use it because it's easy, 24 (5%) because it's fun and 30 (6%) for some other reason.



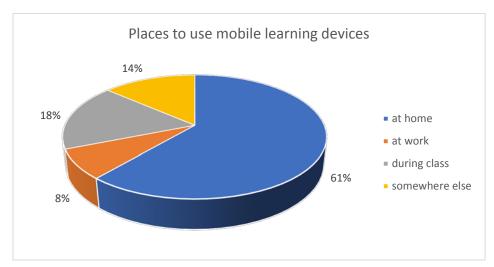
Question: Do you think mobile learning is effective?

In terms of effectiveness, 140 (45%) of students find mobile learning somewhat efficient, while 98 (32%) of them find it efficient. 41 (13%) of them find it very efficient and 30 (10%) students have no opinion about that.



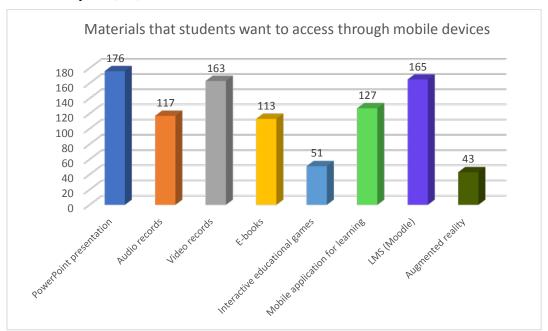
Question: Where do you use your mobile device for your study? (multiple answers permitted)

Since mobile devices allow students to access learning materials anytime and anywhere, it is surprising that as 280 (61%) of students use mobile devices at home. 80 (18%) use mobile device for studying during class, 62 (14%) somewhere else and 35 (8%) at work.



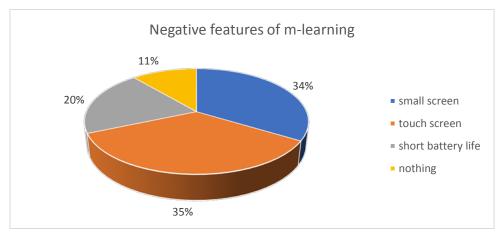
Question: Which of the following learning resources would you be interested in accessing through mobile devices? (multiple answers permitted)

The study revealed that most students are interested in accessing learning materials in form of Power Point presentations 176 (18%), video records 163 (17%) and LMS (Moodle) 165 (17%), then mobile applications for learning 127 (13%), audio recordings 117 (12%) and e-books 113 (12%) and what interests them the least are interactive educational games 51 (5%) and augmented reality 43 (5%).



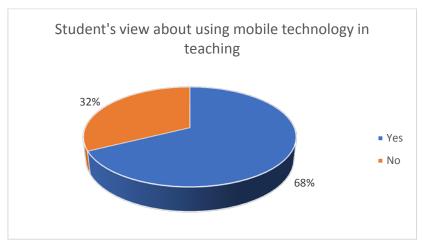
Question: What do you consider as a negative feature of mobile devices? (multiple answers permitted)

Regarding negative features of m-learning 35% of students consider it to be touch screen, 34% of them small screen, 20% short battery life and 11% consider that mobile devices do not have negative features.

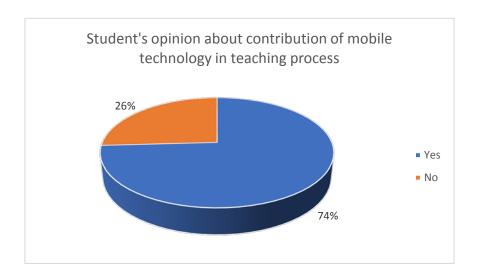


Question: Do you think that mobile technology should be used in teaching?

Regarding research 68% students think that mobile technology should be used in teaching, while 32% of them think otherwise.



Question: Can mobile teaching technology contribute to the quality of the teaching process? 74% students think that mobile technology can contribute to the quality of the teaching process, while 36% of them think otherwise.



5. Conclusion

Survey results show that 94% of students at the University Department of Professional Studies own mobile devices that they can use to access the Internet. It is obvious that students of the Department are well equipped for mobile learning.

As expected, students most commonly access social networks, YouTube, Viber and WhatsApp, via mobile devices.

However, even 81% of them use mobile devices for formal education. Learning materials are most commonly found on LMS (Moodle) and Web sites.

The most common reason for using m-learning is its accessibility, while the other reason is its simplicity.

The materials which students want to access through mobile devices are PowerPoint presentations, video lectures, and LMS (Moodle).

Most students believe that mobile technology should be used in teaching and that it can contribute to the quality of the teaching process.

The results of this survey show that students are interested in m-learning and that efforts should be made to continue the development of m-learning at the University of Professional Studies at the University of Split.

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Augmented Reality as a Learning Tool for Children with Learning Disabilities

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Abstract. Many children around the world are faced with different types of learning disabilities. They are often unfairly labelled as stupid and lazy. These children do not struggle because of low intelligence, in fact, most are just as smart as their peers or smarter. Their brains are simply wired differently. This difference affects their ability to create, process, or store information. The term "learning disabilities" refers to a group of disorders which cause difficulties in several academic abilities, namely speaking, reading, writing or working with numbers. Children with learning disabilities are capable of learning, but they need to learn things in different ways. In recent years, augmented reality has been considered as one of the technologies that can significantly change learning. Augmented reality is a technology that combines virtual reality with our physical world. When viewing the real world through the screen of a device, usually a mobile phone, the computer-generated digital content (text, audio, images, video, 3D objects) is layered over the physical world in a way that makes it appear to be part of the real environment. This technology can transform learning into a more fun, enjoyable, motivating and interesting activity. In this paper, the basics of augmented reality and its functionality will be described. Some of the learning disabilities will be presented, and the use of augmented reality as a learning tool for children with learning disabilities will be shown through practical examples.

Key words: augmented reality, learning disabilities, children, AR types, AR hardware

1. Introduction

To be successful at school a child must work hard. However, for some children, even hard work may not be enough. Sometimes the damage of the process of observation, conclusion and learning, impede the normal development and progress of a person. Thus, children with a learning disability are unable to adopt some things that most of the children easily do. They acquire knowledge, skills and abilities harder and slower. Children with learning disabilities may have difficulty in reading, spelling, writing, reasoning, recalling and organizing information. So, these children may feel frustrated when they cannot master a subject despite trying hard.

But they can achieve more in creative, effective and thoughtful ways. They can learn to think better, to remember better, to become aware of how to learn what to do, and how to compensate

less developed abilities. With the great support of parents, the knowledge of teachers and the persistent work of experts, the child will achieve better results.

Information and communication technologies offer new opportunities for everyone, but these opportunities are specifically more significant for children with learning disabilities. Information and communication technologies offer better opportunities to create interactive, personalized learning materials and activities that are adjusted to the specific needs and characteristics of the child. The use of technology can help children with learning disabilities to encourage their motivation, commitment to their own learning, increase their independence in academic assignments, personalize learning, facilitate communication with peers, reduce frustration and anxiety, develop visual, spatial, mathematical and creative opportunities.

This is precisely the goal of the "ICT Competence Network for Innovative Services for Persons with Complex Communication Needs" [1]. It is a group of colleges, associations, institutions and companies collaborating on European projects to facilitate learning and communication for children and people with disabilities.

The projects have developed a range of interesting applications (both for smartphones and tablets, as well as web-based applications) aimed to stimulate the development of communication skills in children, especially those with disabilities.

Applications are designed for learning letters, words and mastering reading skills, as well as learning basic maths functions. All applications are completely free of charge and can be downloaded to devices by going to the project page and selecting an individual application [1]. In recent years, augmented reality has been considered one of the technologies that can significantly change and facilitate learning. Augmented reality is a technology that combines virtual reality with the real world [2].

2. Augmented reality

The root of the word augmented is augment, which means to add or enhance something. Augmented Reality (AR) adds graphics, video, sounds into our real world to enhance the user's experience.

Looking back at the history of augmented reality technology, we can see that the first prototypes of augmented reality emerged in the 1960s. In 1962, Ivan Sutherland invented Sketchpad, an innovative program that allowed users to draw, copy, move and rotate various shapes. In 1968, Sutherland, with the help of his students Bob Sproull, Quintin Foster and Danny Cohen, developed the first real head-mounted display called the Sword of Damocles that had the ability to monitor the position of the user's eyes and head. Due to the limitations of the technology at the time, the device was so heavy that it could not be worn on the head but mounted on the ceiling [3].

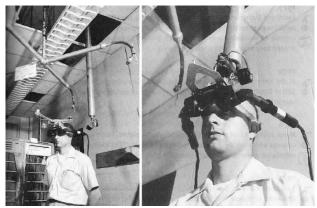


Figure 1 The world's first head-mounted display with the "Sword of Damocles" [3]

In early 1990s Tom Caudell and Mizell, Boeing scientists, coined the term "augmented reality", and the first use of augmented reality technology was in the 1990s to train pilots [4].

Since the 1990s, some large companies have used AR for visualization and training purposes.

Reducing the dimensions of sensors, displays, and other components has enabled production of smaller devices, and with lower prices, devices become more affordable. With the increasing number of smart mobile devices and the constant improvement of their capabilities, augmented reality is penetrating many aspects of human life.

Today augmented reality is a technology that is applied in many fields such as medical training [5, 6, 7], military [8, 9, 10], repair and maintenance [11, 12], tourism [13, 14, 15], education [16, 17, 18], games [19], marketing [20, 21], etc. and has become increasingly used in everyday life.

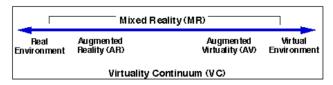


Figure 2 Milgram's Reality-Virtuality Continuum [22]

Currently there are two accepted definitions of AR:

1. Milgram's Continuity of Reality-Virtuality is defined by Paul Milgram and Fumio Kishino as a continuum that extends between the real environment and the virtual environment comprise Augmented Reality (AR) and Augmented Virtuality (AV) in between, where AR is closer to the real world and AV is closer to a virtual environment [22], as depicted on Figure 1.

While both virtual reality and augmented virtuality replace the surrounding environment with virtual ones, AR brings digital content to the real world by combining real and digital data.

- 2. Ronald Azuma's [23] definition of augmented reality is widely referred to in the research literature. It defines augmented reality as one that:
- (1) combines the real world with the virtual world,
- (2) is interactive and in real-time and
- (3) is registered in 3 dimensions.

Augmented Reality is the combination of several technologies that work together to bring digital information.

AR technology allows us to see elements through the screen of a device, usually a mobile phone, which do not exist in real life. These elements extend the reality around us but only if we look at it through the screen.

Augmented reality systems require both hardware and software to implement a compelling AR experience. The software tells the system what to do, and the hardware is the equipment that does it. The hardware components used for AR are the wearable devices that allow the user to see and interact with the system. These basic hardware components are sensors, processors and displays [24].

Sensors provide information about the real world to the AR application for a variety of purposes like the location and orientation of the participant. Other roles of sensors include providing information such as temperature, pH, lightness/darkness, or any other types of information about the environment to the AR application.

Processors in augmented reality systems fulfil several roles. The processor is the "brain" of the technological system. Hence, the core roles of the processor are to receive the signals from the sensors, execute the instructions from the application program based on the sensor information, and create the signals that drive the display(s) of the system.

AR can be displayed on various devices such as monitors, head-mounted displays, eyeglasses, contact lenses, gaming consoles, and even smartphones, among others. The *display* is the device that provides the signals that our senses perceive. Displays provide signals to our eyes, our ears, our sense of touch, and our nose, and perhaps provide a sensation of taste.

There are 4 types of augmented reality today [25]:

- marker-based AR
- marker less AR
- projection-based AR
- superimposition-based AR

Marker based AR

Marker-Based AR is also called Image Recognition or Recognition based AR. Markers can be QR-codes or natural feature tracking (NFT) markers, physical objects, or printed images. A Marker-based AR uses a mobile device camera or webcam to scan a marker [25]. Once recognized the marker on screen is replaced with a computer generate digital content (text, audio, images, video).

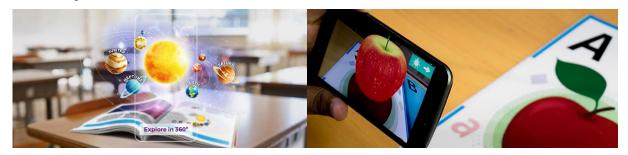


Figure 3 Marker based AR

Marker Less AR

Marker Less AR is also known as Location-based AR, position based and geo-based augmented reality. This type of AR doesn't need special markers to identify the place where a virtual object should appear. It primarily relies on GPS, accelerometer, digital compass, a gyroscope and other technologies to identify phone's location and position with the high level of accuracy. Today all modern devices are equipped with these sensors, so augmented reality is available for everyone who owns a mobile device [25].



Figure 4 Marker Less based AR

Projection-based AR

Projection based augmented reality works by projecting artificial light onto real world surfaces. This allows human interaction by sensing the touch of the projected light. The user's touch is detected by distinguishing between an expected projection and an altered projection. A digital operating canvas is created on virtually any work surface. Projection based AR is used to project a 3D interactive hologram [25].

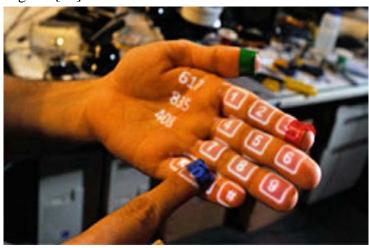


Figure 5 Projection base AR

Superimposition-based AR

Replaces the original view with an augmented one, fully or partially. In this type of AR, object recognition plays an important role. Superimposition based augmented reality either partially or fully replaces the original view of an object with a newly augmented view of the same object [25].



Figure 6 Superimposition-based AR

3. Children with learning disabilities

The scientific study of reading and writing difficulties in children began in the late 19th century. In 1896, the English physician Morgan [26] described the case of a four-year-old boy who had great difficulty reading and writing but was good at mathematics and was generally a clever child. Before that it has been widely held in literature that reading and writing difficulties are one of the indicators of mental retardation.

Learning disabilities arise from neurological differences in brain structure and function and affect a person's ability to receive, store, process, retrieve or communicate information [27]. The term learning disabilities refers to a group of disorders which cause difficulties in several academic abilities, namely speaking, reading, writing or working with numbers.

Learning disabilities vary significantly from one child to another. One child could struggle with reading and spelling, while another reads easily but can't understand maths. Or maybe another child may have difficulty understanding what others are saying. A child confuses letters, numbers and whole words, or he/she is confused by the concept of time, or has difficulty in planning and organizing, or is being uncoordinated and clumsy in space.

Some children have difficulties getting content into the brain. These children struggle with information integration, such as the ability to organize, sequence, retrieve or infer meaning. Other children have difficulty getting information out of the brain. They struggle with fine motor skills, such as handwriting, organizing thoughts on paper or finding the right words to express ideas [28].

The problems are very different, but they are all learning disabilities [29].

When a child has learning difficulties, it means that they learn differently. But that doesn't mean that children who learn and think differently aren't smart. It means they need strategies and support to help them thrive.

Children with learning disabilities are smart as, or smarter than their peers [30], as evidenced by the fact that some well-known scientists and artists had learning disabilities, such as Albert Einstein, Leonardo da Vinci, Thomas Alva Edison, Walt Disney, Agatha Christie, Tom Cruise, George Washington, John F. Kennedy, John Lennon, Alexander Graham Bell, Isaac Newton, Michael Faraday etc. *Thomas Alva Edison was one of the greatest inventors in history, but he went to school for only a few months. Because his teachers thought that he was a slow learner, unable to focus and terrible at mathematics as well as having difficulty with words and speech Edison's mother removed him from school and she taught him at home.*

Despite the increase in general awareness of students with specific learning disabilities, there is still an opinion that these are students who are not interested in school. Such students are often characterized as lazy, negligent, and uninterested in school, which significantly diminishes their chances of achieving school success and quality personal growth and development and brings frustration to parents, teachers and themselves.

The difficulties cannot be cured, nor can they be expected to disappear on their own. However, children can be helped to compensate these weaknesses or even to overcome them.

The most common types of specific learning disabilities are those that impact the areas of reading, maths and written expression. They may co-occur with other disorders of attention, language and behaviour, but are distinct in how they impact learning [27].

Dyslexia is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. The child replaces a word that is similar in sound or similar in appearance (d-b, b-p, i-l, š-ž, m-n) and omits syllables and parts of the word.

Dysgraphia is a learning disability that affects writing and the coordination of the small muscles of the hands, wrists, and fingers (fine motor skills). People with dysgraphia usually struggle with writing and forming letters, as well as being able to write along a straight line and spell words correctly.

Dyscalculia is a learning disability in maths. People with dyscalculia have trouble with maths at many levels. They often struggle with key concepts like bigger vs. smaller. And they can have a hard time doing basic maths problems and more abstract maths.

While not designated as specific subtypes of learning disabilities, there are several areas of information processing that are commonly associated with learning disabilities [27].

Dyspraxia is a brain-based motor disorder. It affects fine and gross motor skills, motor planning, and coordination. It's not related to intelligence, but it can sometimes affect cognitive skills.

Auditory processing disorder - refers to an ability to analyse or find meaning in the information received by listening. Difficulties with auditory processing do not affect what is heard in the ear, but how that information is interpreted or processed in the brain.

Visual processing disorders - refer to the impaired ability to create meaningful images from information received by vision. Visual processing difficulties affect how visual information is interpreted, or processed, in the brain.

Executive Functioning Deficits is the term used to describe weaknesses in the ability to plan, organize, strategize, remember details and manage time and space efficiently.

Attention Deficit/Hyperactivity Disorder (ADHD) is a brain-based disorder that results in significant inattention, hyperactivity, distractibility or a combination of these characteristics.

Modern educational systems must deal with the increasing number of students with learning disabilities, especially dyslexia [31].

The literature states that the average proportion of children with specific learning disabilities is about 10%, which means that out of ten children, one has a specific learning disability. Of course, it should be noted that not all students have been diagnosed with some learning disabilities. Between 10 and 15% of all students have some difficulty reading or writing. These students make more than 80% of students identified as students with learning disabilities [32].

Children who suffer from these disabilities may struggle not only in school but also later in life, during their higher education and even as they try to progress in their professional careers. Thankfully, all the new tools and digital learning aids available nowadays have opened new possibilities and created an increasingly inclusive environment, one in which the effects of learning disabilities are constantly being erased.

4. Literature review

Augmented reality is exploring a new method of innovative learning through visualization and interaction, and when it comes to learning disabilities the potential of such technological development is enormous.

With the rise of the digital age children are spending more and more time behind a screen and using electronic devices for their daily stimulation and interactivity requirements.

Technology is a fun way to get children's attention. Children learn by playing because they have fun and they use their imagination.

Children can develop creative, emotional, mathematical, social, visual and spatial abilities easier and faster with the proper stimulation. Augmented Reality includes 3D images and animation that can maximize motivation and intellectual responsiveness in children. The use of AR in this way can help in engaging young minds and providing a fun educational environment. It is possible to imagine how much they can learn if their attention is captured with beautiful 3D graphics that will come out of smart books or any other physical plane used for the AR experience.

Many AR applications already exist like The MagicBook, SunRa Solar (Solar system AR), GeoAR (3D Geometry) [33], Augmented Reality (AR) kid's Kit 4D. These apps are not specifically designed for children with learning disabilities but can certainly help them.

K. P. Vinumol et al. in their paper present a prototype called Interactive Textbook for assisting children with learning disabilities. The book looks like a normal textbook without any special markers and identifiers. Once the children focus the web camera on a text, the 3D images, audios and videos which explain the text more graphically will be augmented on the page. This enhances children's understanding and makes the learning process easier for them. Analytical results demonstrate that children could learn, remember and gain knowledge via a simple process and user-friendly interface. This study adopted a user centred approach and applied

technology to the learning process of children with learning disabilities, reducing learning barriers and difficulties [34].



Figure 7 Augmenting virtual media to text [33]

Darsheeka et al. created a prototype education tool called Augmented Reality Education Tool (ARET). The ARET application consists of 3 modules: alphabet, numbers and shapes. They are flash cards with tracking points. These tracking points help the application to identify the correct alphabet, shape or number and augment the corresponding objects. The multimedia data in each module comprises of text, audio, video, image and 3D Models. All modules are interactive, as the buttons can be touched to display the data stores, the card can be rotated to view different angles of the object; in the case of shape cards, the output answer text is shown on the card space below. Through the project, the teacher can read 3D books, play interactive games and flashcard pop-up quizzes with the class. As proved by research, the ability to impact the senses of sight and hearing triggers a vital enhancement in the education level of children [35].

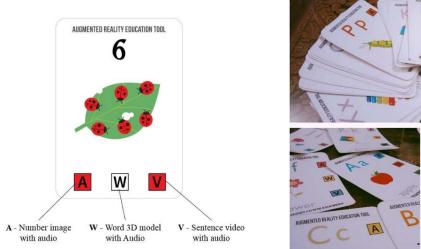




Figure 8 left Virtual Buttons in number flashcard, right Alphabet Flashcards used in ARET [34]

Speech Blubs is an augmented reality-powered speech therapy application for children aged between 1-8. Four men who had speech issues in their youth developed this app. The application uses voice controlled and video technology to develop speech articulation for young children with or without speech difficulties. With the use of the app, the child will build vocabulary and concepts related to everything under the sun. The app has sections on colours, numbers, and shapes, creative sections with songs & rhymes, as well as lessons on body parts, animals, vehicles, jobs, food and much more. The app has thousands of activities which aid through

practice of speech sounds in a fun and engaging way. The latest update has provided additional activity areas which include an endless array of mini games, exercises, videos and stickers [36].



Figure 9 Speech Blubs app

Augmental 1y is an augmented reality (AR) based app which helps people with learning disabilities like dyslexia to read books more easily using the camera on their phone. T. Gupta, et al. in their work tested this application on students of the ages 12-14 years, with 9 females and 5 males. The main parameters that they wanted to test was the change in the reading speed and the students' preferences with respect to the fonts, size, text-to-background contrast ratio and line height. After testing the application, they received positive results with a 21.03% decrease in their overall reading time for the text passages [37].

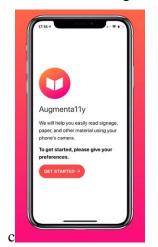




Figure 10 Augmenta11y app

Chien-Yu Lin, et al in their study, explored a new way of integrating augmented reality into educational activities for children with various disabilities. Twenty-one students participated in the experiment (14 boys and 7 girls, 6–12 years) with different disabilities. A free interactive mobile augmented reality (AR) application was developed to facilitate the learning of geometry. For the purpose of study teachers designed teaching materials and created corresponding Aurasma videos to enhance learning. The teaching material involved two games, the traditional Chinese tangram puzzle and a square puzzle game. A user can scan the trigger image placed on a poster with a mobile device to view videos, animations or data. Further interaction can direct the user to a website for more content. Performance data indicated that the use of AR technology could enhance learning motivation and frustration tolerance in children with special needs [38].

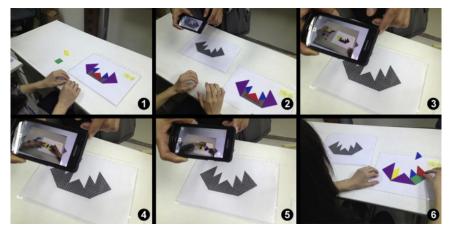


Figure 11 The mobile AR concept [37]

Rega and Mennitto in their paper propose a research project called ASB (Augmented SmartBook). It is based on a technology tool called SmartBook consisting of a tablet, an app, and QR code codes for augmented reality. QR codes will be placed at the edges of textbook pages used at school. Using the tablet children will scan the codes, and see new content proposed by the text of the book using additional materials. In this way the teaching material can be enriched with details that in traditional books can't be reported due to the limited number of pages. In the case of a dyslexic person, the child may avoid reading entire documents made of words and phrases sometimes difficult to understand and learn through images. [39].



Figure 12 Screenshot of minigames. (a) Missing Character, (b) Math, (c) Shape [39]

Serious Games (SG) have an ability to motivate and engage in the therapeutic and learning process. Avila Pesantez, et al. in their paper propose a conceptual model of presents, Augmented Reality Serious Game named ATHYNOS. This game included a natural user interface, based on body movements (use of sensors), as well as AR assistive technology for the learning environment. ATHYNOS has three minigames; each one was designed to help children with learning disabilities. Match minigame created for children diagnosed with dyscalculia, which reinforces the basic arithmetic calculation, promotes motor skills and improves children's motivation. The player chooses a balloon containing a calculation that must match the corresponding result, which is shown using domino cards. The gamer uses the hand movement to complete the action (Fig.13 a). Shape minigame was developed for children with dyspraxia. It helps to improve movement and coordination, fine and gross motor skills. The player looks in detail at the figure of the character located in the centre of the screen and must match it with its respective form shown as a shape (challenge action). At each level, the child must find the correct way to complete the activity (Fig. 13 b). Missing character minigame is based on cognitive behaviour therapies for kids with ADHD. It helps with inattention, impulsive behaviour, concentration difficulties, and working memory. In the minigame, the player selects a game card that contains a tag AR, which is associated with a landscape of Riobamba city, that includes characters of the Child Pass Festival which is shown on the monitor. The challenge is to check how many characters are presented and find out which one(s) are missing. Then, the player drags and drops (Fig. 13. c). ATHYNOS helps players with cognitive and motor skills such as motivation, eye-hand coordination, time management, interactivity, and problemsolving, improving selective and focused attention, which were evaluated through a case study and statistical analysis using the local educational environment [40].

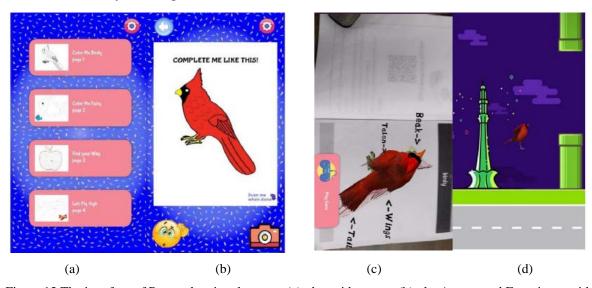


Figure 13 The interface of Peppy showing the menu (a), the guide screen (b), the Augmented Experience with facts (c) and the same cardinal in mini game (d) [41]

Over the years, researchers have found an increase in learning problems among young children especially related to writing.

Abid et al. in their work described the way to fight with dysgraphia using technology as well as paper by augmenting it into something that is both interactive and useful for child development. They developed Peppy, a mobile application using augmented reality (AR). Peppy brings to life through AR enjoyable, thought provoking and intriguing paper prototypes consisting of colouring, games, and puzzles. Authors decided to create an activity book that will have 20 – 30 different exercises for children to practice. For the first exercises, they chose a dot-to-dot colouring activity of a cardinal bird. Colouring and the dot-to-dot book provide good paper

pencil activities for fine motor and eye-hand development. They developed a connected system where every object on the paper is transferred to the digital world (mobile application), where it is then augmented in 3D in the real world, after which the said object is used in a mini game. They aim is to ensure that children remain incentivized to complete the activity and increase the amount of time and concentration they put into the task [41].

5. Conclusion

Augmented reality is an ICT tool that allows users to see and experience the real world mixed with virtual objects without losing the sense of reality.

Augmented reality brings learning to life. AR can be used as a learning technique whereby the environment adapts to the learner. By providing clarification on-demand, learners can gain greater understanding of a topic while discovering and learning.

The AR tool can help children with learning disabilities by making the learning process more fun, which increases the motivation of children. Augmented reality applications can complement a standard curriculum. Text, graphics, video and audio can be superimposed into a children's real time environment. AR tools not only provide children with new ways of accessing information but also new ways of interacting with the information as well.

The use of AR application can help children with learning disabilities to increase their independence in academic assignments, personalize learning, facilitate communication with peers, reduce frustration and anxiety, develop visual, spatial, mathematical and creative opportunities.

The paper presents several applications created for children with various learning difficulties.

These applications help children with learning disabilities in cognitive and motor skills such as motivation, eye-hand coordination, time management, interactivity, and problem-solving, improving selective and focused attention.

We think that little steps have been taken towards the application of AR in teaching children with learning disabilities, but these steps are the basis for a future education system in which children with learning disabilities will be treated with care and respect.

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Experimental Determination Flow Characteristics of the Control Valve

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Abstract. This paper presents an experimental determination of the flow characteristics of the control valve. The flow characteristic is determined by two different measurement cards NI-6009 and PDM-1208LS. The experimental determination of the flow characteristics of the manually operated valve is also shown. Determining the flow characteristics of these valves is necessary in the implementation of the control, for example, flow reservoir or e.g. pools.

Key words: experimental determination, flow characteristics, control valve.

1. Introduction

Control valves are very important part of hydraulic systems. In order to determine the proper control algorithm for the whole system, it is of great importance to define all the elements of the system correctly. If the mathematical model of a system or subsystem is not known to us, then its characteristics are determined experimentally. This paper presents an easy way to determine the flow characteristic of a valve, whose mathematical model was unknown, and which was one of the subsystems of a flow tank control system.

The membrane-driven control valve is the executive organ of the system. The experimental determination of the flow characteristic gives the dependence of the fluid flow (in this case water) on the position of the spin of the mushroom of the valve.

Determination of flow characteristic is performed for different positions of the valve mushroom. Due to the lack of a flow passage through the control valve, this is determined by measuring the time for which the fluid reservoir is filled to a certain height and the volume flow definition is applied according to the following form

$$Q = dV/dt = \Delta V/\Delta t \tag{1}$$

2. Determination of the flow characteristics of the control valve

When determining the volume flow within this experiment, the tank was filled to a height of 20 cm, together with other dimensions of the tank 24 cm thick and 38 cm wide, it gave a volume of 18.24 l

The program by which flow measurement is performed through the control valve in order to determine the static characteristics of the system is created in LabVIEW, its block diagram, and the Fig. 1. and the Fig. 2., using USB-6009 and PMD-1208LS, consequently.

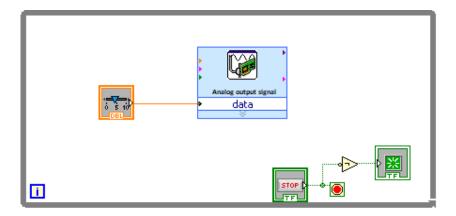


Figure 1 Block diagram program for defining flow control valve characteristics using USB 6009.

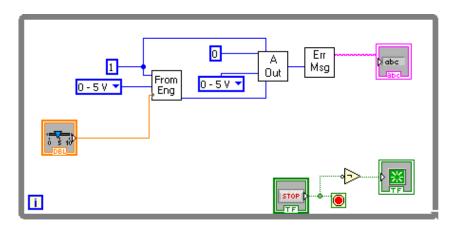


Figure 2 Block diagram of the program for determining the flow characteristics of the control valve using the PMD-1208LS.

A virtual instrument, used to determine the flow characteristics of the control valve, can also be adopted as the concept of an open automatic control system without compromising the effect of the disruption, since the steering system for proper management uses only information about the desired height of the fluid in the reservoir.

The front panel of the virtual instrument is shown in Fig. 3., where the voltage range on the voltage dampener which leads to the output of one of the measurement cards is limited to 0-5V. Also, in accordance with the needs of this measurement, the step of the voltage suppressor on 0.5 V, i.e. it is possible to select one of the following voltages at the output of the measuring card {0,0.5,1.0,1.5,2.0,2.5,3.0,3.5,4.0,4.5,5} [V].

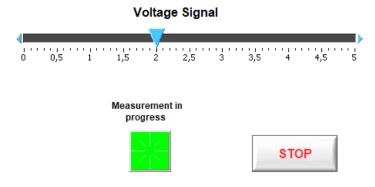


Figure 3 The front panel of the virtual instrument for determining the flow characteristics of the automatic control valve.

The output signal from the measurement-acquisition card is the range of 0-5V. The signal from the computer that is forwarded to the measurement-acquisition card of 0~V after passing through the voltage-current converter gives a current signal of 4mA, which gave the control valve open 20%, since it was subsequently determined that is the range of current-to-pneumatic converter of 0-20mA. In order to overcome this problem, an electro-pneumatic converter with a screw was set up by adjusting zero so that the control valve for the 4mA control valve is in the lowermost position.

Table 1. Measurement results required to determine the flow control of the control valve

Number of measurements	Voltage [V]	Time [s]	Volume flow [1/s]
1	0	0	0
2	0.5	514.19	0.0355
3	1.0	389.28	0.0469
4	1.5	364.08	0.0501
5	2.0	313.14	0.0582
6	2.5	255.45	0.0714
7	3.0	183.53	0.0994
8	3.5	130.41	0.1340
9	4.0	86.21	0.2116
10	4.5	67.93	0.2685
11	5.0	64.65	0.2821

The results of the measurements are given in Table 1, as previously mentioned, the tank is filled to a height of 20cm, which, with other dimensions of the tank, gives a volume of 18.24l. Measurement data are processed and shown in Figure 4. For the measurement results shown,

an approximate curve must be found that will reliably approximate the flow characteristic of the control valve.

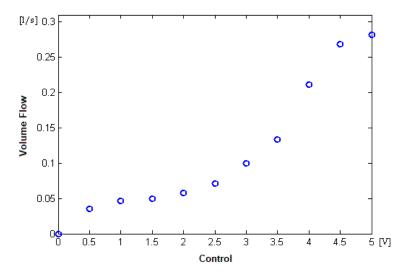


Figure 4 Experimental measurement data.

An approximate curve that reliably describes the measured measurement data is given in Figure 5. Using the linear regression over the obtained measurement data we can get the required solution. To solve this problem, it is convenient to use polyfit and polyval functions. The polyfit function allows the collection of some data to fit with the n-th order polynomial, that is, the polyval function allows calculating the value of that polynomial. The script that allows the fitting of the fifth-level input data for which it is determined that the most reliable description of the flow measurement data through the control valve is:

```
>> x = [0 0.5 1 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0];
>> y = [0 0.0355 0.0469 0.0501 0.0582 0.0714 0.0994 0.1340 0.2116 0.2685
0.2821];
>> xi = x(1):0.1: x(end);
>> p5 = polyfit(x,y,5);
>> y5 = polyval(p5,xi);
>> plot(x, y, 'o', xi, y5);
```

The approximate curve describing the measurement data is given by the next equation

$$Q_c = -0.0011(y_1)^5 + 0.0101(y_1)^4 - 0.0214(y_1)^3 - 0.0093(y_1)^2 + 0.0690y_1 + 0.0013$$
(2)

Assumption 1. The control valve is completely closed, for the output voltage from the measuring card of 0V, while the maximum output voltage of the 5V valve is maximally open.

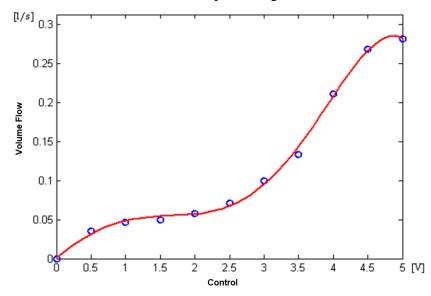


Figure 5 The approximate curve flow characteristics of the control valve.

3. Determination of the flow characteristics of the discharge (manually operated) valve

The discharge valve of the liquid reservoir is manually operated, but there is a numerical division based on which the measurement of the leakage of the liquid from the tank was performed in order to determine its flow characteristic.

13.71

1.3304

	_		
Number of measurements	Valve openness [%]	Time [s]	Volume flow [1/s]
1	0	0	0
2	20	1415.22	0.0129
3	25	405.23	0.0450
4	30	273.71	0.0666
5	40	186.96	0.0976
6	50	73.10	0.2495
7	60	49.93	0.3705
8	70	33.05	0.5519
9	80	21.40	0.8523
10	90	15.23	1.1976

100

11

Table 2. Measurement results required to determine the flow characteristics of the drain valve.

These measurements were performed to expel water from a reservoir for a fluid height of 20cm, in order to use the same input data, as well as when determining the supply automated control valve.

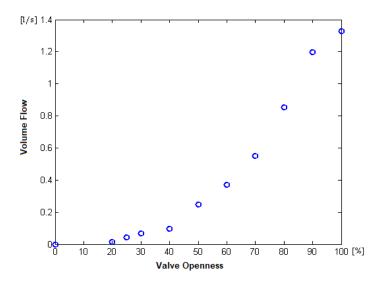


Figure 6 Measurement results required to determine the flow characteristics of the drain valve.

A script that allows the fitting of input data of a second-degree polynomial, i.e. part of the parabola of a quadratic function for which it is established that it is most likely to describe flow measurement data through the drain valve is:

```
>> x = [0 20 25 30 40 50 60 70 80 90 100];

>> y = [0 0.0129 0.0450 0.0666 0.0976 0.2495 0.3705 0.5519 0.8523 1.1976 1.3304];

>> xi = x(1):0.1:x(end);

>> p2 = polyfit(x,y,2);

>> y2 = polyval(p2,xi);

>> plot(x, y, 'o', xi, y2);

Q_i = 0,0002 \cdot y_2^2 - 0,0045 \cdot y_2 + 0,0157 (3)
```

The curve could be approximated by the fifth-degree polynomial, but the coefficients of the polynomial of the third and higher orders are negligible in small values.

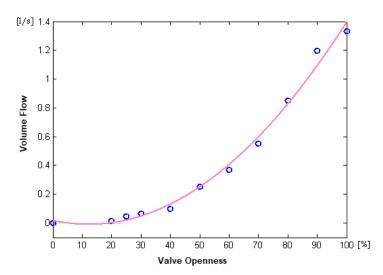


Figure 7 Approximate curve flow characteristics of the drain valve.

The valve's opening in % was obtained based on a partition located on a manually operated drain valve.

4. Conclusions

With both cards and virtual instruments created, the flow characteristics of the inlet (automatic control) valve are recorded. In order to record this feature, it was necessary to use additional hardware, which converts the voltage signal, at the analogue output, from the card. This additional hardware is primarily required for the NI USB-6009, since the maximum current load is 5mA, and control require 4-20mA current. For the PMD-1208LS, the output current limit is 30 mA, so the direct drive of the electro-pneumatic inverter could be achieved. Along with Om's law, and the known resistance of the coil in the converter is not a problem to reach the output voltage range at the analog output. The required current of 4-20mA, the resistance of the coil R_L =165 Ω should be within the limits of 0.66-3.3 V and the neglected resistance of the conductors, considering their length.

Determination of flow characteristics of the valve, when a mathematical model is not known in order to determine flow control algorithms, pools, etc. it is possible experimentally as shown in this paper for different types of valves as presented in this paper for automatic controlled valve and for manually controlled valve. This paper present just a part that has been implemented and designed for the purpose of automatic control of a fluid reservoir.

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Cloud Computing - Infrastructure as a Service Based on AWS

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Abstract. Today, Cloud computing is increasingly used. It is a relatively new technology that is changing the way we used to do business before. Cloud computing is a model in which computing resources are viewed as a service, not a product. There are three basic architectural models of service delivery: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). In terms of performance, each of the three models can be implemented in four ways depending on availability: Public cloud, Private cloud, Hybrid cloud and Community cloud. The goal of this paper is to describe cloud computing, its advantages and disadvantages, with an emphasis on Infrastructure as a service, through the example of the largest cloud service provider, Amazon Web Services. Another purpose of this paper is to give the best possible insight into the benefits of Cloud computing through a few specific examples of web services.

Key words: Cloud Computing, AWS, MSP, IaaS

1. Cloud Computing

The National Institute of Standards and Technology defines cloud computing as a model that provides convenient access to a set of configurable computing resources (networks, servers, data storage, applications, and other services) that can be quickly prepared for use and offered with minimal effort or provider interaction (Mell and Grance, 2011). The essential characteristics of cloud computing are On-demand self-service, which means that the user of the service can choose his own computing resources, such as server and storage without the need for human interaction with each service provider; broad network access or access to services through various devices connected to the Internet (computers, tablets, mobile phones); a wide range of services that can be distributed simultaneously to a large number of users; rapid elasticity that automatically captures and releases resources according to the user's requirements, and the user has the impression that resources are unlimited and always available; measured service as resources are automatically optimized for use and paid for as much as used. Resource use is monitored, controlled and reported, thus providing transparency to both the user and the provider. There are three basic architectural models for cloud computing: Software as a Service, Platform as a Service, and Infrastructure as a Service.

Software as a Service (SaaS) allows the user to use a variety of applications that work on cloud infrastructure. Access to the applications requires an internet connection and web interface, everything else (network, servers, storage, operating system, application settings, etc.) is taken care of by the service provider. This service allows the user to use the application anytime, anywhere.

Platform as a Service (PaaS) allows the user to create and execute programs using a variety of programming languages, services and tools, save data, and access virtual machines through a web browser. The user does not control the underlying infrastructure such as network, server, operating systems, but has control over the deployed applications and configures them himself. The use of the cloud platform results in huge savings in IT equipment for initial

investments. There is no need to buy a server, no worries about operating systems, upgrades, security, all this is taken care of by the service provider, and the user pays only what he uses. Also, if there is a need for more virtual machines or additional storage space, there is no need to buy additional equipment, just rent additional resources.

Infrastructure as a service enables the user to develop and deploy an arbitrary system or application. The user has control over the operating system, storage, deployed applications, choice of network components, etc. There are four ways to deploy each of the three described services: Private Cloud, Public Cloud, Hybrid Cloud, and Community Cloud.

The private cloud, as its name implies, belongs entirely to one company that manages the infrastructure itself, all the data and processing that it contains. Private clouds are expensive because of the large amount of hardware that forms the basis of this environment and the manpower needed for it to function successfully. Private Clouds are used by large enterprises because they have the ability to use all benefits that a private cloud can offer. The main advantage of using a private cloud is security because the private cloud is completely separate from other users, a private cloud is dedicated to the needs and goals of a single organization.

The public cloud is intended for public use and small business. It can be said that the public cloud is a shared, multifunctional infrastructure, the use of which is concluded by a Service Level Provider (SLA) that defines the rights and obligations of both parties, users and service providers. Although, they serve many users, most cloud platforms can guarantee up to 100% uptime because the cloud is designed so that even hardware and network failures do not affect the operation of the cloud. Virtual machines are often hosted on multiple servers in the cloud, so the failure of an individual server does not affect the user's operation (ESDS, 2020).

The Community Cloud is intended to be used by a specific community of users who have a similar mission, security requirements and compliance policies. It may be under the control of some of the community organizations, some third parties, or another combination.

The Hybrid cloud is designed for users who want to keep a critical part of the infrastructure under their own control, within the company, and a less critical part can be stored in a public cloud. It consists of two or more different clouds (private or public) interconnected by standardized or proprietary technology that enables data and applications to be transferred between clouds.

2. Advantages and disadvantages of cloud computing

The main advantage of Cloud computing is that it enables cost-effective on-demand access to your own data and applications from multiple devices connected to the Internet, anytime, anywhere (Bauerle, 2014). With cloud computing, large and small businesses reduce costs and increase productivity. Only the service used and how much is used is paid for. There are no major upfront investments, license fees, concerns about updates, security, and infrastructure maintenance. All of the above is taken care of by the cloud provider so that businesses can focus on their core business without worrying about IT resources. Data storage, processing and access to many applications is possible from any location, anytime, with a web browser and an internet connection.

There are special applications that automatically check and optimize resource utilization, and offer transparent insight into resource consumption. Another benefit is saving time through self-selecting and managing computer resources without interacting with the employees of a particular provider. The term "pay as you go" can be seen as a rental of computer equipment that is paid for depending on the amount, time of use and services selected. It is a model aimed at reducing costs by smart and optimal scaling resources. The pricing for each service is unique.

The main disadvantage of cloud computing is data security and privacy protection. Data that would be stored on local business-owned servers is now stored in unknown locations. This leads to a loss of control over the data. There is no solution that guarantees absolute security. The main risk to the ongoing cloud computing business is the loss of Internet connection. Without an internet connection, access to any resources, data and applications is impossible. It is necessary to have a backup plan in such cases. Cloud computing providers must fulfil high standards of security and data protection. Depending on the country in which they are located, they must comply with all legal regulations of that country, comply with a number of international standards related to information security, protection of confidentiality, integrity and availability of information, and possess a set of security certificates (AWS has 230 security, compliance, and governance services and features and supports 90 security standards and compliance certifications). Numerous large companies (Netflix, Airbnb, etc.) that base their business on cloud computing are a good indicator of all benefits this technology offers.

Each type of cloud computing provides different levels of control, flexibility, and management so that you can select the right set of services for your needs.

3. Amazon Web Services (AWS)

AWS is currently the world's largest provider of cloud computing services (Gartner, 2019). Although, AWS offers all above mentioned services, in this paper we will focus on Infrastructure as a Service. Through its global infrastructure, AWS is able to offer more than 200 web services in a variety of applications from infrastructure technologies like storage, compute, databases, developer tools, networking to new technologies, such as machine learning, internet of things, blockchain, artificial intelligence, data lakes and analytics. The main characteristics of AWS infrastructure are flexibility, scalability, reliability, redundancy, security and high availability. Apart AWS, world's biggest cloud providers are Microsoft, Google, IBM, Alibaba, Sales Force and Oracle.

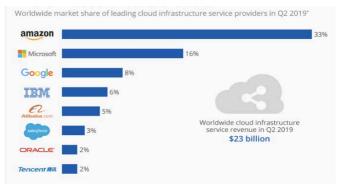


Figure 1: World's biggest cloud providers

3.1 AWS infrastructure

The AWS infrastructure is divided into regions (22), availability zones (69) and points of presence (210) (https://aws.amazon.com). The regions are at the highest level of global infrastructure, providing services worldwide. Within-region availability zones are completely isolated and physically remote. They are interconnected by high-throughput and low-latency and highly redundant, isolated optical cables. In each zone within the region, there are more than one discrete Data Centers, which can consist of hundreds of thousands of servers with redundant power, a dedicated network and special connectivity, housed in separate facilities. This enables much more accessible, more resilient and more scalable services than they would be if they were managed from just one data center. By isolating regions and availability zones, maximum fault tolerance is achieved which enables uninterrupted performance even in the event of power outages, internet downtime, floods, and other natural disasters.

Data centers have four layers of protection: Perimeter, Infrastructure, Data and Environmental layer. The Perimeter layer refers to physical security, depending on the location (professional security guards, fences, surveillance technology and detection of any category of intruders, and other security measures). They are constantly monitored by AWS Security Centers, who monitor and manage physical access, and provide ongoing support for security teams located within each data center. The infrastructure layer refers to the object itself, the equipment and the systems that run them. Water, power supply, telecommunications and Internet connectivity are all redundant so that operations can be performed smoothly even in the case of emergencies. Components such as support equipment, heating, ventilation, air-conditioning and fire-fighting equipment are designed and built to maximize the protection of servers and thus user data. The data layer refers to access restriction and special privileges for each layer. Additionally, there are special procedures and additional system protocols to enter this level. Also, video surveillance and special devices are installed to detect any threatening activity. This layer includes authorization and authentication of authorized persons to access applications.

The environmental layer refers to choosing a location to build a data center to minimize the risk of natural disasters (floods, earthquakes, extreme weather).

AWS infrastructure is monitored 24/7 to ensure the confidentiality, integrity, and availability of costumer's data. All data flowing across the AWS global network are automatically encrypted at the physical layer.

AWS has a network of low latency, high bandwidth and high reliability, and manages its infrastructure itself, which gives greater control at the operational level, avoiding network conflicts based on traffic capacity. All hardware components (servers, semiconductors, routers, load balancers, chips) and related software are specially designed by AWS to ensure a high level of reliability and availability.

3.2 An example of several web services

Amazon Elastic Cloud Computing (EC2) is a virtual computing environment where a user can create virtual servers in the cloud. This service provides complete control over computing resources, and through a simple web interface different instances with different operating systems can be created. There are different types of preconfigured instances that are optimized for different needs depending on the applications that instance will serve, but the user can still modify them. Some of these are General Purpose instances that provide a balanced ratio of computing, memory, and network resources, and are ideal for web servers or code repositories. Compute Optimized Instances are suitable for applications that require high performance processors (machine learning, high performance computing, scientific modeling). Memory Optimized Instances are designed to process large datasets in memory. Storage Optimized Instances are designed for applications that require high, sequential access to large, locally stored data sets (e.g., transaction databases, NoSQL databases, analytical applications) (Amazon Elastic Cloud Computing, 2020).

Amazon Athena is an interactive query service used to analyze standard SQL queries. Queries are automatically scaled. If multiple queries are run at the same time, they are processed in

parallel, resulting in high speed of analysis, even in the case of large data sets and complex queries (Amazon Athena, 2020).

Amazon Aurora is a relational database designed to run in the cloud. It has high performance (five times faster than standard MySQL bases) and is much cheaper (up to ten times) than commercial databases. It provides a high level of security, offering network isolation, encryption of stored data, and data in transit. Due to its high compatibility with standard databases, the user can continue to use all the tools, codes and applications he has used before switching to Aurora. We can say that Aurora combines the performance and availability of traditional databases with the simplicity and cost-effectiveness of open source databases (Amazon Aurora, 2020).

Amazon SageMaker is a service that allows users to build, train, and deploy different machine learning models faster with much less effort and at lower price. (Amazon SageMaker, 2020).

Amazon DynamoDB is a fast and flexible NoSQL database service for applications that need low-latency data access (gaming, web, mobile, IoT). It can handle more than 10 trillion requests per day and can support peaks of more than 20 million requests per second. (Amazon DynamoDB, 2020)

4. Conclusion

Cloud computing is a model in which IT resources are available as a service over the Internet with pay-as-you-go pricing. There are three main models: software as a service, platform as a service, and infrastructure as a service. The main features are on-demand delivery of resources, measurability of services, a wide range of different services and various ways of access. The paper describes in more detail the Infrastructure as a service on the example of AWS. To maintain a high level of quality of cloud-based services, the following features are essential: reliability, security, redundancy, flexibility, scalability, and high availability. The most important benefit of cloud computing is financial, instead of buying and maintaining physical data centers and servers, you can access technology services, such as computing power, storage, and databases, on an as-needed basis from a cloud provider. With cloud computing, costumers have easy access to a broad range of (modern) technologies which enable them to innovate faster.

The main concern regarding Cloud computing is security and privacy of data. Because of strict regulations and numerous security and privacy checks, this is not such a big problem as customers usually think. Cloud computing enables you to focus on core business, with no worries about IT equipment and resources, leading to both a more efficient and effective business performance.

Due to all the mentioned advantages of cloud computing, the speed of development of new applications and services in the market is increasing.

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Physical Objects Access Control Using a Mobile Telephone Network

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Abstract: This paper presents a device for physical objects access control utilizing the resources of a public mobile telephone network that was developed at the University Department of Professional Studies, University of Split. In addition to its commercial application, the developed device can also be used in the education of students in relevant technical fields. The implementation of the solution is based on the application of open source technologies such as the Arduino Uno platform and the GSM SIM900 communication module. A comparison of the developed device with a commercially available Saldux device named "GSM 1" is also given in the paper.

Keywords: Internet of Things, access control, open source, mobile network

1. Introduction

The rapid development of the Internet of Things (IoT) systems enables their applications in various fields such as: supply, transportation and logistics, aeronautics, marine and automotive, telecommunications, medicines and health care, care for the elderly and persons with disabilities, energy systems and more. Today, there are many professional solutions for IoT applications from the well-known companies, for example Libelium Waspmote [1], Electric Imp [2], Amazon IoT Solutions [3] and Estimote Beacons [4].

At the University Department of Professional Studies (SOSS), University of Split, the subjects related to the IoT are studied in several courses: Embedded Computing Systems, Sensors and Actuators, Sensor Networks, Industrial Networks, Computer Networks and Broadband Networks. In addition, students work on various professional projects within Team Projects, Professional Practice and Diploma Thesis under the mentorship of professors. This means that one of the main ways of teaching at SOSS is to learn through participatory teaching methods according to the learning pyramid shown in Figure 1 [5]. In compliance with the application of this teaching method, many professional projects have been realized at the SOSS and have been published in the papers [6, 7, 8, 9, 10].

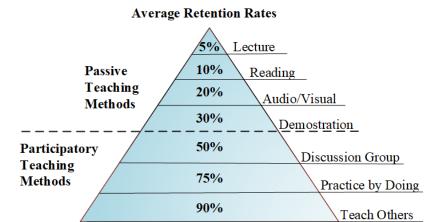


Figure 1. The learning pyramid (adapted from National Training Laboratories, Bethel, Maine [5])

A device for physical objects access control utilizing the resources of a public mobile telephone network, that was developed at the SOSS, is presented in this paper. In addition to its commercial application, the developed device will also be used in the education of students in relevant technical fields at the SOSS. The implementation of the solution is based on the application of open source technologies such as the Arduino Uno platform and the GSM SIM900 communication module as shown in Figure 2.a. This device is compared with a commercially available Saldux device named "GSM 1" which is shown in Figure 2.b [11]. The "GSM -1" door opening control module from Saldux is a powerful device used for authorized door access, passage control or parking control systems.

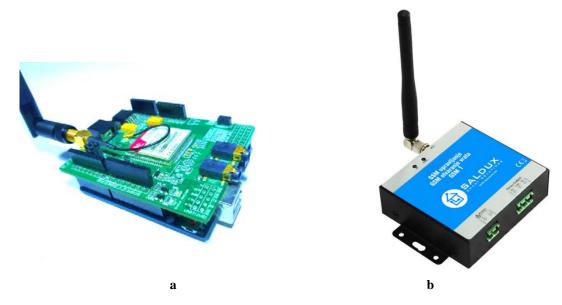


Figure 2. a The device used in the SOSS application based on the Arduino Uno R3 and the SIM900 GPS/GPRS shield, **b** Saldux "GSM 1" device.

This paper is organized as follows: the architecture of the developed device as well as a description of all the components required for its functionality are given in Chapter 2 of the paper. The software solution is presented in Chapter 3. The user manual and the performed tests are described in Chapter 4. A comparison of the developed device with the commercially available Saldux device is given in Chapter 5, and the conclusions are presented in Chapter 6.

2. System design

The system architecture used in this paper is shown in Figure 3. A user can send the text message by a mobile phone using the short message service (SMS) and the message will be received by the SIM900 module. The SIM900 module will communicate with the Arduino through the serial communication protocol when the message is received. According to the received message the Arduino will turn the transistor or relay driver on or off, and the electric lock will be opened or closed. The main capabilities of this device are:

- remote control of electronic appliances by sending an SMS to turn something on/off,
- user notifications by sending an SMS about the device status.

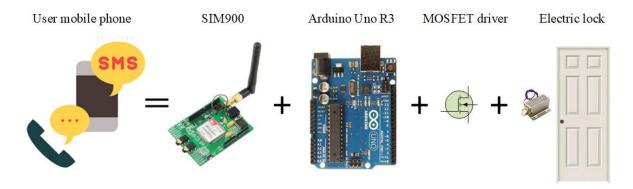


Figure 3 The system architecture

The main components of the developed device are the Arduino Uno R3 and SIM900 module. The Arduino Uno R3 platform [12] is an electronic board with the following characteristics:

- Microcontroller: ATmega328.
- Operating Voltage: 5V.
- Input Voltage (recommended): 7-12V.
- Input Voltage (limits): 6-20V.
- Digital I/O Pins: 14 (of which 6 provide PWM output).
- Analog Input Pins: 6.
- DC Current per I/O Pin: 40 mA.
- DC Current for 3.3V Pin: 50 mA.

The SIM900 module from SIMCom Wireless Solutions Co.,Ltd. [13], is a GSM/GPRS board that supports the following applications:

- connections to the Internet over GPRS network,
- sending and receiving SMS messages,
- making and receiving phones calls.

The complete electronic connection scheme is shown in Figure 4. The GSM/GPRS SIM900 module is connected to an Arduino Uno board via serial communications (Tx, Rx). The successful initialization of the device is signalled by a double blinking of the LED connected to the Arduino pin 13, and a confirmation SMS is sent to the system administrator. Two Power MOSFET (IRFZ44N) switches are connected to the Arduino pins 2 and 3, which control the electrical locks connected to them according to the received SMS message.

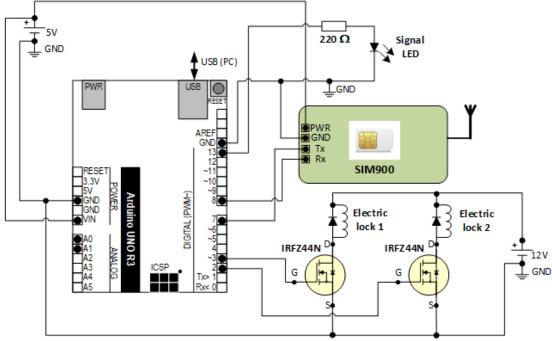


Figure 4 The device electronic scheme

On the GSM/GPRS SIM900 module some adjustments must be made by moving the jumper communication.



Figure 5 Selecting the serial communication

In the developed device "Software Serial" communication according to Figure 6 is selected. This means that the SIM900 Rx and Tx pins are connected to the Arduino pins D8 and D7, respectively.



Figure 6 Jumpers settings

There is also the possibility of a software trigger for the power up of the SIM900 module by soldering the jumper shown in Figure 7 and connecting it to the Arduino digital pin.



Figure 7 Software Triger

3. Software design

The features of the SIM9000 module are controlled with the AT command sets [14]. In this software solution the Marco Martines library is used [15] to simplify programming the AT commands. The software solution is presented using a flowchart. The flowchart shown in Figure 8 refers to the process of including the required libraries, declaring constants, variables and functions, and initializing the device inside the *setup()* function. If the device is successfully initialized and connected to the mobile network, it will be signalled to the system administrator by blinking a signal LED (twice) and sending a text message to its number. If the initialization process failed, the LED blinks 10 times and the device is resetted, and the entire process is repeated.

Including libraries and classes! Declaring constants, global variables and functions! Pin definitions! Start GSM! powerUp() **GSM** No. started? Yes Blinking signal diode Blinking signal diode (10 times)! (2 times)! Device reset! Send SMS to admin! SendSMS()

Figure 8 The device initialization process

After the device has been successfully initialized, the signal processing is started within the *loop()* function shown in Figure 9. If a voice call is received, the device will reject this call and send an SMS to the system administrator. If an SMS message is received, the device will read the command from the message and perform the requested operation and send back the SMS message to the system administrator or user.

The software libraries shown below were used to implement the code.

```
#include "sms.h" //from [15]
#include "SIM900.h" //from [15]
#include "call.h" //from [15]
#include <SoftwareSerial.h> //standard Arduino library
```

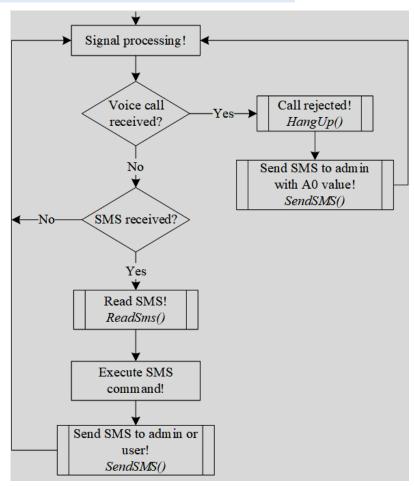


Figure 9 Active state of the device

In order to realize the required functionality of the device, certain functions from the original software libraries have been slightly modified. Modified are functions that relate to reading SMS messages ReadSms(), privacy features PrivacyPrint(), cleaning out the terminator character from an AT commands getAtResult(), uppercase and lowercase conversion ToUpperTmpStr() and software trigger powerUp() and powerDown().

4. Device usage and testing

The SMS messages are used to control the device and make a user authorization. The system administrator mobile phone number is listed in the first position on the SIM card. The enrolment process of other users is managed by the system administrator. If the entire SIM

directory is deleted, by sending an SMS message with the keyword "ADMIN" the new user will be set up as a system administrator. The program allows up to 200 user numbers on the SIM card with specific permissions rights.

Table 1 lists the administrator commands with the descriptions.

Table 1 The administrator commands

O.N.	Commands	Description	
1.	ADMIN	Write the sender number in the first SIM position	
2.	SIM WRITE-+38591xxxxxx:Korisnik	Write the user number in the first free SIM position	
3.	SIM POSITION-X	Return the number entered in that SIM position	
4.	SIM DELETE-X	Delete the number entered in that SIM position	
5.	SIM BOOK DELETE	Delete the entire SIM phonebook	
6.	SEND SMS-+38591xxxxxx:This is a message	Return an SMS with an account amount	
7.	CALL-+38591xxxxxx	The GSM device will call the number in the SMS message, this command can also be used to check the account amount	
8.	POWER OFF	Turn OFF the GSM device, also used for security purposes. It requires a physical reset of the device.	

The user can execute the commands shown in Table 2 to remotely control the device.

Table 2 The user commands

O.N.	Commands	Description
1.	ON 1	OUT 1 = ON (PIN 2)
2.	OFF 1	OUT 1 = OFF (PIN 2)
3.	ON 2	OUT 2 = ON (PIN 3)
4.	OFF 2	OUT 2 = OFF (PIN 3)
5.	STATUS	Request a current status of the device
6.	INFO	Request an info from the device (operator, signal strength, IMEI)
7.	ACK ON	Enable an acknowledgement call back function
8.	ACK OFF	Disable an acknowledgement call back function
9.	PRI ON	Enable privacy (default), don't show the entire calling number in the debug window
10.	PRI OFF	Disable privacy

Additionally, there is also the possibility of calling the device and then the voice call is rejected. In that case the device will send a value from the analogue pin A0 to the user as an SMS message. All SMS messages that are not authorized or do not come from the numbers stored on the SIM card will be forwarded to the administrator.

The functionality of the device was tested in such a way that the administrator and user sent different commands from different mobile phones. All commands were successfully executed and the device returned the corresponding SMS messages.

Figure 10 shows an example of sending and executing **INFO**, **STATUS** and **OFF 1** commands by the user.

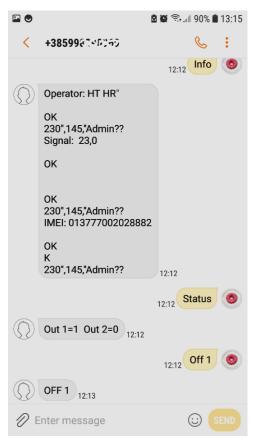


Figure 10 Testing user commands

5. Comparative analysis

In order to make an evolution of the performances of the device developed at the SOSS with a commercially available "GSM 1" device, a comparative analysis of their characteristics is given here. Table 3 provides a concise comparison of the main features of both devices.

Table 3 Device comparison

O.N.	Features	"SOSS" device	"GSM 1" device
1.	No call costs	+	+
2.	Wide spectrum of applications	+	+
3.	Security - a caller ID used to identify, ignore unknown callers and send notifications to the system administrator	+	+
4.	Ease of usage and user friendly	+	+
5.	Easily add and delete users	+	+
6.	Multiple users solution, up to 200 authorized telephone numbers	+	+
7.	SMS notifications to users	+	+
8.	Control multiple electric actuators	+	-
9.	When the voice call is rejected, sending a value from one analogue pin via a SMS to monitor the device	+	-
10.	Ability to communicate with a third party that allows to view the status of remote user accounts	+	-

Note: "+" - satisfies feature, "-" - does not satisfy feature

An analysis of Table 3 shows that both devices meet similar user requirements. It is important to note that the "GSM 1" device is a full custom design for the applications it is intended, while

the SOSS device is developed using open source technologies and software. Because of this approach, the developed device has certain advantages that are reflected in the application of additional security protocols and the ability to control multiple different electrical actuators. In addition, the SOSS device is an educational model applicable to the study of communication protocols, reading sensor measurements, and operating with various electrical devices in a simple and user friendly way. The price of the "GSM 1" device is approximately 100\$, while the cost of all the necessary components for the development of the SOSS device is of the order of up to 50\$.

6. Conclusion

In this paper a device for physical objects access control utilizing the resources of a public mobile telephone network is presented. It was developed at the University Department of Professional Studies, University of Split. The SOSS device is comparable to commercially available devices designed for similar applications such as the "GSM 1" device. In addition, the SOSS device is applicable to the education of students in the relevant technical fields to gain knowledge through practical work. Due to the application of open source technologies, the developed device is very easy to upgrade with new functionalities. One of the future upgrades of the developed device relates to the possibility of saving power consumption by placing the device in a sleep mode during an inactive period.

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Wind-turbine Blades Inspection for Lightning Protection Purposes

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Abstract. Exposure to adverse weather conditions is regarded as one of the most sensitive topics when it comes to wind turbines. The starting point of the inspection is defined by the procedure of establishing the facts regarding wind turbine's blades' surface and structural condition as well as the functionality of Lightning Protection System (LPS).

Particular attention will be directed toward the problem of pitch and yaw control using wind turbine's control system (*pitch*¹, *yaw*²) via specialized software used to test the current condition of the blades.

A three-dimensional display using Cornis software package in combination with an electronically controlled rotating mechanical joint is used for the purpose of inspecting the actual condition of the blades.

Key words: wind farm, wind turbine, blades, lightning strike, protection

1. Introduction

The technology taking primary role in that aspect is the technology of wind. Facilities that convert kinetic energy of wind into electrical energy are called wind farms. Wind farms consist of a series of wind turbines connected by underground cables into one single unit. In addition to turbines, an integral part of any wind farm is its connecting point – electrical substation.

Wind farms are complex facilities with precisely defined conditions that must be met in order for the wind farm to be optimized and functional. Over their life span, several operational risks have been identified in wind farm operations, with lightning strikes being one of the leading ones. Since lightning strikes cannot be prevented, measures are taken to minimize the effects of lightning as much as possible. The subject of this paper is the technical examination of the condition of the blades, which is carried out according to strictly defined requirements.

¹ Pitch – rotation of blades about the axis due to wind influence, blade angle adjustment

² Yaw – nacelle rotation due to wind influence, position adjustment in 3D system

2. Wind turbine specifications

A number of factors determine the average life span of a wind turbine and turbine blades. However, if we adhere to the maintenance plans and programs for proper management, we can say with certainty that a wind turbine's life span is 20 to 25 years. In order to achieve it, it is necessary to have a reliable, professional and regular maintenance plan for all wind turbine components, including blades.

Wind turbines (figure 2.1. and 2.2.) have 3 blades³ that "catch" the wind, which with its blowing force rotates the shaft attached to the blades, powered by a gearbox, and the generator that generates electricity.

The tests are conducted on a turbine manufactured by Vestas, model V112 - 3 MW. The model's declination mark is letter V (Vestas), rotor diameter of 112 m, blade length of 56 m and 3 MW is the value of the installed capacity of each individual wind turbine.

Blades are, we can say, crucial in transmitting wind potential and should be regularly maintained. Due to their exposure, where in vertical position together with the height of the tower they reach a height of 160 m, they are sensitive to the atmospheric discharge of electricity.

Standard inspection of blades on turbines of an average wind farm is carried out at least once a year, while in areas of high thunderstorm activity inspection is recommended every six months.



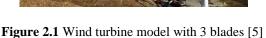




Figure 2.2 Wind turbine model with 2 blades [5]

3. Wind turbine blade structure

Blade length for V112 - 3 MW model is 56 meters, with weight of approximately 11 tons, as can be seen in the photo of the blade transport – figure 3.1.

Blade structure is made out of aerodynamic surfaces, which are mounted on a supporting element and consist of fiberglass reinforced with epoxy resin and carbon fibers.

A copper mantle is installed at the tip of the blade which serves as a lightning rod, i.e. it directs the lightning strike toward the position where the damage, if it occurs, would be minimal. Receptors (copper conduits) are installed on top of the mantle, along the inner side of the blade, 20 m apart, to discharge the lightning current into lightning current transfer unit, LCTU. Figure 3.2. displays the position of LCTU. It is located on a sliding plate which is mounted at the very edge of the blade inside the nacelle.

³ Variants of wind turbines with 2 blades or without blades also exist, but are used in a very small percentage



Figure 3.1 V112 model blade on the ground during transport



Figure 3.2 Lightning current transfer unit, LCTU

Via grounding cable, shown on the image 3.4., lightning current is discharged over the entire length of the tower to the ground, thus avoiding possible damage to the blade structure itself (figure 3.3.) as well as to other installation inside the nacelle.



Figure 3.3 Blade inner structure

Figure 3.4 Grounding cable

4. Inspection implementation analysis

The purpose of the inspection is to identify the blade damage at an early stage so that it can be repaired on time. Therefore, it is necessary to identify the damage extent before the existing damage, under the influence of weather conditions, grows into a much greater, economic and operational damage.

The blade inspection procedure is used to find micron cracks and tears, which are invisible to the naked eye. These small cracks lead to greater damage if not repaired in a timely manner. Let us consider the consequences of a blade damage. Lightning hit the blade with low intensity, but caused a barely visible (cosmetic) damage at the very edge of the blade. The crack is less than a millimeter in length [3]. Adverse weather conditions directly affect the condition of the crack. For example, in case of rain, the crack is filled with water. Wind farms are located at altitudes above 800 m (the wind rose indicates a more intense and stable wind) at which the temperature drops below zero degrees Celsius (0°C). Therefore, under the condition of extreme cold, water in those tiny cracks turns into ice. After a period of time, lightning hits the blade again. This impact (also of lower intensity) is much more devastating due to the fact that in the existing crack on the blade a conductive medium is formed in form of water and ice, which discharges lightning current (with much higher intensity) along the entire length of the structure. It is clear that this causes considerable damage to the blade structure (fiberglass), even so severe that it often causes the turbine to stop. Blades no longer operate in a state of optimized balance (disorder of the forces).

The inspection is performed using a high definition (HD) camera, an optical lens (high zoom capability), a computer software and a mechanical-electric joint that takes photos of the entire length of the blade at precisely defined coordinates. The goal is to detect damage caused by lightning strikes at an early stage so that the damage can be repaired at its beginning. The purpose of the inspection is to prevent damage from increasing to a category 3 or higher (categorization from 1 to 5) [1]. We are talking about damage of a size of a micron and one can easily see the reason for using high-quality equipment that enables detailed zoom and damage display.

In order to perform the inspection in accurate and precise manner, besides the software knowledge, it is necessary to be familiar with the operating conditions of the turbine, as well as, in particular, to properly and safely control the position and the rotation of blades and nacelle in two basic categories:

- blade angle adjustment (pitch) and
- nacelle rotation (jaw).

5. Inspection procedure

First, the equipment is mounted according to figure 5.1. A three-leg stand is installed, which serves as the stand for the mechanical joint that holds camera and lens. The joint is fully controlled through specialized software from the Cornis equipment manufacturer. The laptop (computer) connects to the joint via an HDMI cable or USB port. Then the laptop connects to the camera via another of the same slots (HDMI and USB).

After checking the condition, the stand is placed one meter in front of the wind turbine tower and adjusted to perfect balance (level indicator must be in the middle). This completes the manual assembly of the equipment and we move to the wind turbine where the following series of actions are to be carried out.





Figure 5.1 Mounted equipment prepared for recording (zoom on one of the blades)

First, the wind turbine is stopped if it was in Run mode, which is the most common case. [4] The procedure is as follows. First, we approach the turbine control module, the PLC SCADA, which has a built-in monitor for ease of reference (figure 5.2.). The PLC system is accessed with the assigned username and password. After successful login, the turbine can be operated. The turbine is stopped by entering into Safe mode.

After stopping the turbine, the blades continue to rotate because of inertia (due to their weight as they were previously in motion). This inertia is used to stop the rotation at precisely the right time, that is, in the position of the blade that is suitable for inspection and recording.





Figure 5.2 PLC control module (SCADA interface)

Suitable recording position is shown in figure 5.3. One turbine blade is at the top and other two at the bottom (reverse epsilon), with the blade at the top in perfect line with the tower (it must not deviate left or right).



Figure 5.3 Initial position of blades prepared for inspection [5]

For the purpose of this manipulation, it is ideal to involve two operators who communicate with each other via the walkie-talkie devices. One person is outside the wind turbine and monitors the position of the blades. At the moment when one blade reaches the top, this is reported to the person operating the PLC system, who then activates the signal that triggers the mechanical brake to stop the blade momentarily in that exact position. For the purposes of manipulation, two basic concepts of manipulation (pitch and jaw) need to be explained. Pitch is the command that rotates the blade about its axis in degrees. Yaw is the command that rotates the nacelle clockwise or counterclockwise (again in degrees), provided it cannot be turned more than 3 times in the same direction to prevent the energy cable running down the entire tower from overextending.

These commands are executed following two different principles [4]. Pitch is executed by built-in hydraulics inside the turbine that control the blades, while jaw uses electric motors (eight in total) that rotate the nacelle in a given direction. In standard turbine operations both commands are used to capture optimal wind. Anemometers mounted on the roof continuously send real-time wind parameter signals according to which the PLC command system controls pitch and jaw commands, namely the position of the nacelle and the blades. At the described time, the turbine is not in operation (break state) due to intervention or service and both mechanisms are in manual mode, therefore operated manually.

Furthermore, the exact position of each individual blade (A, B and C) needs to be determined as they are not marked on the outside. In order to do this, we mark one of the blades as A and issue pitch command of 0° , i.e. to rotate so that the entire surface of the blade is in the direction of the wind coming toward the tower (viewed from the ground). This position shows only the blade edges, as the surface faces the wind. This type of check is ideal for the two blades in the bottom position. It is more difficult to visually determine the condition of the blade that is stopped at the top. When we locate the blade that reacted to pitch command of 0° , we remember it and apply the same procedure on the remaining two blades. We now know exactly which blade is A, which B and which C, which is essential for software configuration (figure 5.4.).

After that, we set all three positions in the counter position, i.e. we issue pitch 90 command. So, all the blades turn into position "knife" towards the wind, letting the wind pass. When viewed from the ground, we see the entire surface of the blade, namely one side of it. This is the starting point for recording.

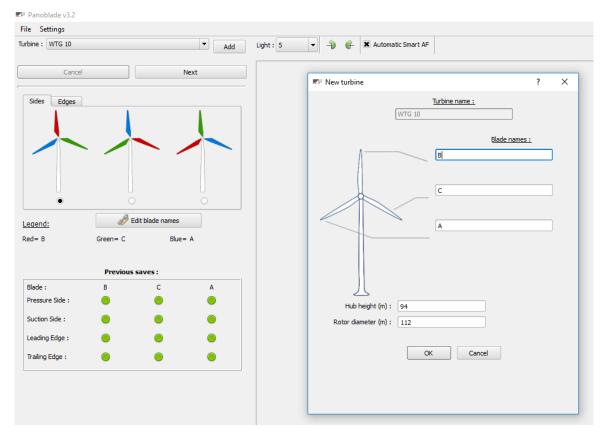


Figure 5.4 Marking of blades

After exiting the wind turbine, we access the laptop that is connected to the rest of the equipment. We launch the program and the homepage opens. We create a new inspection and name it according to the turbine mark we are inspecting (for example WTG1 – Wind turbine generator 1). The next step is to enter the position of each blade (A, B, or C, left, right or up), as defined by pitch manipulation inside the turbine (figure 5.4.).

Then the quality of recording, sharpness and zoom is checked (figure 5.5), and via laptop (using the keyboard arrow keys) we move the mechanical joint with the camera on top. If everything is in order, we enter the coordinates for recording. Each recording series captures 2 blades in different positions. There are always two blades in bottom position which are recorded, while the third blade left in the air is recorded in the following recording series. The coordinates are manually adjusted, i.e. we first go to the top of the blade that is located to the left above us and place the first marker there, after which we descend to the middle of the same blade and place the second marker, and finally we descend to the bottom of the same blade where we place the third and final marker.

After that, we climb again to the top, but now we go a little to the right, i.e. to the top of the second blade – the blade located to the right above us and repeat the marker coordination procedure (3 markers, top, middle and bottom) and with it we conclude the mapping of markers for this position.

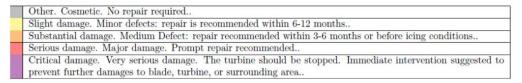
Once again, we check the resolution and press start. The program, in combination with the mechanical joint, records 35 images along the entire length of the blade, first the left one and then it switches to the right one (70 images in total). After that, we check if there are any bad images and if some images need to be recorded one more time with the adjusted brightness level (depending on the weather conditions). It is important to emphasize that the lens must never come into direct contact with the sun, as it will burn out.

Inspection report blade A



Inspection report captions

The following nomenclature is used to describe the level of severity of the defects. The "Other" category is indicated for information purposes and for further monitoring.



Abreviations:

- SS : Suction Side
- LE: Leading Edge
- PS : Preasure Side
- TE : Trailing Edge
- $\bullet~{\rm BW}:{\rm Blade~Width~from~leading~edge}$

Figure 5.5 Snapshot of final inspection report for blade A [1]

When the procedure is complete, we return to the turbine and issue pitch command of 0° . Now the blades rotate toward the edge (viewed from a ground perspective) and we repeat the marker coordination procedure (the recording surface is much narrower as we record the edge of the blade along its entire length). The same is repeated for the second blade, with 35 images recorded along the entire length of the blade, first the left one and then the right one (70 images in total). This way, we completed the first out of three recording series.

Now the break needs to be released and we need to wait for the wind to start rotating the blades (clockwise when looking at the turbine standing in front of it, i.e. looking toward the nose of the nacelle). There is no option to manually start the rotation of the blades (we require wind). To start the rotation of the blades more easily we manually set pitch to 78° .[4] The blades are now positioned in the optimal position for initial wind capture, namely the position from which they are most easily launched. At the moment of launching the blade, the situation is monitored until the next blade (the one that was below to the left) is in the top position.

Then we activate the mechanical brake one more time, issue pitch command of 90° for the largest recording surface, and return to the laptop. All markers are stored and the start option

is activated. After recording in pitch 90° position, we issue pitch command of 0° and record the edge of the blades [4]. The second recording series is completed. We repeat the procedure for the third recording series when the third blade reaches the top.

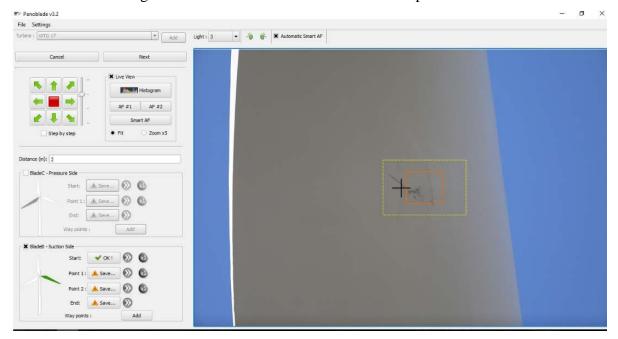


Figure 5.6 The zoomed figure of the damaged part of the blades

After completing the third and final recording series we have 140 images per batch, 420 in total for all three blades that are then processed graphically and in vector via the damage categorization program with detailed damage display. Based on the report, we know exactly which turbines and which blades need to be repaired according to the priority (level) of damage observed. The final step is to disassemble the equipment used, return to the turbine, release the brake, log out of Safe mode, return the turbine into Run mode and move on to test the next turbine.

6. Conclusion

Examining the condition of the blades in terms of preventive procedure is one of the fundamental inspections when it comes to the operational life of a wind farm. Due do the size, the surface it occupies and the specific structural materials from which it was built, the blade is exposed to the risk of lightning strike. Thus, regular and thorough checks of the condition of the blades needs to be carried out in order to avoid potential economic damage. Preventive testing and repairs to the revealed cracks are essential to repairing the damage that can cause the turbine to stop working or preventing damages that cause the damaged blade to be replaced with a new one, as a result of a lightning strike. Therefore, it is necessary to know the blade structure, the operation of the turbine in general, the operating principles of the turbine's control mechanisms, but also the software package for damage testing. The inspections should be carried out at least once a year, and for areas of high thunderstorm activity it is recommended to repeat the inspection every six months.

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Chronological Order of Offshore Semi-submersible Drilling Rig Spill and its Consequences in the Gulf of Mexico

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Abstract. Due to the steady growth of offshore economy, changes to the eco system are inevitable. Water resources are of crucial importance, but they are constantly being exposed to various environmental risks. In order to reduce these unwanted consequences, especially ecological ones in water resources, security is now gaining much needed importance.

Thus, this paper attempts to outline the disadvantages and consequences of the economic impact on exploration activities in the example of the Gulf of Mexico oil platform spill. Apart from the fact that the initial explosion represented a threat to human lives, the consequences are far reaching influencing the entire macroecological system.

Global economic politics, by defining it's research deadlines, had the effect of neglecting the basic laws of the profession. The main purpose of this paper is to answer the question of whether a disaster could have been avoided. Contribution to the protection of water resources from potential environmental pollution is a basic path of the development of society's awareness as a whole.

Key words: ecology, offshore economy, security, politics, economics

1. Introduction

The environmental disaster that occurred in the Gulf of Mexico on April 20th, 2010, which resulted in rig sinking two days post explosion. The analysis of the course of events shows the inevitable catastrophe caused by human error which was proved to be a direct consequence of corporation politics and the negligence of métier.

The pursuit for higher output performance resulted in an uncontrolled situation within the rig control system. At that moment, the unexpected consequences reached unprecedented proportions.

The shores of the islet, which was mostly dependent upon tourism and fisheries, became full of oil, the air was unbearable, and the staff of British Petroleum (BP) imposed emergency situation upon seeing this wreaking havoc.

This is due to the seepage of crude oil from the seabed that occurred after the rupture of the Macondo well¹ and the oil rig explosion.

¹ Name for the well from which the oil was extracted, shown in Figure 1.1

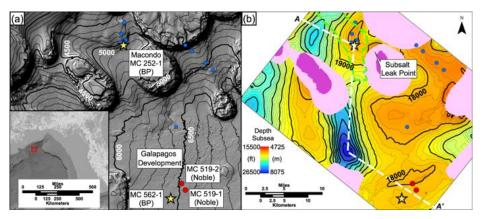


Figure 1.1 Macondo well

Izvor: William, F.; Pinkston, M.; Flemings, P. B.: *Overpressure at the Macondo Well and its impact on the Deepwater Horizon blowout*, Scientific Reports volume 9, Article number: 7047 (2019)

2. Structural organization

The British Ship Classification Society first encouraged the classification of platforms by issuing a certificate that the platform has met all the requirements for safe operation, according to the Rules for the Construction and Classification of Mobile Offshore Units. [1]. A rig (franc. *plate-forme*) is a fixed or mobile platform with a superstructure intended for offshore drilling below the seabed for the exploration and / or production of crude oil or natural gas. There are two basic types of rigs by purpose:

- drill and
- production.

The drilling rig is, in principle, an autonomous moving float unit with or without its own propulsion system. According to the method of placement and retention in the working position are distinguished: supported rig (self-lifting and submersible) and floating rig.

The production rig is used to extract energy resources like crude oil or gas from the well and is in principle tied to the production site.

3. Analysis of events that preceded the disaster

British Petroleum (BP) was responsible for the rig. Crude oil spills were leaked from an oil well that was drilled about 1.5 kilometers below seabed.

BP and Halliburton employees arrived on the platform four days before the event itself. They were tasked with determining the actual condition of the Macondo well and its commissioning. However, the workflow became a real danger of turning the well into the "well from hell" [2].

By April 20th, they were nearly six weeks behind with more than \$58 million over budget. [2] Deepwater Horizon shown in Figure 3.1. suppoused to complete the drilling, which was left behind from the previous platform, approximately 9,000 feet until the pay zone(oil and gas tanks). Two and a half miles below the seabed was a large reservoir of Middle Miocene oil and gas in porous rock formation at temperatures of approximately 262°F. [2]

A series of events and decisions resulted in an explosion also called Swiss Cheese effect. Eliminating at least one of them probably could have prevented or reduced the scale of the event itself. The report investigates eight cause and effect elements that are thought to be the cause, that is, the contribution to the oil spill.



Figure 2.1 Deepwater horizon [9]

The condition of the drill pipe according to Figure 3.2 is defined through three elements:

- pressure testing, in particular the negative pressure test of the Macondo well,
- monitoring of wells,
- confirmation of control.

BP and Transoceans procedures in relation to each of the elements of cause and effect were insufficient.

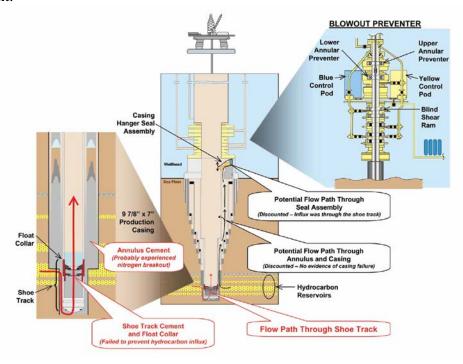


Figure 3.1 Macondo well test procedure [3]

The total depth of the well is (18304 ft) 5579 m, with a temperature (TD is $262^{\circ}F$) $128^{\circ}C$. the well head is at (5054 ft) 1540 m and the seabed is at (5067 ft) 1541m. Position 9 7/8 "liner hanger at (15103ft) 4603 m, 9 7/8" liner shoe at (17168ft) 5230 m. The final production column is 19.04.2010. positioned at 9 7/8 x7.

Before the catastrophe, the quality of cement was questionable due to the excessive amount of nitrate, and the cement mass was unstable. Instead of 21, as standardised, six centralizers were installed in end columns. The cement on the production column reached a height

(17260ft) of 5261m. The positive pressure test was satisfactory. The negative pressure test placing the well into an unbalanced state to ensure that the cement will retain and prevent the hydrocarbon from entering the well has resulted in high preassure in the well. A " effect of the bladder " was suspected as there was no indication of a leak from the well. Tests were performed on the kill line and not on the drill pipe.

Misinterpretation of the negative pressure test again resulted in a blowout.

Prior to negative pressure, a volume mud bar and a specific gravity of 424 bbls² of 16 ppg³ was in the annular, and 30 bbls of fresh water and 352 bbls of seawater were used to squeeze the same. The weight of the mud under the column of water was 14.17 ppg. The drill pipe was at 8367 ft. Due to the leakage of the annular preventer, 50 bbls of seawater have leaked out of the pipe. According to one of the crew members, the drill pipe had previously been moved on a closed annular preventer, damaging the annular preventer rubber element.

During the negative pressure test, a pressure of 1400 psi⁴ was recorded on the well. The crew interpreted the high value of the pressure in the drill as the effect of the bladder - the displaced mud presses on the space around the annular space and the resulting pressure is transferred to the pressure in the pipe.

The second test was performed on the kill line. At the kill line, the pressure was close to zero-having no flow for 30 minutes. The negative pressure test was assumed to have been satisfactory, although there was no logical explanation for why there was so much difference in the pressure of the drill pipe and the injection line- unless the injection line was blocked. The crew continued to squeeze out the heavy mud. The well was brought to an underbalanced state (lower well pressure than the formation pressure) and due to poor quality cement, the crude oil reached the well (Figure 3.3.). Pressure increased. The closure of the inside blow out preventer (IBOP) and the annular preventer were approached. The middle pipe ram for the pipes is closed. Hydrocarbons suppressed the mud, methane spreaded around the platform and entered the engine room.

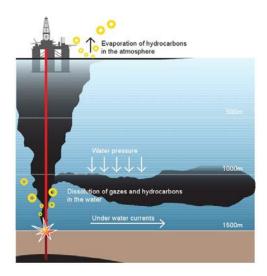


Figure 3.2 Crude oil leakage [4]

The consequence is a loss of power management system (PMS) a dynamically positioned system being lost. Blow out preventer (BOP) did not work due to a 27V battery failure caused by a faulty connection. The yellow preventer of damage (POD) double acting solenoid valve

² barrels

³ pound per gallon

⁴ pounds per square inch

was incorrectly connected. Due to malfunction of BOP control system caused by inadequate maintenance, BOP was not fully functional.

A sheer ram and LMRP disconnect device is activated. The order was sent to the control system but no hydraulic flow was registered. There is a loss of power at this point, but the lower marine riser package (LMRP) has not been disconnected from the BOP, resulting in the hydrocarbon being spilled into the sea. It is estimated that over the course of 86 days, the oil spill amounted up to 780,000 m3 (4.9 million barrels).

4. Event expansion

During the negative pressure test, there were several warning signs indicating a problem. The first sign was a negative pressure test that gave conflicting results showing a pressure reading of 1400 psi and then 1240 psi- when they should have been zero. The test was easily accepted as satisfactory because they did not have standardized data for the test results.

There are other possible explanations- but all of them are unfathomable. Furthermore, these results were transmitted to BPs onshore personnel. Namely, the assumption was that no action had been taken to determine the cause of the deviation or to re-evaluate the negative pressure test (Figure 4.1). A closed mud extraction system was not used to allow more precise monitoring of the well upon returning to an unbalanced state.

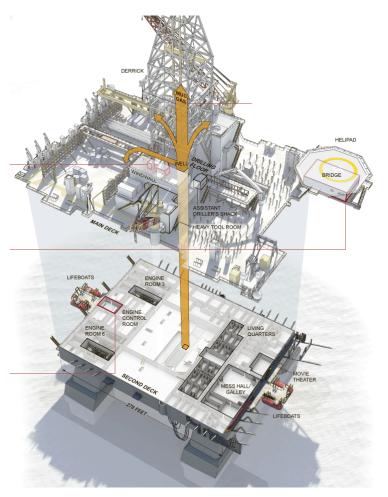


Figure 4.1 Crew reaction [5]

About five hours before the explosion, an unexpected loss of fluid was observed in a pipe located in the well. Two hours prior to the explosion, a second negative test was performed, which was also considered satisfactory. But, 51 minutes before the explosion, warning signs were noticed. However, it was too late, since crude oil was already moving uncontrollably out

of the well. 18 minutes before the explosion, hydrocarbons exploded and leaked to the surface. Hydrocarbons began spreading uncontrollably across the rig- and then an explosion occurred.

So, summing up the aforementioned, it can be stated how the factors that led to the disaster were:

- ✓ hydrocarbon reservoir source
- ✓ no well stability being established
- ✓ hydrocarbons entering the well
- ✓ well bore control lost
- ✓ ignition of hydrocarbons
- ✓ BOP not responding
- ✓ Oil spill consequence.

Following the Macondo disaster, most of the Oil and Gas Exploration and Production Regulations now require operators and subcontractors to install acoustic control systems on offshore equipment. Prior to the disaster, only the Norwegian and Brazilian authorities had proclaimed the installation of acoustics in subsea equipment (acoustic BOP control) mandatory. Following this accident, the recommendations of the American Petroleum Institute (API) are to install acoustic BOP control system in deepwater drilling rigs.

Despite the fact that acoustics on the Deepwater Horizon would not prevent the flow and spillage of the oil, the acoustic system is certainly crucial and inevitable redundancy system for cotroling the subsea equipment in case of emergency situation.

4.1 Technical aspects of the event

During the night of April 20th, a sudden torrent of natural gas bursted through the cement core of the well- causing the plant to explode.

Deepwater Horizon was not originally intended for work on the Macondo well. Six months earlier, extraction began with another platform known as "Marianas". Hurricane Ida damaged this platform and needed repairing. It was drilled 4,000 feet below the seabed and 9,000 feet left until reaching the pay zone.

Neither of the factors mentioned earlier can be deemed as solitary agent for causing the tragedy of the Macondo oil well. To be more specific, a series of failures involving numerous different parties led to an explosion and fire that led to 11 people losing their lives and for causing a widespread pollution in the Gulf of Mexico.

Decisions made by multiple companies and work teams have contributed to the accident, which is said to have arisen from "a complex and interconnected set of mechanical failures, human judgments, engineering design, operational implementation and team interfaces".

The specific sequence of events leading up to the disaster can be described as following: the cement mass at the bottom of the Macondo well failed to retain hydrocarbons inside the reservoir as intended- allowing gas and liquids to flow through the production casing

the results of the negative pressure test were wrongly accepted by both BP and Transocean the crew failed to recognize and act on the hydrocarbon inflow into the well until the hydrocarbons had expanded and quickly floated to the surface

after eruption, the product is brought to the surface where it is diverted to the mud gas separator- causing the gas to drain directly to the platform instead of being diverted overboard the gas flow into the engine rooms through the ventilation system created the possibility of ignition, which was not prevented by the fire control system.

4.2 Technical aspects of the event

Since the company- which had been using chemicals beyond its permissible level, sank large quantities of crude oil to the bottom of the Gulf, pollution occurred. Inevitably, the Deepwater Horizon disaster has left its effects on the ecosystem.

In addition to the increased mortality of dolphins and seabirds, studies have indicated that due to the aforementioned disaster, 20 animal species are on the verge of extinction.

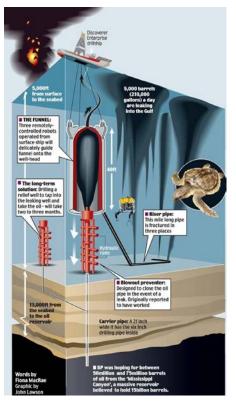


Figure 4.2.1 Consequence of oil spill damage [6]

The oil spill lasted 87 days before the well was closed on July 15. The amount of spilled crude oil is estimated at more than 969 to 100,635 barrels (790,000 to 16,000,000 litres) per day. [7] As a consequence, about 6,000 km2 of marine surface has been polluted. For over a month, unsuccessful attempts were made to stop the initial crude oil eruption. However, reports from 2012 showed that there was still a leak of crude oil from a well in the sea. [12]



Figure 4.2.2 The explosion of Deepwater Horizon [8]

Causes of accidents or hazards are often a human factor. Ignorance, failure to comply with regulations, instructions and commands, as well as fatigue, fear and panic can lead to danger on naval installations. Also, these include failure to perform regular inspections, improper maintenance as a whole relating to machinery failures, electrical installation, signalling, navigation, ventilation, refrigeration and fire systems, steering systems, cargo handling and anchoring systems, etc. Emerging hazards on platforms are shown in Figure 4.2.3.

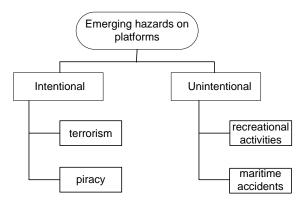


Figure 4.2.3 Emerging hazards on platforms

The specific events that led to the fire were a mixture of human and technical failures. In recent years, there has been an increasing emphasis upon the so-called 'human factors' in terms of the oil, gas and construction industries. Audit findings and maintenance records identified potential weaknesses in the BOP testing and maintenance management regime.

4.3 Economics as a cause

Two U.S. Congressmen responsible for investigating the crash, Henry Waxman and Bart Stupak, came into possession of a memorandum confirming that the BP managers knew about the problems. However, the memorandum does not mention who decided that the drilling was to be continued even after the problem was discovered.

Exploration and drilling costs exceeded expectations [10] and it's been six weeks late.

The political compromise passed by the Act favoured the primary purpose of promoting offshore drilling. The compromise-defined law stipulated that the development and production plan must set out "environmental safeguards to be applied".

5. Conclusion

All in all, it can be concluded how it is necessary to take all possible precautionary measures in order ensure the wells being under control at all times during their operation. In addition, it is mandatory to use optimal drilling technology in terms of technical and safety stability. Furthermore, the conditions need to be closely and constantly monitored and evaluated to minimize the potential for the well being used or tested.

When it comes to the main technical cause of the Deepwater Horizon (DWH) crash, it can be said that the cement pumped into the bottom of the well did not prevent nitrate suppression. To be more specific, because of the high nitrate content, the cement stopped the hydrocarbon leakage.

So, it is obvious that the factors that increase the risk are following:

- drilling complication small total amount of cement
- the cement mass itself poorly designed and tested
- implementation of rig safety abandonment procedures performed at the last minute.

As mentioned earlier, the results of the negative pressure test conducted on April 20 were misinterpreted. Then, series of buoyancy signals were ignored during the last hour before explosion. And so, buy the time the (BOP) device was activated it was too late to prevent a disaster. Furthermore, the protective mechanism was not adequately fitted.

The underlying cause of the accident was insufficient safety training and assessments of the employees (BP and its Transocean contractors, Halliburton). Investigation reports revealed a number of failures in the management and implementation of security aspects that led to the accident itself.

And so, the assumptions of the cause of the accident can be stated as:

- inadequate risk assessment –failure to recognize prewarning systems of deviation points and changes of the well
- lack of timely recognition and response to early warning signals
- lack of CRM (crew resource management) trainings
- negligence of rig management team and senior staff
- lack of management capability
- inability to recognize the situation from the experience of other accidents and failures.

Due to this, changes of the regulatory reform are now being proposed, since the established regulatory structure of MMS as of April 2010 has proved to be completely insufficient when it comes to addressing risks in situations such as Macondo.

It has been agreed that the following changes will include:

- separation of leasing from regulatory oversight functions
- a risk-based approach similar to the "security case" approach used in the North Sea
- inspection and approval of the facility's safety
- regular inspection,
- tighten international security standards
- conduction of transparent reporting when it comes to incidents and errors for the purpose of learning and preventing accidents
- exploring better planning for emergency response.

The idea for writing this paper came from the fact that ten years have passed since the accident on Deepwater Horizon.

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Role of E-learning in the Improvement of an Educational Process

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Abstract. In this paper the combined learning is explored as a new educational and pedagogical dimension. The importance of information and communication technology is emphasized as an inevitable factor for its support. The paper analyzes a possible software solution for that purpose, i.e. an e-learning system adapted for this concept. It can be concluded that the method of combined learning represents a significant improvement of an educational process.

Key words: E-learning, combined learning

1. Introduction

Problems in education such as out-dated teaching contents due to the rapid scientific and technological development, poor working conditions, lack of the needed didactic materials and teaching aids, are all elements which affect the educational process as a whole. The technological development demands the change in curricula and syllabuses, continuous education of teaching staff, introduction of innovation in the teaching process.

Phenomena of individualization and differentiation of a teaching process have been present in pedagogical and psycological teories and teaching practice. This issue had been currently specially in focus due to the fact that it has to be adjusted and implemented with the contemporary demands of technological and technical advances.

2. Possibilities of IT application in combined learning

The most important factor in on-line teaching is successful communication. Communication with each student is different due to the fact that every students has their own learning style. After an initial communication activity, there is content related to the teaching process itself communication (debate on practical tasks, support for students to understand the content, motivation to engage).

There are many software tools designed to support a teaching process [1-3]. The Internet as a technology is one of the most significant elements of the process. Internet applications provide an extended learning process which is not dependable on teaching institutions. Such

concept allows the improvement in the conventional learning by introducing self-study and distant learning [4, 5].

There are 5 parameters which demonstrate the dynamics of the development of an individualized teaching model [6]:

- individualization of the teaching-learning content: a student chooses certain topics
 among the suggested list in the teaching syllabus of a course, based on his or her
 interests, then the student repeats and practises as much as he is capable to (number
 of repetitions and practice tasks varies in quality, level of difficulty and (or) quantity,
 or number),
- individualization of time: refers to the pace and speed of learning,
- individualization of teaching sequences: possibility of choosing options and reorganization of teaching sequences based on the previous individual experience of students, their overall cognitive, emotional and motivational structure,
- individualization of personal attentiveness: it refers to different communication activities between a teacher and a student, specific feedback which is individually adapted and differentiated, and encouragement for each student,
- individualization of learning and teaching activities in a teaching process: possibilities of choosing and using different activities by students and teaching activities by teachers in order to achieve the learning-teaching objectives in the high quality and efficiency.

The Internet is a global network of computers and a specific medium which can be implemented in the educational process [7-10]. The amount of information existing on the Internet is difficult to access and to measure. Sophisticated tools can be used to provide detailed and precise parameters of the Internet bandwidth. On the website Internet Traffic Report the following precise data on the Internet bandwith are available:



Figure 1 The Internet Bandwith Index on certain continents [11]

Information technology and the Internet are both based on the development of computer hardware and telecommunication services. Hardver development has resulted in high increase of all system components performances, especially of the central process unit, then high capacity memory increase, decrease of overall dimensions, then possibilities to provide the networking and compatibility of different systems, communication, as well as multimedial possibilities. What is most significant in commercial and massive use of computers is an immense desrease in cost of hardware. For those reasons, the application of information-communication technology is an inevitable segment in educational system support.

This paper deals with the concept of an educational sotware which can be applied in the combined learning approach. The system is supposed to provide options to create on-line courses and tests, as well as a possibility of communication among users. The basic software concept is its universality. Such concept has to be a universal system for designing courses, tests and forums. Educational system has to provide [12]:

- totally flexible learning approach "anytime, anywhere"
- individualized, personalized and relevant teaching and learning.

Courses, tests and forums are the general elements of every e-learning system:

- Courses are basic units of knowledge transfer between a teacher and a student,
- Tests are a basic unit which measures success of the acquired knowledge. Within one course it is possible to organize multiple testing,
- Forum, as an extra feature of a course is a basic means of coopration between students and teachers. Within one course it is possible to organize many forum activities.

User priviledges represent a universal principle when projecting software. They are based on the roles which certain participants have in the system:

- User management Administrator and lecturers can manage priviledges and access rights of other participants both registerted and non-registered users.
- Communication All users can communicate between themselves by using the system for private communication which is offered by the system.
- Managing the courses it connects all functions which allow teachers to create courses.
- Access to the material it connects all functions which allow students to attend a course.
- User cooperation is a group of functions which allow users to cooperate between one course.
- Installation consists of different functions which allow an administrator to install the system successfully.

E-learning model represents a bigger whole with a huge number of sub-systems [13]. By the classification process certain roles are alloted, protection is provided, and the whole process of system maintenance is systematized, both on inner and outer level.

3. Application of combined learning – experiences

Combined learning approach in Serbia is still at its inception. However, studies carried out by Starford University and University of Tennessee provided significant insight into certain mechanisms by which combined learning is better than both traditional methods and individualized ways of e-learning, analysed separately [14]. This research proves that combined learning increases possibilities of efficacy in learning.

Introduction of e-learning in program caused the increase in percentage of success as much as 94%. This improvement was assigned to the possibility of "live happening" which makes students more motivated to do their homework on time within a course, studying within a certain time slot, possibilities of interaction with teachers and raising mentorship quality. Research carried out at Starford stresses that connecting materials for self-study and "live" elearning can have a high impact onto the overall use and percentage of realized courses, but also allow faculties and colleges to earn their revenues from the initial investment very quickly.

Another research done through the program Physician's Ehecytive MBA (PEMBA) at the University of Tennessee showed that courses with combined learning can be finished within half the time as originally planned, within half the expense by using an enriched combination

of "live" e-learning, self-study and in-class learning. This course has also shown overall success of 10% increase when compared with the traditional in-class environment, which made that study the first formal study which demonstrated significant improvement of the e-learning application. This result was achieved by experienced approach to combined learning which included many ways of traditional and virtual "live" e-learning, combined with the possibilites for students to test their knowledge in the working context and cooperate with others in adapting their specific needs to the environment.

Technical College Čačak, founded in 1960, innovated the curricula before the official Law on higher education RS prescribed that as an obligation, at the same adapting syllabuses to meet the demands of the contemporary industry. In the academic 2002/2003, the first generation of undergraduates enrolled Technical College Čačak to study six-semester studies (three years). As many as 6 study programs in the field of engineering and technology were accredited by the National Accreditation Body in 2007. In 2009 graduate studies were accredited as well, and afterwards all undergraduate programs were re-accredited. In 2017 master professional studies were accredited for the first time, namely: Mechanical Engineering and Engineering Informatics, Electrical Engineering and Computing. In 2019, additional master program was accredited – Production Engineering.

After the six-semester studies had been introduced, certain issues occurred. Students who did their degree with only 5 semesters and those who have enrolled the college before 2002 were in an inferior position than those who afterwards completed 6-semester studies. Due to lacking 1 aditional semester, knowledge and the degree of these graduates were not fully recognized by the public (im terms of wages and title), so the national educational framework alloted them a lower position, below the higher education position, and were not rewarded with 180 ECTS as they are nowadays. For this reason, majority of these graduates decided to continue their education to complete one more semester. The problem occurred when 65% of those students could not attend in-class teaching due to almost all of them had been full-time employed.

After a survey was administered and an interview with the graduates was held, the conclusion was that Saturday would be the most favourable option for the in-class teaching, while practical classes would be realized via tests and assignments posted on the Internet.

In that way, those students would use their time to complete the tasks in the evenings, after work, or at weekends, without their coming to the college facilities.

The completed assignments would be sent to their teachers and then students would receieve proper feedback. They expressed their preference for the combined learning approach. While the in-class teaching was organized at the college facilities during which they received general instructions and introductions, by doing practical tasks online, they could handle all their private, educational and business obligations easier.

Counting from the time when the process of the Bologna principle implementation in higher education started, it can be seen that there have been more and more students who work. At the very begining, the percentage of the employed students was around 10%, but nowadays that number is around 20%. The main reason why 18-year olds decide to look for the job first and after a year or two decide to study, is their inferior financial status. Basically, those students cannot finance their studies. In order to provide the same conditions for the employed students, the college organizes evening classes (according to the Bologna principles, attendance is compulsory). The survey administered with the present students brought similar results as the previous one. They also expressed their preference for the combined learning approach, so that they could be in the same position as the full-time students.

Such and similar situations are evident in other colleges and faculties. Based on everything said, there is a plausible reason to implement the combined learning as a teaching method in Technical College Čačak, but in others, as well. This paper suggests how a model of software support to implement such solution can be realized.

4. Conclusion

The paper analyses different aspects of possibilities of the combined learning application. It can be concluded that continuous development of technology imposes introduction of new courses and concepts, as the support to the active learning in the computer-assited teaching process.

The advantage of the online teaching when compared to the traditional method is the possibility of interaction (communication) of teachers with every student separately, as many times as demanded by students. Through such communication, teachers receive feedback on students' performance, on their learning style and their progress and pace of understanding. Very quickly after the initial data received, a teacher can adapt and alter other teaching methods.

The more feedback teachers get from their students, the more quality the teaching process will be, since it is the main reason students are motivated. In the classical method, each teacher develops his own communication style with his students. Teachers can transfer their experience to the on-line teching as well, with certain upgrade with new pedagogical implications. In this way, teachers guide each student to make progress in his own tempo, so that he can realize the planned educational content.

The paper deals with the characteristics a purposeful on-line educational system should have. The basic concept of the on-line system is based on its universality. As there is a possibility of creating courses and tests by users, the universality of this concept is obvious. The given components of the system can represent generic models which can be applied for this purpose.

Based on the forementioned, it can be concluded that the application of the combined learning is of great importance in upgrading of the traditional teaching-learning process. The development of information technology has provided possibilities to innovate pedagogies, to develop the teaching process, increase student motivation and increase of the overall educational quality.

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Scalable Video Coding and Statistical Multiplexing as a Means to Increase Channel Utilization

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Abstract. HEVC is an efficient technique developed to reduce HD video streaming. Scalable video encoding, SVC, introduces layered encoding as its extension. Base Layer delivers video data to clients with fewer requirements and capabilities in terms of screen size, decoding complexity and power limitations. For customers who want better video performance, enhancement layers of video are emitted. Thus SVC saves channel capacity by preventing distribution of the same video stream in different resolution to different clients (receivers) within a single multiplex. It is possible to assign a number of different video content, e.g. TV programmes in a broadband multiplex, cellular network or the Internet. An important feature of the compressed video stream is variable bit rate, VBR. To avoid the need to reserve capacity for individual video streams which will not always be used, statistical multiplexing, Statmux, is proposed. Statmux manages the total channel capacity dividing it into individual video streams according to current requirements. This paper will perform a simplified quantitative analysis of these techniques' application. Up-to-date rates for HD video streams encoded by HEVC will be used. Using a relatively simple Matlab program, the number of video programmes allocated in a defined channel capacity will be calculated, with and without the use of SVC and Statmux techniques. An example would be RF channel multiplex in DVB-T2 terrestrial television, with TV programmes from SD to UHDTV resolution. The principle can also be applied to other types of video distribution.

Key words: HEVC, scalable encoding, statistical multiplexing, simulcasting, single layer coding

1. Introduction

Nowadays video applications have been widely used in our daily life. Today various digital video applications cover a very large range from multimedia messaging, phone communications, Internet video conferencing and video streaming, high-definition (HD) and ultra-high-definition (UHD) TV broadcasting, DVD and Blu-ray storage. Different applications use various devices, with different screen resolutions, processing capabilities, and network bandwidth requirements. Users may also use various devices for the same application. The consumption conditions may be very heterogeneous, and also changing dynamically along time. Different networks, such as broadband and wireless networks, may have different characteristics. Even in the same network, the network bandwidth may also vary in different conditions.

These dynamic and heterogeneous conditions have significantly increased the importance of scalable coding. Compliant sub-streams can be easily extracted when network and terminal conditions are resource constrained. The needs for heterogeneity already motivated many years ago the development of the rather efficient Scalable Video Coding (SVC) standard, based on the very popular H.264/AVC standard. In order to provide scalability SVC extends the H.264/AVC standard to encode video content as a set of hierarchical *layers*, starting with the *base layer* (BL). BL

contains the lowest level of spatial, temporal and quality fidelities. The basic version of the video is coded as *base layer* (BL and improved versions of the video coded as *enhancement layers* (EL) to hierarchically increase the spatial, temporal or quality/rate. According to [1], the SVC standard provides various scalability capabilities with about 10% bitrate increase regarding nonscalable H.264/AVC streams at the highest fidelity while enabling the truncation at various bitrate points. This is a significant rate reduction, especially considering that the decoder complexity only slightly increases since interlayer predictions are mostly performed in the compressed domain.

In recent years, the newest standard, HEVC (High Efficiency Video Coding), is reaching full maturity. Since it uses more advanced features and higher efficiency coding tools, it has better coding efficiency than previous video coding standards. HEVC was designed to substantially improve the coding efficiency with reduced bit rate by half with comparable image quality, at the expense of about two to four times increased computational complexity compared to H.264/AVC [2]. There was a constant effort to reduce both the rate and complexity [3]. The number of devices using HEVC is increasing dramatically, and it attracts extensive attention. Several significant improvements have been further made on top of HEVC [4].

In order to accommodate heterogeneous device capabilities, network conditions and client applications, Scalable High Efficiency Video Coding (SHVC), an extension of HEVC, has been proposed [5]. Similar to SVC, SHVC supports scalability in temporal, spatial and quality. In addition, it provides bit depth scalability (bit depth from low to high, e.g., 8 to 10 bit), and color gamut scalability (from narrow to wide, e.g., from ITU-R Recommendation BT.709 to BT.2020).

In SHVC, multiple layers need to be encoded, using inter-layer predictions. The encoding process of each layer is the same as that of HEVC [6]. As expected, the SHVC encoding process is more complex than that of HEVC. Therefore, it is highly desirable to improve coding speed, especially for wireless applications and in real time [7].

When distributing multiple TV programmes on a fixed bandwidth channel, the bit rate of each video stream is often constant. Since video sent at a constant quality has a variable bit rate nature (VBR), it is a very nonoptimal solution. Instead, the total rate can be shared dynamically among all programmes [8]. The video quality will be increased because of allocating bitrate where it is needed. Statistical multiplexing (StatMux) is a technique used for better capacity utilization. The main advantage of the statistical multiplexer is a much more even quality and a higher minimum quality achieved across all streams [9].

Therefore, the main objectives of this paper are:

- to determine bit rates of individual HD and UHD video format programmes encoded by HEVC and its scalable extension regarding video coding efficiency with respect to the relevant single-layer solutions and simulcasting,
- to determine the statistical multiplexing efficiency in limited capacity multiplexes, analyze effects of both, improved coding efficiency and increased utilization of channel capacity, and determine benefits of joint application, and finally
- to calculate the number of video streams (e.g. TV programmes) accommodated in adequate capacity, with and without these techniques application.

To achieve its goals, this paper is organized as follows: Section II makes a brief review of the growing demand for video communication and increased bitrate requirements for new HD and UHD video formats. This section provides an example of the required data rate for an uncompressed HD video stream.

Afterwards, Section III explains the basic version of HEVC standard as well as efforts to enhance the standard in several ways, including work on the embedded-bitstream scalability.

Next, Section IV presents recent developments on SHVC, scalable video coding based on the HEVC, and presents the *status quo* of quality scalable video coding performance.

In Section V StatMux is presented, as a means to distribute the channel capacity among the bit streams dynamically, according to the required bandwidth. The performance of StatMux depends on the statistical properties of the multiplexed bit streams as well as the number of bit streams.

In Section VI a simulation using a relatively simple specially developed Matlab program is given. The number of video programmes in different formats, allocated in a defined DVB-T2 channel capacity will be calculated, with and without SVC and Statmux techniques. The calculations were performed for three coding solutions: SHVC, single-layer and simulcasting.

Based on the presented results, conclusions were reached of HEVC and its scalable extension in the application of actual and expected formats of HD and UHD video streams. Also, new coding techniques which could meet the growing rate requirements are mentioned.

2. Growing Demand for Video

Video content in global Internet traffic is increasing from 75% in 2017 to the expected 84% in 2020. Improving their quality significantly influences the quality of the whole internet traffic. This trend will continue not only because of the increasing number of applications, but also due to the expectation of better quality of content. Certainly, better quality means higher throughput, and it needs higher coding efficiency!

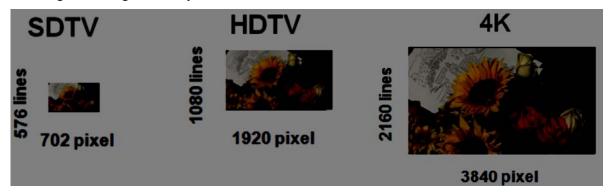


Figure 2.1 Illustration of changing video format

Similarly, broadband systems also move from SD and first generation of HD content (HD720p and HD1080i) to HD1080p and sometimes UHD format. Some world events are broadcasted in UHD 8K format. In addition to changing the format, other performance enhancements are also available, which also require more rate. When introducing UHD, it would be possible to consider doubling the frame rates again, to 100Hz. In general, a future broadcasting standard could increase the relative resolution of the chrominance information from 4:2:0 to 4:2:2 or even 4:4:4. The video information in digital broadcasting transmissions is currently represented with 8-bit accuracy, although 10 or 12 bit is generally used in digital production. The color space for HD and UHD will also be improved in line with the already adopted new recommendations. Improvements in audio compression efficiency will be offset by increases in the number of surround sound channels.

Mobile data traffic is expected to increase for more than 20 times over the next five years. Video is a "must have" on portable devices so it is expected to have higher throughput and lower power consumption.

We will take a look at the rate of one TV program in HD1080p format. Uncompressed 1080p high definition video at: 50 frames/second, 1920 x 1080 pixels per frame, and 8 bits x 3 (luma and chroma bits) has 2.5 Gb/s bit rate, and to save this content a memory in Terabits is required. Nowadays, the Blu-Ray DVD has the capacity of 50 Gb (single-layer) and Read rate of 72 Mbits/s. TV Broadcast has video streaming capacity from 1 Mb/s to 50 Mb/s. It means: 30x to 1200x compression is required.

Compression is the possibility to remove redundant information from the video sequence. In a video sequence there can be: Spatial, Perceptual, Statistical and Temporal redundancy. It is

necessary to recognize all of them and reduce the original rate, without video stream quality degradation.

3. High Efficiency Video Coding (HEVC)

Video compression ensures interoperability between the encoder and the decoder. Support multiple use cases and applications using the appropriate Levels and Profiles. The Video coding standard specifies the decoder: mapping of bits to pixels. Previous coding techniques improve the compression ratio twice every decade. Figure 3.1 shows the previous and future development of compression techniques (Source: Ateme: Transforming Video Delivery, 2019). A chronology of expected new coding standards showcases new standards named: AV1, MPEG-5 and VVC.

The main HEVC (or H.265) objective is to significantly improve the compression performance with respect to the H.264/AVC High profile. More specifically, about 50% bitrate reduction for similar perceptual quality, with emphasis on high and super-high resolution content. The expected main benefits are:

- reduce the burden on global networks,
- easier streaming of global networks,
- account for advancing screen resolutions (e.g. UHD).

HEVC is equally intended to encode video content for both broadcast and multicast television broadcasts and for transmission of video content via Internet. The industry developed a utility software for Viewing HEVC Formats. It is a video extension application that allows computers and devices to read HEVC coded videos. Also, it lets users select the video player that will play the HEVC file.

The HEVC standard includes several important technical advances regarding the previous standards, notably a picture partitioning into coding tree blocks (CTBs) covering a rectangular picture area of N×N samples with a maximum size up to 64×64 , instead of the old 16×16 macroblock concept. The coding units are divided into prediction and transform units. In entropy coding adaptive binary arithmetic coding (CABAC) is adopted in the current scheme.

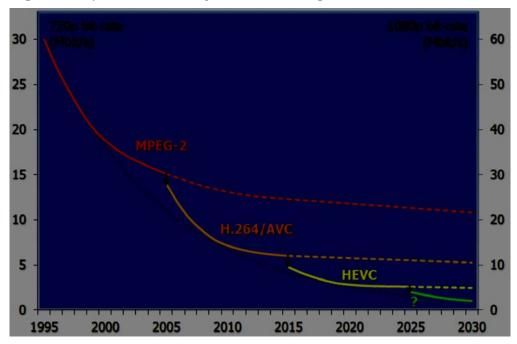


Figure 3.1 Illustration of bitrate trends in practice

After finalization of the HEVC base specification, the work on extensions is continued. The Format Range Extension (RExt) provides tools to support 4:0:0, 4:2:2 and 4:4:4 color spaces and additional bit depths. Already during the initial phase of HEVC, multi-layer extensions were planned and the proper hooks were included into the base specification. The Scalability extension of HEVC

provides support for spatial, temporal, SNR and color gamut scalability. It has been designed as a high-level syntax only extension to allow reuse of existing decoder components. The multiview extension of HEVC (MV-HEVC) provides support for coding multiple views with inter-layer prediction. It was designed as a high-level syntax only extension to allow reuse of existing decoder components. The 3D extension of HEVC (3D-HEVC) provides the increased coding efficiency by joint coding of texture and depth for advanced 3D displays.

The Screen Content Coding (SCC) extensions will improve compression capability for a video containing a significant portion of rendered (moving or static) graphics, text or animation rather than (or in addition to) camera-captured video scenes. Example applications include wireless displays, remote computer desktop access, and real-time screen sharing for videoconferencing.

HEVC format is very compatible with very large displays as well as high-quality visuals. It is ideal for 8192×4320 resolution screens, 8K UHD televisions, and every supporting hardware utilizing the H.265 Main 10 Profile. HEVC Video Extensions lets users watch high-quality videos in HEVC video compression standards.

With HEVC Video Extensions, users can have fun streaming movies and online shows. They must remember, however, that playback experience may be inconsistent. Factors like PC performance and video resolution can also affect playback quality. HEVC Video Extensions is a "must have" for users owning high-resolution displays and smart televisions. High-resolution displays are becoming more accessible for users. Unfortunately, some media platforms even lack HEVC support. The simple software enables enjoyment of HD visuals from movies.

4. Scalable Video Coding (SHVC)

As mentioned, during the initial phase of HEVC, multilayer extensions were planned. The proper hooks were included into the base specification. SHVC is a good candidate for introducing new services thanks to backward compatibility features with legacy HEVC receivers through the base-layer (BL) stream and the next generation ones by adding enhancement layers (EL). That is how SHVC saves substantial bitrate with respect to simulcast (independent coding of programmes).

SHVC provides support for spatial, temporal, quality (SNR), bit depth, color gamut, interlaced to progressive and hybrid codec scalability, or a combination thereof. It has been designed as a high-level syntax only extension to allow reuse of existing decoder components. SHVC encoder is based on multiple instances of the HEVC encoder, where each instance encodes one video layer. The architecture offers several advantages of being modular and close to the native HEVC coding block scheme. However, the close-loop SHVC architecture requires the complete decoding of the reference lower layer frames to decode a higher quality layer, which considerably increases the complexity of both encoder and decoder processes. SHVC defines high level syntax elements mostly at the level of Video Parameter Set (VPS) header. These syntax elements provide information on the video layers such as the number of layers, and for each layer: resolution, bit depth and the inter-layer dependencies.

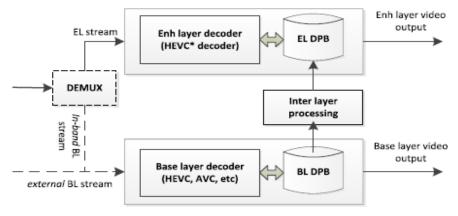


Figure 4.1 Block diagram of the SHVC encoder by encoding two spatial scalability layers

The up-sampling operation is a standard operation performed by 8-tap and 4-tap interpolation filters for luma and chroma samples, respectively. The down-sampling operation carried-out to produce the lower resolution video is not standard and can be considered as a pre-processing operation. Figure 4.1 shows a block diagram of the SHVC encoder encoding two layers in spatial scalability configuration and the outputs from the two encoders are multiplexed to form one bit stream that conforms to SHVC [7]. In the case of quality scalability (same resolution), the encoding process remains unchanged, except that the picture used for inter-layer prediction is used without being upsampled and its MVs (Motion Vectors) up-scaled.

Broadcast systems can use scalability to distribute programmes to users at different distances. Remote users can accept more robust coded BL, while closer users additionally use the content of one or more ELs.

5. Statistical Multiplexing of HDVideo Traffic (StatMux)

Television broadcast is usually done on fixed bandwidth channels, due to having to be sent modulated on a frequency band. This means that one or several programmes are fitted into a single channel with fixed bit rate. When multiplexing a number of streams to create a constant bit rate transport stream, we have generally two alternative ways to do this. The simplest way is to divide the total bit rate among all elementary streams and encode all these with a constant bit rate, but it is in conflict with the goal to maintain a constant video quality.

The more optimal way is to encode all elementary streams with a variable bit rate while making sure that the total bit rate does not exceed the bit rate of the transport stream. In StatMux, a fixed bandwidth communication channel is shared for transmitting several bit streams. The channel is virtually divided into several variable bandwidth channels that are adapted to the variations in the bit rate of the bit streams. The attempt is to distribute the channel capacity among the bit streams dynamically according to the required bandwidth by the bit streams such that a virtual variable bandwidth channel is allocated to each bit stream. Utilizing statistical multiplexing in conjunction with HEVC and its extensions is expected to provide a high performance for the broadcast system in terms of resource utilization and quality of service.

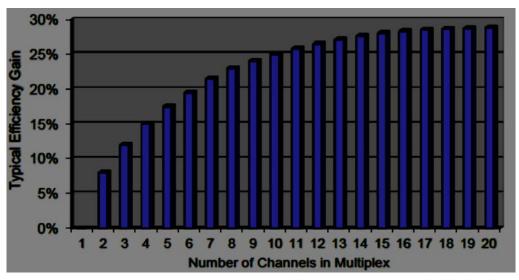


Figure 5.1 Statistical multiplexing gain in terms of number of programmes

The performance of StatMux depends on the statistical properties of the multiplexed bit streams as well as the number of bit streams. The statistical properties of video bit streams depend on the encoding parameters such as bit rate, frame rate, and picture size as well as video content and the rate control method. On the other hand, the number of services depend on the service bitrates and the channel capacity. Consequently, the performance of StatMux is application dependent and it

should be evaluated specifically for each application. The best effect is achieved by multiplexing a number of statically independent bit streams (e.g., different TV programmes).

Figure 5.1 shows that for a large number of programmes, the capacity of StatMux is about 30% less than the sum of the capacities of individually coded programmes (CBR) [10]. In the next section, the proposed effects of StatMux to HD and UHD broadcast services for fixed roof-top reception is evaluated.

6. Simulation results

A good indication is encoding of various formats HD and UHD TV programmes in multicast and broadcast systems. Data rate estimates for HEVC encoded 720p/50, 1080i/25, 1080p/50 HD formats and 2160p/50 UHD format are done in [11]. Some of these estimates were used in the calculations below in this paper. For each programme, a maximum of 1Mbit/s is assumed for audio and associated data. It is assumed that rates required for the programmes of the first HD generation HD720p and HD1080i are similar, and require 15% less capacity than the HD1080p format. At the same time, it can be assumed that UHD2160p, Phase 1 programmes require a three times higher rate than HD1080p.

The HD 720p and HD1080p encoded HEVC rates are relatively small. Coding techniques have always been improved during deployment in terms of efficiency, complexity and speed of coding (and decoding). In the simulations, we will take into account the progress which will be made by improving HEVC in terms of the required rate for UHD-1 Phase 1 format in the next few years.

Likewise, the rate reduction considered for the Scalability Overhead of SHVC compared to Single Layer Coding, ranges from 15% (current situation, 1 enhancement layer) to 5% (in the near future, 2 or more enhancement layers) relative to the same Single Layer rate. In order to have a fair comparison, the bitrate differences between SHVC and simulcast coding are compared at same quality (PSNR). Expected rates are shown in Table 6.1.

HD720p, HD1080i and HD1080p - Single Layer, Simulcasting and SHVC							
HD720p or HD1080i	HD1080p	UHD Phase1	Simulcast HD1080i + HD1080p	Simulcast HD1080p + UHD Phase1	SHVC overhead	SHVC HD1080i + HD1080p	SHVC HD1080p + UHD Phase1
3.83	4.50	13.50	8.33	18.00	0.05	4.73 5.18	14.18 15.53

Table 6.1 Estimated bit rate per programme for different HD and UHD formats

Table 6.1 clearly shows: relatively large number of HD programmes can be accommodated in the standard 40.2 Mbps DVB-T2 multiplex for fixed roof-top reception. But, even the HEVC's coding efficiency increase as is expected, the number of UHD programmes is only three. A logical combination is to broadcast one or two UHD and some HD programmes.

If the same TV programme is broadcasted in both formats, e.g. HD1080p and UHD the efficiency is further reduced. The left diagram in Figure 6.1 shows that 40.2 Mbps DVB-T2 multiplex is capable to allocate 9 HD1080p or 11 HD720p programmes. If due to different terminal equipment these programmes need to be broadcasted parallel in both formats (simulcast) then the number is reduced to only 5 delivered programmes. SHVC reduces simulcast capacity. The Scalability Overhead moves between 5-15% relative to H1080p single layer rate. Figure 6.1 suggests that SHVC increase this number to 8-9 programmes, depending of coding efficiency (the area between the black lines). It is a significant increase.

^{*}UHD-1 Phase 2 will include HDR, HFR and Wide Colour Gamut and require more capacity.

What happens if UHD programmes are broadcasted? The right diagram in Figure 6.1 shows the placement of HD1080p and UHD programmes single coded, in simulcast and with scalable implementation. The rate of UHD programmes is too high. A maximum of 3 UHD programmes, or only 2 in simulcast with the possibility of adding one or two HD programmes, can be accommodated. SHVC improvement can be measured by some additional HD programmes.

What can improve statistical multiplexing? Can these numbers increase enough without waiting for new coding and multiplexing techniques? The left diagram in Figure 6.2 shows that DVB-T2 multiplex is capable of providing 12 HD1080p or 14-15 HD720p programmes. As given in Figure 5.1, a very good capacity utilization was achieved. Even more, the number of SHVC programmes increased from 8-9 to 10-11 and reached satisfactory channel capacity utilization. The number of simulcast programmes increased from 5 to 6 which only confirms the great benefit of scalable coding.

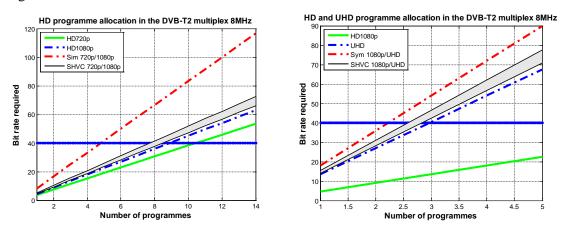


Figure 6. 1 Number of HD and UHD programmes in DVT-2 multiplex with HEVC rate reduction

What about the improvement of UHD programmes? Looking at the right diagram in Figure 6.2, as might be expected, it is quite small. StatMux efficiency on 2-3 programmes for all of the described scenarios is, according to Figure 5.1, about 10% and this cannot significantly improve the number of programmes. Of course, the addition of 2-3 HD programmes is very useful. But it is obvious that new coding techniques must be used for UHD programmes broadcasting.

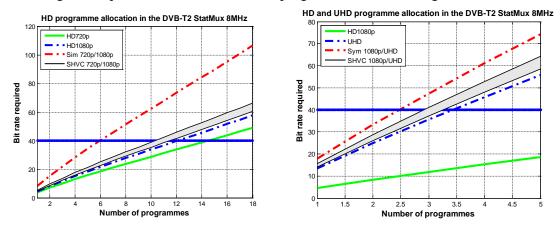


Figure 6. 2 Number of HD and UHD programmes in DVT-2 multiplex with HEVC and StatMux

The above examples confirm: SHVC saves transmission and storage costs. It can be used successfully for delivering HD content for given heterogeneous client distribution. StatMux helps to allocate bitrate optimally for each programme and each layer in multicast and broadcast systems. In combination with SHVC it visibly increases the number of programmes and raises the quality level of the broadcast content.

As mentioned, for the time being, the bit rate required for UHD-1 Phase 1 is too high. UHD-1 Phase 2 will include High Dynamic Range, High Frequency Range and Wide Colour Gamut. The situation for UHD-2 needs further scientific testing, as delivery standards are still being formulated. Obviously, for these formats new hardware and software improvements are needed.

In addition to improving coding efficiency, implementation challenges were also considered to maximize the processing speed and minimize the hardware cost. However, this pattern of one dominant video codec per decade now appears to be changing, as we move into a more complex, multi-codec world. The new coding techniques AV1 (AOMedia Video 1), MPEG-5 EVC (Essential Video Coding) and VVC (Versatile Video Coding) will increase compression efficiency gains of about 50% compared to HEVC. The capacity of the multiplexes will be enhanced by higher QAM order, layered division multiplexing, more MIMO antennas, a coherent high-capacity channel (channel bonding, TFS) etc.

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Improvement of Characteristics of Gas-Filled Surge Arresters on Low-Voltage Levels by Application of New Materials and Constructions

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Abstract: The most commonly used component in the over-voltage protection on low-voltage level is a gas-filled surge arrester. Its basic advantage over other components for the over-voltage protection (arresters diodes and varistors) is the reversibility of characteristics after their implementation, while its main drawback is the lower reaction speed. Manufacturers improve the reaction speed by introducing the Alfa radioactive source into gas-filled surge arresters, which creates significant drawbacks in radiation protection and the prevention of environment contamination. Based on listed drawbacks, this paper explores the possibilities of applying the effect of a hollow cathode and materials of low value of output for the construction of electrodes in order to achieve the same response speed, without the use of radioactive sources.

Key words: over-voltage, gas arresters, breakthrough, construction.

1. Introduction

The ever evolving level of miniaturization of electronic devices and frames combined with the increasing contamination of the environment with fast electromagnetic waves and ionizing radiation promotes the problem of the over-voltage protection on low-voltage level. Elements of said protection can be non-linear and linear. Non-linear elements can be over-voltage diodes, varistors and gas-filled surge arresters, while linear parts can be different kinds of electric filters. Most commonly used components for the over-voltage protection on low-voltage level are gas filled surge arresters. They work on the principle of electrical gas breakdown at low pressures. The advantages of using gas-filled surge arresters over other alternatives for the over-voltage protection are its ability to conduct large impulsive currents and the strength of dissipation. The main drawback is lower response speed which should be increased while retaining reversibility of the process. Manufacturers have been increasing the response speed by implementing Alfa radioactive sources which, in the absence of legislative regulations and technical norms, lead to other problems in terms of radiation protection and prevention of environment contamination.¹

¹ A. Schwab, *Hochspannungs messtechnik messgerate und messvefrahren*, Heidelberg, D: Springer-Verlag, 1981.

Detailed research of the over-voltage gas-filled surge arrester ignition, i.e., the response of the gas isolation to the impulsive workload, lead to the idea of using cathodic effects, the effect of the hollow cathode and the effect of the spike, for achieving pre-ionization, i.e., reducing the statistical time of the dynamic gas breakdown. Experiment results obtained under controlled conditions, based on the model of over-voltage gas-filled surge arresters without pre-ionization, with pre-ionization on the basis of Alpha and Beta radioactive sources, with pre-ionization on the basis of the effect of hollow cathode and the effect of the spike, have shown that cathodic effects can speed up the over-voltage gas-filled surge arresters response time, but slightly less effectively than what can be achieved using the radioactive charge.²

2. Construction of over-voltage gas-filled surge arresters

Over-voltage gas-filled surge arresters are non-linear elements that are used for over-voltage protection. They are labelled SVP (Surge Voltage Protector), more often labelled GDT (Gas Discharge Tube), but the most common label is GFSA (Gas Filled Surge Arresters), although the German name Fuse with Noble Gas (Edel gas sicherung) best suits its function. They work on the principle of electrical gas breakdown at low pressures. In terms of energy durability, they are the most durable, while regarding costs, they are also the most affordable elements for the over-voltage protection on low-voltage levels. The advantages of over-voltage gas-filled surge arresters, compared to other elements for the over-voltage protection, are: the ability to conduct high currents (up to 60kA), low individual capacitance (order of magnitude of 1pF which makes them suitable for application at high frequencies) where capacitance comes from the capacitor which consists of an electrode in the state without current which is negligible in terms of capacitance to other elements of over-voltage protection (over-voltage diode has 12000pF, while metal-oxide varistors have 15000pF) and high and constant resistance (at voltages lower than turn-on voltage of $10^8\Omega$ - $10^{10}\Omega$, while in the state of conducting it is in order of magnitude of $0,1\Omega$). The function of the gas-filled surge arrester is based on the Townsend's mechanism of gas breakdown. The over-voltage gas-filled surge arrester consists of two identical metal electrodes immersed into a ceramic or glass case (chassis). The distance between the electrodes (the "inter-electrode gap" or "gap") is in the order of magnitude of 1mm. In some cases, on the inner wall of the case, radioactive isotopes can be applied in order to increase the response speed (α -radiation). The isolation medium can be a Noble gas (Neon, Helium, Argon etc.) or a mixture of Noble gases at the pressures between 0,01 and 1bar. The arrester case must be constructed out of non-porous materials because Noble gases, as it is known, have complete outer-most electron shell and can be found exclusively in atomic form, while their small dimension allows them to easily defuse through porous containers. Basic cross section of an over-voltage arrester is given in Figure 1.

² D. Brajović, M. Vujisić, M. Stojkanović, U. Kovačević, A. Vasić, "Stabilization of Gas-Filled Surge Arresters Characteristis by use of Ionizing Radiation", Nuclear Technology and Radiation Protection Vol. 26, No. 2, pp. 164-170, 2011.

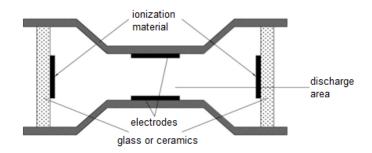


Figure 1 Basic cross section of a over-voltage arrester³

3. Installation for the characterization of the electrical gas breakdown

The installation for the characterization of the electrical gas breakdown consists of two parts: gas-vacuum installation with a chamber for electric discharge and the electrical installation.⁴ The electrical installation also consists of two parts: a voltage source and measurement systems.

3.1 Gas-vacuum installation with a chamber for discharge

The function of the gas-vacuum installation lies in providing needed environmental conditions for electric discharge in the chamber. Following requirements must be met: right kinds of gases, possibility of mixing them in proper ratios, suitable atmosphere pressure of the chamber and gas flow.

3.2 Electric sources

Over-voltage sources with both direct and alternating slow-rising voltages, and impulsive voltageof variable characteristics must be provided in order to analyse electric characteristics of the gas breakdown. Some parameters of the source must be adjustable in such a way as to allow the complete specificity of parameters of the gas-electrical breakdown. Basic schematics of electric sources are given in Figure 2. and 3. Direct and impulsive high-voltage sources are divided and are being connected to test outlets one at a time.

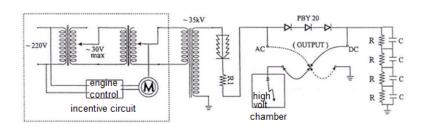


Figure 2 Simple schematic of the high-voltage source⁵

³ Hoppadietz, F. "Rechnerische Ermittlung von statistischen Durchschlagspannungen und Stichprobenumfang". *Elektrie* 32, 5, pp. 474-476, 1978.

⁴ D. Brajović, M. Vujisić, M. Stojkanović, U. Kovačević, A. Vasić, "Stabilization of Gas-Filled Surge Arresters Characteristis by use of Ionizing Radiation", Nuclear Technology and Radiation Protection Vol. 26, No. 2, pp. 164-170, 2011.

⁵ W. Bich, M.G. Cox, P.M. Harris, Evolution of the 'Guide to the Expression of Uncertainty in Measurement', *Metrologia*, Vol. 43, pp. 161–166, 2006.

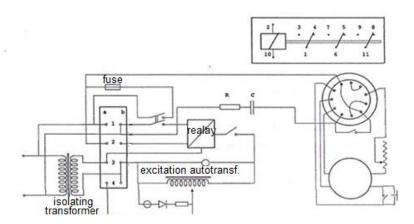


Figure 3 Primary part of the high-voltage direct source⁶

The high-voltage source of impulsive voltage is constructed on the principle of charging and discharging high-voltage capacitors via resistors (impedances). A simplified schematic of a high-voltage impulsive source is shown in Figure 4.

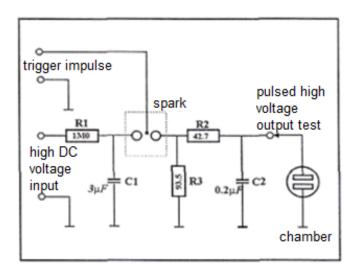


Figure 4 Simplified schematic of the circuit for forming voltage impulse⁷

Desirable time constants of the high-voltage impulse can be achieved by choosing different dimensions of resistors and capacitors.

3.3 Measurement electronic equipment

The measurement installation is complex because multiple units of measurement are being measured according to their own character: level, duration, frequency, and more. Direct voltage voltmeters are used for measuring: Iskra, Unimer 1 with high-voltage1:1000 probe, Unimer VXR1006 with 1:1000 probe, and oscilloscopes.

⁶ M.Grabe, *Measurement Uncertainties in Science and Technology*, Berlin, D: Springer, 2005.

⁷ A. Kost: *Numerische Methoden in der Berechnung elektromagnetischer Felder*. Berlin, D: Springer-Verlag, 1994. –ISBN 3-540-55005-4

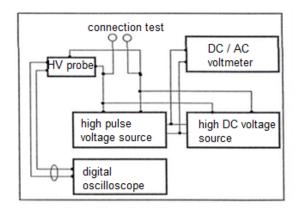


Figure 5 Block schematic of the measurement system⁸

The Textronix 7633 oscilloscope with the high-voltage measurement probe V 15 HF 15 kV, DC&Pk to Pk AC, HP 974A was used to measure the impulsive voltage. The schematic of the electric part of the system is given in Figure 5.

The testing chamber is one of the base elements of the testing system. Its role is to provide all elements required for testing gas breakdowns. Most importantly it must satisfy required conditions in terms of vacuum: good mechanical hardness of walls and constructive parts, and be well sealed at the edges of connected parts. Moreover, it has to provide enough space for installing the electrode system and radioactive source. The electrode system, found in the discharge chamber, consists of electrodes and electrode carriers. One carrier is fixed, while the other is connected to the mechanism that allows the adjustments of the gap. Carriers also must allow axial movement and parallelism of the electrode surfaces between which electric discharge happens.

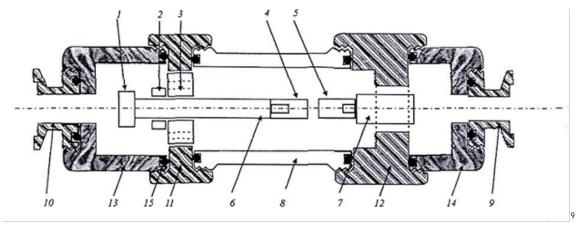


Figure 6 Testing chamber with electrode system¹⁰

⁸ P. Osmokrović, D. Petković, O. Marković, N. Kartalović, Đ. Vukić: "Measuring System for Fast Transient Monitoring in Gas – Insulated Substations", *ETEP*, , Vol. 24, No. 6, pp. 165-172, 1997.

⁹ gas-vacuum couplings 9, 10; parts from non-conductive materials 13, 14; connecting parts made from brass 11, 12, that are at the same time editorials of high-voltage; transparent chamber wall 8; sealing rings 15. Electrode system consists of interchangeable electrodes 4, 5; a fixed carrier 7 and movable carrier 6; the mechanism for adjusting the gap 1, 2, 3;

¹⁰ D. Brajović, M. Vujisić, M. Stojkanović, U. Kovačević, A. Vasić, "Stabilization of Gas-Filled Surge Arresters Characteristis by use of Ionizing Radiation", Nuclear Technology and Radiation Protection Vol. 26, No. 2, pp. 164-170, 2011.

A special procedure is used for adjusting the gap. The start of the gap measurement is determined via instruments for measuring resistance with small output voltages on measuring contacts (to avoid sparks). Measuring contact connect to high-voltage editorials (Figure 6, positions 11 and 12) which have electric contact with the cathode and anode in the chamber. Movement is achieved by turning the electrode carrier (Figure 6, position 6) via millimetre thread (position 3). The position is secured by the screw nut (position 2). The electrode position is controlled via micrometer screw on the carrier head (position 1). "Null" gap value is calculated at the moment when the resistance shown by the instrument increases by a few orders of magnitude from some minimal value. After adjusting the desirable gap, electrodes are fixed and the electrode system is sealed into the chamber.

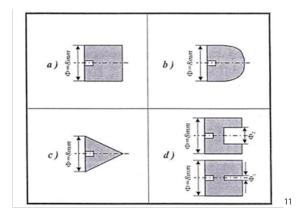


Figure 7 Electrode shapes 12

For the simulation of the over-voltage gas-filled surge arrester with radioactive charge, Alpha or Beta source is installed in the model arrester. Source is installed into the optimal position, in accordance with previous theoretical considerations, i.e., it had the maximal efficiency in terms of increasing the response time of the model arrester. Americium Am²⁴¹ and Strontium Sr⁹⁰ were used for Alpha and Beta sources respectively. During the installation and experiment work regulations were upheld, i.e., the radiation level was monitored in the room via sound signals and the previously installed GM counter. Experimenters had protective coats and radiation dosimeters. After returning sources into iron containers, contamination of clothes and hands was monitored.

3.4 Measuring procedure

Measuring was done according to the following protocol: 13

1) Construction of the model over-voltage gas-filled surge arrester. This includes choosing materials and the electrode shape, their placement in the chamber and the gap between them.

¹¹ a) cylindrical b) horn-shaped c) cone d) hollow cathode with two blind-holes of different sizes

¹² D. Brajović, M. Vujisić, M. Stojkanović, U. Kovačević, A. Vasić, "Stabilization of Gas-Filled Surge Arresters Characteristis by use of Ionizing Radiation", Nuclear Technology and Radiation Protection Vol. 26, No. 2, pp. 164-170, 2011.

¹³ G. Yue, W. Liu, W. Chen, Y. Guan, Z. Li and H. Wang, "Measurement methods of very fast transient overvoltage in gas insulated switchgear with complete process", *Proceedings of the Chinese Society of Electrical Engineering*, Vol. 31, pp. 1827, 2011.

- 2) Construction of the model gas-filled surge arrester. Testing the effects of radioactive radiation, which includes installing Alpha and Beta emitters on specially constructed carriers in the chamber.
- 3) Connecting the testing chamber to the gas-vacuum system.
- 4) Vacuuming of the gas-vacuum system while conducting multiple tests with work gas. This includes maintaining the pressure stability using needle valves for controlling the airflow and valves towards vacuum pumps. In order to be considered stable, pressure must be constant in the interval of 30 minutes. Otherwise, the sealing of the system was not adequate.
- 5) Comparing the alternating voltage. This means comparing graphs of the alternating voltage on the tested model of over-voltage gas-filled surge arrester before and after one test with the test voltage.
- 6) Turning on the electrode system. This includes doing 10-15 consecutive breakdowns with impulsive voltage with 30s intervals between them.
- 7) Measurement of the dynamic breakdown voltage, which means measuring 100 consecutive values of the dynamic breakdown voltage with 30s intervals between them.
- 8) Changing the position of the operating point of the model over-voltage gas-filled surge arrester and repeating the measuring procedure, which includes changing the parameters of the gas chamber (pressure, inter-electrode gap, electrode shape, radioactive charge) after which the aforementioned procedure is repeated in its entirety.

3.5 Procedure of evaluating measuring results

The procedure was done according to the following protocol: arithmetic mean was calculated from 20 measured values of the static breakdown voltage. Resulting breakdown voltage values, in relation to the product *pd*, are shown alongside a theoretically (analytically) made curve for the Paschen's breakdown. Other parameters remained unchanged. [9]

One hundred values of the accidental variable "dynamic breakdown voltage" were tested for being a part of Gaussian (Normal) or Weibull distribution using the hi-cube and graphic tests.

One hundred values of the variable dynamic breakdown voltage were used to determine arithmetic mean and standard deviation, for the variable pressure of work gas in the test chamber, while other parameters were kept unchanged and were shown graphically, in function related to product pd.

One hundred values of the variable dynamic breakdown voltage were used to determine impulsive characteristics of the model over-voltage gas-filled surge arrester.

4. Results and discussion

Measurements of static and dynamic breakdown voltages of Argon were determined by following parameters: pressure and inter-electrode gap, presence of Alpha and Beta radiation, electrode system with the hollow cathode and electrode system with implemented spike. Paschen's curves were made for Townsend's and streamer's breakdown mechanism, with the use of cylindrical and horn-shaped electrodes.

4.1 Static and dynamic breakdown voltage of Argon for the product pd on 10-2-102 Pam interval

Figure 8 shows the dependency between static and dynamic breakdown voltage values for the product pd and Argon with inter-electrode gap as the parameter. The interval is between 10^{-2} Pam and 10^2 Pam. Cylindrical cathodes were used. Figure 8 shows theoretical curves derived from equations for the Townsend's breakdown mechanism, the streamer's breakdown mechanism for primary avalanche coefficient and optimal values of the secondary emission coefficient $\gamma = 10^{-7}$. Based on figure 8, it can be concluded that Paschen's law applies to Argon, excluding points left of the minimum, i.e., that product pd is a good alternative in points right of the minimum.

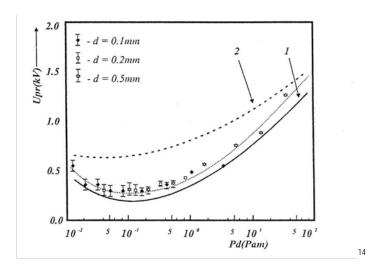


Figure 8 Paschen's curve for Argon. Dependency of static breakdown voltage and variable pd with interelectrode gap as the parameter. Electrodes are cylindrical ¹⁵

4.2 Static and dynamic breakdown voltage of Argon for the product pd on 10^{-2} - 10^{2} Pam interval, in the presence of Alpha radiation source

Figure 9 shows the dependency between static and dynamic breakdown voltage values for the product pd and Argon with inter-electrode gap as the parameter. Interval is between 10^{-2} Pam and 10^2 Pam. Cylindrical cathodes were used. Theoretical curves were derived from equations for the Townsend's breakdown mechanism and the streamer's breakdown mechanism and optimal values of the secondary emission coefficient $\gamma = 10^{-6}$. Based on figure 9, it can be concluded that implementation of the radioactive source slightly decreases the values of static breakdown voltage. This change is equivalent to the changes in the coefficient γ in Townsend's region for one order of magnitude (i.e., optimal value of y for experimentally determined points on the curve in Figure 8 is 10^{-7} , while points on the curve in Figure 9 is 10^{-6}).

624

 ¹⁴ Curve 1 - for Townsend's breakdown mechanism, Curve 2 - for streamer's breakdown mechanism
 ¹⁵ D. Brajović, M. Vujisić, M. Stojkanović, U. Kovačević, A. Vasić, "Stabilization of Gas-Filled Surge Arresters Characteristis by use of Ionizing Radiation", Nuclear Technology and Radiation Protection Vol. 26, No. 2, pp. 164-170, 2011.

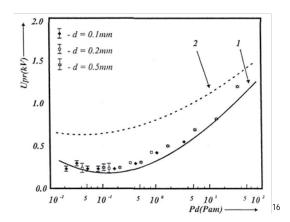


Figure 9 Paschen's curve for Argon with implemented Alpha source. Dependency of static breakdown voltage and variable pd with inter-electrode gap as the parameter. Electrodes are cylindrical ¹⁷

4.3 Static and dynamic breakdown voltage of Argon for the product pd on 10^{-2} - 10^{2} Pam interval, in the presence of a Beta radiation source

Figure 10 shows the dependency of static breakdown voltage values for the product pd and Argon with inter-electrode gap as the parameter in the presence of a Beta radiation source. The interval is between 10^{-2} Pam and 10^{2} Pam. Cylindrical cathodes were used. Figure 10 shows theoretical curves derived in the aforementioned way. Based on the said figure, it can be concluded that implementation of a Beta radioactive source decreases values of the static breakdown voltage. The slightly lower change of the coefficient γ is attributed to the absence of secondary electrons which, in case of Alpha particles, are created when exiting the cathode.

The efficiency of Beta radiation is evident in the region left of the Paschen's minimum (Figure 10). Firstly, it can be observed that this caused lower concavity similarly to the case of horn-shaped cathode system without radioactive radiation. This change can be explained by the fact that the electron ionization efficiency is higher in higher volumes, and that Beta electrons participate in the breakdown process which, in turn, increases the probability of the creation of initial electron.

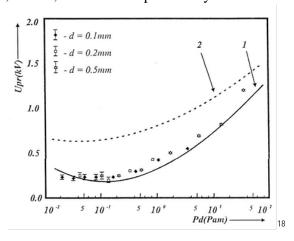


Figure 10 Praschen's curve for Argon with implemented Beta radiation source. Dependency of static breakdown voltage and variable *pd*, with inter-electrode gap as the parameter. Electrodes are cylindrical [10]

625

¹⁶ Curve 1 - for Townsend's breakdown mechanism, Curve 2 - for streamer's breakdown mechanism

¹⁷ D. Brajović, M. Vujisić, M. Stojkanović, U. Kovačević, A. Vasić, "Stabilization of Gas-Filled Surge Arresters Characteristis by use of Ionizing Radiation", Nuclear Technology and Radiation Protection Vol. 26, No. 2, pp. 164-170, 2011.

¹⁸ Curve 1 - for Townsend's breakdown mechanism, Curve 2 - for streamer's breakdown mechanism

4.4 Static and dynamic breakdown voltage of Argon for the product *pd* on 10⁻²-10² Pam interval, for electrode system with a hollow cathode

Figure 11 shows the dependency between static breakdown voltage values for the product pd and Argon with inter-electrode gap as the parameter. The interval is between 10^{-2} and 10^{2} , while the inter-electrode gap is between 0.1 and 1.0 mm. Criteria by which the size of the hollow is chosen is by calculating the free path of electrons. In given conditions and for chosen parameter values of the experiment, the free path of electrons can be calculated by using the following formula (1):

$$\lambda_{opt} \approx \frac{(pd)_0}{p_{prob}} \tag{1}$$

where $(pd)_0=3\cdot 10^{-1}$ Pam of pd value in the point of Paschen's minimum and pressure at which the test is done equals $ap_{\text{prob}}=4\cdot 10^3$ Pa. From these values $\lambda_{\text{opt}}\approx 1$ mmis calculated, from which two values for radius or the hollow cathode are chosen: $\Phi_1=0.2$ mm $<<\lambda$ and $\Phi_2=1$ mm $\approx\lambda$.

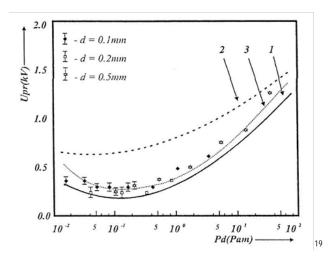


Figure 11 Paschen's curves for Argon with implemented hollow cathode²⁰

4.5 Static and dynamic breakdown voltage of Argon for the product pd on 10^{-2} - 10^{2} Pam interval, for electrode system with a spike

Figure 12 shows the dependency between static breakdown voltage values for the product pd and Argon with inter-electrode gap as the parameter. The interval is between 10^{-2} and 10^{2} , while the inter-electrode gap is between 0.1 and 1.0 mm. By comparing the curves from Figure 12 and 8 it is concluded that no significant changes occurred, in other words, the effect of the spike has no effect on the breakdown system.

626

 ¹⁹ Curve 1 - for Townsend's breakdown mechanism, Curve 2 - for streamer's breakdown mechanism
 ²⁰ U. Kovačević, K. Stanković, N. Kartalović, B. Lončar, "Design of capacitive voltage divider for measuring ultrafast voltages", *International Journal of Electrical Power and Energy Systems*, Vol. 99, pp. 426-433, 2018.

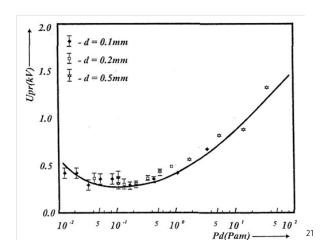


Figure 12 Paschen's curves for Argon with implemented spike²²

5. Conclusion

Based on the vast spectrum of experimental results, it can be concluded that it is necessary to legislatively regulate distribution, application and disposal of over-voltage gas-filled surge arresters with radioactive charge and it is advisable to use radioactive isotopes with shorter half-lives (2-3 years) for the construction of over-voltage gas-filled surge arresters in order to determine the time after which they pose no radiation or contamination threats. It is more efficient to use Beta source compared to Alpha source because Beta source is the most efficient when aimed towards the critical volume in front of cathode, in the direction from cathode to anode. Alpha source is most efficient when aimed towards the critical volume in front of cathode, in the direction from anode to cathode and, if possible, in such a way as to position the maximum of Bragg's curve (Bragg's peak) in the region of the cathode. The effect of the spike cannot be used to increase the response time of over-voltage gas-filled surge arresters, but using the effect of the hollow cathode leads to desirable effects in terms of protection. Given the findings of this paper and its inability to explore all possible applications of this effect, more experiments should be carried out in the effort of speeding up the response time of over-voltage gas-filled surge arresters. Further examinations of the possibility of more efficient application of the effect of the hollow cathode for increasing response time of overvoltage gas-filled surge arresters should be carried out in the more manner. The exploration of the possibility of combined application of short half-life Beta radioactive isotope and the hollow cathode effect. The beta radioactive isotope should be placed inside the hollow cathode. Exploration of the possibility of applying a cathode with multiple evenly spaced out hollows, with the radius larger than the critical radius, made out of output materials and materials that possess a high melting point and good heat dissipation. The system should be constructed based on the matrix of tubes, with a radius larger than the critical radius, made out of electrodes $(E_{iz}=1.34 \text{ eV})$ immersed in Copper or Wolfram. Exploration of the possibility of increasing the hollow cathode efficiency by applying a magnetic field, in other words, by extending the

²¹ Curve 1 - for Townsend's breakdown mechanism, Curve 2 - for streamer's breakdown mechanism.

²² U. Kovačević, D. Brajović, K. Stanković, P. Osmokrović, *Measurement Uncertainty of Fast Pulse Voltages Measurements with Capacitive Divider*, 2016 IEEE International Power Modulator and High Voltage Conference (IPMHVC), July 5 – 9 2016, San Francisco, CA.

electron travel paths by rotating them in the hollow of the cathode. By increasing the number of electron-ion pairs that are generated by colliding incidents in the hollow whose radium, in such a case, can be lower than the critical radius.

The aforementioned guidelines are not mutually exclusive, but in fact complementary to one another, as such a construction based on them would be more than an adequate substitute for a system based solely on radioactive isotopes.

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Influence of Cutting Speed on Temperature during End Milling

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Abstract. Milling is one of the most complex cutting machining processes. This process is influenced by many output parameters and one of the most important parameters is the temperature because it affects the tool wear and tool life. Cutting tools are expensive and have a duration that is measured in minutes and therefore, predicting temperature and tool wear during the machining process is of the great importance for the understanding and optimization of process parameters. To determine cutting temperature or temperature fields in end milling different methods can be used. Measuring temperature with infrared thermal imaging camera is most suitable method concerning capturing values of temperature fields. In the research field of cutting process, the finite element method is regarded as a very useful tool to study the cutting process of materials. The aim of this paper is the modeling and simulation of milling predictive temperature in the cutting zone by using the finite element method. In order to predict the occurrence of thermal processing milling was used software package Third Wave AdvantEdge. 3D model of the workpiece and end mill was created in the software package SolidWorks. Workpiece material AISI 4340 steel and tool material Carbide-General were selected from the AdvantEdge library of 3D materials. For proper cutting conditions we have presented the results of simulation-based on which the influence of cutting speed on the temperature in the cutting zone is analyzed.

Key words: finite element method, milling, temperature, cutting speed, Third Wave AdvantEdge

1. Introduction

Although the metal cutting machining process is widely investigated, even since 1900, the parameter choice of the cutting conditions, tool materials and cutting tool geometry for small range of production is still based on the operator's experience or recommended values. The chosen processing parameters are rarely optimal and small range of production does not justify the experiment performing for achieving increase of efficiency. For larger production ranges, the cutting parameters are received by the experiments whose aim is to achieve efficiency maximum. The experiments' costs are compensated with the large quantity of the produced parts. However, we should bear in mind that the production experiments are very expensive and long lasting. Therefore, it is necessary to develop either more efficient strategies which reduce the number of experiments or to completely eliminate experimental investigations.

Milling is one of the most important conventional cutting procedures, used in metal processing industry. It is also one of the most complex metal cutting machining processing, because the process with the mill, as a multicutting tool, represents more complex operation than turning and drilling, not only because of larger number of cutting edges, but also because the cross section of the chip is variable during the processing performance of one tooth. The machining process itself is accompanied by lots of phenomena, which influence the outer

performance of the machining process. One of the phenomena is also the great quantity of warmth released in the cutting zone.

Besides, it is considered that after the turning, milling is the most frequent machining process, in which the chip is removed. One of the most represented milling types is the milling with end mills. The process of milling with end mills is one of the typical interrupted processes. Considering the periodical mill tooth enters and exits from the contact with the workpiece in that process, it leads to periodic heating and cooling during machining. Due to this alternating tool heating and cooling, the cutting temperature is important performance that influences tool tool wear and the quality of the processed surface.

To set the cutting temperature or the temperature field with front milling, the various methods are used. Due to the complexity of milling, the main difficulties occur in cutting temperature measurement because: the tool rotates and tool teeth enter and exit from the contact with the workpiece; heat covered zone moves across the workpiece surface; chip can disturb the measurement and the like.

For temperature measurement of milling, during the previous decades, the large number of experimental methods is developed. Thermocouples are frequently used during the temperature measurements, because they are easy for using. They cover large scope of temperatures and are relatively cheap, although the mistakes during their installation are possible, as well as during the reading interpretation. Radiation based methods allow to measure the temperature without the contact with the object of measurement. These methods include the temperature measurement by the infrared pyrometer and an infrared camera. It proved that the method of measuring the temperature with infrared camera is the most convenient method, considering the recordings of the temperature field values. Many authors (Sutter, 2003; Pittalà, 2010; Shindou, 2015) use an infrared camera in their research for measuring the temperature in the cutting process. The high quality of thermographic equipment offers the most acceptable level of the measurement accuracy, although this method can be imprecise due to emissivity coefficient change, difficult access to the narrow cutting zone, and the possibility that chip, with its position, hide the area whose temperature is measured. Lauro at al. (2013) used an infrared camera to monitor the temperature change during milling of aluminum 7050. Medina at al. (2012) investigated the influence of the face milling machining parameters on temperature in the cutting zone, for different types of materials.

The experimental approach for machining process studying is expensive and time consuming, especially when the great range of tool geometry is included, materials and the parameters of the cutting conditions, too. Because of these difficulties, alternative approaches are developed, such as mathematic simulations in which the numeric methods are most frequently used. It showed that, among the numeric methods, the finite element method is more purposeful and widely used. Therefore, the finite element method is basically defined as the dividing of the real system of continuous surrounding into small elements, in order to reduce the problem, via the description of the features of each element, at the end, on solving the system of algebraic equations, whose solutions comprise the behaviour of the whole system.

The finite element method is widely applied in 2D and 3D modeling of cutting machining process. The simulations which use the finite element method, have the central role in the developing of tools and cutting machining process, but the simulation performance is not easy. In the last decades the modeling of cutting tools and simulation of machining process became popular and irreplaceable method in the investigation and development, even in the industrial applications (Escamilla, 2010; Fedorov, 2014; Kadirgama, 2009). The complex software programs, that have been recently made, using the finite element method with newly

developed mathematical patterns, are installed on super computers and they gave the researchers relevant data about characteristic nature of cutting machining process.

In that context, the process analysis by the finite element method is becoming the main instrument considering the modeling and simulation of cutting machining process. It has got important advantages, such as the prediction of: cutting resistance, chip shape, cutting zone temperature, tool wear, and it can be used for different materials of tools and workpiece. By using the finite element method, the accurate models of cutting machining process, which represent the starting point for optimization of processing parameters, can be created. It is possible to reduce the number of experimental investigations in that way, as well as the costs of their performing.

2. Experimental investigations

Experimental investigations were performed on the MAHO 600C milling machine. The workpiece material, used for the experimental research, is AISI 4340 (30CrNiMo8). The dimensions of the workpiece were 50x30x7 mm. The tool used for experimental investigations was solid carbide end mill EC-E4L 10-22/32W10CF72, coating layers TiAlN, manufacturer ISCAR, Israel (ISCAR Cutting Tools, 2020).

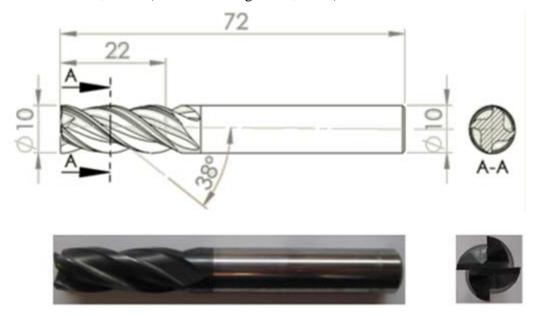


Figure 1. End mill EC-E4L 10-22 / 32W10CF72

For the temperature measurement in the cutting zone, the special infrared camera, sensitive to the radiation of the object on certain temperature, was used. The temperature recording during the experiment is carried out with FLIR InfraCAM Western infrared camera (FLIR Systems, 2020). The workpiece and the mill are previously coloured in black because of the emissivity. Machining parameters for each experiment are given in Table 1.

Table 1 Parameters of end milling machining process

Feed per tooth, $s_z = 0.028$ [mm/z]; Depth of cut, $a = 1.00$ [mm]						
Exp. 1 Exp. 2 Exp. 3						
Cutting speed, v =[m/s]	1,05	1,15	1,31			

By using the infrared camera for the selected machining parameters, the cutting zone temperatures were measured. Figures 2,3 and 4 show the temperature distribution in the

cutting zone. The maximal, average and minimal temperatures in the cutting zone, with the dimensions of a rectangle 10x3 mm, were registered from the recording.

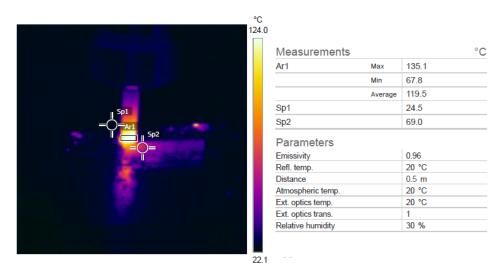


Figure 2. Temperature distribution record for cutting speed 1,05 m/s

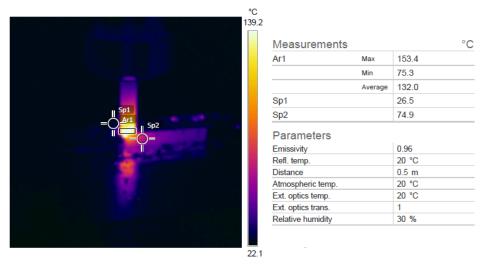


Figure 3. Temperature distribution record for cutting speed 1,15 m/s

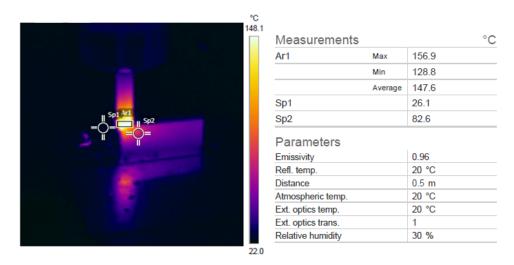


Figure 4. Temperature distribution record for cutting speed 1,31 m/s

3. Software Third Wave AdvantEdge

The correct choice of FEM (finite element method) software is very significant for defining the range and quality of the analysis which will be performed (Constantin, 2010). Some of the more significant softwares, which are used today for the simulation of the metal cutting machining process, are: ANSYS, Third Wave AdvantEdge, Abaqus and Deform 3D. Besides, the comparative analysis of commercial software packages, which use finite element method, gives the investigators help in choosing the most convenient software which can satisfy their demands.

Software Third Wave AdvantEdge is explicit commercial program for projecting, advancing and optimization of the machining process (Third Wave Sistems AdvantEdge User's manual, 2015). The software of this program is adjusted for the metal cutting machining process. The software is very detailed and, at the same time, it has got the user environment which enables users to adjust the data not only for modeling, but for simulations, as well. It is capable of modeling the complex interactions between the tool and the workpiece and it covers the wide range of different kinds of cutting machining process (Kadirgama, 2014). In AdvanEdge simulations can run in demonstration mode, decreases the simulation time but is less accurate and standard mode, requires longer simulation time but is more accurate (Constantin, 2012). AdvantEdge utilizes Tecplot software (Tecplot User's manual, 2015) to display and assist in analyzing simulation results.

The program structure consists of three modules: preprocessing module, simulation module and postprocessing module. Preprocessing module represents the starting point which enables the users to post the whole simulation, to define the tool geometry, material features and processing parameters. The data for simulation control are entered in this module. Simulation module is the module in which the simulation is actually performed. When the data for modeling are entered and when the simulation is started, the software counts the estimations, based on the finite element method. These estimations are hidden, so the user cannot see them.

After the estimations are finished, in postprocesing module the results are processed and displayed in various forms like charts and images. Among the displayed results there can be enumerated: chip formation, chip and tool temperature, cutting forces, steady state variables such as: strain, stress, strain von Misses, etc.

4. End milling simulation

For creating a simulation of milling process in program packages for analysis with the help of finite element method, the appropriate methodology is used. It consists of the following steps: making of 3D tool and workpiece model in CAD program package, import of model in FEM program package, defining the tool and workpiece material, defining the simulation parameters, the computer processing of the simulation and the display and analysis of the simulation results.

For milling simulation in AdvantEdge program, the model of end mill is create in SolidWorks and then the simplified model, in order to reduce the number of nodes and elements of model. Only the cutting part of the mill, which takes part in the processing, is taken into consideration. Then the simulation models are recorded as STL files and imported into AdvantEdge.

The workpiece model is not created in SolidWorks program, the option Create/Edit Standard Workpiece, which AdvantEdge offers as a choice, is used instead. The tool and workpiece materials are chosen from own libraries. For workpiece material the steel AISI 4340 is chosen, whereas for tool material the carbide with coating layer TiAlN is chosen. The

simulation with the model of simplified mill with enter simulation parameters. The cutting temperature was chosen as exit simulation performance.

5. Analysis of influence of cutting speed on cutting temperature in software AdvantEdge

For the same cutting conditions, as in the experiment with solid carbide end mill, three simulations were created, on the basis of which the influence of cutting speed on the cutting zone temperature is analysed. In AdvantEdge's subprogram Tecplot, the comparable displays of simulation results can be included, by choosing the option Multi-Project Display. The displays of comparable simulations which are recorded in the same time moments (by selecting the same zone which is shown) are given on the figure from 5 to 7. The minimum temperature level of 50 °C is chosen as well as the maximum level of 250 °C in 11 magnification levels. The colour shades, shown in lower right corner, are connected to the colour shades on the tool, workpiece and chip, with blue representing the minimum temperature, and red maximum.

On the figure 5, the chosen zone is the zone in which the tooth exits from the contact with workpiece and it can be noticed that the tooth top is in simulation with the biggest cutting speed in red zone, which means that in this case the temperature is the highest.

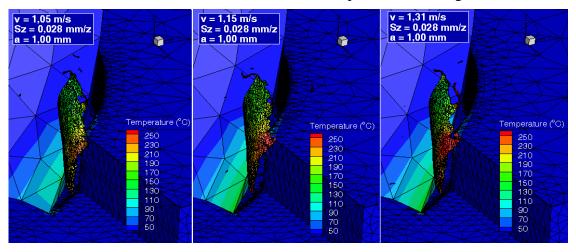


Figure 5. Comparison simulations with different cutting speed

On figure 6 the tool from comparative simulations is recorded, where it can be better seen that with the increase of cutting seed, the temperature field with the highest zone is moved from the top along the cutting edge of the end mill.

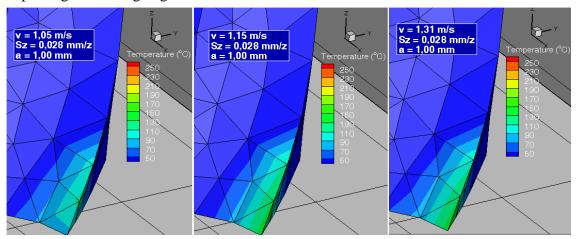


Figure 6. A highlighted tooltips on comparative simulations

Figure 7 gives the recording of chip on the comparative simulations for the different cutting speeds.

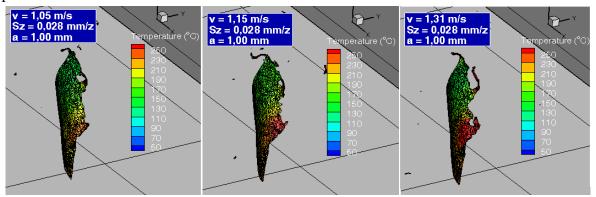


Figure 7. Separated display of the chip on the comparative simulations

On figure 8 the comparative diagrams of the cutting zone temperatures (the highest values) are represented, in relation to processing time for the chosen machining parameters. The analysis was performed by observing one tooth of the end mill in the process, starting from his contact with the workpiece until the exit from the workpiece, which corresponds to the rotation of the end mill of 90°. After the entry of the end mill teeth in the workpiece, rapid increase in temperature values can be noticed. Repeated temperature rise occurs during new tooth entering the contact with the workpiece.

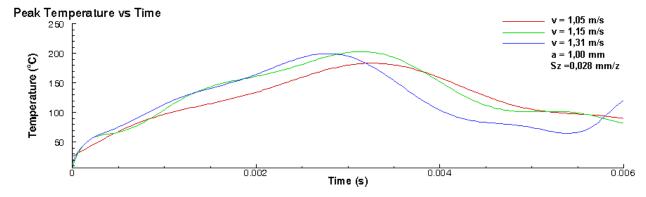


Figure 8. Temperature-time diagram for different cutting speeds

On figure 9 the diagram of temperature depending on angular length of processing is shown. For the length of angular processing of 90°, it can be seen that the temperature rapidly decreases halfway through the processing length.

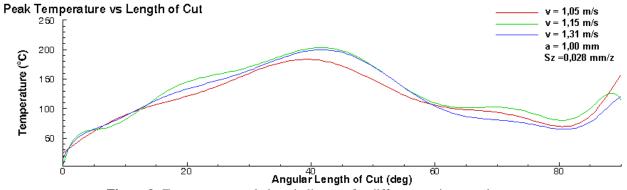


Figure 9. Temperature-angle length diagram for different cutting speeds

6. Simulations vs. experiment

The variation of temperature distribution between FEA simulations and experimental work are shown in Table 2.

$s_z = 0.028 \text{ mm/z}$ a = 1.00 mm	Measured temperature	Simulation temperature	Error	
v = [m/s]				
1,05	119,5 °C	99,7 °C	16,57%	

115.4°C

159,2 °C

12,58%

7,86%

Table 2 Results comparation between simulations and measured temperature

132.0 °C

147,6°C

By comparing the experiment and the simulations showed that the error for the first simulation of 16,57% and for the third simulation 7,86%. It can be concluded that AdvantEdge allows analyzing temperature in the cutting zone and permit obtaining reliable data for the experiment validation. The error between experimental work and simulation by FEA is in the range of $\pm 20\%$.

7. Conclusion

1,15 1.31

According to the obtained results, it can be concluded that in AdvantEdge software we can analyse, with great accuracy, the cutting zone temperatures for milling simulations. After creating the simulations, thanks to the subprogram Tecplot, the influences of the machining parameters on the cutting temperature can be directly analysed. For appropriate cutting conditions, the influence of cutting speed on the cutting zone temperature can be analysed in a convenient way. The precise geometry of tools makes it possible to get the reliable results in predicting the cutting zone temperature, although it influences significantly the time increase which is needed to process the simulation. Simulation of milling in AdvantEdge allows analyzing temperature in the cutting zone and permit obtaining reliable data for the experiment validation. The error between experimental work and simulation by FEA is in the range of $\pm 20\%$.

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Investigation of Economic Dimension of the Complex Product Production Cycle

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Abstract. The achievement of Business and Production System (BPS) is largely dependent on production adjustment to the conditions of demand and application of innovative solutions in the sphere of technology, organization and management. To make the price competitive, the costs of business operations should be reduced, the observed losses should be eliminated or reduced to acceptable levels and resources should be engaged accordingly by using corresponding management methods. The production cycle is the duration of business and manufacturing activities which are required to be conducted in the entire process, with the minimum flow of time, maximum use of production capacities, and optimal engagement of financial resources. The paper presents the calculation of the optimal production series and the current assets of a complex product included in the production program of "Sloboda" – Cacak Co.

Key words: complex product, production cycle, production series, current assets

1. Introduction

The features of the contemporary production process of top organization and management methods are grounded on the principles of economies of times and the principles of lean production, a new philosophy of production. A frequently posed question is: What is lean? In literature there are a number of interpretations among which the most commonly encountered are:

- "It is a comprehensive set of techniques which, when combined, allows you to reduce and eliminate wastes. This will make the company leaner, more flexible and more responsive by reducing waste." (Wilson, 2009),
- "Lean is the systematic approach to identifying and eliminating waste through continuous improvement by flowing the product or service at the pull of your customer in pursuit of perfection." (Nash, Poling & Ward, 2006),
- "Stated in the most basic form, lean manufacturing and a lean enterprise or business mean that the company is focused on supplying exactly what the customer wants, in the form they want it in, free of defects, at the exact time that they want it, with minimal waste in the process." (Kocakülâh, Brown & Thomson, 2008).

Production should be organized according to the push-pull principle, with minimum inventories, manufacturing only what is really necessary, neither too early, nor too late.

Current assets should be engaged to the maximum in the production process, which is determined by the size of the production series, length of production cycle (PC) time, moment and manner of their engagement. The time and economic dimensions of PC should be mastered, so that the system responds promptly, in real time, no matter whether the orders are small-scale, large-scale, standard or special.

Investigation of PCs implies a set of activities that have to define optimum production series, calculations for the amount of components required, cycle design, production preparation and launching, management of production activities, with current assets engagement and the analysis and calculations of the coefficient of material running time.

The aim of this paper is to present the procedure for determining the optimal production series of a complex product and the amount and manner of engagement of current assets needed for its financing.

The experimental part of the investigation was conducted at "Sloboda" Company Čačak. 'Sloboda' Co. – Cacak is one of the lead business-manufacturing systems in Serbian metal industry. The major components of its production program are weaponry and military equipment. Production is characterized by the globalization of operating business, a large number of complex products, a variety of technologies and equipment, multi-variety technological solutions and the installment of the same parts into a number of different products.

2. Optimum production series and calculations of the quantity of components

To enable flexible and economic production in smaller-scale series represents the first and foremost principle of contemporary production. Therefore, a problem is posed of inventing models that will enable the calculations of optimal production series, with minimizing total business operating costs. Many authors in their papers (Backović & Vuleta, 2000; Berlec et al. 2014; Bulat & Bojković, 2001; Glock, 2010; Pahl, Voß & Woodruff, 2007; Vila & Leicher, 1983; Jovanovic, 2015) deal with the problems of defining optimum production series using a variety of methods and techniques.

Having in mind that the behavior of costs in series production depends on the volume of production (Figures 1 and 2), the size of production series should be calculated in such a way that the opposite orientation of the nature of costs is optimally harmonized (Figures 3 and 4). This means that the optimum series size $(q_o = x_o)$ is characterized by minimal costs per unit of product. Respecting the mentioned constraints, the analytical expression for calculations is defined by the relation (1):

$$q_o = \sqrt{\frac{2C_nQ}{c_1T}} \quad N = \frac{Q}{q_o} \tag{1}$$

where:

 C_n are total fixed costs required to accomplish the order $(Q \equiv X)$,

 c_1 are variable costs per unit of product in unit of time (day),

T is period of time required to accomplish the delivery,

N is the number of optimum–launched series,

 $F_1(x)$ are function of the total fixed costs per order (Figure 1),

 $F_2(x)$ are function of the total variable costs per order (Figure 2),

F(x) are function of the total order costs depending on the production series size (Figs 3 and 4).

On grounds of the data from the Company's annual balance sheet corresponding technical documentation and relation (1), the optimum size of the production series was calculated, amounting to 10000 pieces. The number of optimum—launched series is nine.

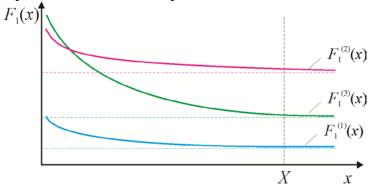


Figure 1 Fixed costs of a complex product

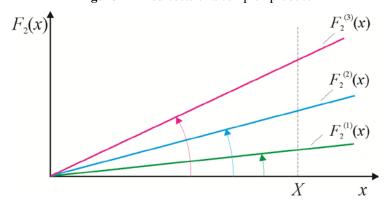


Figure 2 Variable costs of a complex product

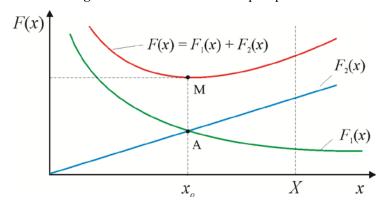


Figure 3 Illustration of a total order cost

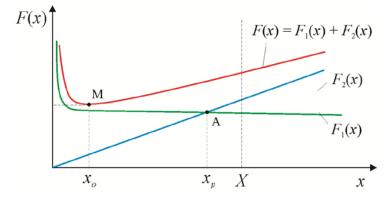


Figure 4 Optimum series size

Calculations of the quantity of components require: calculations of optimum production series using relation (1), drawing of products' hierarchical structure graph (Figure 5), establishment of inventories in unfinished production (warehouses, work tasks), definition of planned technological waste and inventories at the end of the year for the continuity in the production.

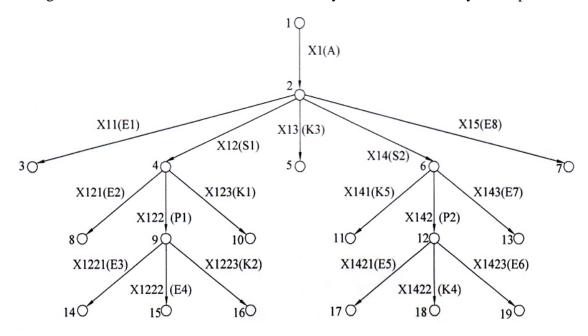


Figure 5 Graph of products' hierarchical structure

Planned quantities of components (q_{ijk}) can be calculated using the following formulas (Jovanovic, 2015):

$$x_{iik}: q_{iik}^{(1)} = m_{iik} \cdot Q_i = n_{iik} \cdot q_{ii}$$
 (2)

$$x_{ijk}: q_{ijk}^{(2)} = \frac{n_{ijk} \cdot q_{ij}}{1 - \check{S}_{ijk}} = \frac{m_{ijk} \cdot Q_i}{\prod (1 - \check{S}_{ijk})}$$
(3)

$$x_{ijk}: q_{ijk}^{(3)} = \frac{n_{ijk} \cdot q_{ij} - q_{ijk}^{M}}{1 - \check{S}_{ijk}} - q_{ijk}^{RN}$$
(4)

$$x_{ijk}: q_{ijk}^{(4)} = \frac{n_{ijk} \cdot q_{ij} - q_{ijk}^{M}}{1 - \check{S}_{iik}} - k \cdot q_{ijk}^{RN}$$
 (5)

where:

 x_{ijk} is the component designation,

 q_{ijk} are planned quantities of components,

 \check{S}_{ijk} is the planned waste,

 q_{ijk}^{M} are quantities of components in a warehouse,

 q_{iik}^{RN} are quantities of components in launched work tasks,

k is the coefficient that takes into account work task accomplishment level (per cent),

 m_i is the quantity of the *i*-th component in a final article,

 n_i is the quantity of the *i*-th component in the first superior level of a hierarchical scheme.

For the optimum quantity of 10000 pieces of a complex product, using the corresponding formulas (2) - (5), calculations were made for the quantity of components required for further analysis (Tab. 1).

3. Current assets engagement

Unlike fixed assets partially spent in the production process, current assets are a part of business assets that are entirely spent in the production process and their overall value is transferred onto the product. Current assets can be engaged in the production process in a smaller- or larger-scale, depending on the production series size, time period, moment and manner of engagement. Business operating costs (T_p) can be calculated using the formula (6). Other costs (T_o) are divided into variable (T_{ov}) and constant (T_{oc}) , relation (7). Using formula (7), one can derive the formula for calculating the value of norm-hours for other variable costs $(VN\check{C})_{ov}$, relation (8).

$$T_p = T_m + T_r + T_o = T_m + T_r + O \cdot T_p \Rightarrow T_p = \frac{T_m + T_r}{1 - O}$$
 (6)

$$T_o = O \cdot T_p = T_{ov} + T_{oc} = 0.2 \cdot T_o + 0.8 \cdot T_o$$
 (7)

$$T_{ov} = \sum W_{ov_i} \cdot q_i^{(4)} = \sum t_i \cdot q_i^{(4)} \cdot (VN\check{C})_{ov} \Rightarrow W_{ov} = t_i \cdot (VN\check{C})_{ov} \Rightarrow$$

$$(VN\check{C})_{ov} = \frac{T_{ov}}{\sum t_i \cdot q_i^{(4)}}$$
(8)

where:

Tm is total cost of direct material,

Tr is total cost of direct work,

To is total other cost,

 t_i is time per operations.

Current assets engaged prior to the beginning of production (P) can be calculated using the relation (9), and in this case amount to 35.095.718 dinars. Current assets (O_{si}) engagement depending on the designed PC length will be calculated using the gantograms (Figs 6 and 7) and relation (10) or using some program (e.g. MS Project).

$$P = T_{OC} + \sum_{i} (q_i^{(2)} - q_i^{(4)}) \cdot (W_{r_i} + W_{ov_i}) + + \sum_{i} (q_i^{(2)} - q_i^{(3)}) \cdot W_{m_i}$$
 (9)

$$O_{si} = T_{m_i} + a_i \cdot X_i, a_i = \frac{T_{r_i} + T_{ov_i}}{T_{c_i}}, X_i = 1, 2, ..., T_{c_i}$$
(10)

where:

Wm is unit cost of direct material,

Wr is unit cost of direct work,

Wov is unit other cost, Tc is PC length.

Using the MS Project software, the designed PC length of complex product amount to 134 days (Figs 6 and 7). Diagrams of current assets engagement are given in Figs 8 and 9, correlation coefficient and regression curves are defined by relations (11) and (12).

Table 1 Parameters for determining total and variable business operating costs

ਾਰ ਨ	Produ	ıction	stage							_				
Ordinal				$q_{i}^{(3)}$	$q_i^{(4)}$	t _i	$q_i^{(4)} \cdot t_i$	W_{m_i} (din/	W_{r_i}	$W_{\sigma_{V_i}} = t_i \cdot (VNC)_{\sigma_{V_i}}$	T_{mi}	T_{ri}	Tovi	T_{vi}
Ordinal	Mark	ni	m_i	(piece)	(piece)	(nč/piece)	(nč)	piece)	(din/piece)	(din/piece)	(din)	(din)	(din)	(din)
1	2	3	4	5	6	7	8=6*7	9	10	11	12=5*9	13=6*10	14=6*11	12+13+14 =15
1	X	1	1	7792	9052	0,375	3394,5	320	75	26,25	2493440	678900	237615,00	3409955,00
2	SK1	1	1	5539	8084	0,3375	2728,35	60	67,5	23,625	332340	545670	190984,50	1068994,50
3	SK2	1	1	5392	7912	0,475	3758,2	368	95	33,25	1984256	751640	263074,00	2998970,00
4	P1	2	2	6797	14676	0,425	6237,3	180	85	29,75	1223460	1247460	436611,00	2907531,00
5	P2	2	2	6280	13996	0,45	6298,2	200	90	31,5	1256000	1259640	440874,00	2956514,00
6	E1	0,1	0,1	569	826	0,275	227,15	15,75	55	19,25	8961,75	45430	15900,50	70292,25
7	E2	2	2	6797	14676	0,125	1834,5	94	25	8,75	638918	366900	128415,00	1134233,00
8	K1	1	1	-	-	0	0	0	0	0	0	0	0,000	0,00
9	E3	2	4	4223	25343	0,1375	3484,6625	6,6	27,5	9,625	27871,8	696932,5	243926,38	968730,68
10	E4	1	2	2418	13411	0,051	683,961	25,5	10,2	3,57	61659	136792,2	47877,27	246328,47
11	K2	1	2	-	-	0	0	0	0	0	0	0	0	0
12	K3	1	1	-	-	0	0	0	0	0	0	0	0	0
13	E5	0,02	0,04	30	234	5	1170	179,5	1000	350	5385	234000	81900,00	321285,00
14	K4	2	4	-	-	0	0	0	0	0	0	0	0	0
15	E6	8	16	13534	97993	0,061	5977,573	42	12,2	4,27	568428	1195514,6	418430,11	2182372,71
16	K5	4	4	-	-	0	0	0	0	0	0	0	0	0
17	E7	1	1	3191	7076	0,1125	796,05	117	22,5	7,875	373347	159210	55723,50	588280,50
18	E8	0,025	0,025	135	198	10,5	2079	1967,4	2100	735	265599	415800	145530	826929
	TOTAL:			5,418	38669,45	2620,34	1083,6	379	9239666	7733889	2706861	19680416		

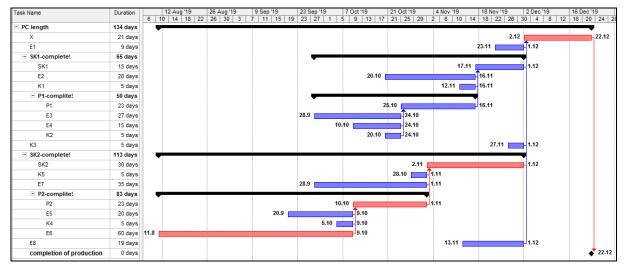


Figure 6 Gantt chart – the latest beginning

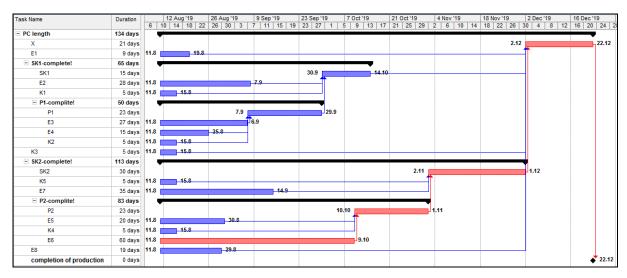


Figure 7 Gantt chart – the earliest beginning

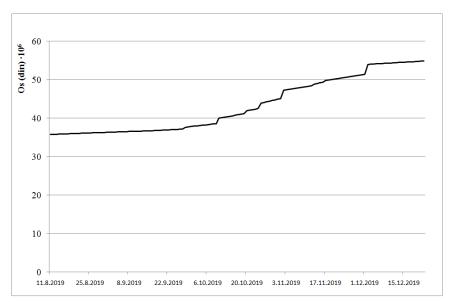


Figure 8 Diagram of current assets engagement (O_s) as a function of time (T_c) , the latest beginning

$$O_s(t) = -1.1 \cdot 10^{18} + 10^{14} \cdot t - 3.4 \cdot 10^9 \cdot t^2 + 5.2 \cdot 10^4 \cdot t^3 - 3 \cdot t^4, R = 0.99$$
 (11)

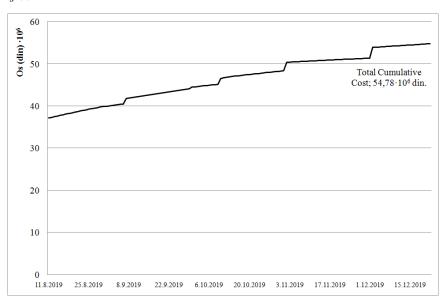


Figure 9 Diagram of current assets engagement (O_s) as a function of time (T_c) , the earliest beginning

$$O_s(t) = 7.8 \cdot 10^{16} - 7 \cdot 10^{12} \cdot t + 2.4 \cdot 10^8 \cdot t^2 - 3.7 \cdot 10^3 \cdot t^3 + 0.0021 \cdot t^4, R = 0.99$$
 (12)

4. Conclusion

Production systems of weaponry and military equipment have a specific position and role in the economic environment of the Republic of Serbia. Threats to survival, uncertain direction of changes in the environment, a large number of limitations, the globalization of business operations and impact of various markets, all impose two key dimensions of strategy upon 'Sloboda' Co. – Cacak: prediction and risking. Viewed in this context, the principle of time-economy in production domain requires thorough investigations and mastering of time and economic dimensions of production cycles.

Respecting technical, technological, production and plan documentation, data from the Company's annual balance sheet and relations (1)-(10), the following results were obtained:

- optimum size of the production series is 10000 pieces and the number of optimum—launched series is nine,
- the amount of parts (Tab. 1, columns 5 and 6) needed for the analysis of current assets was calculated,
- using MS Project, the PC length (Tc = 134 days) was designed and the gantt charts were presented for two diametrically opposed manners of production organization (earliest and latest beginning), Figs 6 and 7,
- the diagrams of current assets engagement as a function of time, for both gantt charts, are shown on Figs 8 and 9. The diagrams of assets engagement are similar, which indicates a great value of inventories in unfinished production process, amounting to 64%.
- the amount of engagement of current assets needed to finance production are 54.776.134 dinars (Figs 8 and 9).

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CIET Split 2020 Track 4

Interdisciplinary
Teaching and Learning

The Role of Motivation in the Development of Students' Speaking Skills

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Abstract. Motivation is one of the factors affecting the success or failure of students in foreign language learning. While the students may participate in the class in other skills such as reading, writing and listening, they behave more unwillingly when it comes to speaking in the second language. It is necessary to investigate what motivates and demotivates in learning English in general and in learning the skills of speaking in particular. Learners need to know the factors that lead them to be motivated to speak during classes and the ones that hinder them from improving themselves. For the above reasons, the aim of this paper is to investigate the motivation in improving speaking skills among students. The paper also focuses on methods used by the teachers to motivate their learners during speaking lessons, suggesting motivational strategies and techniques. Specifically, the paper examined the following research questions: (1) What are their reasons for learning English? (2) What are students' difficulties in speaking English in the classroom? (3) What are the factors demotivating them in achieving the English-speaking skills? Students' responses were analysed and some suggestions for teachers have been highlighted. Since there is no doubt that student motivation for speaking English in the classroom can be increased by using creative techniques, there are effective strategies that teachers may use to generate student's interest for enhancing their speaking skills and make their students more involved.

Key words: motivation, speaking, skills, classroom

1. Introduction

All teachers will appreciate that motivating students is probably one of the most difficult aspects of the profession. This is especially evident when teaching a second language since learning a second language is a long and often challenging task for many students.

The term motivation in a second language learning context is seen according to Gardner (1985) as 'referring to the extent to which the individual works or strives to learn the language because of a desire to do so and the satisfaction experienced in this activity.' According to the Oxford English Dictionary, motivation is 'the reason or reasons behind one's actions or behaviour'. It is easier and more useful to think in terms of the 'motivated' learner: the one who is willing to invest effort in learning activities and to make progress. Student motivation naturally has to do with students' desire to participate in the learning process.

Many teachers and researchers now believe that motivation is one of the most important factors that determine the success of second language learning. Learner motivation has become recognized as perhaps the major determining factor for successful learning whether it is an adult learner or a high school student. It has a very important role in determining success or failure in any learning situation and it can affect the way in which students'

approach and understand school in general, how much effort, interest and time they pay to learning. Motivation is one of the key issues in language learning and skills to motivate learners are crucial for language teachers.

Research on motivation in L2 learning has been heavily influenced by the work of Canadian psychologist Gardner. In the EFL context, motivation to learn the second language is viewed as comprising three elements: (Gardner, 1985))

- 1. The motivated learner makes effort to learn the language. There is a consistent attempt to learn the material, by doing the homework, by looking for opportunities to learn more, by doing extra work etc.
- 2. The motivated learner wants to achieve the goal and will strive to achieve success.
- 3. The motivated learner will enjoy the task of learning the language. For him or her learning is fun as well as a challenge.

All three elements; effort, desire and positive attitude are seen as necessary to distinguish between learners who are motivated and those who are less motivated. Motivation also explains why people decide to learn the language, how hard they are going to pursue it and how long they are going to sustain this activity. Indeed, in the majority of cases, learners with sufficient motivation can achieve a working knowledge of the second language. Without sufficient motivation, however, even the brightest learners are unlikely to succeed.

2. Students' de-motivation

However, student motivation is not always present, and the lack of motivation is a persistent problem faced by many teachers at all levels of post-secondary education and it is the challenge we personally face every day.

Dornyei, a distinguished linguist defined de-motivation as "specific external forces that reduce or diminish the motivational basis of a behavioural intention or an ongoing action". In his work, he points out that it means that a strong negative factor restrains the present motivation with some other positive motives still remain ready to be activated.

Students study and learn for different reasons. They perform in order to receive reward like graduating or passing a test or getting a grade. A great number of students have little desire or motivation to improve language proficiency. Students who don't have real interest in the course content are just going to study enough to pass the test. They don't have interest in a deep understanding of the topic, so they are happy with low test scores, they just want to pass the exam. In addition to that students know that they can pass an examination with just a minimum effort. The problem for many English teachers is how to make the students understand that the knowledge of English is something that they will need in their future life and career.

One of the most demotivating factors for learners is when they have to learn something that they cannot see the point of because it has no relevance to their lives. If the learner perceives what he is learning to be relevant and transferable to other situations, he will find learning meaningful and his motivation to acquire the skill or knowledge will increase.

Some recent research shows that many students do poorly on assignments or in participation because they do not understand what to do or why they should do it. Teachers should spend more time explaining why we teach what we do, and why the topic or approach or activity is important and interesting and worthwhile. In the process, some of the teacher's enthusiasm will be transmitted to the students, who will be more likely to become interested. Similarly, teachers should spend more time explaining exactly what is expected on assignments or activities.

One of the reasons why students are not motivated to learn can be the boredom that often characterizes the foreign language classroom. Many of them are physically present in the classroom but mentally absent; they fail to invest themselves fully in learning.

In direct contrast to this, however, is the strong desire of many adults (part-time students) to learn. They generally approach the classes differently. They also want to get a grade, but they usually want to learn and understand the material because they know that they will be able to use the material in their future life or career. We have two categories of students; full-time students who arrive immediately after graduation from high school (18 or 19-year olds), and part-time students who sometimes come after years of work. They are working people occupied with their jobs. They often lack study skills and they struggle to keep their jobs, raise families, deal with financial problems, limited funds while trying at the same time to improve their knowledge by going to college. Some of the many reasons for their interest in studying include acquiring new skills necessary for the workplace and preparation for a new job. The important thing is that there is a high level of awareness about the importance of learning English as a second language.

For the foreign language teacher, working with demotivated students may result in a certain level of frustration due to the general lack of interest and commitment by some students. We try to make lessons more engaging and have invested hours in preparing interesting lessons. We have made the lesson plans and now we must face the reality of the classroom where we will attempt to put these plans into action. However, things do not turn the way we have planned. For example, some students may not respond to our directions and may be uninterested or demotivated for number of different reasons. The questions that we, teachers, in such cases, often raise include:

- why don't the students seem to care about the course?
- why don't they seem interested in the content of the courses?
- why do they only care about their grades, but not learning
- why do they study for an exam at the last minute?

In the following text we are trying to get an insight into our students' attitudes towards learning a language as well as the causes of their motivation and de-motivation.

2.1 Causes of de-motivation

With respect to the causes of lack of motivation, Gardner (1999) elaborates that the causes of the students' lack of motivation could be uninspired teaching, boredom, lack of perceived relevance of materials and lack of knowledge about the goals of the instructional programme. These four, as he further says, very often become source of students' motivation. Uninspired teaching, for example, affects students' motivation to learn. In this context, a monotonous teaching, in many cases, reduces the students' motivation due to their feeling of boredom. In response to the issue of motivation, Babu (2010) argues that lack of motivation in learning causes students' hesitation to speak English in the classroom. He says that the background of this situation is that students are not motivated by the teachers towards the communication in English. Furthermore, Babu believes that motivation is a product of good teaching. In his further explanation, he emphasizes that to motivate students to learn well and actively communicate in English, teachers should have passion, creativity and interest in their students. In other words, students' motivation is really influenced by the teachers' teaching performance. Therefore, it is important that teachers also show enthusiasm in their teaching performance. He suggests that teachers should provide constant encouragement and support as well as ask questions. Other suggestions to increase students' motivation are shared by Liu and Huang (2010). They say that to overcome students' lack of motivation, teachers can do activities like promoting students' awareness of the importance of English, enhancing students' interest in English, and developing their self-confidence.

One of the obstacles to speaking is the reluctance to communicate in English by the learners due to some reasons including fear of making mistakes, lack of self-confidence, fear of teachers' negative feedback and insufficient vocabulary. Another reason why students keep silent is when they fear of losing face in case they make mistakes. These reasons cause learners to experience stress and anxiety which hinder their confidence to speak in front of their classmates. Another cause of students' reluctance to speak is when teachers choose a topic that is known very little by the students, so they have nothing to say about it nor is it interesting to them. As a result, they seem to have no motivation to talk. Taking the mentioned obstacles into account, language teachers should motivate and encourage learners to speak English about interesting topics by providing them with a relaxed atmosphere where learners are not afraid to use English

3. The role of the teacher

Motivation researchers in the past have been rather reluctant to come out with practical recommendation for teachers. During the last decade, however, things have started to change More and more articles and books have been published about this subject and attention has been turned to classroom applications. It has been generally accepted by most of them that students' motivation can be worked on and increased. For most teachers the real motivational issue is to find ways to encourage their students to accept the goals of the given classroom activities. When the students are motivated the teacher can perform his/her job the best. A teacher can do a lot to improve the student's motivation and the effort involved is an essential part of the teaching profession. Awareness of how students' attitudes and beliefs about learning develop and what facilitates their learning can assist teachers in their work with students.

There are dozens of games and activities to help teachers get through the academic year. These games and engaging activities can be used to complement the course curriculum, giving students an opportunity to develop their English language and skills in motivating and enjoyable ways.

Teachers are also under enormous pressure to cover the curriculum. This have forced many teachers to rush through the required content, despite the fact that doing so results in a lack of student motivation, interest and long-term learning. Furthermore, many materials used by teachers fail to capture the interest of students due to the heavy emphasis on vocabulary and grammar. Learner anxiety and other negative feelings can also sometimes block the learner. Language anxiety or the uneasiness to communicate using a restricted language code is a key factor that reduces motivation and achievement (MacIntyre, 1999). In a language class the fear of making mistakes is so strong in some students that they are practically determined to stay silent rather than risk committing a grammatical error.

4. Speaking skills

In learning any language, speaking plays an essential part in language acquisition. Considering the role of speaking as one of the English language skills that non- English students have to learn, we believe that an effort should be done to help students improve speaking performance. Teachers' efforts should be focused on developing students' ability to speak since learning to speak is considered as the greatest challenge for all language learners Language teachers try to improve students' speaking skills through the use of different techniques such as role play, discussions, simulations or by improving students' vocabulary and pronunciation.

A speaking skill in class is given importance by Baker and Westrup (2003) who state that a classroom is a place where students can practice using the language in a supportive environment and not only a place where they learn about the rules of language. The success in

language learning and the effectiveness of the English course are evaluated by learners according to how well they feel they have improved in their spoken language proficiency. In the teaching of English, a speaking activity must focus on how to assist students to use and to communicate in English (Richard, 2008). This is important as most students often evaluate their success in language learning as well as the effectiveness of their English course on the basis of how much they feel they have improved in their speaking proficiency. (Pinter, 2006). In this sense, teachers have to give more opportunities to their students to express themselves by providing them with speaking activities that enable them to speak English (Brown, 2001). The desire to communicate in English is the primary reason why speaking is considered to be the most important skill to improve. A speaking skill is the most important skill to acquire in a foreign or second language learning. Studies demonstrate that the speaking skill is the most neglected skill in language instruction. Most students do not even have the opportunity to speak in the classroom or outside it. Moreover, speaking is not a part of the examination in most language courses.

As it has been discovered by many researchers, foreign language learning best occurs through interaction, Teachers should therefore provide learners with the opportunities to communicate in English Since many learners' goal in language learning is to be able to communicate fluently in formal and informal interactions, classroom activities should be designed to promote oral fluency.

The use of modern communicative language teaching approaches in the language classrooms and the widespread use of the English language have increased the demands to have good speaking skills. Sometimes the feelings of learners may prevent them from achieving the desired goal (Tanveer, 2007). They take oral communication courses, and they are expected to perform well and develop their communication skills by means of these courses. However, it has been observed that in EFL classrooms, especially in speaking courses, students are reluctant to use the foreign language they have been learning. This has been a great challenge for EFL teachers for years and the teachers often complain about their students' silence during oral language courses. While the students may participate in the activities incorporating other skills such as reading, writing and listening, they are unwilling when it comes to speaking English. These unwilling students generally refuse to participate in speaking activities where they should be more active in order to develop their communication and speaking skills. The problem exists among EFL learners from beginning to more advanced levels. There may be many factors preventing students from playing active roles in the classroom. Even the learners who have learned the language for so many years find it difficult to speak when they are required.

The ability of speaking is a complex process in its nature; many of the learners are anxious to speak in the classroom or outside it due to different social or psychological reasons, so they keep silent. With regular practice, it is sure that the English language learners can considerably develop their speaking skills. Then they can perform well in the classroom discussions and debates and gradually develop their speaking skills. Over the time, with regular practice, hey will be in a position to give presentations on their own or deliver short speeches in the classroom and outside it

Among the four basic skills of the English language, speaking seems to be difficult because the speakers have to produce sentences on their own. However, it can be quite difficult for foreign or second language learners to produce sentences without learning the grammatical structures and having proper knowledge of adequate vocabulary. Therefore, the English language learners face many problems when required to express themselves orally. The English teachers have to adopt techniques to develop the speaking skills of those learners who have a deep fear of making mistakes while some others are simply too shy. It is necessary for language teachers to implement some common strategies such as role plays,

group work, projects, etc. to avoid shyness and unwillingness of the learners so that they can participate in the speaking activities in the classroom. Moreover, the primary job of a language teacher is providing opportunities for learners by encouraging them to use English not only in the classroom but also in their daily interaction with their classmates, teachers or any other English-speaking people, if possible. Teacher splay the greatest role in developing students' speaking skill by implementing different strategies and techniques in the classroom which will make learning of speaking more effective. All this suggests the importance of creating a supporting atmosphere of learning in the classroom.

4.1 The importance of teaching speaking skills

In order to find out whether somebody knows a language we often ask, "do you speak English?" Thus, knowing a language is always associated with speaking in it. Teaching speaking is also crucial because it can help improve other language skills; it can help learners build vocabulary, improve grammar, listening and writing as well.

Even if there are four other skills in the English language learning, speaking skills are the most effective ones among them as a majority of communication is done through speech. Therefore, speaking skills are the most important method of communication. In the present global world, language is used as a tool for communication. As English is considered the international language and it is spoken all over the world, it serves the purpose of communicating with the people who live in different regions and continents.

There is no doubt that proficiency in each skill is necessary to become a good communicator, but the ability to speak skilfully provide the speakers with several distinct advantages. The main advantages of speaking skills are:

- to participate actively in pair or group activities in the classroom
- to give a speech on different occasions.
- to participate actively in debates and group discussions.
- to interact with people all around the globe.
- to get better job opportunities.

As speaking skills play a vital role in many aspects, there is a need for EFL learners to concentrate more on them. Furthermore, the teachers are advised to implement useful strategies in their classrooms in order to involve the learners more in learning speaking skills in their English classrooms. Since there are many advantages of teaching speaking skills, the English teachers should aim to practice more these skills and give the priority to them as they are very useful for the overall development of the learners' performance.

In order to make the language learning process a more motivating experience teachers need to put a great deal of thought into developing programmes and create interesting lessons by applying the techniques of teaching that encourage learners to participate actively.

5. The study

How to speak English well still remains a question that many learners of English, especially the students of colleges and universities are trying to answer. To find out the answer to this question it is necessary to investigate what motivates and demotivates students in learning English in general and in learning the skills of speaking in particular.

5.1 Participants

Our 77 students, from two departments (first year students from the Department of Accounting and Finance and second year students from the Department of Business Trade),

took part in this small research. These students share the similar curriculum regarding their compulsory subject, and they are supposed to have an intermediate level of proficiency in English.

5.2 Instruments

The tools used for the study is the questionnaire for the students, containing four questions/topics.

- 1. What are your reasons for improving your speaking abilities?
- 2. Whish factors de-motivate your speaking in the classroom.
- 3. Comment the topics of the textbook by choosing one answer (dislike/don't mind/like).
- 4. Comment the classroom speaking activities by choosing one answer (dislike/don't mind/like).

In first two of them students were able to choose more than one answer, and in last two for each topic listed under activities or topics of the textbook they had to decide among three given answers.

5.3 Procedures

The students had 10 minutes to complete the questionnaire. The purpose and importance of the study were explained. While students were completing the questionnaires, any questions were clarified by the teacher.

6. Results of the study

Table 1 Students' reasons for improving their speaking abilities

Reasons	Number of students	Percentage
A To get a better job in the	65/77	84,41%
future		
B To communicate with	43/77	55,84%
foreigners		
C To study people and	4/77	5,19%
culture of English-speaking		
countries		
D To read newspaper, watch	33/77	42,85%
TV programs, listen to		
music in English		
E To live and study abroad	18/77	23,37%
F To get better marks in the	16/77	20,77%
exam		
G English is a compulsory	0/77	0%
subject,		

84,41% of them, the highest percentage identified the major reason for learning English speaking was to get a job in the future. The reason for this was that most of the students believe that the English language proficiency may play an important role during that process. In addition to this, more than 50% of the students wanted to learn English for the purpose of communicating with foreigners. A little more than 40% of the students who completed the questionnaire reported to be interested in reading newspapers, watching TV programs and listening to music. None of them claimed that their only reason for improvement is the fact that English is a compulsory subject. In brief, it can be said that the two main types of motivation, integrative and instrumental motivation play a crucial role in our students'

motivation for learning speaking skills. All students want to learn English, primarily for a future job, and secondly for better understanding of foreigners or possible business partners.

Table 2 The factors de-motivating students' speaking in the classroom

Factors	Number of students	Percentage
A Not enough time for	21/77	27,27%
speaking activities		
B The classroom	21/77	27,27%
atmosphere		
C Too many students in the	12/77	15,58%
classroom		
D Lack of vocabulary	29/77	37,66%
E Fear of pronunciation	26/77	33,76%
mistakes		
F Fear of grammar mistakes	35/77	45,45%
G Boring speaking topics	10/77	12,98%
H Boring speaking activities	0/77	0%
I Other members in the	30/77	38,96%
group are not active		
J Learning speaking is tot	3/77	3,98%
useful to you		
K The content of the	4/77	5,19%
textbook is not suitable		
L Teacher doesn't use much	1/77	1,29%
English in speaking		
M Teacher is not	1/77	1,29%
enthusiastic		

The table shows that the first de-motivating factor students face is fear of grammar mistakes. The second factor was a situation in which other members of their group are not active from their point of view. Moreover, the lack of vocabulary is also a disadvantage as well as fear of pronunciation mistakes.

Table 3 Students' comments on the topics of the textbooks

Topics	Number of students				
	Dislike	Don't mind	Like		
Brands	7	23	47		
Travel	6	19	52		
Change (people and organisations)	10	44	23		
Organisation (company structure)	13	35	29		
Advertising (media and methods)	12	30	35		
Money (financial terms, investments)	10	30	37		
Taking part in meetings	12	36	29		
Telephoning	13	35	29		
Socialising	11	30	36		
Dealing with numbers	14	28	35		

According to the results, we can happily conclude that the topics used in the textbook were suitable and satisfactory and in order to reduce students' de-motivation, it is necessary to pay

attention to the material used for teaching. In all cases there is always the largest number of students (out of 77) who liked them and the smallest number of students in the survey didn't like these topics from the previous semester.

Table 4 Students' comments on activities in the classroom

Activities	Number of students				
	Dislike	Don't mind	Like		
Role play	37	31	9		
Discussion on a given topic	17	23	37		
Doing projects in groups and presenting	23	19	35		
them					
Case study presentations	30	40	7		
Individual power Point presentations	44	21	12		
Talking about yourself and personal	45	21	11		
experience					
Summarizing	34	30	13		
Activities in which there is some sort of	9	40	28		
competition					
Telling a story	34	26	17		
Describing pictures	15	37	25		

Discussion and group work were the only activities that the majority of students liked. The discussion is probably the most general of them all, and that maybe the reason for choosing it. Doing projects in groups rather than individual ones is also something that suits them more than individual projects in general.

There are much more of them that our students dislike. The highest percentage goes to Power Point presentations and talking about themselves and their personal experiences. The majority of them also decided that they disfavour role play, as well as summarizing and telling the story.

We have to admit that the results show negative attitude towards these speaking activities in general, but something that cannot be passed over are class hours that are definitely not suitable. They usually start too late, either at 6 pm or more frequently at 8 p.m. This aspect affects students for sure and unfortunately timetable is something that is out of our hands.

7. Conclusion

No matter what the underlying motivation to study a second language is, what cannot be disputed is the fact that motivation is an important factor when examining successful second language acquisition. Thus, providing the learners with the motivation to learn is one of the best steps we can take to facilitate learning success. Increasing student motivation to learn can be challenging, but it is an essential element in being an effective teacher.

Teaching speaking is a very important part of second language learning. The ability to communicate in a second language clearly and efficiently contributes to the success of the learner later in every phase of his/her life. Therefore, it is essential that language teachers pay great attention to teaching speaking. Rather than leading students to pure memorization, providing a rich environment where meaningful communication takes place is desired. With this aim, various speaking activities such as those listed above can contribute a great deal to students in developing basic interactive skills necessary for life. These activities make

students more active in the learning process and at the same time make them more motivated for learning.

To provide successful English lessons the teachers have to focus on their students' needs. If they focus on students' needs, they'll not only be preparing students to face the business world with the right English skills, but also helping them to achieve success in life. This is best described by Bruner, the author of one of the most important and influential works on education.

"The best way to create interest in a subject is to render it worth knowing, which means to make the knowledge gained usable in one's thinking beyond the situation in which learning has occurred."

(Bruner: "The process of education", 1960, 31)

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The Importance of Developing Awareness and Self-awareness in the Intercultural Communication Class

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Abstract

Professionals in the field of ESP have long argued that one of the main challenges they have to face, particularly in academic settings, in teaching Intercultural Communication in English is the highly heterogeneous profile of student groups, particularly in terms of language level. Such task becomes even more challenging if, beyond significant differences regarding linguistic abilities, students also display various cultural backgrounds. Nevertheless, once language barriers are overcome, cultural differences may be turned into an advantage in the Intercultural Communication class: by raising students' awareness and self-awareness, by referring to personal experience, otherwise theoretical concepts such as stereotyping can be assimilated, understood and avoided in real life contexts. This paper aims to illustrate the means by which this was achieved within an Intercultural Communication in English class, held with Master level students (International Business and Intercultural Strategies) at the Faculty of Economics and Business Administration, "Alexandru Ioan Cuza University" of Iasi. The paper comprises three parts and *Conclusions*. Its first part will provide information related to the theoretical background of Intercultural Communication, with a stress on the main topics which form the core of the field. The second part of the paper will deal with the presentation of our particular context with a focus on our students' needs and expectations. The plan and details of the Intercultural Communication in English class on *Stereotypes* will be unfolded within the third part of this paper. Final remarks regarding the main outcomes of the lesson as well as its relevance in the more complex process of teaching Intercultural Communication will be made in the *Conclusions* of the paper.

Key words: Intercultural Communication, Cultural Awareness, Stereotype, Teaching Methodology

1. Introduction

Whether we like it or not, globalization has become a phenomenon which shapes our lives, both at a personal and professional level. The movement of people and the movement of goods bring about the movement of attitudes and behaviour, of customs and traditions and the necessity to make all these cohere and harmonize within our culturally diverse world. Consequently, there is increasing awareness of the need to develop intercultural skills, i.e. abilities to communicate across cultures, either national or regional, organizational or individual, religious or ethnic, etc. It is not our purpose to provide a comprehensive definition of the term "culture" though we may point to some key issues related to it: encompassing ideas related to beliefs, values, customs, traditions, religion, artefacts, history, geographical boundaries and characteristics, language, etc., culture is perhaps among the most complex terms in the world dictionary. Perhaps one definition which somehow fits the introductory lesson into intercultural communication would be "the way we do things around here" ("here" meaning a country, an organization, a small or big community, in one word the context). Since, according to researchers in the field, all communication is situational, the

importance of cultural aspects, which nevertheles significantly contribute to the creation of context, proves paramount in any type of human interaction, be it personal or professional. Surely, the solid basis of any intercultural communication course is provided by the research conducted by the pioneers in the field: from Geert Hofstede, to Fons Trompenaars, E.T. Hall, John Mole, Martin Gannon and Richard Lewis, many have contributed to creating the grounds of Intercultural Communication research. Moreover, the field is further explored and exploited through the work of Bob Dignen, Ian McMaster, Jane Jackson, Erin Meyer, and many others.

While most professionals in the fields of Business and Communication (and not only) are familiar to Hofstede's dimensions (Power Distance, Uncertainty Avoidance, Individualism/ Collectivism, Masculinity/ Femininity, Long Term Orientation), with those introduced by E.T. Hall (High Context and Low Context cultures, Monochronic and Polychronic cultures) or with Martin Gannon's cultural metaphors, the contributions made by Bob Dignen and Ian MacMaster, which stress on slightly different aspects in intercultural communication have, perhaps due to their rather recent date, been but little dealt with: they rightfully point to the key skills which should be acquired in order to ensure successful intercultural communication: the ability to assess competence and trustworthiness, to show respect, to build rapport, to empathise, to motivate others and to build trust, to network and to manage conflicts. However, all these abilities can not be acquired in the absence of knowledge provided by the work of the above mentioned pioneers. Beyond all these, as shown below, the perspectives which proved genuinely inspirational for our paper are the ones conveyed by the works of Jane Jackson and Erin Meyer as well as the author's own experience.

2. Our Context: Is it Truly Intercultural?

The key idea which underlies the purpose of this paper is perfectly expressed by Jane Jackson in the *Preface* to the second edition of her work, *Introducing Language and Intercultural Communication*: "Critical self-awareness is essential for effective intercultural communicators" (Jackson, 2020, p. XV). Consequently, Business English and, implicitly, Intercultural Communication learners should be encouraged to discover themselves, to reflect on the discoveries they make, and to act critically upon them.

A means to motivate people in performing such analyses and to foster awareness and self-awareness further leading to mutual acceptance and understanding in an increasingly globalized world is provided by the use of narratives in different cultural and linguistic contexts and interviews as real life examples. It is for these reasons that we have chosen to use such tools in order to teach *Stereotypes* in our particular context despite some disadvantages entailed by our method.

It is nevertheless widely acknowledged that ESP is a field which relies heavily on the purpose of meeting learners' needs. Most often, these needs relate to their professional lives, i.e. with their need to communicate successfully in professional settings. These settings cover a wide area of professions: from doctors to flight attendants, from engineers to seamen, from teachers to business leaders, all these learners need to acquire the necessary skills in order to cope with the linguistic and, as more and more widely acknowledged, with the cultural challenges they might come across in the increasingly globalized world.

Our paper aims to illustrate the particular case of a group of first year Master students in International Business and Intercultural Strategies at the Faculty of Economics and Business Administration, "Alexandru Ioan Cuza University" of Iasi, Romania dealing with a typical topic for the Intercultural Communication in English class – *Stereotypes*. Given the particular context, we consider that our experience could prove useful to our peers and could, moreover, contribute to developing a syllabus for Intercultural Communication courses.

The given context was quite challenging given the fact that the group is made up of 27 students, aged between 21 and 24 years old, out of which 5 are male and 22 are female. The most interesting aspect of this rather heterogeneous group is the fact that these students have different educational backgrounds: most of them (17) graduated from the Faculty of Economics and Business Administration, though from different specializations (International Business, Management, The Economy of Trade, Tourism and Services) while others (8) graduated from the Faculty of Letters (English-German, German-French, German-Romanian), one student graduated from the Faculty of Philosophy (Political Sciences) and one from the Faculty of Law. Fortunately, the profile of our Master programme is interdisciplinary and meets the needs of a wide range of graduates. Moreover, while most of our students are Romanian (21), one of them is half Greek, half Romanian and 5 were born, raised and educated in the Republic of Moldova (therefore, they were raised in a bilingual medium, i.e. Romanian and Russian). The lesson on Stereotypes was quite relevant since they had already been acquianted to the representative metaphors widely used in the field of teaching intercultural communication (the "onion", the "iceberg", the "peach vs. coconut") as well as to the key cultural dimensions authored by well-known reaserchers in the field, namely Geert Hofstede, E.T. Hall, Fons Trompenaars, Richard Lewis, etc.

My first aim was to raise awareness among my students of the various cultural backgrounds they had, of the complex cultural "onions" they actually represented: after all, they were so different in terms of expectations and these differences arose primarily due to their personal background as well as to the various undergraduate studies they had undergone. Their attitudes towards our institution (The Faculty of Economics and Business Administration) and towards me (as a teacher here) varied greatly. This difference in terms of attitude and expectations came as a natural consequence of their backgrounds — an aspect which I managed to explain by means of the "onion" metaphor.

I further tried to convince them of the huge advantages that may be derived from such an "intercultural" (although at a lower scale) experience, of the great possibility they had to combine their knowledge and skills so as to add value to our educational programme. Of course, their reactions were mixed: as expected, some were quite enthusiastic and others displayed reluctance to the whole synergy that might have been the outcome of such cooperation. However, I advanced by introducing the topic of Stereotypes. After having provided some of the best known definitions of the phenomenon, I asked them to think of the most common stereotypes related to various nations around the globe, then to various regions of our country and finally, to students from other Faculties. At the same time, after having stressed on the negative aspects of stereotyping, I introduced them to the extremely interesting perspective that Erin Meyer shares in her famous work, The Culture Map. The author draws a clear line between stereotyping and "learning about cultural contexts": faced with the allegation that "speaking of cultural differences leads us to stereotype and therefore puts individuals in boxes with general traits", she rightfully concludes that: "Yes, every individual is different. And yes, when you work with people from other cultures, you shouldn't make assumptions about individual traits based on where a person comes from. But this doesn't mean learning about cultural contexts is unnecessary. If your business success relies on your ability to work successfully with people from around the world, you need to have an appreciation for cultural differences as well as respect for individual differences. Both are essential" (Meyer, 2015, p. 13).

Thus, departing from this, we started working on the below activity: first, I handed out the answers provided in the interview I had conducted the previous summer (the details are given below) in the form of a gapped text. My purpose was to introduce them to some new vocabulary in the field of international transport, to revise prepositions and idioms (to a limited extent) and to ask them to make assumptions related to the interviewee, i.e. to identify

his age, nationality, professional status as well as to identify some key topics on which the interview focused. They were asked to work in pairs, they were given ten minutes to read and try to fill in the text with the missing information. The words they were supposed to identify and use in order to fill in the text are underlined. Then, we spent another ten minutes to structure the information they had managed to grasp, to check and clarify the new vocabulary and linguistic items, to discuss and draw conclusions on the answers provided by the interviewee. At the end, I also provided them with the questions I had formulated. All in all, the activity took about thirty out of the total fifty minutes allocated to our lesson on *Stereotypes*.

3. Awareness and Self-awareness in the Intercultural Communication Class: A Case-Study

The primary purpose of conducting this interview, occasioned by my 2019 experience aboard a Merchant Marine Ship (as a passenger), was to learn more about the way a Westerner perceives Eastern Europeans, based on his professional experience aboard. The only westerner on the ship at the moment of the interview (July, 2019) was a young Irishman at the beginning of his career. I kindly asked him to answer, as honestly as possible, the following questions. I reassured him that his answers would remain confidential and would not affect, in any way, his stay on that ship or on any other vessel, nor would they affect, in any way, his professional life. His permission regarding the publication and reference to his opinions was granted.

Ouestions:

- Q1: Please state your name, age, nationality
- Q2: Please describe your experience as a seaman (vessels you served on, nationalities you came across, periods of time aboard)
- Q3: From your experience, which is the most significant advantage in a seaman's life?
- Q4: From your experience, which is the most significant disadvantage in a seaman's life?
- Q5: Based on your professional experience, please state your general opinion, related to any aspect you can think of, on:
- Russians
- Romanians
- Bulgarians
- Ukrainians
- Eastern Europeans (in general)

Q6: What is the most striking difference between Western and Eastern Europeans that you have experienced so far in terms of:

- food and drink
- attitude towards power
- punctuality
- politeness
- tolerance
- Q7: One taboo topic (something you would not discuss, under any circumstances) of conversation with your fellow Eastern Europeans (if any):
- Q8: One taboo topic (something you would not discuss, under any circumstances) of conversation for you (if any), in professional settings:
- Q9: The thing you miss most while aboard:
- Q10: What countries have you visited so far as a tourist? Which one did you like/ enjoy the most?

Answers:

"1. P. M., 21, Irish

- 2. I have worked on fishing vessels (10 months total sea time), <u>container</u> ships (6 months) and <u>passenger</u> ferries (2 months) and worked with a large range of nationalities including crew from the Philippines, India, Ghana, China, Lithuania, Poland, Romania, Bulgaria, Spain, Ukraine and Russia.
- 3. The unconventional work schedule is the most appealing aspect of <u>seafaring</u> from my perspective. Spending weeks or months on board a ship has the advantage of allowing your <u>wages</u> to build quickly as your money is difficult to spend while on board and also means a long period of rest will follow after signing <u>off</u>. The combination of both of these allows for a "<u>work hard play hard</u>" lifestyle which I believe is much more rewarding that any standard 9-5 office job where I would spend my life looking <u>forward</u> to the next weekend.
- 4. Extended periods with limited communication with friends and family can prove to be a challenging part of a <u>seafarer's</u> life.
- 5. Russians: as a whole country, Russia can be perceived in Western Europe as somewhat intimidating which may be a result of propaganda or how the former Soviet Union has been portrayed in our nation's history education. Upon working with Russians, they did not fall into the stereotypes I would have expected and on the whole have been relatively friendly. A topic of conversation that has come up a few times is <u>corruption</u> and I am left with the impression that police and similar public authorities may be paid <u>off</u> with relative ease in Russia and surrounding areas, which is not remotely the case in <u>Ireland</u>.

Romanians: Romania tends to be viewed as one of the less wealthy countries in Europe where I am from which is perhaps due to a large percentage of my village's fishing fleet's crew coming from there. I noticed from having worked with Romanians for a long time that their attitudes to work, professionalism and overall conduct has varied greatly without an overall trend becoming evident.

Bulgarians: I have not a vast experience working with Bulgarians but would just note that I have not encountered any negative experiences.

Ukrainians: I expected Ukrainians to be more hostile amongst themselves and towards Russians given the country's current affairs but the professionalism I have came across on board ships is very good.

Eastern Europeans: One of the most noticeable differences between Eastern Europeans is how readily they are to spend long periods at sea to make a living. I feel that it might be due to limited opportunities to work and earn the same money <u>ashore</u>. Most people from UK/ Ireland would not work on ships for periods of 6 months at a time. Overall it is difficult to distinguish the finer details between different countries in Eastern Europe as they are generally viewed collectively.

6. Food and drink: Compared to my country, Eastern Europeans tend to be fonder of seafood. Fish is widely eaten in UK/ Ireland but shellfish, squid etc. are less common. The methods of preparing fish are different also as it is unlikely that you would encounter fish with bones in UK. Most food and drink preferences, in my experience, are fairly similar, especially when compared with Asian diets.

Attitude towards power: I have not come across any major differences in attitude toward power other than that Western Europeans may be slightly less willing to conform to a leadership style in which they have no input. Western Europeans seek to have their opinions heard and place more importance on this, whereas Eastern Europeans seem more content to allow authority figures to carry out their duties.

Punctuality: Overall this is about the same in my experience.

<u>Politeness</u>: In UK/ Ireland, politeness is very important in professional and social situations. The use of good manners can be considered essential but also, when greeting someone, it there is a tendency for people to start a small conversation rather than meeting them with a simple greeting. This seems to be a habit that is exclusive to Western Europeans.

<u>Tolerance</u>: This is something that has been rapidly changing in the UK and Ireland in recent years with the legalisation of Gay Marriage and the openly homosexual Irish Prime Minister elected. The majority of people in Western Europe, sexual orientation, race, religion or nationality are accepted with no issues which I believe is not the case throughout Eastern Europe. For example, Russia and Ukraine's views on gay marriage.

- 7. No topic springs to mind as taboo.
- 8. Normally, in professional settings, religion and politics are not to be discussed, however on board a ship with different nationalities, I find that discussing these topics is easier and see it as a good way to learn about other countries.
- 9. After some time on board, I begin to miss fast food quite a lot. I can get used to a limited internet and being away from a lot of different parts of life ashore, however over time I begin to miss the food and drink that is inaccessible on board more and more.
- 10. As a tourist, I have never visited any countries outside <u>UK/ Ireland</u> but from my experience travelling on ships, I have been lucky enough to go ashore in USA, China, South Africa and Spain. From these, I enjoyed South Africa where the people were very friendly and welcoming."

(P.M., interviewed aboard MSC MARS, July 2019)

Most students realized that the interviewee came from a Western European country. Some of them even guessed it was Ireland/ Great Britain. Few managed to estimated his age and position on the ship (a cadet). All of them had fun trying to fill in the missing information and to make assumptions related to the interviewee's profile. They all enjoyed discovering themselves and others through the lens of a person with a totally different cultural background. After all, one thing they all had in common was age. By using this interview, I managed to bring together people from the same generation, to compare and contrast their cultural backgrounds and assumptions and to draw some valuable conclusions on issues such as: identity, otherness, sterotypes.

4. Conclusions

One important aspect that this activity has attempted to focus on by means of discussing the issue of Stereotypes is identity. As Jane Jackson rightfully notes, "identity defines how we see ourselves and our place in the world. It is influenced by both internal and external elements (e.g., others' perception of us)" (Jackson, 2020, p. 112). Consequently, the ability to understand and define identity as one of the most complex concepts underlying culture is essential in teaching Intercultural Communication. The above mentioned author's work has proved extremely valuable and inspiring for the purpose of this paper: not only that Jane Jackson manages to tackle with the complex issue of identity by providing clearly structured definitions of the concept but she also succeeds in drawing a classification of various types of identities: personal, social, cultural, racial and ethnic, class, language, sexual, age, religious, etc. Moreover, the author also points to the fact that "ethnocentrism often results in stereotyping, a strong tendency to characterize people from other cultural backgrounds unfairly, collectively, and usually negatively" (Jackson, 2020, 147). We believe that stereotypes can be avoided once we all become aware of ourselves, once we identify ourselves and the position we hold and once we understand that the *other* should not only be understood and tolerated but also valued for the relational input it provides within the huge variety of human interactions. Certainly, stereotypes are fueled by bias and prejudice, two other phenomena that need to be dealt with as they represent serious risks in the way of successful communication. The above teaching idea was aimed to enable the acquisition of two types of skills: linguistic and intercultural. My students have clearly demonstrated that the linguistic purpose of the lesson was achieved since they have all managed to acquire new vocabulary, of which, I am sure, they will make good use in the future. However, the intercultural input, beyond providing information (for they have definitely managed to understand the information related to the cultural dimensions and to the theories involved in this case study), i.e. the necessity to become aware and self-aware implied by the whole process of intercultural communication is rather difficult to assess given the sensitivity and complexity of the topic. We can but hope that, due to the real-life experience provided by the case study and to the genuinely intercultural context they have all managed to create by attending the same Master programme, we have, at least to a certain extent, managed to emphasize the importance of awareness and self-awareness as key steps in ensuring successful intercultural communication.

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Academic English: A Different Perspective

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Abstract. Although challenging at times, both teaching and learning have always been a source of inspiration that drives further personal and professional development for all those involved in the process. Enriched with years of experience, teachers become confident enough to introduce and test unorthodox approaches to teaching whose primary aim is to maximise learners' cognitive response. One of those approaches is the so-called Dogme or the Teaching Unplugged which was originally devised by Scott Thornbury: he realised that classes were invaded by lesson plans, flash cards, workbooks, textbooks, et al., to the extent that learners themselves ceased to be the focus of the lesson. The Teaching Unplugged focuses on the learners and their linguistic needs - it is primarily communicative and material light. Inspired by this very method, several courses of Academic English were devised for lecturers – the experts in a number of topics that are taught to students as a part of their study programmes at the University Department of Professional Studies. The courses were a part of the in-house professional training whose purpose was to prepare lecturers for linguistic challenges that may occur in communication with students from the Erasmus Student Exchange Programme. The paper will be divided in two parts. In its introductory part, the Design to the Edges approach, as a new idea that has recently emerged in the teaching world, will be discussed with the emphasis on the Teaching Unplugged. Its central part will address the extent to which this approach shaped Academic English classes.

Key words: methodology, creative teaching, learner-centredness

1 Introduction

The last several decades saw a shift in the understanding of the ways the humans grasp the world around them. Their unique abilities shape their experiences and are reflected in knowledge acquisition which is unique for every individual. According to Howard Gardner's revolutionary Theory of Multiple Intelligences from 1983, people do not exclusively possess one intellectual capacity but also many other types of intelligences, such as musical, interpersonal, spatial-visual, bodily-kinaesthetic and linguistic intelligences. In other words, in order to be able to assess a full range of human capacities, one has to understand that every individual possesses a range of abilities and, at the same time, she may be particularly strong in a specific area. For example, an individual might be rather strong in linguistic intelligence but may also possess musical and naturalistic intelligence. These revolutionary precepts have influenced the teaching world and found their application in the most recent approaches. In terms of general education, the recent most significant approach that will hopefully inspire revolution in education is the so-called Design to the Edges. More specifically, within the sphere of foreign language teaching, ELT – English Language Teaching respectively, a strong accent on the individual needs of learners is visible in the approach called the Dogme, which is also known as the Teaching Unplugged.

2 From Design to the Edges to the Teaching Unplugged

Design to the Edges is a brilliant concept devised by Todd Rose, a Harvard professor and specialist in the field of the science of the individual. The concept is described in his book *The End of Average* and was presented at Tedx Sonoma County – x – independently organized Ted event. In both his book and talk, he challenges the principles of standard education. The standard education is based on the idea that was created during the Industrial Revolution – the idea that statistical averages represent the benchmark for measuring human potential.

However, the average person does not exist and the average is a myth, since we are all a combination of a variety of talents and skills. Therefore, in the context of education, an average student is also a myth. In order to enable the evolution of education and, consequently, more inspiring and enjoyable school curricula, one should acknowledge the so-called jaggedness principle. According to the principle, every student has a jagged learner profile – one may be brilliant at language and mediocre, if not failing, at maths. In other words, all students, including gifted ones, have strengths and weaknesses. Therefore, curricula should be thoughtfully designed to optimize for the full range of students' abilities and interests, so that, in each subject, gifted students should be challenged and the struggling ones should not be left behind. This is possible to accomplish: with all the technology at their disposal, teachers can easily create flexible learning environments.

Similarly, *the Teaching Unplugged* places the emphasis on the individual linguistic needs of students in the context of English language teaching. The term, and subsequently approach, were created by Scott Thornbury and Luke Meddings in 2001.

It is important to emphasize that this is an approach and not a method and is, therefore, descriptive and not prescriptive. It can be introduced within rigid curricula structure for several classes to bring at times much-needed breath of fresh air.

The approach is communicative in its entirety and is based on linguistic needs of students.

What makes it different from other similar approaches is the fact that it is a course book and technology free. Resources should be provided either by the students or whatever topics and materials the teacher comes across, again as a reflection of students' interests. The view behind this is that students truly learn when they are involved and interested in the topic and when they feel that the material and topics presented are relevant to their own living experience. All the language work is based on the emergent language – the language produced by students, rather than pre-planned by a teacher. Students and teachers are "partners in crime" – co-creators of classes and they all work together in one big group. Another novelty is that students should not be placed in different level groups. English has been a lingua franca for quite some time and everyone has been exposed to it to some extent. The term a true beginner has ceased to exist due to the above mentioned exposure and every person has some knowledge of it and, therefore, is able to start on its improvement at any time.

The Teaching Unplugged may seem daunting to inexperienced teachers who feel more confident in structured classes, with a course book and other official materials at their disposal, but once it is tried and tested, it is a resource every teacher gladly returns to, even for a limited time. In addition, whenever one decides to try it, one does not have to take a strictly purist approach. In the true Teaching Unplugged style, the "rules" exist to be broken and moulded according to the preferences of students. In other words, teachers can use some chapters from textbooks, benefits of technology, such as podcasts, TED talks, grammar exercises from different exercise books, et al, as long as these resources reflect students' interests and linguistic needs and are, thus, conducive to their linguistic improvement.

3 Academic English with a Twist

3.1 And the idea was born.....

In the period 2015 - 2019, five Academic English courses were devised for lecturers who taught, and still do, at the University Department of Professional Studies.

They had all been experts in their fields and well versed in research methodology, which meant that they regularly published research papers in renowned international journals. Formal specific linguistic structures and vocabulary, used in writing papers in which specific topics were addressed, had never represented a source of problem to them. What they lacked at the time was linguistic fluency in communication with international students who participated in the Erasmus progamme. Therefore, although the official title of the course was Academic English, it became soon apparent that the exclusive teaching of that specific language would not benefit lecturers at all. After all, they were rather good at its basics, since they used it in their research papers. At that moment of epiphany, it was decided that some academic variants would be taught and practised, but the emphasis would be placed on communication skills through a variety of topics that would appear through spontaneous discussions with the teacher.

3.2. From the first session onwards...

The first session, in duration of three classes of forty-five minutes, was an introductory one in which both the levels of fluency and fields of interest of lecturers – participants were noted. Participants were given a task to introduce themselves and were given several minutes to prepare by jotting down their thoughts which would then be articulated in sentences. What was meant under introduction was not the exclusive presentation of their professional achievements: they had to think about their passions and aspirations outside professional world. And, then they started rather reluctantly but, as the session went by, the variety of discussions arose from the mere self-introduction: religious issues, music, culture, teaching methods. They even helped each other with finding relevant words or expressions, and even asked each other questions on some issues that arose and that they wanted to clarify.

So, the first barrier was broken: their fear of linguistic inadequacy disappeared the moment they started speaking about themselves. It was not a common, dry self-introduction, but the representation of who they really were and what mattered to them. At that moment they stopped thinking about possible mistakes and just talked spontaneously.

As their teacher, or, rather, their learning partner, I provided help with translation of words, clarification of different context usage and on the spot correction of mistakes, such as the wrong use of prepositions, tenses and collocations. In the end, I wrote the emergent language and its corrections on the white board to summarize the most significant linguistic issues that we together dealt with in the course of the session.

The following nine sessions, each in duration of three forty-five-minute classes, were based on the emergent language and topics of interests to the participants - the topics that they wanted to discuss and, at the same time, become more informed about.

As I did not take a purist approach, which, in the true manner of the Teaching Unplugged is perfectly acceptable, I used technology available resources, such as podcasts, blogs, online magazines, TED talks and already established language and vocabulary practice books, to provide enough materials for their linguistic development. Their final task was the delivery of presentation based on one of the topics that was covered at their lectures, as a part of a specific course syllabus. Whilst delivering presentations, they had to demonstrate the knowledge of structures and vocabulary that they had acquired during the course.

4. Conclusion

The amount of both the language and vocabulary work was significantly greater than what the case would have been had I decided to limit it by a textbook content. Lecturers – participants, possibly for the first time in their lives, were in control of their learning, which, in turn, had a positive impact on their motivation levels. A relaxed but challenging learning atmosphere had as a result significantly improved fluency, grammatical accuracy, linguistic complexity and increased levels of motivation for further self-study.

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French and German: Differences and Similarities in the Use of Indicative and Subjunctive in Adverbial Clauses

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Abstract. This paper provides an outline of contrastive approach applied to the interpretation of the indicative and subjunctive mood in French and German subordinate adverbial clauses. This is highlighted through a general comparative analysis of the linguistic terms in question with the purpose of pinpointing their similarities and dissimilarities. Firstly, a brief insight into the indicative and the subjunctive in both languages is provided. Secondly, adverbial subordinate clauses are shortly discussed. Thirdly, the study delineates an overview of the following adverbial clauses: clauses of place, time, manner, exception, reason clauses, result clauses, purpose clauses, concessive clauses, conditional clauses, comparative clauses. The methodology used comprised a presentation of detailed lists of both French and German conjunctional phrases introducing both verb moods. Sources consulted and cited for the examples analysed are grammar books, course books and dictionaries. Finally, this study's conclusion outlines a set of its most important findings: a high congruence in the use of the two verb moods is noticed in both French and German clauses of place and exception. There is no record of subjunctive usage in clauses of time, place, manner, exception and reason clauses in German, whereas French purpose clauses merely employ the subjunctive. In the remaining adverbial clauses, some major or minor differences are noticeable. Adverbial clauses in French generally display more frequent subjunctive use than adverbial clauses in German. Additionally, methodical implications of these results have been regarded as considerably conducive to successful French and German foreign language teaching.

Key words: adverbial clause, the indicative, the subjunctive, conjunctions, comparison.

1. Introduction

This paper's aim is to consider the use of the indicative and subjunctive mood in subordinate adverbial clauses of French and German through applying a ¹contrastive approach to the interpretation of the two linguistic terms and systems. A verb constitutes the main part of the predicate within a sentence. The sentence content may be presented in various ways.

1.1 French

There are six verb moods; four finite (*les modes personnels*) and two non-finite (*les modes impersonnels*) verb moods. The former group comprises the indicative, the subjunctive, the

¹Contrastive analysis represents a systematic description and comparison of two languages (a native and a target/second or foreign language) in order to pinpoint similarities and dissimilarities between them and thus to facilitate teaching and learning the target language. Its basic assumption underlies that fact that similarities should result in positive transfer and facilitated acquisition of the target language, whereas dissimilarities should cause negative transfer and possible emergence of transfer error on all lexical levels of the target language.

imperative mood and the conditional, all four being distinguished by the grammatical categories of person and number. The latter consists of the infinitive and participle, the former not being distinguished by either the category of person or the category of number and the latter being distinguished solely by the category of person. Verb tenses are variously deployed in certain verb moods. Thus eight (one present, five past and two future) tenses may be deployed in the indicative, four may be applied (one present and three past) in the subjunctive, two (one present and one past) may be attributed to the conditional, infinitive and participle while only one (present) in the imperative.

1.2 German

As opposed to French, German is characterized by only three finite verb moods (*Modi*) consisting of the indicative, subjunctive and imperative and three non-finite verb moods (*infinite Verbformen*) comprising the infinitive, present participle and past participle. The participles in contrast to other non-finite verb forms may exceptionally be inflected as adjectives preceding nouns as attributes. Finite verb moods are marked by the categories of person, number, tense and voice excluding the imperative. All tenses (one present, three past and two future) can be applied in both the indicative and subjunctive mood, while merely one (present) can be used in the imperative.

1.3 General facts about verb moods and subordinate clauses

Each of the finite verb moods conveys a different speaker's viewpoint, a psychological attitude and/or a communicative relationship to the content that has been uttered; the indicative mood expresses statements of facts, objectivity and certainty. On the other hand, the subjunctive mood reflects a speaker's subjective attitude, uncertainty, unreality, possibility, affective participation, and doubt about the spoken content and is typically used for what is imagined, hoped for, demanded, or expected. The conditional is dominated by the aspect of eventuality; wish, whereas the imperative is used to express commands, requests and encouragement. The use of the subjunctive mood as a syntactic element introducing subordinate clauses has been the most frequent in all complex sentences including the ones indicating the reported speech. Complex sentences are sentences consisting of one main and one or more subordinate clauses that are dependent on the main clause. Subordinate clause complements the main clause in various ways and can be classified as nominal, relative and adverbial clauses. In relation to the main clause, nominal clauses can function as its subject, object, complement, attribute and appositive. Relative clauses generally function as restrictive or non-restrictive modifiers of noun phrases, are functionally parallel to attributive adjectives and are introduced by relative adverbs and pronouns. An adverbial clause is part of the main clause in the same way as other adverbials are, such as an adverb or prepositional phrase. Considering certain morphosyntactic disparities of the two languages and various classifications of both complex and subordinate adverbial clauses in consulted sources, we have opted for the aforementioned one due to its suitability for a systematic and well laid out comparison and analysis.

2. Adverbial clause

According to the semantic functions of adverbial clauses, we distinguish the following categories: clauses of place, time, reason, result, purpose, manner, exception, concessive, conditional and comparative clauses. They are regularly introduced by both distinguishable

subordinating conjunctions and conjunctional phrases with or without the accompanying ²correlatives that we shall point out in this paper.

2.1 Clause of place

A clause of place is a subordinate clause functioning as an adverbial of place to the main clause. It is introduced by interrogative adverbs with place meaning.

2.1.1 French

A clause of place is preceded by the following adverbs: où, d'où, là où, par où, jusqu'où, à l'endroit où.

The **indicative** mood is the verb mood used in clauses of place.

"J'irais *où* vous voudrez" (Robert, 1995:1555)

The **subjunctive** mood is not used in clauses of place.

2.1.2 German

The use of verb moods in either a clause of place or any other subordinate clauses of German is not determined and defined by any conjunctional phrase introducing the clause of place or any other subordinate clause. Conjunctional phrases for clauses of place are adverbs of place (position and direction): wo, woher, wohin, soweit.

The main clause usually contains correlatives as pronominal adverbs of place: dort, dorthin.

The **indicative** mood is introduced by all the conjunctions present in clauses of place.

"Ich habe ihn dort gesehen, wo ich ihn überhaupt nicht erwartet hatte."

(Glovacki-Bernardi, 2001: 40)

Clauses of place do not contain any verbs in the **subjunctive** mood.

2.1.3 Comparison

Both languages use only the indicative mood due to the aspect of reality and objectivity attributed to the expressed verb action.

2.2 Clause of time

A clause of time functions as an adverbial of time for the main clause. It relates the time of the situation in its clause to the time of the situation the main clause. The time of the main clause can be previous to that of the adverbial clause, simultaneous with it, or subsequent to it. 2.2.1 French

In French, the verb mood to be used in clauses of time and all the other compared subordinate clauses is directly contingent on the conjunctional phrase introducing them. Conjunctions may convey:

- simultaneousness: quand, comme, lorsque, au moment où, à mesure que, au fur et mesure que, aussi longtemps que, tant que, cependant que, durant que, en meme temps que, pendant que, alors que, tandis que, chaque fois que, toutes les fois que,
- posteriority: après que, dès que, aussitôt que, aussitôt après que, sitôt que, une fois que, depuis que, maintenant que, à present que, du jour où,
- anteriority: avant que ... ne, en attendant que, jusqu'à ce que, d'ici à ce que, du plus loin que, avant le moment où, en attendant le moment où.

Conjunctions conveying the time relationship of simultaneousness and posteriority typically require the **indicative** use.

² *Grammar* (of words such as neither and nor) corresponding to each other and regularly used together. Correlatives may be, depending in large part on the predicate of the main clause, pronouns, adverbs, pronominal adverbs and prepositional phrases.

"Chaque fois que la colère s'emparait de lui, son front se plissait."(Beaujeu et al., 1991:102

"Dès que j`arriverai, je vous préviendrai." (Dubois&Lagane, 1997:190)

Conjunctions conveying the time relationship of anteriority certainly require the **subjunctive** mood. The sentence content has not been realized yet and thus has been considered uncertain.

"Il faut agir avant qu'il soit (ou qu'il ne soit) trop tard." (Dubois&Lagane, 1997:190)

2.2.2 German

Conjunctions introducing clauses of time may indicate:

- simultaneousness: indem, indessen, sobald, sooft, solange, während, wenn, wie, seit (dem), als,
- anteriority: als, nachdem, sobald, sowie, kaum dass, wenn, seit (dem,)
- posteriority: bevor, bis, ehe.

All the conjunctions determining the relationship of simultaneousness, anteriority and posteriority are followed by verbs in the **indicative** mood as the feasibility of the main clause content is always considered real and certain.

"Sobald das Schiff anlegte, betrat ein Mann das Deck." (Glovacki-Bernardi, 2001:33)

"Dem Patienten ging es besser, *nachdem* er die Tabletten eingenommen hatte". (Buscha et al.,2013:178)

"Du kannst noch im Garten spielen, *bis* das Abend fertig ist." (Glovacki-Bernardi, 2001:34)

The **subjunctive** mood is not used in any clauses of time.

2.2.3 Comparison

In French, the subjunctive mood is applied with the relationship of anteriority that is conveyed by its conjunctions, whereas clauses of time in German make exclusive use of the indicative regardless of the expressed time relationship.

2.3 Reason clause

Reason clause conveys a direct relationship with the main clause. The relationship may be that of cause and effect, reason and consequence, motivation and result and circumstance and consequence.

2.3.1 French

Conjunctions indicating a real reason are: parce que, puisque, comme, du moment que, dès lors que, en ce que, sous prétéxte que, surtout que, vu que, étant donné que, pour la simple et bonne/seule raison que, considérant que, attendu que, those indicating a possible, but a negated reason are: non que/non pas que/ ce n'est pas que...mais c'est que/mais parce que, faute que, soit que...soit que, que...ou (que)...ou (non).

The **indicative** mood is preceded by conjunctions indicating a real reason.

"Beaucoup d'enterprises ferment *parce qu*'il n'y a pas assez de travail." (Beacco di Giura et al., 2003:86)

The use of the **subjunctive** mood is required after the conjunctions indicating a possible, but a negated reason.

"J'ai quitté mon appartement, *non qu*'il fût trop petit, *mais parce qu*'il manquait ce confort."(Beaujeu et al., 1991:108)

2.3.2 German

Conjunctional phrases of reason clauses are: weil, da (cause and effect), zumal (da), um so mehr/um so weniger als (an additional reason), dass, and prepositional phrases auf Grund dessen, auf Grund der Tatsache.

If the main clause is followed by the subordinate clause, it may contain the following correlatives daher, darum, deshalb, deswegen, aus dem Grunde.

All the conjunctions of reason clauses are exclusively associated with the **indicative** mood.

"Das Auto begann (daher) zu schleudern, weil die Strasse sehr glatt war."

(Helbig&Buscha, 1996:689)

"Ich fahre im Januar sehr gern in die Oztäler Alpen, *zumal* die Alpen als besonders schneesicher gelten". (Buscha et al., 2013:176)

Reason clauses do not contain any verbs in the **subjunctive** mood.

2.3.3 Comparison

In French, there is regular use of the subjunctive mood after conjunctions conveying a possible, but negated reason. However, German displays exclusive use of the indicative since there is no clearly expressed semantic distinction between a real and a possible, but still negated reason.

2.4 Result clause

A result clause complements the main clause by indicating the consequence of the situation in the main clause.

2.4.1 French

Conjunctions of result clauses can express either the manner or the intensity of the consequence conveyed.

The **indicative** mood is obligatory:

- after the conjuction conveying manner si bien que.
 - "Il a mange goulûment, si bien qu'il a été malade." (Grevisse&Goosse, 1995:370)
- after the conjunctional phrases conveying the intensity of the consequence: si/tant/tellement/tel...que.
 - "Elle éprouvait *tant* de rancoeur *qu*'elle souhaita de mourir." (Robert, 1995: 2208)
- after the conjunctions expressing intensity, however, only if the consequence is considered an objective result of the main clause content: de façon que, de manière que, de (telle) sorte que, à tel point que, au point que, à ce point que.

"Il s'en est tire *de telle sorte que* tout le monde a été satisfait." (Dubois&Lagane, 1997:196)

The use of **subjunctive** mood is required:

- after the locutions assez/suffisament/trop/trop peu/suffisant...pour que.
- "Ces faits sont *trop* anciens *pour que* tu t'en souviennes." (Dubois&Lagane, 1997:196)
- when preceded by a negative or an interrogative main clause.
 - "Je *n*'en ai pas un besoin *tel que* je ne puisse attendre. (Robert, 1995:2220)
- after the conjunction sans que.
 - "Il est sorti sans qu'on le remarque." (Dubois&Lagane, 1997:198)

Conjunctions conveying manner and conjunctions expressing intensity may be followed by the subjunctive use if there is a nuance of volition and eventuality reflected by the consequence: de façon à ce que, de (telle) façon que, de manière à ce que, de (telle) manière que, de (telle) sorte que, à tel point que, au point que, à ce point que

"Articulez, de sorte que l'on vous comprenne bien." (Robert, 1995:2116)

2.4.2 German

Result clauses are introduced by the following conjunctional phrases: so dass, dass with the obligatory correlative so and solch-, ohne dass, als dass with the obligatory correlative zu.

Conjunctions conveying manner so dass, ohne dass and the conjunction expressing intensity dass with the correlative so require the use of the **indicative**.

"Er hinkt, so dass er nicht schnell gehen kann." (Helbig&Buscha, 1996:693)

The use of both subjunctive and indicative is possible in unreal result clauses for present and past with the conjunctional phrase *als dass* and the correlative zu. The **subjunctive** mood is preferred if there is a minor possibility for the clause content to be realized in the present time, whereas both moods are equally suitable to express unfeasibility of past actions.

"Das Haus war zu teuer, als dass wir es hätten mieten können/mieten konnten."

(Glovacki- Bernardi, 2001: 38)

2.4.3 Comparison

Both languages use both verb moods, but a more frequent subjunctive usage may be noticed in result clauses of French due to interrogative and negative main clauses and certain locutions. The indicative use in French is related to conjunctions conveying the manner and the intensity of consequences, in German it is linked with all the conjunctions and that of the subjunctive is associated exclusively with unreal result clauses.

2.5 Purpose clause

A purpose clause is a subordinate clause denoting a purpose or aim of the main clause content.

2.5.1 French

Purpose clauses are introduced by conjunctions: afin que, à seule fin que, pour que, de/par peur que, de/par/dans la crainte que, de façon/sorte/manière que.

The **indicative** mood is not used in purpose clauses.

A purpose clause expresses an aim or a purpose that a speaker wants or does not want to be achieved. Thus, the resulting consequence is uncertain and the **subjunctive** is the only suitable verb mood to be used.

"Le notaire a procédé à la vente des biens *afin que* chacun reçoive sa part. (Beaujeu et al., 1991:111)

2.5.2 German

Purpose clauses are introduced by: damit, seldom dass

The **indicative** is mainly used in purpose clauses, particularly in everyday speech.

If the main clause is followed by the subordinate clause, it may contain correlatives: *darum*, *deshalb*, *deswegen*, *zu dem Zweck*, *in der Absicht*

"Wir investieren *darum* viel Geld in die Qualität des Erzeugnisses, *damit* das Vetrauen des Verbrauchers erhalten bleibt."(Glovacki- Bernardi, 2001:37)

The **subjunctive** mood may be used in this type of subordinate clauses only when referring to past actions.

"Der Vater schickte Helene auf den Markt, *damit* sie Obst und Gemüse kaufe." (Medić, 1992:143)

2.5.3 Comparison

The indicative mood is not used in purpose clauses of French. In German, it is possible to use the subjunctive solely for past actions.

2.6 Concessive clause

A concessive clause indicates that the situation in the main clause is contrary to what one might expect in view of the situation in the concessive clause.

2.6.1 French

The **indicative** mood is required:

• after conjunction *même si* (with both concessive and conditional meanings).

"Même si on les menaçait de représailles, ils resteraient sur leurs positions." (Beaujeu et al., 1991:120)

• after conjunctions conveying the time relationship of simultaneousness with concessive meaning: *lorsque*, *alors que*, *tandis que*.

"Ceci est beau *alors que* celui-là ne me plaît pas." (De Dominicis, 1997:969)

• after the correlative sequence *tout...que*.

"Toute comprehensive qu'elle était, elle a manifesté sa désaprobation."

(Beaujeu et al., 1991:120)

The **subjunctive** mood is required:

• after the concessive conjunctions: bien que, quoique, encore que, (bien) loin que, malgré que, au lieu que."

"Quoique nous soyons en hiver, la temperature est très douce."

(Dubois&Lagane, 1997:193)

• after the correlative sequences: si/pour/quelque...que.

"Pour têtu qu'il soit, il devra céder." (Grevisse, & Goosse, 1995:372)

• when preceded by adjectives and indefinite pronouns, adverbs and adverbials *qui que, quoi que, où que, quelque...que, quel que.*

"Quoi que je dise, on ne me croira pas." (Dubois&Lagane, 1997:193)

2.6.2 German

Conjunctional phrases introducing concessive clauses are *obgleich*, *obwohl*, *trotzdem*, *wenn auch*, *selbst wenn*, *sogar wenn*, in formal literary German *obzwar*, *obschon*, *wiewohl*, *wenngleich*, correlatives *doch* (combined with *so*), *dennoch*, *trotzdem*, conjunction *dass* and prepositional phrases *trotz der Tatsache*, *trotz des Umstandes* etc.

The **indicative** mood is used:

• when introduced by the abovementioned conjunctions and conjunctional phrases:

"Obwohl es schon sehr spat war, so kam er doch." (Glovacki-Bernardi, 2001:39)

• when the concessive meaning of the main clause content is conveyed by interrogative adverbs, adverbials, pronouns *wann*, *wie* (*immer*), *womit* and the particle *auch*, the conjunction *ob*, and the particle *so* with an adjective or adverb in the subordinate clause.

"Womit sich der Junge auch befasst, ihm gelingt alles." (Helbig&Buscha, 1996:692)

The **subjunctive** mood is used:

• in unreal concessive clause introduced by conjunctional phrases *auch wenn, sogar wenn, selbst wenn* with the strong conditional force. It is used to convey an unreal, imaginary concessive relationship between the clauses.

- "Auch wenn es geregnet hätte, hätten wir den Ausflug gemacht." (Helbig&Buscha, 1996:204)
- in a real concessive clause with the phrase *wenn auch* and the modal verb *sollen* attaching to it an additional tone of eventuality.

"Auch wenn er nicht kommen sollte, werden wir seinen Beitrag besprechen"

(Helbig&Buscha, 1996:691)

2.6.3 Comparison

Concessive clauses of both languages make use of both moods. However, there is a greater presence of the subjunctive in French rather than in German.

2.7 Conditional clause

A conditional clause conveys a direct condition in that the situation in the main clause is directly dependent on the situation in the conditional clause. A direct condition may be either an open condition expressing something that may be true or a hypothetical condition conveying something which is not true or is imaginary.

2.7.1 French

The **indicative** mood is indicated by conjunctions: *si, même si, si même, comme si, selon que, suivant que...ou que.*

"Si tu avais admis cette opinion, tu aurais eu tort."

(Grevisse&Goosse, 1995:374)

The **subjunctive** mood is employed:

• when preceded by conjunctions: comme si, si tant est que, si ce n'est que, sinon que, s'il est vrai que, au cas que, en cas que, à (la) condition que, sous (la) condition que, supposé que, à supposer que, en supposant que, en admettant que, pourvu que, pour autant que, pour peu que, à moins que...ne, soit que...soit que, soit que...ou que, que...ou que, que.

"En cas qu'il ne soit pas à la maison, reviens tout de suite." (Horetzky, 1991:95)

2.7.2 German

Conjunctional phrases pertaining to conditional clauses are: wenn, falls, insofern, im Falle dass, correlatives so, dann. A condition related to the situation in the main clause may also be expressed by the subordinate dass clause and prepositional phrases unter der Bedingung, unter der Voraussetzung, in dem Falle, gesetzt den Fall, vorausgesetzt in the main clause.

All of the aforementioned conjunctional phrases indicate the **indicative** mood. However, the conjunction *wenn* is followed by the indicative mood only when conveying an open condition and thus forming type 1 conditional (*reale Konditionalsätze*).

"Wenn Eltern den Computer als Babysitter missbrauchen, dann entstehen oft Probleme. "(Glovacki-Bernardi, 2001:35)

"Gesetzt den Fall, dass wir morgen frei haben, besuche ich dich." (Buscha et al., 2013:177)

The **subjunctive** mood is applied:

• if there is a hypothetical or unfulfilled condition expressed and introduced by the conjunction *wenn*, thus resulting in forming type 2 conditionals (*irreale Konditionalsätze*) and type 3 conditionals (*irreale Konditionalsätze*).

"Wenn die Haifischen Menschen wären, wären sie dann netter zu den kleinen Fischen?" (Buscha et al., 2013:73)

• in a real conditional clause with the modal verb *sollen* with or without a conjunction to express an additional eventuality modification attached to it.

"Falls er die Arbeit nicht allein schaffen sollte, werde ich ihm helfen." (Helbig&Buscha, 1996:690)

2.7.3 Comparison

Conditional clauses of both languages employ both verb moods, however, slightly differently. In French the usage of verb moods is determined by conjunctional phrases (independently of the type of condition expressed) whereas in conditional clauses in German the indicative use is required with an open condition expressed and the subjunctive usage is requested when conveying a hypothetical condition.

2.8 Comparative clauses

A comparative clause compares a proposition expressed in the main clause with a proposition expressed in the subordinate clause. A comparison includes comparisons of equivalence, non-equivalence and proportionality or equivalence of tendency or degree between two situations.

2.8.1 French

The **indicative** use is required:

• after conjunctions introducing a comparison of equivalence *comme*, tel que, ainsi que, de même que, de la même façon/manière que, le même qui, le même que, tel...tel, autre...autre, aussi...que, autant...autant, those introducing a comparison of non-equivalence plutôt que (de), autre que, autrement que, plus (de)...que, moins (de)...que, mieux que, pire que and those introducing a comparaison of proportionality plus...plus, mieux...mieux, mieux...plus, plus...mieux, moins...moins, moins...plus, plus...moins, selon que, suivant que, d'autant plus/mieux/moins...que, autant que, à mesure que, au fur et à mesure que.

"J'agirai *comme* j'ai toujours fait en pareil cas." (Dubois&Lgane, 1997:197)

The **subjunctive** mood is generally introduced in expressions *autant que je sache, autant que je me souvienne*.

"Autant que je sache: dans la mesure où je suis au courant." (Robert 1995: 159)

2.8.2 German

The most common conjunctions for comparative clauses are: wie, als, als ob, als wenn, je...desto/um so.

The **indicative** mood is applied when preceded by conjunctions of equivalence *wie* with the obligatory correlative *so* (*genau*), those of non-equivalence *als* and those of proportionality *je...desto/um so*

"Im Februar war es *genau so* kalt, *wie* es im Januar war." (Helbig&Buscha, 1996:685

"Er weiss viel mehr, als ich dachte." (Medić, 1992:141)

"Je mehr ich lese, um so reicher wird mein Wortschatz." (Helbig&Buscha, 1996:687)

The **subjunctive** use is preferred to the indicative use in an unreal comparative clause expressing something that is not true, but imaginary. Conjunctions are: *als, als ob, als wenn*.

"Ann tut so, als ob sie nichts hörte/höre/hört." (Glovacki-Bernardi, 2001:39)

2.8.3 Comparison

Both linguistic systems apply both verb moods. However, the use of the indicative prevails in French, whereas the subjunctive is employed solely with the aforementioned conjunctional phrases.

2.9 Clause of manner

A clause of manner functions as an adverbial of manner for the main clause.

2.9.1 French

The use of the **indicative** is required:

- after conjunctions implying a relationship of equivalence and manner simultaneously: comme, ainsi que, de même que.
 - "Il fallait bien de même qu'elle se couchait la dernière." (Robert, 1995:1381)
- after conjunctions implying a manner and a nuance of time simultaneously: à mesure que, au fur et à mesure que.
 - "Elle reculait à mesure qu'on le remarque. (Dubois&Lagane, 1997:198)
- after conjunctions implying a manner and a result simultaneously but only if the expressed clause is real: *de manière que, de façon que, de sorte que.*
 - "Il a partagé les gateaux *de manière que* tout le monde est satisfait." (Grevisse&Goosse, 1995:369)

The **subjunctive** mood is used:

- after the conjunction sans que with a restrictive meaning.
 - "Il est sorti sans qu'on le remarque." (Dubois&Lagane, 1997:198)
- occasionally after conjunctions simultaneously introducing a relationship of manner and result if the expressed clause content is merely supposed or unreal.
 - "Il a partagé les gateaux *de manière que* tout le monde soit satisfait." (Grevisse&Goosse, 1995:369)

2.9.2 German

Conjunctional phrases for clauses of manner are conjunctions implying equivalence and manner at the same time: *indem*, *dass* with obligatory correlatives (*dadurch*, *damit*), conjunctions *ohne dass*, *anstatt dass* and *statt dass*.

The **indicative** use is introduced by all conjunctions of clauses of manner.

"Er verbesserte seine Leistungen, *indem* er regelmässig tranierte." (Helbig&Buscha, 1996:685)

Clauses of manner do not contain any verbs in the **subjunctive** mood.

2.9.3 Comparison

It may be noticed that French uses both verb moods. German, however, uses exclusively the indicative mood.

2.10 Clause of exception

A clause of exception excludes a part of the main clause content from the main clause.

2.10.1 French

The **indicative** mood is indicated by the conjunctions *sauf que*, *excepté que*.

"Je suis satisfait de mes vacances, sauf que le temps était mediocre." (Dubois&Lagane, 1997:198)

The **subjunctive** mood is not used in clauses of exception.

2.10.2 German

Conjunctional phrases for clauses of exception are: ausser dass, ausser wenn.

The use of the **indicative** is preceded and introduced by the aforementioned conjunctions.

"Er war geheilt, ausser dass er in der Aufregung manchmal ein wenig stotterte."

(Helbig & Buscha, 1996: 456)

The **subjunctive** mood is not used in any clauses of exception in German.

2.10.3 Comparison

Both languages use only the indicative mood due to the aspect of reality and objectivity attributed to the expressed verb action.

3. Conclusion

Upon completion of the comparison of the two languages, the following facts should be pointed out:

- Clauses of place in both languages display identical use of both verb moods; both use only the indicative mood.
- Verbs in clauses of time in German are deployed solely in the indicative. French and its subjunctive use is related to conjunctions introducing the relation of anteriority.
- Reason clauses in German use solely the indicative mood. In French, however, conjunctions of a possible, but negated reason are followed by the subjunctive mood.
- Result clauses in both languages display use of both verb moods, however, with prevalence of the subjunctive in French.
- Purpose clauses in French introduce exclusively the subjunctive mood. German is dominated by the indicative, with the exception of the subjunctive being possibly used for past actions.
- Concessive clauses of both languages make use of both verb moods, with the subjunctive being more frequently used in French.
- Conditional clauses of both languages display the use of both verb moods; the use of verb moods in French is dictated by the choice of conjunctions, whereas in German it is determined by the type of the condition expressed.
- Comparative clauses in both languages apply both verb moods, however, French is dominated by the indicative mood.
- Clauses of manner in French use both verb moods as opposed to German and its only verb mood used; the indicative.
- Clauses of exception in both languages display identical use of both verb moods; both use only the indicative mood.

It should be pointed out that both linguistic systems display identical usage of the verb moods in their clauses of place and exception. Other adverbial clauses feature less or more noticeable distinctions. Thus, for example, clauses of place, time, reason, manner and exception in German use only the indicative, whereas purpose clauses in French apply solely the subjunctive mood. Result, concessive, conditional and comparative clauses in both languages deploy both moods. The subjunctive use is, however, more frequent in French due to abundance of conjunctional phrases explicitly introducing it. The aforementioned speaker's aspect of eventuality adds to the frequency of its use. In German, on the contrary, the subjunctive use is not defined by any conjunctional phrases, but primarily by a speaker's attitude or the unfeasibility and unreality of the expressed clause content. It is these features of the subjunctive that considerably contribute to its obligatory appearance in unreal conditional clauses and possible use in other adverbial clauses.

Mention should also be made of the fact that the use of the verb moods is sometimes dependent on language styles or registers applied. In spoken and written language, there is a growing tendency to use the indicative mood more frequently. In German, in both speech and writing there is growing prevalence of the indicative use. Even in negative result clauses, we encounter the present indicative more regularly than the past subjunctive, a formal reinforcement of the negative clause meaning. This is due to the increased need for the

simplification of a rather complex system of verb moods and more efficient information communication.

Similarities in the use of the two verb moods can be ascribed to their common Indo-European origin and ancestor, whereas their differences can be justified by the existence of various groups of Indo-European languages (Romanic and Germanic language) French and German belong to.

Methodical and didactic implications of applying the contrastive approach to the verb mood interpretation are numerous, particularly in teaching German and French as second or foreign languages. A French and German teacher's familiarity with basic disparities and similarities in the mood use between the two languages can considerably contribute to successful teaching of the target language. Contrastive analysis may and should assume a significant role in teaching adult learners or native speakers of French and German the target German and French language respectively (with emphasis on lexical, grammatical and syntactic accuracy), as higher levels of instruction imply carrying out a comparison of the languages and retrieval of their translation equivalents. Contrastive analysis of transfer errors into German and French may prevent their emergence or at least mitigate their frequency in the target language.

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Maximising Student Linguistic Output through Project Tasks

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Abstract. The very content of Business English classes demands a rather rigid structure: there are a large number of language-specific topics to be covered in a limited period of time. Therefore it seems that a traditional PPP - Present, Practice, Produce - approach may be the best option to not only complete the course on time, but to ensure that students will actually have acquired sufficient, if not entire, amount of specific vocabulary and structures that are defined by the syllabus created for a particular level of linguistic knowledge. Recent approaches to language teaching, however, suggest that a certain level of student involvement in the acquisition of knowledge is necessary in order to create a stimulating learning environment. In other words, instead of having them listening passively and doing a set of exercises that result from artificially created linguistic situations, it is advised to engage them in a variety of task-based activities. The so-called TBLT – task-based language teaching – provides an excellent alternative and can be introduced even in a busy syllabus schedule. It revolves around a specific task which students do and complete by themselves, using both the already acquired and new vocabulary and structures. It also represents an excellent diagnostic tool for a teacher to detect linguistic weaknesses and strengths of students and act accordingly. TBLT is integral to Business English syllabi within the specialist professional graduate study programmes at the University Department of Professional Studies. The first part of the paper will address both TBLT and PPP and its central part will revolve around the two task-based activities, summary writing and presentations, and their benefits in terms of the improvement of overall linguistic fluency and accuracy that was reported by students upon their completion.

Key words: task-based language teaching, student centeredness, linguistic output

1 Introduction

The most recent approaches to foreign language teaching emphasise the importance of active participation on the part of students in the knowledge acquisition process. The more involved they are, the more successful the final outcome will be: linguistic fluency and complexity imbued with structural and semantic accuracy. Therefore a shift has occurred in the LSP teaching methodology. The very methodology is based on the so-called PPP – Practice, Present, Produce approach that proved highly effective in terms of covering a rather comprehensive, language specific syllabus in a limited time frame. However, this approach has its limitations and to ensure that students reach certain levels of fluency, teachers introduce a number of project tasks. Their execution is based on the precepts of the task-based approach.

2 Present Practice Produce (PPP) versus Task-Based Teaching (TBLT)

Present, Practice, Produce is an instructional model that has been used for decades. Most teachers become acquainted with this approach during the initial stages of teacher training. Its name reveals three stages of teaching. In the first stage, the teacher *presents* a linguistic item

in a clear context to illustrate its meaning and use. This can be done through a text, a listening exercise, a dialogue, random examples of sentences, etc. Then, through a *practice* stage students are given a series of exercises, such as filling the gaps, matching halves of sentences, matching words and meanings. The purpose of this rather controlled stage is to help students to grasp the correct use of linguistic items, so that, one day, they are capable of using them correctly in the real life. In the final, *production*, stage, students are asked to produce these linguistic items in a variety of communication exercises, such as expressing their views on related topics, a role play, at al. By being able to complete this final stage successfully, they also have to use all the linguistic items that they have already learnt.

Although this method is rather traditional and seems quite logical, there are a number of limitations to it. First, whole practice is done in a rather artificial and controlled atmosphere in which students may appear to be capable of using the target language accurately. Consequently, several lessons later, since they have practiced language items in artificial situations, students may not produce the language correctly or not produce it at all. Finally, in the production stage, it is highly likely that they will find themselves capable of using existing language resources and avoid any application of newly introduced linguistic items, since they may not be comfortable enough to use them.

PPP is teacher centred and leaves a very little room for a true involvement on the part of students. The task-based language teaching, however, focuses on the linguistic needs of students and by its very nature is communicative. It revolves around the completion of a certain task and the study of linguistic items is determined by the quality of language that students use to complete a task. Tasks are executed in several stages. In a pre-task stage, the teacher introduces the topic and provides clear instructions on what to do in the task stage. In this preparatory stage a teacher may remind students of language that may be useful for the task and even play a recording of people discussing the task. In the task stage, students prepare a task in pairs or groups using the language resources that they have, whilst the teacher monitors their progress and provides all the necessary help. Then, in *post-task stage*, particularly in the *planning stage*, students prepare a brief oral or written report on the task that they report to the class orally or read the written report. In the analysis stage, the teacher highlights parts of reports for content and language analysis. The final stage is the practice stage: based on the linguistic output, the teacher selects linguistic areas for further practice. The students do the practice activities, which helps them to increase their confidence in terms of fluency and accuracy.

The task-based learning is motivating and enjoyable, since the students are given freedom to use all their language resources in a natural context. The exploration of the linguistic items is determined by students' needs rather than a decision made by the teacher.

In conclusion, research suggests that it is difficult to predict what students will learn during the language course and, instead of following a single approach, it is advisable to combine several different approaches to maximise their exposure to language and, consequently, their linguistic output.

3 Project Tasks – Summary and Presentation

3.1 Summary

The summary writing is the activity that precedes preparation of a presentation in a particular format. The presentation is based upon one of the professional seminars that students have already presented in their mother tongue during professional courses that are part of their professional study programme.

Teaching summarizing skills is often neglected, since it is widely believed that this is the skill that is acquired naturally. However, as it has been confirmed in everyday teaching practice, students are unable of creating them in a correct manner, since they do not grasp their very essence: summaries are shortened versions of long texts, and, thus, contain key information without examples and details. When asked to write a summary, students either write long detailed summaries or extremely short ones that miss the main ideas of texts. Therefore, prior to any serious writing task, they should be provided guidelines by the teacher. The teacher may also produce summarising exercises to illustrate both its form and creation process. A typical exercise usually includes reading of longer texts in pairs or small groups and deciding on the main ideas that are then articulated in the form of a summary. At this point, the teacher introduces some formulaic language of academic writing that introduces the main idea and provides a lead into the text body, such as this paper/text addresses, according to the author/to the resources, the focus of the text/paper is on, the text/paper highlights, etc. The summary closure – the conclusion adds a final touch to it and, therefore, it is important to teach concluding sentences. These restate the main idea and are introduced with in conclusion, finally, lastly, to conclude, in the end, as a final point.

The same strategies are used in writing summaries of professional papers. Students highlight main ideas and focus their summaries on them, which later help them to organize the content of presentations. Summaries are written in Croatian, since students are not accustomed to direct writing in a foreign language and are then translated into English. They, thus, do not only practice summarizing but also translation into foreign language. Translation is not an automated activity; it is a cognitive process in which students raise awareness of differences that exist between languages. In addition, it provides an opportunity for both retrieval of language resources and enrichment of their knowledge with new vocabulary and structures.

Finally, aside from the previously addressed linguistic benefits, summarizing improves other skills that are significant for both the academic and professional life of students: writing (creation of a summary), vocabulary, reading and critical skills (selection of the main ideas).

3.2 Presentation

Preparing and delivering an oral presentation is an effective communicative activity that has been widely used by ESP teachers to promote oral proficiency encompassing complexity, fluency and accuracy. It provides a learning experience and teaches lifelong skills that will be beneficial to ESP students in all study programme courses as well as later in their careers. It also ensures that students are actively involved in oral practice and are given the opportunity to use language in meaningful ways for social, academic and future professional purposes.

Some general content-related advantages of making oral presentations for ESP students are: creating understanding of the content, demonstrating knowledge of the content, moving the audience to action.

There are also the most valued linguistic benefits and numerous general assets regarding overall presentational aspects. The former comprise the following: bridging the gap between language study and language use; using the four language skills in a naturally integrated way. The latter concern helping students to organize and construct information in a coherent matter; developing an effective thesis for an oral presentation; practicing the use of logical and emotional appeals; understanding the importance of transitions in adding coherence; practicing the use of voice, gesture and bodily action to convey meaning, preparing an effective introduction and conclusion for a presentation, creating an effective and useful speaking outline and notes, developing experience and confidence in one's presentational skills and enhancing team work in collaborative and supportive environment.

However, teaching oral presentation skills has been met with some resistance due to arguments expressed by many teachers about appropriateness and constraints of using a mainly student-centred oral presentation in a still traditionally prevailing teacher-centred ESP learning environment. These refer mostly to a large amount of class time needed for an oral presentation, its incompatibility with a rather comprehensive and extensive language syllabus and limited time frame and a frequently obvious gap between the current level of performance and the intended learning experience. This may often result in a breakdown of language production and frustration for students. Therefore, the need for establishing a comfortable and low-threat learning environment that lowers students' anxiety and boosts their confidence, from the perspective of second language acquisition, has long been emphasized and recognized.

Considering all its above addressed benefits, the introduction of oral presentation into ESP classrooms, with structured planning and organization, provides a rewarding and stimulating experience both for teachers in developing facilitating skills and for students in training themselves to have confident presentations in public.

3.3. Task-based approach to preparing and delivering a presentation

As it was previously highlighted, the innovativeness of task-based language teaching (TBLT) is embedded in the idea that a language course can be composed of nothing but tasks. Performing these tasks supported by focus-on-form encourages incidental secondary language acquisition that proves to be more effective in the long term than intentional language learning and therefore disputes the necessity of direct language teaching. In task-based language pedagogy, these tasks are defined as devices for organizing the content and methodology of language teaching (Prahbu, 1987). At the level of "workplans" (the forms of materials for teaching language these tasks take) they are also distinguished from exercises by four defining criteria suggested by Skehan (1998a)

- (1) they are primarily focused on meaning,
- (2) they are defined by goals which need to be worked towards,
- (3) they constitute outcome-evaluated activities
- (4) real-world relationships are integral to them

In accordance with these basic distinguishing criteria and underlying theoretical background of TBLT, delivering an oral presentation preceded by a summarizing activity can be considered as a suitable task upon which a task-based lesson could be easily drawn upon. An oral presentation following the summary writing provides an excellent opportunity for the development of students' linguistic skills while engaging in communicative activity, ensures communication of propositional content and pragmatic communicative meaning, allows for students' performance to be evaluated in terms of whether the communicative goal has been achieved and finally manifests a relationship between the activity that arises from the task and the way language is used in the real way. Therefore, designing a presentation-based lesson should easily fit into the existing methodology of task-based instruction and should involve consideration of three commonly distinguished stages or components of a task-based lesson: the *pre-task phase*, the *during task phase* and the *post-task phase*. The three phases will be delineated in the following section.

3.3.1 Pre-task phase

Strategic planning

This first phase concerns the various activities and strategies that teachers and students can undertake prior to dealing with a specific task. These strategies should whet students' appetites to perform the task and help them to perform it whilst promoting acquisition of new

language and mobilisation of the existing linguistic resources. Students are provided with an advance outline of what they will be required to do and the outcome they will arrive at.

Strategic planning is selected out of four possible pre-task options available in TBLT (performing a similar task, providing a model, non-task preparation activities and strategic planning) through which students' requirements and task outcomes can be tackled. It encompasses teaching summary writing, translation and preparation and delivery of an oral presentation. Prior to performing each of the three task activities students are divided in pairs and given the task work plan, guidance focusing on both form and content in what to plan and time to plan their task performance, as suggested by Foster and Skehan (1996).

Thus in teaching summarising skills they are first acquainted with the task of writing a summary based on their professional papers. Secondly, they are also provided with detailed guidelines to summarizing (including picking out main ides of a reading, ordering sentences and connecting them using transition words, paraphrasing them) and explicit introduction of formulaic language of academic writing. Thirdly, they are allocated 10 minutes to plan the summarizing.

However, teaching and facilitating translation does not only include provision of linguistic forms and strategies (e.g. terms, multi-word lexical units, passive voice, past and present participles, reduced relative clauses...) for performing the task activity but also activation of student's previous content knowledge and addition of background information serving as a means of defining the topic area of the presentation task. Recommended activities for addressing its linguistic demands focus on targeting unfamiliar vocabulary and include: predicting (i.e. brainstorming a list of task-related words), cooperative dictionary search (i.e. allocating different students to look up in their dictionary) and words and definitions (i.e. students match a list of words to their definitions via a word chart). Finally, these are followed by students' pairs being allocated 10 minutes to carry out translation planning

Detailed guided planning within this phase involves a teacher's definition of the task (preparing and delivering a summary-based presentation) and the learning outcome (communicating content based on an economics topic and interwoven with the development of accuracy, complexity and fluency in language use that is to be evaluated), specification and emphasis on the key questions to be answered in the presentations (definition of an economic concepts, its theoretical background, practical examples, case studies, possible implications), explanation of the layout of the organization, structure and design of a 6-8 minute 12-slide PowerPoint presentation that is to be subsequently graded (e.g. introduction, body, summary and conclusion) and expansion on all presentational aspects (use of voice, emotional appeals, transitions, body language). It also comprises detailed introduction of useful linguistic and syntactic forms that are considered to be typical of the formulaic language used in presentations (e.g. the purpose of this presentation is, to start with, I'd like to expand on, as I mentioned earlier, as we will see later, let me sum up, in conclusion...) and demonstration of opening and closing speech examples via available online videos. This explicit teaching is followed by instructions relating to planning potentially emerging content (e.g. ,,thinking about what questions listeners might ask") and potential language reference or use (e.g. "thinking what grammar they need to do the task"). These options enable a teacher to focus the students' attention on different aspects of language use. Students working in pairs are given 20 minutes to plan on task performance. In this planning phase they work on the presentation and decide who will give each part. They share ideas, brainstorm and argue, write down notes and make an outline of presentation where they should define the task, support idea, provide details and give conclusion.

3.3.2. The during-task phase

There are two basic kinds of the methodological options available to teachers in this phase that centres around the task itself. The first kind comprises *task-performance options* that relate to how the task is to be undertaken and that may be taken and thus planned by the teacher prior to the actual performance of the task. These involve setting strict time limits or allowing students to complete the task in their own time, deciding whether to allow the students access to the input data while performing the task and whether to introduce some surprise element in the task. The second type of options is called *process options* and they involve the teacher and students in on-line decision making about how to perform the task as it is being carried out. It is concerned with the way in which the discourse arising from the task is constructed rather than methodological decisions about the way task is to be dealt with.

Among the available *performance options* setting a strict time limit (45 minutes) for the completion of the task, as recommended by Lee (2000), and allowing students access to the input data (translated summaries, useful formulaic language, opening and closing speech samples, layout of the presentation, highlighted presentational aspects) during the task performance, as suggested by Joe (1998), are opted for. Therefore, students working in pairs are required to use one laptop on which they are working on putting together a PowerPoint presentation within a set time limit of 45 minutes. They are also encouraged to enrich their presentations with different templates, background pictures, fonts, music, video clips, props or anything else that will make their presentations more attractive and make their speech more appealing as long as these comply with the provided outline of the design, layout and structure of a presentation. They are also reminded to make sure they go over all the given useful phrases and the chosen content vocabulary and use them in their presentations. As the task is being performed, the teacher monitors students' language use and notes down emerging errors.

Some key *process options* in task-based pedagogy are selected drawing on Ellis (2001): students are enabled use loose discourse structure consisting of adjacency pairs, to control topic development, to use referential questions (i.e. questions that the questioner does not know answer to), to function in both initiating and responding rules, to negotiate meaning when communication problems arise, to repeat other students' utterances or teacher's utterances as private speech to establish subjectivity and they are provided with content-focused feedback by their teacher.

In order to both make the discourse pedagogically effective and to ensure that the interaction can be regarded as communicative the teacher is encouraged to successfully combine the role of "instructor" and "interlocutor" by employing both the implicit and explicit focus-on-form techniques. Furthermore, these techniques are intended to potentially increase the linguistic value of a task by inducing observing of linguistic forms lying at the edges of students' current interlanguages. The implicit interactional devices employed by task participants are requests for clarification and reformulation, recast or rephrasing of other participants' unclear utterances. The explicit strategies used include providing explicit correction or drawing explicit attention to another participant's wrong use of a linguistic form (e.g. "Not x but Y"), expressing a metalinguistic comment focusing on another participant's incorrect language use (e.g. "Past Tense not Present Tense"), asking a query (e.g. "Why is "can" used here?") and giving advice regarding the use of as a specific linguistic form (e.g. "Remember you need to use past tense.").

Throughout the whole during-task phase students are prompted and motivated to complete the preparation of their presentations entirely in English. However, their occasional use of Croatian is allowed and tolerated as it serves as a means of establishing goals for the set activity and the procedures for accomplishing it.

Finally, students are asked to deliver their thoroughly prepared presentations on a chosen economics subject matter in pairs in front of their classmates. Each student speaks for 3-4 minutes. Their delivery addresses and incorporates the input content and structure data, the linguistic input and the input provided on presentational aspects. Special emphasis is placed on the use of the appropriate voice pitch, body language, transitions and emotional appeals. Their overall performance is being evaluated and reviewed by both their teacher and their classmates as their presentation is being delivered. The evaluation and review is based on the following criteria: content, organization, grammar, vocabulary, delivery, and overall impression, which will be further discussed within the post-task phase described below.

3.3.3. Post-task phase

The post-task phase strives toward achieving two major goals: (1) encouraging reflection on how the presentation was prepared and delivered and (2) encouraging attention to forms that proved to be problematic to students whilst performing the task.

Reflecting on the task includes asking students to reflect on and evaluate their own performance. As suggested by Willis (1996), they are invited to summarize the outcome of the task and in accordance with Ellis (2009), they are asked to comment on which aspect of language use (fluency, accuracy, complexity) they focused and why, how they dealt with communication problems and even what language they learned from the task. They also consider the ideas for improvement of their future task performance. Lastly, they are given a simple questionnaire as an evaluation form of the task itself.

After conducting their own evaluation of their performance and the task itself students are informed of their presentation and speaking grades given by their classmates and their teacher. Each specific category and an assigned grade (covering the set content, following the given structure, using partly predetermined vocabulary, intermediate to upper-intermediate – level grammar, providing delivery and overall impression) are explained in detail. The highest-graded categories are those referring to content, structure and vocabulary, whereas grammar and delivery categories are lowest-graded. The teacher's and classmates' grades do not differ significantly.

Focus-on-form section of this task phase attends primarily and extensively to forms that the students used incorrectly while performing the task and a few "natural" forms that they failed to use. The target forms are dealt with two options available to the teacher: (1) review of student error and (2) production practice activities.

Review of student errors concerns the actual examples of errors made together by students and noted down by the teacher in the during-task phase. Within this task phase they are addressed with the whole class. The errors concerning delivery are first elicited from the students and then highlighted and expanded on. They mainly concern lack of or insufficient eye-contact, reading off the notes or off the slides and inappropriate voice pitch used during the delivery. Secondly, the teacher writes sentences illustrating the linguistic errors on the board, students correct them, and the teacher writes up the corrected versions and provides brief explanations. The most frequently encountered and noted down linguistic errors refer to the deviant use of verb tenses, passive voice, phrasal verbs, collocations, targeted useful formulaic language, wrong word and sentence order, incorrect subject and verb agreement and spelling and pronunciation.

Production practice activities following the review of noticed errors are intended to provide practice of selected forms. These exercise types include substitution, gapped sentences, jumbled sentences, transformation drills. Students are given an example of each exercise type consolidating the aforementioned incorrect language use.

4. Conclusion

The overall purpose of this presentation-based methodological approach has been to create opportunities for ESP learning and skill-development through collaborative knowledge building. The overall predetermined learning outcome and the successful development of linguistic and presentation skills through pair work have been largely achieved.

It has been ensured that communicative meaning (presenting an economics topic) has been conveyed through a discourse that is essentially conversational in nature and highly motivating for students to take linguistic risks due to effective scaffolding of their communicative efforts. It has also been provided for the explicit formulation of messages and implicit/explicit focus on specific linguistic forms in each phase of the task; through guided strategic planning, by means of focus-on-form techniques and through explicit instruction. Furthermore, special attention has been paid to promoting engagement of every pair member in the performance of the task by announcing the subsequent public performance of the outcome of the task to be undertaken by all members of the group. Mixed-ability class issue has been addressed not only through encouraging students to request for clarification or recast, but also via work in pairs constituted of a less and more proficient student. This latter technique proves to be very beneficial to the development of both students' proficiency and to be generating a reduction in a level of anxiety felt by the less proficient student.

Regarding students' evaluation of their task performance and the task itself, their answers and comments have been rather positive, honest and objective. They reflect their satisfaction with their task performance, the task itself and highlight their obvious weaknesses and strengths in their language use. According to them, their performance has been rated as very good, particularly in regard to the set content, structure and vocabulary, due to their invested effort and the teacher's explicit and implicit teaching techniques. They mainly focused on developing fluency and complexity at the expense of accuracy and dealing with communication problems through questions, requests and recasts. The task has been evaluated as exceptionally useful in communicating the given content within a natural context arising from personalized and relevant language and finally, as extremely motivating and rewarding as it has displayed a real-world situation.

In regard to review of students' linguistic errors, the most frequently encountered and noticed errors concern considerable and frequent grammar and syntactic forms and slight and occasional morphological forms. The former could be attributed to the lack of the pre-existing grammar and syntax knowledge, whereas the latter is easily associated with insufficient and superficial effort made at preparing the presentation. However, both types of errors indicating development of a lower level of accuracy in comparison to fluency and complexity could be considered as resulting from the strict time framework being assigned to the students to complete the task. This in line with some research studies indicating that placing an emphasis on accuracy in a task performance requires that students complete the task in their own time, whereas encouraging fluency should be supported by setting a time limit. There is also a case for claiming that the primary goal of the presentation has been perceived by students as communicative and that of prioritizing fluency with resulting gains in complexity. The most frequent errors made during the presentation's delivery tend to be caused by students' unconfident body language, insufficient and rare eye-contact resulting from reading off the notes and slides and inappropriately adjusted voice pitch. The phenomenon of these errors could arise from a variety of factors: partial or insufficient preparation on students' part, differences in students' language aptitude, personal and social skills and their own techniques of dealing with the communicative stress placed on them by the teacher's request for public performance.

The aforementioned various activities used in the post-task phase may be considered as beneficial to ESP acquisition for a variety of reasons.

Firstly, encouraging students to think about possibilities for improvement of their task performance may induce the development the metacognitive strategies of planning, monitoring and evaluating, which are considered to be very important for language learning. Secondly, asking students to evaluate the task itself can help teachers to decide on using similar tasks in the future or looking for a different type. Thirdly, focusing on forms by reviewing students' errors constitutes a valuable post-task option that is necessary to avoid the danger that students will develop fluency and complexity while neglecting accuracy. It should also be mentioned here that attention to forms even in this phase does not, by any means, detract from the primary focus on message content as the defining characteristic of the task. Fourthly, production practice activities employed in reviewing students' errors do not merely result in reinforcing and consolidating the targeted linguistic features, but also in activating a number of already partly acquired linguistic resources within students' interlanguages. They may also help students automatize the forms they have started to use incidentally, but have not mastered yet.

It could be concluded that a modular approach to ESP teaching, as shown through this case study, that gives primacy to TBLT throughout but also allows for the inclusion of explicit instruction as a means of helping students overcome persistent learning problems possibly constitutes the best methodological proposal for ESP teaching.

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Undergraduate and Postgraduate Students' Perceptions on a Challenge-Based Learning Experience: Education vs. Food Engineering

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Abstract

The development of the competences set for higher education BAs and MAs is a main concern for HE institutions. Different methodological approaches may contribute to a more student-centred, hands-on approach. This paper reports on the perceptions of two groups of higher education students who took part in a Challenge-Based Learning (CBL) experience.

Participants belonged to different educational backgrounds. The first group were undergraduate students from a BA in Primary Education course in Florida Universitària and, the second group had enrolled in an MA in Food Engineering.

CBL is an educational practice in which students collaborate with their communities, face real situations and make decisions to design a solution to overcome a challenge arranged in agreement with their educators, besides the outcomes are made public. In these cases, undergraduate students visited different English schools for three days and planned and taught different activities at each one of them. Undergraduates presented their experience in an international symposium. Postgraduate students conducted a research process on molecular cell detection in molluscs, gathered data and wrote a paper that was submitted to a journal.

Data was obtained through questionnaires and individual and small group interviews on the perceptions of the participants about their learning process, the competences acquired and their overall satisfaction.

Results suggest that students perceived their learning process as more motivating and they also believed they had acquired the competences proposed in their syllabus in a deeper extent and were satisfied with their work.

Key words: Challenge-based learning, Higher Education innovation, professional competences

1. Introduction

The acquisition of the competences set for undergraduate and postgraduate courses and doctoral programmes is a commitment to fully accomplish for lecturers. These learning experiences are a challenge for higher education (HE) practitioners and their institutions as they are responsible for the students' academic and professional development so that HE students can tackle efficiently contemporary issues (García-Martín et al., 2016).

The objective of this paper is to present higher education students' perceptions on the accomplishment of two different educational experiences in two different settings with the

Challenge-Based Learning as the framework of reference. On the one hand, two groups of undergraduate students from a BA in Primary Education (pre-service teachers) who took TEFL subjects at Florida Universitària (FU) and two groups of postgraduates who had registered in an MA in Food Engineering at the Universitat Politècnica de València (UPV).

1.1. Challenge-Based Learning (CBL)

A challenge stands, in this kind of educational experience, an activity, a task or situation that promotes the students' active learning by getting them involved. The challenges entail a real practice in a real context and link them with the setting and the implementation of a solution to respond the question that triggers the initial question.

CBL is a proposal of meaningful learning since higher education students are supposed to master soft skills such as critical thinking, teamwork, problem-solving and decision-making. In this sense, CBL offers wider learning opportunities by putting in practice aspects to be develop in the competences in real contexts. The scenarios students face entails making decisions by interacting with different students in a given setting. Moreover, CBL requires a factual solution with a real action as a result of a process in which students analyse, design, develop and carry out the best outcome to tackle the challenge so that other students, members of the community or related agents may screen it and measure it. Lecturers stand for coaches, co-researchers and learning-process counsellors so that they are able to guide and learn from their students (Apple Inc., 2008)

The reported benefits of CBL in higher education range from a deeper understanding of the topics they deal with, their diagnose and definition as well as their creativity (Icaza, 2015 cited in Tecnológico de Monterrey, 2015). Students find themselves closer to the communities they interact with (Probert, 2015 cited in Tecnológico de Monterrey, 2015) and develop communicative skills as the result of their learning process which has an outcome and is shared by different social means (Johnson et al., 2009).

Different institutions have adapted their own models from Apple's proposal (2008) and its phases have been modified (García-Martín et al., 2018; Tecnológico de Monterrey, 2015). Nonetheless, they all have some aspects in common. The need of an atmosphere of collaboration, the questions that trigger the challenge, the brainstorm and research to provide real-world, hands-on solutions and the need to make it public. Last but not least, the opportunities to reflect upon the learning process and the decision-making situations with peers and lecturers who act as a coach (Tecnológico de Monterrey, 2015).

1.2. Students' perceptions on CBL experiences

Although CBL is a rather innovative and incipient learning experience in HE settings, different studies have highlighted the benefits perceived by students and teachers on different active methodologies. In Catalonia, Navarro et al. (2015) reported that facing through projects, their HE students had improved their competences in the cooperative team-work, their involvement and their skills to transfer their acquired knowledge to actual practice. Similarly, in the Basque Country, García-Martín et al. (2018) reported that students felt that by having been involved in a CBL experience they had learnt more, acquired the professional competences up to a higher extent and the difference in the approach in the teacher-students relationship. Lecturers also reported that their efforts focused on the organisation of groups and their management as well as providing feedback and support all along the process. Rodriguez et al. (2015) confirmed that students had the impression of having developed the competences of their engineering degrees in Madrid in a similar way as their colleagues had informed.

Johnson and Adams (2011) reported that students perceived that they contributed by putting forward their ideas and doing creative work, besides students proved to be 'good judges' of their contributions by assessing their consistency. Cheung et al. (2011) also applied CBL in the USA to improve cybersecurity education and reported participants' gains in terms of "their computer skills, security knowledge, ability to teach others and interest in the topic of cybersecurity" (2011, p. 6) however the formative assessment showed differences among students. Nevertheless, researchers recommended it as an active method despite the efforts made by teachers to provide extra support.

In a different context, Shruptine (2013) also asserted that his secondary school students had developed their sense of responsibility regarding their work in terms of collaboration and planning for the challenges set for them in the video edition.

All in all, previous research seems to point out that students have the perception of improving their competences, learning more than they would through a traditional teacher/lecturer-centred approach and show their satisfaction with the active learning process they engaged in.

2. Method

The main aim of this paper is to find out students' perceptions on the use of CBL with regard to its inclusion in undergraduate and postgraduate HE modules and how this practice could be improved. In order to carry out the research process the following research questions were posed:

- RQ1. What are undergraduate and postgraduate students' perceptions and rate of the CBL experience?
- RQ2. What are the aspects of the CBL process that could be improved?

2.1. Participants

The students who took part in this study were twenty-three (N=23) undergraduate and postgraduate students. Eight of them (N=8) were male and fifteen (N=15) were female. Their ages ranged from 21 to 30.

The group of undergraduate pre-service teachers from Florida Universitària in València were enrolled in 3rd year of a 4-year degree. There were twelve students (N=12), four (N=4) males and eight (N=8) females. On the other hand, the postgraduate students from the MS in Food Engineering were in a group of eleven (N=11), four (N=4) male and seven (N=7) female.

2.2. Materials & instruments

The data gathered for the present study was collected from questionnaires and semi-structured individual and group interviews carried out after completing the whole CBL process. By using both methods, the participants' ratings gained insights on the perception of their participation in this learning experience and enabled researchers to gain reliability and interpret the results (De Castro, 2015). This triangulation must be supported by the researchers' critical thinking or the sample, which in this case is not numerous, however it offers a small portion on this learning innovation. These methods assure the rebuttal of ideas and bring about evidence to build up judgements (Simons, 2011).

Participants were asked to participate freely and were informed that they could withdraw at any time in the interviews. As for the questionnaires, they agreed to take part by completing the questionnaires.

Coding

In order to give account of the participants' contributions either from the questionnaires or the interviews the codes used have been set with the initials of the institution plus the number assigned to a participant. For instance, undergraduate students (Florida Universitària) + participant 3= UG.P3. or postgraduate student (Universitat Politècnica de València) + Participant 5= PG.P5.

Questionnaire

A self-administered online questionnaire was also used so that a structured set of statements and their agreement to them with respect to the aspects related to undertaking the CBL as part of these higher education modules was gained. The items used in this paper were used based on similar research on students' perceptions in to Rodriguez et al. (2015) as Table 1 shows in a likert scale from 1 to 6. Moreover, an open-ended question was also set so that participants could come up with the aspects of the experience that they would highlight. Participants took a mean time of 6 minutes and 21 seconds to complete the questionnaires.

Table 1. Questionnaire on CBL learning experience.

Items	Statements
Item 1	By engaging in CBL you have learnt more.
Item 2	CBL entails a heavier workload than other methods.
Item 3	CBL promotes the acquisition of skills more than traditional approaches.
Item 4	You feel satisfied of your results with respect to the tasks implemented.
Item 5	CBL is recommendable as a learning experience to other HE students.
Item 6	This module has turned out to be interesting.
Item 7	This CBL experience can have an impact on your professional development.
Item 8	Before it ran, you thought this module's complexity was
Item 9	After it ran, you think this module's complexity is

Interviews

The first instrument used was a group interview so that a creative dialogue was promoted as well as building meaning (Simons, 2011). Different interviews were carried out. Three of them were individual and three of them were in groups. The questions posed related to the impact of the CBL on the subject in which it took place and the development of the method itself. The interviews were audio recorded and transcribed for analysis so that further information could be put forward.

The interviews included the following questions:

- 1. What are your thoughts about the CBL experience?
- 2. What are the differences of CBL with respect to other methods?
- 3. What is, in your opinion, the impact of this CBL experience on the development of the competences in your BA/MA?
- 4. What do you think about the activities to make your CBL process public (paper, presentations, symposium...)?
- 5. What would you change from your CBL experience?

2.3. Procedure

The questionnaires and the interviews were carried out right after the completion of the whole CBL practice. Participants engaged in the interviews and a few days later they completed the questionnaires for student from both institutions.

Challenges

The challenges were carried out during two academic years (2018-2019 & 2019-2020). Undergraduate students (pre-service primary school teachers) from Florida Universitària undertook the same challenge during those two academic years whereas postgraduate students from UPV carried out different challenges defined by the characteristics of the module and the lecturers' availability.

The paradigm of CBL proposed by Appel Inc. (2008) was adapted for both institutions as tables 2 and 3 show below:

Table 2. CBL and tasks in pre-service teacher education at Florida Universitària.

CBL	Tasks undertaken
Generating a collaborative atmosphere	First meeting with students
	Inviting students from previous years
	Watching videos made by former students
Presenting the challenge/s	Participating in a virtual exchange (VE) with
	TEFL teachers
	Visiting three primary schools in Coventry,
	England
	Preparing story-telling classes for primary
	school students
Setting groups	Just one group
Creating the questions that will guide the process	How to arrange and take part in VEs?
	What are English schools like? Differences and
	similarities
	How can stories be told in a foreign language
Gathering information	Research on those questions
Brainstorming solutions	Group meetings every week
Setting a plan and applying it	Students planned their actions and presented
	them before the visit and after the visit
Making it public	Students took part in a Symposium and
	presented results in front of a board of TEFL
	experts
Reflecting on the process & receiving feedback	Weekly meetings and lecturer's supervision
	Self and peer-assessment through questionnaires
	and interviews

Table 3. CBL and tasks by postgraduate students at UPV. The academic year is stated in case tasks were different.

CBL	Tasks undertaken
Generating a collaborative atmosphere	First meeting with students
Presenting the challenge/s	18-19. Writing a research paper based on the
	results obtained with the use of two molecular
	techniques
	19-20. Presenting in pairs different molecular
	techniques in front of reputed local researchers
Setting groups	18-19. Just one group
	19-20. Using Aronson's puzzle to enhance cooperative learning.
Creating the questions that will guide the process	What are the main techniques used to carry out purposeful and quality molecular research?

Gathering information	Research on those techniques and scientific
	paper's structure
Brainstorming solutions	Group meetings every week
Setting a plan and applying it	Lectures were dedicated to research & decision- making
Making it public	18-19. Paper was submitted to a journal 19-20. Molecular techniques were presented in front of three internationally reputed researchers.
Reflecting on the process & receiving feedback	Weekly meetings and lecturer's supervision

3. Results and discussion

Before the results are explained and discussed it must be stated that the sample of students who participated prevented this paper from presenting statistical differences in the perceptions. However, the results given and the students' reflections can shed some light on the implementation of active methods in HE.

To start with, the results of both groups from both institutions showed a rather high level of agreement to the assertions in all the items. Nearly all of them showed more than 50% in every item (5 and 6 in the likert scale).

Students perceived that they had learnt more and had worked harder in this learning experience. Undergraduate students thought that around 85% of them had worked harder whereas postgraduate perceived it in a less extent, 75%.

Both groups of students were really satisfied with the work they had carried out. On the one hand, undergraduates' degree of satisfactions reached 90% when counting up the highest vales (5 and 6). Postgraduates, on the other hand, reached 80%, however, up to a 65% of them went for the highest rank. Likewise, undergraduates and postgraduates would highly recommend this learning experience, up to 90% in both cases. Although, the former ones, pre-service teachers, rated it greatly: almost 60% of participants rate it as highly recommendable. From the latter ones, MA engineers, 45% of them went for the highest rate.

Furthermore, around 80% of undergraduates reckoned that this experience could have a great impact on their professional career. As for postgraduates, 90% considered that it could have a great impact, nonetheless, around 30% of them thought that it could have a great impact, whereas 65% of undergraduates rated the top.

Development of HE modules' competences

In this regard, undergraduates and postgraduates show a great level of agreement with the statement. Participants perceived that they are to develop fuller competences than using more traditional approaches, as figures 1 and 2 depict below.

This experience meant a great chance to put into practice in a real context all the theoretical contents, as several undergraduate participants stated. One of them stated in the questionnaire that:

UG.P5. " [...] From this method I highlight the connection between the contents covered in the classes and the real world since we were able to experience the results obtained in a real context developing some more skills."

In accordance with what the previous undergraduate student stated, postgraduates also found it beneficial:

PG.P9. "From my point of view this experience enabled to connect the topics covered with its academic and professional dimension".

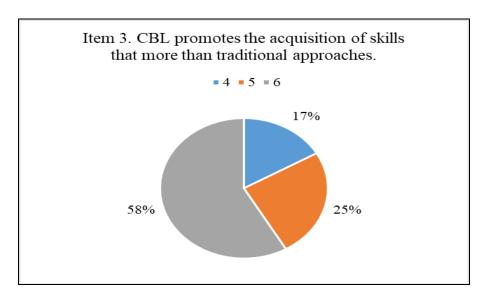


Figure 1. FU's undergraduate students' percentages of agreement on item 3 statement.

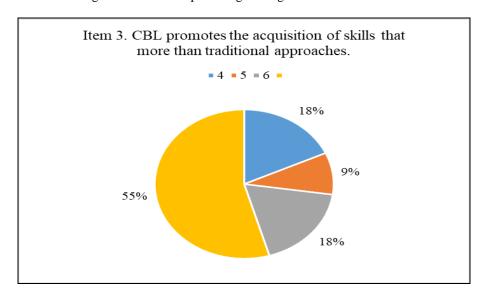


Figure 2. UPV's postgraduate students' percentages of agreement on item 3 statement.

Aspects to be improved

Students rated the experience as very satisfactory as explained above. Besides, the interviews brought about interesting points to be born in mind in the future with regards to the aspects of organisation. As far as the undergraduate students are concerned, on the one hand the need of story-telling practice in Spanish as a foreign language:

UG.P12. "I think we could have had more training in teaching Spanish as a foreign language, as I found challenging to tell a story to English kids in our language."

And the involvement of partners in the virtual exchange:

UG.P6. "In the virtual exchange there is a need to establish the same kind of communication with the partners, all of the them must be committed to carry out the tasks that the exchange implies, rather than posting on a forum in different days"

As for the postgraduate students, more theoretical support with more detailed outline was required:

PG.P4. "It would be a great help if the Power Point was with a worksheet that would explain the molecular analysis technique so that the slides would be explained by adding a word document."

Moreover, the fact that their background in terms of basic knowledge on a topic was diverse made some of them demand a more traditional approach so that they could face the challenge more efficiently. It seems to suggest a lack of autonomy in their learning to self-direct their research process, as the following participant suggested:

PG.P6. "It could be a good idea to have a master class so that the basics on molecular biology are reviewed."

As exposed above, the research questions posed can be answered the following way:

RQ1. What are undergraduate and postgraduate students' perceptions and rate of the CBL experience?

The results described above suggest that the perceptions of the undergraduate and postgraduate students on the CBL experiences are quite good. In general terms, they perceived that they had developed the competences in a greater extent and have acquired a greater sense of team-working through the process. They also found it useful for their future professional practice and the fact that undergraduates were in contact with practitioners in a real context was highly-regarded. Postgraduates also conceived the experience as appealing, particularly the team-work techniques as a facilitator for the acquisition of new knowledge.

RQ2. What are the aspects of the CBL process that could be improved?

With respect to this particular question, a few comments on the organisation of the projects since the vast majority of participants were very happy with the CBL experience on the whole. There were however a few aspects that the participants stated which could be improved from the procedures used during the organisation and design of the activities. For instance, the presentation groups for postgraduate students or the organisation of the virtual exchange with respect to the topics covered, the tasks, and the involvement of partners. In addition, the story-telling in Spanish would entail more practice than the one carried out before the visit.

4. Conclusions

From the results discussed above, it can be stated that students welcomed the use of an innovative and active methods in HE. Moreover, CBL seems to provide undergraduate and postgraduate students with more professional skills and improve their competences as well as enhance their team-work skills as in some other HE experiences before (Cheung et al., 2011; García-Martín, 2018; Navarro et al., 2015; Rodriguez et al., 2015).

The number of participants stands for a limitation for the generalization of the results, moreover, the whole arrangement of activities seems to be a drawback for lecturers who embark on a rather complex designing task and the extra effort in the design of the learning process (Cheung et al., 2011).

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Automatic Programming Task Grading – A Case Study in CodeRunner use at the University of Applied Sciences Velika Gorica

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Abstract. This professional paper presents a case study in the use of CodeRunner, a Moodle plugin, at the University of applied sciences Velika Gorica. The paper demonstrates how three of our undergraduate courses, Programming, Programming language C, and Algorithms and data structures, have been improved by using this plugin. A short introduction to Moodle and the CodeRunner plugin is covered by the paper before it moves on to present a concrete programming practice and exam task examples, both before and after CodeRunner implementation. Compound student results before and after the implementation of the plugin are compared. Finally, the paper presents results of a poll which encompassed two generations of students and examines student satisfaction with our implementation of the CodeRunner plugin.

Key words: higher education, CodeRunner, programming course, automatization, University of applied sciences Velika Gorica

1. Introduction

The authors of this paper describe an e-learning method used in some of the programming courses at the University of applied sciences Velika Gorica. While a Moodle system called Gaudeamus has been in use at the university for many years, several courses have recently started using an automatic programming task grading tool, a plugin called CodeRunner. CodeRunner was developed by Richard Lobb and Tim Hunt and has (along with its predecessors) been used by the University of Canterbury. Since CodeRunner is a free, open-source plugin, the authors as well as other institutions have started using it. At the authors' institution the use of this plugin has greatly reduced the teaching staff workload and has received praise from the students. For these reasons the authors have conducted a survey on student satisfaction with this way of presenting and grading programming tasks and have analysed the results of it along with a short description of the systems (Moodle and CodeRunner) it depends on in this paper. It is the hope of the authors that the paper will help introduce this plugin to other programming teachers and encourage its use in even more institutions and other courses of our own which have yet to move away from manual grading of programming tasks.

A similar paper, which describes the use of the same plugin at the Conventry University, was recently published by David Croft and Matthew England (Croft & England, 2020) and the principal author of the plugin, Richard Logg along with Jenny Harlow published his own paper in 2016 (Lobb & Harlow, 2016). These previous papers focused on presenting CodeRunner itself and made only short mentions of student satisfaction and results. This paper presents a more thorough analysis of a satisfaction survey and exam results before and after CodeRunner. While the programming tasks themselves are likely to be quite similar between the different institutions, for completeness sake, we have included a short description of the Moodle e-learning system in chapter 2 and the CodeRunner plugin in chapter 3. However, we highly recommend readers whose interest in CodeRunner is peaked by this paper also to read the aforementioned ones, as they will provide a better picture of the plugin.

2. Moodle e-learning system

Moodle is a learning platform designed to provide educators, administrators and learners with a single robust, secure and integrated system to create personalized learning environments (Moodle HQ, 2020). The name Moodle is actually an acronym that stands for Modular Object-Oriented Dynamic Learning Environment and it is known as a Learning Management System (LMS) or a Virtual Learning Environment (VLE). Moodle was originally developed by Martin Dougiamas and the first version was released on the 20th of August 2002. Today, Moodle is exceptionally popular around the world and is currently used in 234 countries, on 110 thousand websites, has over 180 million users and over 2 billion quiz questions already created by users. These numbers make Moodle the world's most widely used learning platform. Users range across academic and enterprise level usage. Moodle is written in PHP and it is free for download as an Open Source software, under the GNU General Public License. It is free to be deployed on a private secure cloud or a wide range of web servers and can be adapted, extended and customized for commercial and non-commercial use without any licensing fees. Its multilingual capabilities with over 120 languages are making it available around the world. Moodle can be configured by enabling or disabling its many builtin features and external tools. It is flexible and it can be fully customized by a modular set up and available plugins and add-ons. There is also the possibility for developers to create plugins and integrate external applications for specific functionalities. At the time of writing this paper, there were over one thousand and six hundred plugins free for download and over nine hundred registered developers on the moodle.org website.

The Moodle interface can be extensively adapted and customized to suit an organization's visual identity. Moodle is a web application and its main interface is designed in the form of a web portal. The central section displays key content while the side columns contain additional modules for system management and navigation. This allows for management of files, events through a calendar, users, course attendance, activity results, settings and many other aspects of the system. The types of administration options available to a user depend on the system settings, the number of optional modules installed, and the privileges or roles of the logged in user.

University of Applied Sciences Velika Gorica has been using Moodle for many years now under the name Gaudeamus at the web address gaudeamus.vvg.hr (Figure 1).



Figure 1 Implementation of the Moodle system - Gaudeamus

Gaudeamus enables e-learning for five undergraduate study programs and three graduate study programs with over 150 courses. The undergraduate study program Computer Systems Maintenance includes, among other courses, courses concerning programming, namely Programming, Algorithms and Data Structures and Programming Language C. These use a plugin called CodeRunner which enables a special question type that requires students to submit program code of given specifications. This plugin has gradually been implemented in the mentioned programming courses since 2017. and its use is the primary focus of this paper.

3. CodeRunner plugin

In a paper published by its principal developer CodeRunner is described as "a free and open-source Moodle question-type plug-in that lets teachers set questions where the answer is program code" (Lobb & Harlow, 2016). We use CodeRunner for programming tasks in our Programming, Programming language C and Algorithms and Data Structures courses. This chapter gives one example of these programming tasks for the programming language Python and one example for programming language C. Examples demonstrate questions that are given to students in exercises and mid-term exams. The examples have been translated to English for the purpose of this paper, as actual classes (and the corresponding programming tasks) are conducted in the Croatian language.

3.1 Creating CodeRunner questions

Creating a CodeRunner question is similar to creating any other Moodle question. All questions (including CodeRunner questions) must be placed in the "Question bank" inside the course on Moodle. Such questions can be grouped by category.

When creating a new CodeRunnner question it is necessary to choose one of the available programming languages. The selected programming language will be used for checking the student's solution.

One other important property is grading and penalty. The student can check their solution multiple times. Questions can be set so a penalty is applied every time a student submits their solution, i.e. reduce the maximum number of points by a certain percentage.

For every CodeRunner question, test cases must be supplied. Test cases can be visible or hidden to students. Test cases are used to determine whether a solution is correct.

3.2 Programming language Python task example

We use Python in the courses Programming and Algorithms and Data Structures. These courses require students to write programming codes to solve given tasks.

CodeRunner supports Python versions 2.x and 3.x. When creating a CodeRunner question for Python it is necessary to choose the correct version (python2 or python3). In our courses we use Python version 3.x, so it is necessary to select python3 for our CodeRunner questions.

Figure 1 shows an example of a CodeRunner question. The student is required to write a function which counts uppercase letters in a given string. This function must return the result (integer number) to the caller.

CodeRunner questions contain written instructions for the student and examples for unit testing (test cases). Two such examples are shown in Figure 2. These examples are visible to the students. There are also hidden examples that are visible only to teachers and are used for determining the correctness of the student code.

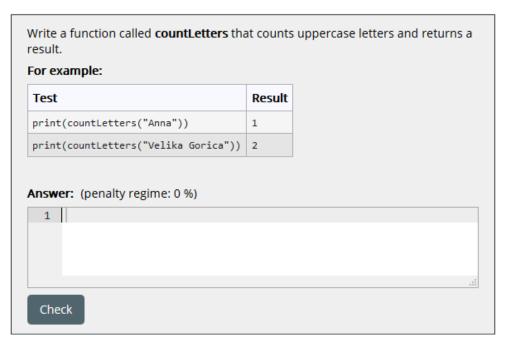


Figure 2 Example of CodeRunner question for the programming language Python

After inputting an answer, students can check their solution by clicking the button Check. The CodeRunner plugin uses a separate server, called Jobe server, to execute the student code and to compare the output of the student's solution to the expected results of the unit testing (test cases). Results of the unit testing are shown to the student, but only for those tests which are configured as visible tests. If there are hidden tests, students are notified that their solution has failed a hidden test case. Students can't see which of the hidden tests their solution had failed. In an exam situation multiple Checks may or may not impose a percentage point penalty each time they are used. So far, our courses have not made use of this penalty system and have allowed infinite testing. It can be argued that this makes tests too easy and we are still considering this decision but the option of removing the penalty is certainly useful for many non-exam situations such as regular programming exercises. The figures below show the interface students see when their solution is incorrect (Figure 3) and when their solution is correct (Figure 4).

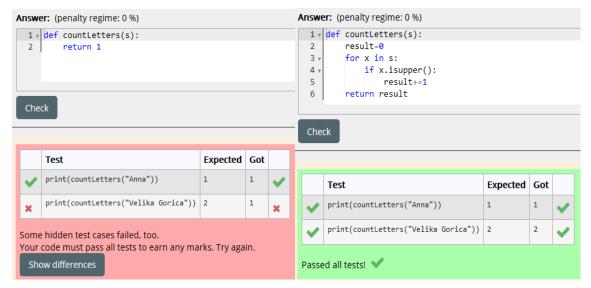


Figure 3 Incorrect answer

Figure 4 Correct answer

In the authors experience, this interface is highly functional and loved by the students. Since the "Got" column in the response interface can display interpreter (or complier) errors, we have seen examples of students forgoing the use of IDLE, an integrated development environment (IDE) for Python which we use in our courses, completely. Of course, CodeRunner is not an IDE and the results of its exclusive use have varied highly with student skills. As expected, lower skilled students are slower and less successful when working like this. We do not forbid writing code directly into CodeRunner but do discourage it. The recommended workflow for programming tasks in our courses is to write code (and test it) in an IDE and copy it into CodeRunner when satisfied with the initial testing.

3.3 Programming language C task example

For programming language C, CodeRunner supports two types of questions. These are c_program and c_function.

Questions of type c_program allow the creation of tasks in which students need to write an entire C program. The solution must contain *include* statements and a *main* function. The solution can contain additional functions. Test cases for this type of question must contain input and/or output data (depending on the question the teacher created). As before, teachers can select which test cases are visible to students.

Questions of type c_function are designed for tasks in which students are required to write only additional functions. In this case, *Include* statements and the *main* function are part of the question and not written by the student. Teachers must specify the name of the function or functions that the students are required to create. Teachers are required to supply the body of the *main* function. For every question, teachers must supply the input and/or output data for use in the test cases. They must also choose which test cases will be visible to students. In this type of question, students don't see the *include* statements and the *main* function. Students only see the body of the *main* function (that the teacher wrote) and the test cases.

Figure 5 shows an example of a CodeRunner question for programming language C. This example shows a question with test cases (body of the main function as well as input and output data), the correct answer and the interface for giving a correct solution.



Figure 5 Example of a CodeRunner question for the programming language C

4. Student survey results

In order to gauge the success of our implementation of the plugin and the conversion of our programming exams to it we conducted a student survey covering two generations of students at the University of Applied Sciences Velika Gorica. To help keep the survey anonymous we refer to these generations as generation A and B. The survey asked students to compare their experience with programming tasks on two courses, the Programming course which used CodeRunner for practice tasks and mid-term exams and the course Algorithms and Data Structures which did not. The courses are otherwise similar, as they both require students to complete programming tasks in Python and are held by the same teachers. Because of this, these courses were selected as the focus for our survey.

The survey was anonymous, completely voluntary, consisted of 10 questions and was hosted on Google Forms. To attempt ensuring that the survey was indeed completed by students only, it was open only for a brief period during classes for the appropriate generations. All of the questions, except question 6, were answered by selecting a number between 1 and 5, with 1 being the worst grade and 5 being the best. Question 6 had three possible options which consisted of answers in sentence form and are shown in the list below.

The survey was completed by a total of 86 students, 36 from generation A and 50 from generation B. The questions and the aggregated responses, split by generation, are listed below:

- 1. Grade your satisfaction with the Gaudeamus (VVG Moodle) e-learning system.
 - Generation A average: 4,24
 - Generation B average: 4,28
- 2. Grade the quality of programming tasks (are they easy to understand, of appropriate difficulty, do they help you understand the curriculum) on the Programming course.
 - Generation A average: 4,47
 - Generation B average: 4,04
- 3. Grade the implementation of programming tasks using CodeRunner on the Programming course.
 - Generation A average: 4,47
 - Generation B average: 4,38
- 4. Grade the quality of programming tasks (are they easy to understand, of appropriate difficulty, do they help you understand the curriculum) on the Algorithms and Data Structures course.
 - Generation A average: 4,24
 - Generation B average: 3,44
- 5. Grade the implementation of programming tasks (without CodeRunner) on the Algorithms and Data Structures course.
 - Generation A average: 4,32
 - Generation B average: 3,39
- 6. Which method of conducting programming tasks do you prefer:
 - a) I prefer programming tasks using CodeRunner.
 - Generation A total: 27
 - Generation B total: 36
 - b) I do not think using CodeRunner in programming tasks makes a significant difference.
 - Generation A total: 7
 - Generation B total: 9
 - c) I prefer programming tasks without CodeRunner.
 - Generation A total: 2
 - Generation B total: 5
- 7. Grade your opinion of CodeRunner functionality.
 - Generation A average: 4,32
 - Generation B average: 4,44

- 8. Grade CodeRunner ease of use.
 - Generation A average: 4.53
 - Generation B average: 4,54
- 9. Which grade did you get on the Programming course (if any).
 - Generation A average: 3,73
 - Generation B average: 3,64
- 10. Which grade did you get on the Algorithms and Data Structures course (if any).
 - Generation A average: 3,41
 - Generation B average: 3,86

Overall, the combined result to perhaps the most important question, question 6, shows an overwhelming support for CodeRunner use among the students. As shown in figure 6, this support amounts to almost three quarters of students preferring programming tasks with CodeRunner.

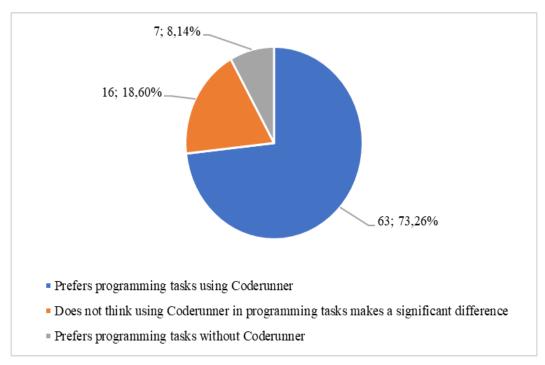


Figure 6 Combined answers to question 6

Despite this, the earlier questions (2-4) regarding programming task quality showed very similar results for both courses in generation A and a preference for the Programming course (CodeRunner tasks) in generation B. This discrepancy might be caused by the fact that generation B is mid-term with the course Algorithms and Data Structures while generation A has already completed the course. The result might be different if both generations finished both courses and this was the chief reason for keeping the generations separate in the survey. The results of these questions are presented in figure 7.

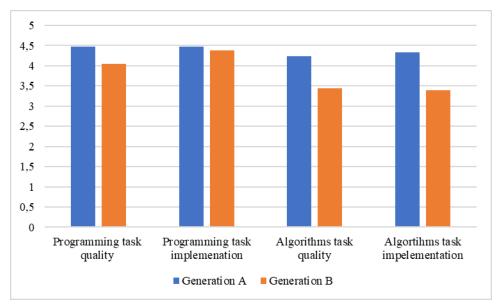


Figure 7 Programming tasks student grading

When asked to give a general grade of CodeRunner without considering concrete programming tasks on either course (questions 7-8) both generations gave CodeRunner very high marks (4 or higher), as shown in figure 7

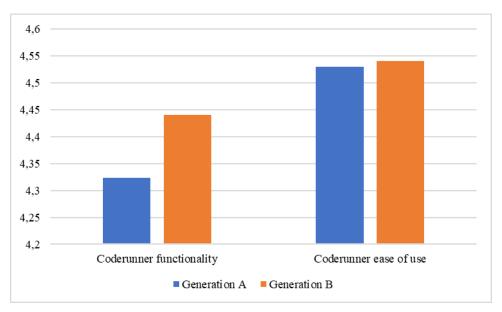


Figure 8 CodeRunner student grading

Questions 1 (general Moodle satisfaction), 9 and 10 (grade achieved by students on the courses) were added as an attempt to link dissatisfaction with the Gaudeamus implementation of Moodle or low student performance on the course to (a possibly low) satisfaction with CodeRunner. However, we could establish no such relation. Students which got low grades from these courses or expressed a dissatisfaction with Moodle still graded CodeRunner highly. The number of cases was too low to consider a statistical analysis of this correlation.

Finally, we compared results of mid-term exams before and after CodeRunner implementation to further assist in judging usefulness of the CodeRunner module. For this purpose, we compared mid-term written exam results of the Programming Language C course. This course recently switched over to CodeRunner so results before and after the implementation of the plugin were readily available. We did not use this course as part of the

students survey because it is an electoral course and has a significantly smaller number of students then the (mandatory) courses used in the survey. The numbers used for statistical analysis below might not seem that low, but they encompass entire generations. We suspect only a portion of these students would fill out the voluntary survey, so we decided against trying to test this course in a survey and have instead compared mid-term average marks and pass rate results.

We have seen an overall increase in average marks (slight decrease in 1st mid-term and increase in 2nd) and a huge increase in pass rate for this course. The improvements were as follows:

- 1st mid-term exam: a 3.5% decrease in average marks with a 40% increase in pass rate;
- 2st mid-term exam: a 22.4% increase in average marks with a 50% increase in pass rate.

However, the hypothesis that CodeRunner has an effect on mid-term average marks failed a t-test with a significance level α =0.05 for both mid-term exams. The results of the two-tailed t-tests were:

- Comparison of non CodeRunner generation 1st mid-term results (M = 8.32, SD = 7.20) with CodeRunner generation (M = 8.03, SD = 7.03) showed no significant improvement t (59) = 0.16, p = 0.87.
- Comparison of non CodeRunner generation 2^{nd} mid-term results (M = 4.96, SD = 5.53) with CodeRunner generation (M = 6.07, SD = 5.92) showed no significant improvement t(50) = -0.65, p = 0.5.

Similarly, the pass rate increase, while it seems huge and was certainly a pleasant surprise to the teaching staff, has failed the x^2 test with the same significance level. The results of the statistical significance analysis were as follows:

- 1st mid-term exam: $x^2(1, N = 61) = 0.1985, p = 0.655914$
- 2^{st} mid-term exam: $x^2(1, N = 52) = 1.1226, p = 0.289351$

A similar comparison of pre and post CodeRunner results was presented in 2020 by Croft and England. Their paper presents results achieved by Coventry University students on the 4000CEM course where they achieved an average exam mark 7% higher and a pass rate 10% higher than before (Croft & England, 2020). However, no statistical significance analysis results are presented in that paper.

5. Conclusion

Students have shown an overwhelming preference for automatically graded programming tasks which were conducted via CodeRunner as opposed to traditional manually graded programming tasks. While we have not seen a significant impact on student grades it is undoubtable that using the CodeRunner plugin is preferred by students and has saved a lot of time for the teaching staff which would have otherwise been spent manually grading the exams. An institution already using Moodle can make use of this free plugin with a minimum investment: a standard plugin addition to Moodle and the maintenance of an additional server which acts as a sandbox and runs the student code - Jobe server (Lobb & Hunt, 2016).

A paper by Lobb and Harlow concluded that both staff and students enjoyed using CodeRunner and the staff were particularly pleased with not having to manually grade handwritten code (Lobb & Harlow, 2016). The autohors of this paper fully agree with this assessment from a teacher's point of view and the survey confirms the student attitude.

Based on the above, as well as their own experience with the plugin, the authors highly recommend using the CodeRunner module to improve programming courses.

6. Acknowledgements

The authors would like to thank the developers of CodeRunner, Richard Lobb from the University of Canterbury, New Zealand and Tim Hunt from The Open University, UK for creating this powerful tool and making it available to educators worldwide. We would also like to thank the students of the University of Applied Sciences Velika Gorica who participated in the survey and helped confirm our assumptions of their satisfaction with the system.

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Determining the Elasticity Constant of a Spring Using a Microcomputer

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Abstract: This research presents a different approach to the problem of determining the elasticity constant of steel springs. Elongation of the spring is measured using the ultrasound sensor and a controller board in the appropriate computer environment. Arduino provides the ability for constructing a device with the goal of connecting the computer and the physical world, otherwise known as the "Internet of things." Because of that, and its simplicity as well as its versatility, Arduino has great potential to be used for teaching in STEM fields. We showcase this new paradigm in teaching physics by connecting natural sciences, modern electronics, information, and communication technology.

Key words: Arduino, Internet things, STEM

1. Introduction

The aim of our experiment is to demonstrate the proportionality between the force and the extension of the spring. The coefficient of elasticity of the springs will be determined by Arduino (an open source electronics platform based on easy-to-use hardware and software). The resulting coefficient of proportionality is subsequestly compared with the coefficient obtained in the CoachLab program (multifunctional interface with real-time display of the measured data on the computer).

When determining the coefficient of elasticity, the spring is loaded with weights. The results obtained attempt to demonstrate the proportionality between spring extension and weight. The coefficient of proportionality is the coefficient of spring elasticity. In this paper, in addition to using Arduino, the spring coefficient is measured using the CoachLab program and using a metric tape to measure the length of the extensions. Arduino can be very useful in teaching physics, and unlike the Coach device, Arduino is more accessible because of its price.

2. Coefficient of elasticity

Elasticity is the ability of a body to resist a distorting influence and to return to its original shape and size. If the material is elastic, the object will return to its initial shape and size when these forces are removed. Elasticity can be described by Hooke's law [1], which is a linear relationship

between force and extension. Hooke's law shows the relationship between the tensile force F and corresponding extension Δl .

Hooke's law:
$$F = k \cdot \Delta l$$

In our study three springs were used and we set out to determine their elasticity. The initial measurement is done with the spring and an adjacent hook. For each additional measurement we add a 50-gram weight to the hook. As the mass increases, the force increases, and the spring streches.

The ratio of force to spring extension is a spring constant or constant of elasticity:

$$k = \frac{F}{\Delta l}$$
, $F = mg$, $g = 9.81 \frac{m}{s^2}$

Springs used in our experiment are shown in Figure 1, Figure 2, and Figure 3.







Figure 2 Steel spring 2



Figure 3 Steel spring 3

3. Experiment using Arduino and metric tape

Arduino is an open source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs, sense lights, allow for button pressing and turn such inputs into an output, like activating a motor or turning on an LED. Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital inputs/outputs, 6 analog inputs, a USB connection, a power jack, an ICSP header, and a reset button.



Figure 4 Arduino UNO microcontroller plate



Figure 5 Ultrasonic Sensor HC - SR04

Arduino plate and ultrasonic sensor for distance measurement are used in this experiment. The Arduino microcontroller programming is performed in the Arduino IDE program environment.[2]

The measuring device consists of an ultrasonic sensor HC - SR04 connected to the Arduino UNO microcontroller plate. In addition to properly connected hardware, software is required to perform all the necessary measurements. The software that allows measuring the distance of the spring from the sensor is as following:

```
1. const int trigPin = 9;
2. const int echoPin = 8:
3. long time;
4. int distance;
5. void setup() {
6. pinMode(trigPin, OUTPUT);
7. pinMode(echoPin, INPUT);
8. Serial.begin(9600);
9. }
10. void loop() {
11. // digitalWrite(trigPin, LOW);
12. delayMicroseconds(2);
13. digitalWrite(trigPin, HIGH);
14. delayMicroseconds(10);
15. digitalWrite(trigPin, LOW);
16. time = pulseIn(echoPin, HIGH);
17. distance = time*0.34/2;
18. Serial.print("Distance in millimeters: ");
19. Serial.println(udaljenost);
```

The sensor resolution is 0.3 cm and the measuring range is 2 to 500 cm, covering the angle up to 15°. The sensor works on the principle of sending an audible wave that is repelled from the obstacle and returns to the sensor. In this experiment, the sensor measures the distance, which is then displayed on the computer. The distance equals the distance between the spring and the sensor. As the spring loads with a larger mass, the distance decreases and the extension of the spring is equal to $\Delta l = l_0 - l_1$.

3.1. Measurement results by Arduino

Table 1 Measurements in Arduino for steel spring 1

Mass (g)	Distance from Arduino detector l (mm)	Real distance (mm)	Δl (mm)	Δl (m)	Mass (kg)	Coefficient of elasticity k (N/m)
only dish	785	785				
50	747	747	38	0,038	0,05	12,90789474
100	712	710	73	0,073	0,1	13,43835616
150	678	675	107	0,107	0,15	13,75233645
200	640	638	145	0,145	0,2	13,53103448
250	605	602	180	0,18	0,25	13,625
300	568	567	217	0,217	0,3	13,56221198
350	535	532	250	0,25	0,35	13,734
400	498	497	287	0,287	0,4	13,67247387
450	464	462	321	0,321	0,45	13,75233645
500	431	427	354	0,354	0,5	13,8559322

The mean value of the coefficient of elasticity is 13,58 N/m. In order to verify our results we measured standard deviation for each measurement. Standard deviation is a measure of the amount of dispersion of a set of values. The results are more precise when standard deviation diminishes in value. In other words, when standard deviation is low, the results are close to average value. Standard deviation is calculated as following:

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (x_i - \overline{x})^2}$$

The standard deviation of the mean value is 0,25 N/m. The result is recorded in the form $(13,58 \pm 0,25)$ N/m.

Table 2 Measurements by Arduino for steel spring 2

Mass (g)	Distance from Arduino detector l (mm)	Real distance (mm)	Δl (mm)	Δl (m)	Mass (kg)	Coefficient of elasticity k (N/m)
only dish	672	672				
50	650	650	22	0,022	0,05	22,29545455
100	630	627	42	0,042	0,1	23,35714286
150	607	604	65	0,065	0,15	22,63846154
200	585	581	87	0,087	0,2	22,55172414
250	563	559	109	0,109	0,25	22,5
300	540	536	132	0,132	0,3	22,29545455
350	517	515	155	0,155	0,35	22,1516129
400	496	492	176	0,176	0,4	22,29545455
450	472	469	200	0,2	0,45	22,0725
500	452	447	220	0,22	0,5	22,29545455

The mean value of the coefficient of elasticity is 22,45 N/m. The standard deviation of the mean value is 0,35 N/m. The result is recorded in the form $(22,45 \pm 0,35)$ N/m.

Table 3 Measurements by Arduino for steel spring 3

Mass (g)	Distance from Arduino detector I (mm)	Real distance (mm)	Δl (mm)	Δl (m)	Mass (kg)	Coefficient of elasticity k (N/m)
only dish	708	708				
50	678	674	30	0,03	0,05	16,35
100	644	639	64	0,064	0,1	15,328125
150	608	604	100	0,1	0,15	14,715
200	575	570	133	0,133	0,2	14,7518797
250	539	535	169	0,169	0,25	14,51183432
300	505	500	203	0,203	0,3	14,49753695
350	473	467	235	0,235	0,35	14,6106383
400	439	434	269	0,269	0,4	14,58736059
450	408	400	300	0,3	0,45	14,715
500	373	364	335	0,335	0,5	14,64179104

The mean value of the coefficient of elasticity is 14,87 N/m. The standard deviation of the mean value is 0,54 N/m. The result is recorded in the form $(14,87 \pm 0,54)$ N/m.

3.2. Measurement results by the distance tape (most basic measurement)

While using the same springs and the same weight increments, we also used measuring tape to measure elasticity of the springs. Measuring tape is used to measure distance every time additional weight is added to the spring. The coefficient of elasticity is measured in two different ways. First, we use the following formula:

$$k = \frac{F}{\Lambda l}$$
 $F = mg, g = 9.81 \frac{m}{s^2}$

Second, we use the method of least squares. After making both measurements, the results are compared.

Table 4 Measurements by measuring tape for steel spring 1

mass (kg)	Δl (m)	Coefficient of elasticity k (N/m)
0,05	0,038	12,90789
0,1	0,075	13,08
0,15	0,11	13,37727
0,2	0,147	13,34694
0,25	0,183	13,40164
0,3	0,218	13,5
0,35	0,253	13,57115
0,4	0,288	13,625
0,45	0,323	13,66718
0,5	0,358	13,70112

The mean value of the coefficient of elasticity is 13,42 N/m. The standard deviation of the mean value is 0,24 N/m.

The result is recorded in the form $(13,42 \pm 0,24)$ N/m.

Table 5 Measurements by measuring tape for steel spring 2

mass (kg)	Δl (m)	Coefficient of elasticity k (N/m)
0,05	0,023	21,32609
0,1	0,046	21,32609
0,15	0,069	21,32609
0,2	0,091	21,56044
0,25	0,114	21,51316
0,3	0,135	21,8
0,35	0,158	21,73101
0,4	0,181	21,67956
0,45	0,203	21,74631
0,5	0,228	21,51316

The mean value of the coefficient of elasticity is 21,79 N/m. The standard deviation of the mean value is 0.19 N/m.

The result is recorded in the form $(21,55\pm0,17)$ N/m.

Table 6 Measurements by measuring tape for steel spring 3

mass (kg)	Δl (m)	Coefficient of elasticity k (N/m)
0,05	0,035	14,01429
0,1	0,070	14,01429
0,15	0,104	14,14904
0,2	0,139	14,11511
0,25	0,174	14,09483
0,3	0,207	14,21739
0,35	0,240	14,30625
0,4	0,274	14,32117
0,45	0,310	14,24032
0,5	0,344	14,25872

The mean value of the coefficient of elasticity is 14,25 N/m. The standard deviation of the mean value is 0,08N/m.

The result is recorded in the form $(14,17 \pm 0,11)$ N/m.

We also analyzed data from Tables 4, 5, and 6 by utilizing the method of least squares.[6] In order to use this method, independent and dependent variables have to be identified. In Hooke's law formula $F = k \cdot \Delta l$ can be written as $\Delta l = F/k$, as such Δl depends on F. Change in one variable causes change in the other variable, which indicates that the two are proportional with each other. Linear dependence can also be illustrated with a graph if all correlations $(F, \Delta l)$ are placed in the coordinate system. The least squares method is intended to identify the coefficient which shows linear dependence between two variables. Free variable is different from zero, which eliminates systematic error. After comparing the following expressions $\Delta l = F/k$, $y = A_1 x + A_2$ we deduct $A_1 = 1/k$. A_2 allows the line to go through experimental points with the lowers margin for error. Finally, parameters A_1 i A_2 are calculated form the following formulas:

$$A_{1} = \frac{n \sum_{i=1}^{n} x_{i} y_{i} - \sum_{i=1}^{n} x_{i} \sum_{i=1}^{n} y_{i}}{n \sum_{i=1}^{n} x_{i}^{2} - (\sum_{i=1}^{n} x_{i})^{2}} \qquad A_{2} = \frac{\sum_{i=1}^{n} x_{i}^{2} \sum_{i=1}^{n} y_{i} - \sum_{i=1}^{n} x_{i} \sum_{i=1}^{n} x_{i} y_{i}}{n \sum_{i=1}^{n} x_{i}^{2} - (\sum_{i=1}^{n} x_{i})^{2}}$$

Table 7 Measurements by meter for steel spring 1 (method of least squares)

mass (kg)	$y = \Delta l$ (m)	x = F(N)	$xy = F\Delta l \text{ (Nm)}$	$F^2(N^2)$
0,05	0,038	0,4905	0,018639	0,24059025
0,1	0,075	0,981	0,073575	0,962361
0,15	0,11	1,4715	0,161865	2,16531225
0,2	0,147	1,962	0,288414	3,849444
0,25	0,183	2,4525	0,4488075	6,01475625
0,3	0,218	2,943	0,641574	8,661249
0,35	0,253	3,4335	0,8686755	11,7889223
0,4	0,288	3,924	1,130112	15,397776
0,45	0,323	4,4145	1,4258835	19,4878103
0,5	0,358	4,905	1,75599	24,059025

After we use the data from Table 7 and utilize the formula for coefficient A_1 , we receive the following outcome:

$A_1 = 0.072394$, which is followed by: $k = 1/A_1$, k = 13.81336N/m.

Table 8 Measurements by meter for steel spring 2 (method of least squares)

mass (kg)	$y = \Delta l$ (m)	x = F(N)	$xy = F\Delta l \text{ (Nm)}$	$F^2(N^2)$
0,05	0,023	0,4905	0,0112815	0,24059
0,1	0,046	0,981	0,045126	0,962361
0,15	0,069	1,4715	0,1015335	2,165312
0,2	0,091	1,962	0,178542	3,849444
0,25	0,114	2,4525	0,279585	6,014756
0,3	0,135	2,943	0,397305	8,661249
0,35	0,158	3,4335	0,542493	11,78892
0,4	0,181	3,924	0,710244	15,39778
0,45	0,203	4,4145	0,8961435	19,48781
0,5	0,228	4,905	1,11834	24,05903

 $A_1 = 0.046038$, which is followed by: $k = 1/A_1$, k = 21.72101N/m

Table 9 Measurements by meter for steel spring 3 (method of least squares)

mass (kg)	$y = \Delta l \text{ (m)}$	x = F(N)	$xy = F\Delta l \text{ (Nm)}$	$F^2(N^2)$
0,05	0,035	0,4905	0,0171675	0,24059
0,1	0,07	0,981	0,06867	0,962361
0,15	0,104	1,4715	0,153036	2,165312
0,2	0,139	1,962	0,272718	3,849444
0,25	0,174	2,4525	0,426735	6,014756
0,3	0,207	2,943	0,609201	8,661249
0,35	0,24	3,4335	0,82404	11,78892
0,4	0,274	3,924	1,075176	15,39778
0,45	0,31	4,4145	1,368495	19,48781
0,5	0,344	4,905	1,68732	24,05903

 $A_1 = 0.069774$, which is followed by: $k = 1/A_1$, k = 14.33195N/m

4. Experiment using CoachLab

Another way to calculate the coefficient of elasticity is through the CoachLab program and device.



Figure 6 CoachLab interface

CoachLab is a multifunctional interface for computerized measurement and control. It is an interface with a real-time display of measured data on the computer. An ultrasonic sensor is used for distance measurement. The sensor connects with the CoachLab, and the computer shows the motion in the coordinate system. In order to see the measurement, the code is entered in the program (Figure 7). The motion function is obtained for the three different masses of each spring. To be able to read the motion time, it is necessary to fit the functions by changing the input parameters (Figures 8, 9 and 10). [4]

We calculated the coefficient of elasticity by utilizing the following formula

$$T = 2\pi \sqrt{\frac{m}{k}} \to k = \frac{4m\pi^2}{T^2}$$

- 4.1. Measurement results obtained in the CoachLab program
- The results for steel spring 1:

First mass m = 2.0,055kg

Calculated value of the coefficient of elasticity is 12,91 N/m.

Coefficient of elasticity k read from the CoachLab program (Figure 7) is 13N/m.



Figure 7 Program in CoachLab

Second mass m = 3.0,055kg

Calculated value of the coefficient of elasticity is 12,92 N/m.

Coefficient of elasticity read from the CoachLab program is 13 N/m.

Third mass m = 4.0,055kg

Calculated value of the coefficient of elasticity is 12,92 N/m.

Coefficient of elasticity read from the CoachLab program is 13 N/m.

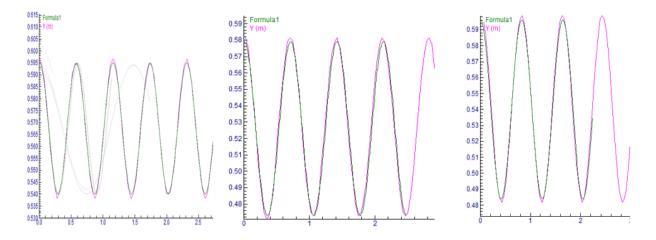


Figure 8 Chart of fitted spring 1 from the CoachLab program with mass 1 = 2.0,055kg, mass 2 = 3.0,055kg, mass 3 = 4.0,055kg, mass of spring 1 is 0,0093kg

• The results for steel spring 2:

First mass m = 2.0,055kg

Calculated value of the coefficient of elasticity is 20,52 N/m.

Coefficient of elasticity read from the CoachLab program is 20,3 N/m.

Second mass m = 3.0,055kg

Calculated value of the coefficient of elasticity is 19,36 N/m.

Coefficient of elasticity read from the CoachLab program is 20,3 N/m.

Third mass m = 4.0,055kg

Calculated value of the coefficient of elasticity is 19,93 N/m.

Coefficient of elasticity read from the CoachLab program is 20,3 N/m.

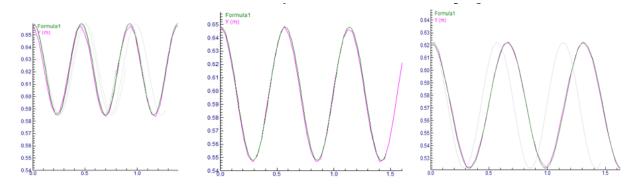


Figure 9 Chart of fitted spring 2 from the CoachLab program with mass 1 = 2.0,055kg, mass 2 = 3.0,055kg, mass 3 = 4.0,055kg, mass of spring 2 is 0,0336kg

First mass m = 2.0,055kg

Calculated value of the coefficient of elasticity is 13,84 N/m.

Coefficient of elasticity read from the CoachLab program is 14 N/m.

Second mass m = 3.0,055kg

Calculated value of the coefficient of elasticity is 13,68 N/m.

Coefficient of elasticity read from the CoachLab program is 14 N/m.

Third mass m = 4.0,055kg

Calculated value of the coefficient of elasticity is 13,57 N/m.

Coefficient of elasticity read from the CoachLab program is 14 N/m.

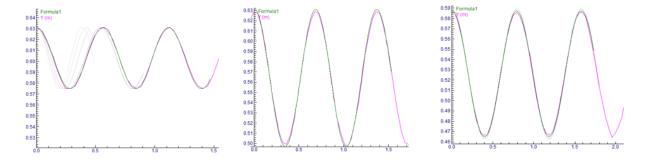


Figure 10 Chart of fitted spring 3 from the CoachLab program with mass 1 = 2.0,055kg, mass 2 = 3.0,055kg, mass 3 = 4.0,055kg, mass of spring 3 is 0,0074kg

If the examined measurements are compared for each spring, it is evident that the results are approximately the same. The result of the first spring is 12.91 N/m in Coach program, and above 13N/m in Arduino and with meter tape. If any of the three springs are analyzed, the result of Coach is always lower than the other two types of measurements. One of the reasons may be that it did not include the contribution of the spring mass. If the total weight was to be added to the ½ mass of spring, the coefficient of elasticity would increase. It increases if the

mass increases. When the function is fitted, it is possible to notice a deviation at the top of the function because the direction of the motion changes at those points. The direction of the force changes abruptly and this is why irregularities are seen. The mean deviation is very small, which means that all data are grouped around average values.

5. Comparing results

 Table 10 Mean values for elasticity coefficients for all measurements

Steel spring	k Measurements by Arduino	k Measurements by meter	k Measurements by Least squares method	k Measurements by CoachLab
Steel spring 1	13,58	13,42	13,81336N/m	13
Steel spring 2	22,45	21,55	21,72101N/m	20,3
Steel spring 3	14,87	14,17	14,33195N/m	14

Table 11 Aggregate Coefficient K results from Tables 1-6

k	k	k	k	k	k
from Table 1	from Table 2	from Table 3	from Table 4	from Table 5	from Table 6
(Arduino)	(Arduino)	(Arduino)	(meter)	(meter)	(meter)
12,90789474	22,29545455	16,35	12,90789	21,32609	14,01429
13,43835616	23,35714286	15,328125	13,08	21,32609	14,01429
13,75233645	22,63846154	14,715	13,37727	21,32609	14,14904
13,53103448	22,55172414	14,7518797	13,34694	21,56044	14,11511
13,625	22,5	14,51183432	13,40164	21,51316	14,09483
13,56221198	22,29545455	14,49753695	13,5	21,8	14,21739
13,734	22,1516129	14,6106383	13,57115	21,73101	14,30625
13,67247387	22,29545455	14,58736059	13,625	21,67956	14,32117
13,75233645	22,0725	14,715	13,66718	21,74631	14,24032
13,8559322	22,29545455	14,64179104	13,70112	21,51316	14,25872

Table 12 Measurements of elasticity for different springs – measured by Arduino and measuring tape

	Table 1	Table 2	Table 3	Table 4	Table 5	Table 6
Middle value	13,58315763	22,44532596	14,87091659	13,417819	21,552191	14,173141
Variance	0,064423349	0,119813355	0,292851675	0,059670752	0,030377045	0,01139737
Standard Deviation	0,25381755	0,346140658	0,541157718	0,244275975	0,174290119	0,106758464
Coefficient of variation	1,87%	1,54%	3,64%	1,82%	0,81%	0,75%

Variance is an average quadratic deviation from the mean. Standard deviation is an average difference from the mean.

The coefficient of variation is the measure of dispersion and represents percentage contribution of the standard deviation in relation to the arithmetic mean. Lower variation indicates lesser dispersion of information.

If we compare constant elasticity value gained by utilizing multiple measurements, we see that results overlap pretty well. Standard deviation is small for each measurement, however, error is there.

The present error is greater when using Arduino compared to using measuring tape, and that is based on reading extension of the spring. Ultrasound sensor sends and receives an ultrasound wave that reverberates off the barrier and the results are presented on the computer screen. Results do not always overlap. In other words, we get similar (but not the same) results for the same extension of the spring. In other words, the Arduino method (with sensor as a measuring device) is not completely precise.

We need to consider human error when using measuring tape as a method.

In the context of the CoachLab method, the error appears as a consequence of inability to match curves with each other. In order for this measure to be perfect, curves have to overlap in all parts, which is often not possible. CoachLab is an excellent method for calculating sizes that are not measurable with a formula.

6. Conclusion

This paper proves Hooke's Physical Law. The coefficient of spring elasticity was determined by using three different methods. The results are approximately equal with minimal deviations. It would be interesting to check how much spring weight affects the measurement. Some literature states that we should add 1/3 of the spring weight to the overall weight. Since those are not definitive prescriptions, we did not use them in our study. In the third measurement (CoachLab program), the spring mass was neglected and in these measurements the coefficient of elasticity was lower. It should be noted that extreme masses were neglected and were not used during measurements.

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Chronological Order of Offshore Semi-submersible Drilling Rig Spill and its Consequences in the Gulf of Mexico

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Abstract. Due to the steady growth of offshore economy, changes to the eco system are inevitable. Water resources are of crucial importance, but they are constantly being exposed to various environmental risks. In order to reduce these unwanted consequences, especially ecological ones in water resources, security is now gaining much needed importance.

Thus, this paper attempts to outline the disadvantages and consequences of the economic impact on exploration activities in the example of the Gulf of Mexico oil platform spill. Apart from the fact that the initial explosion represented a threat to human lives, the consequences are far reaching influencing the entire macroecological system.

Global economic politics, by defining it's research deadlines, had the effect of neglecting the basic laws of the profession. The main purpose of this paper is to answer the question of whether a disaster could have been avoided. Contribution to the protection of water resources from potential environmental pollution is a basic path of the development of society's awareness as a whole.

Key words: ecology, offshore economy, security, politics, economics

1. Introduction

The environmental disaster that occurred in the Gulf of Mexico on April 20th, 2010, which resulted in rig sinking two days post explosion. The analysis of the course of events shows the inevitable catastrophe caused by human error which was proved to be a direct consequence of corporation politics and the negligence of métier.

The pursuit for higher output performance resulted in an uncontrolled situation within the rig control system. At that moment, the unexpected consequences reached unprecedented proportions.

The shores of the islet, which was mostly dependent upon tourism and fisheries, became full of oil, the air was unbearable, and the staff of British Petroleum (BP) imposed emergency situation upon seeing this wreaking havoc.

This is due to the seepage of crude oil from the seabed that occurred after the rupture of the Macondo well¹ and the oil rig explosion.

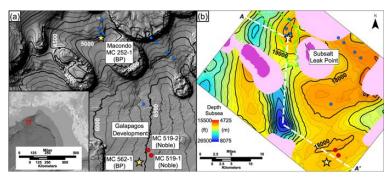


Figure 1.1 Macondo well

Izvor: William, F.; Pinkston, M.; Flemings, P. B.: *Overpressure at the Macondo Well and its impact on the Deepwater Horizon blowout*, Scientific Reports volume 9, Article number: 7047 (2019)

2. Structural organization

The British Ship Classification Society first encouraged the classification of platforms by issuing a certificate that the platform has met all the requirements for safe operation, according to the Rules for the Construction and Classification of Mobile Offshore Units. [1]. A rig (franc. *plate-forme*) is a fixed or mobile platform with a superstructure intended for offshore drilling below the seabed for the exploration and / or production of crude oil or natural gas. There are two basic types of rigs by purpose:

- drill and
- production.

The drilling rig is, in principle, an autonomous moving float unit with or without its own propulsion system. According to the method of placement and retention in the working position are distinguished: supported rig (self-lifting and submersible) and floating rig.

The production rig is used to extract energy resources like crude oil or gas from the well and is in principle tied to the production site.

3. Analysis of events that preceded the disaster

British Petroleum (BP) was responsible for the rig. Crude oil spills were leaked from an oil well that was drilled about 1.5 kilometers below seabed.

BP and Halliburton employees arrived on the platform four days before the event itself. They were tasked with determining the actual condition of the Macondo well and its commissioning. However, the workflow became a real danger of turning the well into the "well from hell" [2]

By April 20th, they were nearly six weeks behind with more than \$58 million over budget. [2] Deepwater Horizon shown in Figure 3.1. suppoused to complete the drilling, which was left behind from the previous platform, approximately 9,000 feet until the pay zone(oil and gas tanks). Two and a half miles below the seabed was a large reservoir of Middle Miocene oil and gas in porous rock formation at temperatures of approximately 262°F. [2]

A series of events and decisions resulted in an explosion also called Swiss Cheese effect. Eliminating at least one of them probably could have prevented or reduced the scale of the

¹ Name for the well from which the oil was extracted, shown in Figure 1.1

event itself. The report investigates eight cause and effect elements that are thought to be the cause, that is, the contribution to the oil spill.



Figure 2.1 Deepwater horizon [9]

The condition of the drill pipe according to Figure 3.2 is defined through three elements:

- pressure testing, in particular the negative pressure test of the Macondo well,
- monitoring of wells,
- confirmation of control.

BP and Transoceans procedures in relation to each of the elements of cause and effect were insufficient.

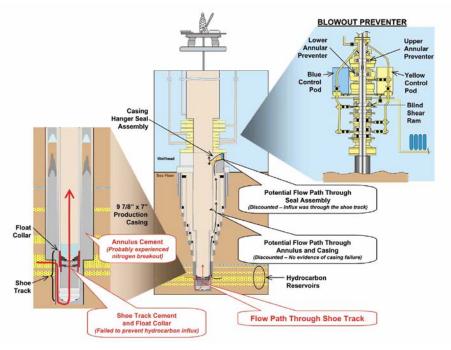


Figure 3.1 Macondo well test procedure [3]

The total depth of the well is (18304 ft) 5579 m, with a temperature (TD is $262^{\circ}F$) $128^{\circ}C$. the well head is at (5054 ft) 1540 m and the seabed is at (5067 ft) 1541m. Position 9 7/8 "liner hanger at (15103ft) 4603 m, 9 7/8" liner shoe at (17168ft) 5230 m. The final production column is 19.04.2010. positioned at 9 7/8 x7.

Before the catastrophe, the quality of cement was questionable due to the excessive amount of nitrate, and the cement mass was unstable. Instead of 21, as standardised, six centralizers were installed in end columns. The cement on the production column reached a height (17260ft) of 5261m. The positive pressure test was satisfactory. The negative pressure test placing the well into an unbalanced state to ensure that the cement will retain and prevent the hydrocarbon from entering the well has resulted in high preassure in the well. A " effect of the bladder " was suspected as there was no indication of a leak from the well. Tests were performed on the kill line and not on the drill pipe.

Misinterpretation of the negative pressure test again resulted in a blowout.

Prior to negative pressure, a volume mud bar and a specific gravity of 424 bbls² of 16 ppg³ was in the annular, and 30 bbls of fresh water and 352 bbls of seawater were used to squeeze the same. The weight of the mud under the column of water was 14.17 ppg. The drill pipe was at 8367 ft. Due to the leakage of the annular preventer, 50 bbls of seawater have leaked out of the pipe. According to one of the crew members, the drill pipe had previously been moved on a closed annular preventer, damaging the annular preventer rubber element.

During the negative pressure test, a pressure of 1400 psi⁴ was recorded on the well. The crew interpreted the high value of the pressure in the drill as the effect of the bladder - the displaced mud presses on the space around the annular space and the resulting pressure is transferred to the pressure in the pipe.

The second test was performed on the kill line. At the kill line, the pressure was close to zero-having no flow for 30 minutes. The negative pressure test was assumed to have been satisfactory, although there was no logical explanation for why there was so much difference in the pressure of the drill pipe and the injection line- unless the injection line was blocked. The crew continued to squeeze out the heavy mud. The well was brought to an underbalanced state (lower well pressure than the formation pressure) and due to poor quality cement, the crude oil reached the well (Figure 3.3.). Pressure increased. The closure of the inside blow out preventer (IBOP) and the annular preventer were approached. The middle pipe ram for the pipes is closed. Hydrocarbons suppressed the mud, methane spreaded around the platform and entered the engine room.

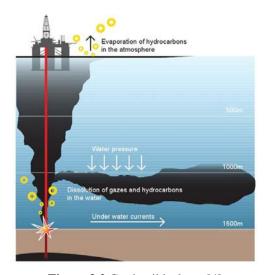


Figure 3.2 Crude oil leakage [4]

² barrels

³ pound per gallon

⁴ pounds per square inch

The consequence is a loss of power management system (PMS) a dynamically positioned system being lost. Blow out preventer (BOP) did not work due to a 27V battery failure caused by a faulty connection. The yellow preventer of damage (POD) double acting solenoid valve was incorrectly connected. Due to malfunction of BOP control system caused by inadequate maintenance, BOP was not fully functional.

A sheer ram and LMRP disconnect device is activated. The order was sent to the control system but no hydraulic flow was registered. There is a loss of power at this point, but the lower marine riser package (LMRP) has not been disconnected from the BOP, resulting in the hydrocarbon being spilled into the sea. It is estimated that over the course of 86 days, the oil spill amounted up to 780,000 m3 (4.9 million barrels).

4. Event expansion

During the negative pressure test, there were several warning signs indicating a problem. The first sign was a negative pressure test that gave conflicting results showing a pressure reading of 1400 psi and then 1240 psi- when they should have been zero. The test was easily accepted as satisfactory because they did not have standardized data for the test results.

There are other possible explanations- but all of them are unfathomable. Furthermore, these results were transmitted to BPs onshore personnel. Namely, the assumption was that no action had been taken to determine the cause of the deviation or to re-evaluate the negative pressure test (Figure 4.1). A closed mud extraction system was not used to allow more precise monitoring of the well upon returning to an unbalanced state.

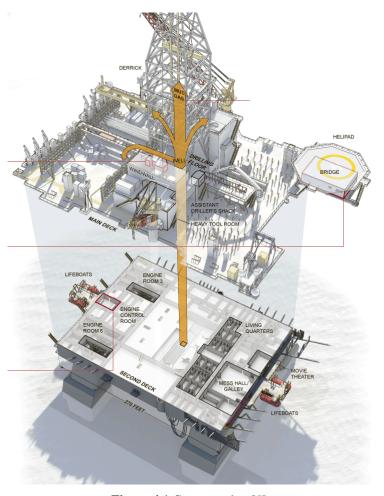


Figure 4.1 Crew reaction [5]

About five hours before the explosion, an unexpected loss of fluid was observed in a pipe located in the well. Two hours prior to the explosion, a second negative test was performed, which was also considered satisfactory. But, 51 minutes before the explosion, warning signs were noticed. However, it was too late, since crude oil was already moving uncontrollably out of the well. 18 minutes before the explosion, hydrocarbons exploded and leaked to the surface. Hydrocarbons began spreading uncontrollably across the rig- and then an explosion occurred.

So, summing up the aforementioned, it can be stated how the factors that led to the disaster were:

- ✓ hydrocarbon reservoir source
- ✓ no well stability being established
- ✓ hydrocarbons entering the well
- ✓ well bore control lost
- ✓ ignition of hydrocarbons
- ✓ BOP not responding
- ✓ Oil spill consequence.

Following the Macondo disaster, most of the Oil and Gas Exploration and Production Regulations now require operators and subcontractors to install acoustic control systems on offshore equipment. Prior to the disaster, only the Norwegian and Brazilian authorities had proclaimed the installation of acoustics in subsea equipment (acoustic BOP control) mandatory. Following this accident, the recommendations of the American Petroleum Institute (API) are to install acoustic BOP control system in deepwater drilling rigs.

Despite the fact that acoustics on the Deepwater Horizon would not prevent the flow and spillage of the oil, the acoustic system is certainly crucial and inevitable redundancy system for cotroling the subsea equipment in case of emergency situation.

4.1 Technical aspects of the event

During the night of April 20th, a sudden torrent of natural gas bursted through the cement core of the well- causing the plant to explode.

Deepwater Horizon was not originally intended for work on the Macondo well. Six months earlier, extraction began with another platform known as "Marianas". Hurricane Ida damaged this platform and needed repairing. It was drilled 4,000 feet below the seabed and 9,000 feet left until reaching the pay zone.

Neither of the factors mentioned earlier can be deemed as solitary agent for causing the tragedy of the Macondo oil well. To be more specific, a series of failures involving numerous different parties led to an explosion and fire that led to 11 people losing their lives and for causing a widespread pollution in the Gulf of Mexico.

Decisions made by multiple companies and work teams have contributed to the accident, which is said to have arisen from "a complex and interconnected set of mechanical failures, human judgments, engineering design, operational implementation and team interfaces".

The specific sequence of events leading up to the disaster can be described as following: the cement mass at the bottom of the Macondo well failed to retain hydrocarbons inside the reservoir as intended- allowing gas and liquids to flow through the production casing the results of the negative pressure test were wrongly accepted by both BP and Transocean the crew failed to recognize and act on the hydrocarbon inflow into the well until the hydrocarbons had expanded and quickly floated to the surface

after eruption, the product is brought to the surface where it is diverted to the mud gas separator- causing the gas to drain directly to the platform instead of being diverted overboard the gas flow into the engine rooms through the ventilation system created the possibility of ignition, which was not prevented by the fire control system.

4.2 Technical aspects of the event

Since the company- which had been using chemicals beyond its permissible level, sank large quantities of crude oil to the bottom of the Gulf, pollution occurred. Inevitably, the Deepwater Horizon disaster has left its effects on the ecosystem.

In addition to the increased mortality of dolphins and seabirds, studies have indicated that due to the aforementioned disaster, 20 animal species are on the verge of extinction.

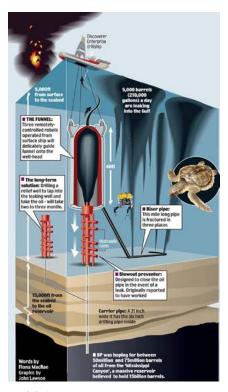


Figure 4.2.1 Consequence of oil spill damage [6]

The oil spill lasted 87 days before the well was closed on July 15. The amount of spilled crude oil is estimated at more than 969 to 100,635 barrels (790,000 to 16,000,000 litres) per day. [7] As a consequence, about 6,000 km2 of marine surface has been polluted. For over a month, unsuccessful attempts were made to stop the initial crude oil eruption. However, reports from 2012 showed that there was still a leak of crude oil from a well in the sea. [12]



Figure 4.2.2 The explosion of Deepwater Horizon [8]

Causes of accidents or hazards are often a human factor. Ignorance, failure to comply with regulations, instructions and commands, as well as fatigue, fear and panic can lead to danger on naval installations. Also, these include failure to perform regular inspections, improper maintenance as a whole relating to machinery failures, electrical installation, signalling, navigation, ventilation, refrigeration and fire systems, steering systems, cargo handling and anchoring systems, etc. Emerging hazards on platforms are shown in Figure 4.2.3.

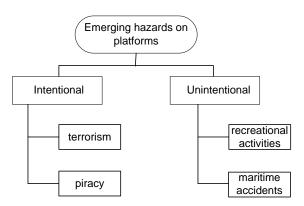


Figure 4.2.3 Emerging hazards on platforms

The specific events that led to the fire were a mixture of human and technical failures. In recent years, there has been an increasing emphasis upon the so-called 'human factors' in terms of the oil, gas and construction industries. Audit findings and maintenance records identified potential weaknesses in the BOP testing and maintenance management regime.

4.3 Economics as a cause

Two U.S. Congressmen responsible for investigating the crash, Henry Waxman and Bart Stupak, came into possession of a memorandum confirming that the BP managers knew about the problems. However, the memorandum does not mention who decided that the drilling was to be continued even after the problem was discovered.

Exploration and drilling costs exceeded expectations [10] and it's been six weeks late.

The political compromise passed by the Act favoured the primary purpose of promoting offshore drilling. The compromise-defined law stipulated that the development and production plan must set out "environmental safeguards to be applied".

5. Conclusion

All in all, it can be concluded how it is necessary to take all possible precautionary measures in order ensure the wells being under control at all times during their operation. In addition, it is mandatory to use optimal drilling technology in terms of technical and safety stability. Furthermore, the conditions need to be closely and constantly monitored and evaluated to minimize the potential for the well being used or tested.

When it comes to the main technical cause of the Deepwater Horizon (DWH) crash, it can be said that the cement pumped into the bottom of the well did not prevent nitrate suppression. To be more specific, because of the high nitrate content, the cement stopped the hydrocarbon leakage.

So, it is obvious that the factors that increase the risk are following:

- drilling complication small total amount of cement
- the cement mass itself poorly designed and tested
- implementation of rig safety abandonment procedures performed at the last minute.

As mentioned earlier, the results of the negative pressure test conducted on April 20 were misinterpreted. Then, series of buoyancy signals were ignored during the last hour before explosion. And so, buy the time the (BOP) device was activated it was too late to prevent a disaster. Furthermore, the protective mechanism was not adequately fitted.

The underlying cause of the accident was insufficient safety training and assessments of the employees (BP and its Transocean contractors, Halliburton). Investigation reports revealed a number of failures in the management and implementation of security aspects that led to the accident itself.

And so, the assumptions of the cause of the accident can be stated as:

- inadequate risk assessment –failure to recognize prewarning systems of deviation points and changes of the well
- lack of timely recognition and response to early warning signals
- lack of CRM (crew resource management) trainings
- negligence of rig management team and senior staff
- lack of management capability
- inability to recognize the situation from the experience of other accidents and failures.

Due to this, changes of the regulatory reform are now being proposed, since the established regulatory structure of MMS as of April 2010 has proved to be completely insufficient when it comes to addressing risks in situations such as Macondo.

It has been agreed that the following changes will include:

- separation of leasing from regulatory oversight functions
- a risk-based approach similar to the "security case" approach used in the North Sea
- inspection and approval of the facility's safety
- regular inspection,
- tighten international security standards
- conduction of transparent reporting when it comes to incidents and errors for the purpose of learning and preventing accidents
- exploring better planning for emergency response.

The idea for writing this paper came from the fact that ten years have passed since the accident on Deepwater Horizon.

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Using Macrostrategies in Teaching Business English

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Abstract. One of the challenges involved in teaching English to undergraduate students is the actual diversity of both their language level and general learning abilities. Their first year as university students is also their first contact with English for Specific Purposes (ESP), which brings along a new set of difficulties, forcing both teachers and students to get creative in terms of the teaching-learning process. It has long been acknowledged that focusing on learners' needs is the primary goal of teaching ESP, so choosing the right approach to meet those diverse needs is essential. Starting from B. Kumaravadivelu's premise that going beyond methods and focusing on a macrostrategic framework for language teaching is more realistic nowadays, this paper will discuss how these ten macrostrategies can be implemented in a Business English context. It will show, based on our practical experience with undergraduate students, that achieving the best results in the foreign language classroom is often a subjective and theory-neutral process, which requires constant trial and error, adaptation and flexibility, while also proving that an integrated approach, in keeping with the bigger picture of living in a globalized world, is especially significant in the business field.

Key words: teaching, ESP, macrostrategies, Business English

1. Introduction

The number of people all over the world using English in their business activities is, no doubt, impressive, and there are also millions who do this on a daily basis, since their income depends on it. In other words, business (English) is booming, and the number of students who choose to study Economics and Business Administration at our university has been growing steadily, with the occasional shift in interest from one specialisation to another. Preexperienced learners continue to mix with job-experienced ones (Frendo 2012: 1) in my classrooms, but they all seem to share similar goals: to either develop their family business, start their own or work for a multinational company. Therefore, in terms of teaching strategy, it is important to take our learners' needs into consideration, without compromising on our objectives as language teachers. As Wilga Rivers rightfully points out, "as fashions in language teaching come and go, the teacher in the classroom needs reassurance that there is some bedrock beneath the shifting sands," (apud Kumaravadivelu 2003: 23) so for a while the communicative approach seemed the best option, because it was flexible enough to address the different learning needs. The students were also familiar with this approach, since it has been implemented on a large scale for quite some time in Romanian schools and most teaching materials also follow its principles.

However, much like B. Kumaravadivelu, teachers understand at some point in their career that the realities of the English classroom require a more pragmatic *postmethod* approach, which "empowers practitioners to construct personal theories of practice." (Kumaravadivelu 2003: 33) Post-method pedagogy is described as "a three-dimensional system consisting of pedagogic parameters of particularity, practicality and possibility" and is set to "propel the language teaching profession beyond the limited and limiting concept of method." (Kumaravadivelu 2003: 34-38)

Below, we will discuss how the macrostrategic framework the author proposes in support of postmethod pedagogy can be implemented in the Business English classroom.

2. A Focus on Macrostrategies

The ten macrostrategies Kumaravadivelu proposes are the following:

- Maximize learning opportunities
- Minimize perceptual mismatches
- Facilitate negotiated interaction
- Promote learner autonomy
- Foster language awareness
- Activate intuitive heuristics
- Contextualize linguistic input
- Integrate language skills
- Ensure social relevance
- Raise cultural consciousness (Kumaravadivelu 2003: 39-40).

These, of course, are general guidelines based on which teachers can develop their own situation- and need-based microstrategies, which will help implement change. And while all ten should be considered, to some degree, by the Business English teacher, there are a few that are worth a deeper discussion, due to either their importance or the specific features they display in the context of teaching undergraduate business students.

2.1 Maximizing Learning Opportunities

This macrostrategy is the most general and we perceive it as the main duty of teachers, but it is also one of the most difficult to measure. Ideally, teachers should take advantage of every minute they have together with the learners inside the classroom, while also providing opportunities and advice on how to continue the learning process outside the formal learning environment. Kumaravadivelu lists here three microstrategies that can help with this goal and which are already being implemented at our university: *connecting with the campus community* (students are encouraged to participate to all sorts of educational events, they can connect with their colleagues via social media groups or apps and they stay informed through the official virtual communication channels; also, through the Ministry of Education's ROSE Project funded by the World Bank, our university has inaugurated a Centre for Learning in 2018, which aims to offer counselling and coaching sessions to students in need of remedial support), *connecting with the local community* (through internships with local companies) and *connecting with the global community* (through the Internet and foreign exchange programs).

Moreover, Business English teachers like myself have a unique opportunity to maximise learning opportunities because through the use of students' place of work as an excellent resource for teaching materials, in addition to it being a great place for our learners to put the theory into practice. Through their jobs or the students' exchange programs, they can easily become part of a community (be it local or global), where they can interact with competent speakers of the target language, which is key in achieving some other teaching goals as well. The beauty of teaching ESP stands in its specificity, which makes our role as teachers a little more clearly delineated. However, this also means that there may be a higher risk of perceptual mismatches, as some activities can be perceived as non-relevant by students if they are not overtly business-focussed.

2.2 Minimizing Perceptual Mismatches

Citing several studies which showed that teachers are often surprised that students sometimes perceive classroom activities, teacher's goals and approach in a completely different way than they had intended, Kumaravadivelu shows that there are several sources for this, from cognitive to cultural, to instructional mismatches. From our personal experience, students tend to disregard activities that do not involve usage of specialised business vocabulary or anything that they have encountered several times in previous lessons (or during their school years) - like grammar-focussed exercises - because they fail to see the bigger picture of learning English as a whole: language, civilisation, culture and all the nuances in between. At this stage in their studies, they need constant reassuring that what is asked from them has practical applications at work. But as Kumaravadivelu rightly points out, these mismatches are as unavoidable as they are identifiable and manageable. Teachers might find it difficult to help students make the switch between mandatory and optional education (school vs. university studies), and although English is a mandatory subject during their first two years at university as well, they are faced for the first time with the specificity of ESP, the new requirements and the different approach to teaching or assessment methods. In order to help students adjust to their new reality (which unfortunately leads to a dropout rate after the first year of up to 30%), teachers need to facilitate negotiated interaction.

2.3 Facilitating Negotiated Interaction

This macrostrategy ultimately focuses on two main issues: talk management and topic management, as part of what Allwright (1981) has called the management of learning. Basically, it is about giving learners a reasonable degree of freedom over how and what they talk about in the classroom. The types of questions the teacher asks will determine the kind of answers given, so at this level students need to be stimulated in order to be able to answer all kinds of questions and also choose how to answer based on their own interests.

Topic management is even more important, because it is obvious that students will retain more of what interests them or what is relevant for their work, which means that teachers need to make sure they allow for student-lead interaction for a certain amount of their class. The most common topics that we cover during our courses are culture and cultural differences, companies, marketing and advertising, human resources and recruitment and business travel. They allow us to discuss business speaking and writing skills like socialising, presentations, meetings, negotiating, business correspondence, contracts, agendas and minutes, CVs etc. but it is also important for students to decide which of these are most relevant for them and focus on those.

2.4 Promoting Learner Autonomy

When working with young adults, the teacher realises early on that flexibility is key. At this stage, students have strong opinions and are more pragmatic, requiring a certain level of autonomy that might have confused their younger selves. The narrow view of learner autonomy involves enabling learners learn how to learn, which actually is a very complex endeavour, since it ranges from helping students develop critical thinking, self-control and discipline to taking responsibility for their own learning, strategies and objectives. The broad view of learner autonomy "goes much further than academic autonomy by actively seeking to help learners recognize socio-political impediments placed in their paths to progress, and by providing them with the intellectual tools necessary to overcome them." (Kumaravadivelu 2003: 141) While this approach is definitely positive in itself, it is also something that teachers might achieve only indirectly, which is totally acceptable given the constraints of a two-year twice a month business English course. As long as negotiated interaction is at the

core of course development and delivery, students will find their own way to achieving learner autonomy.

2.5 Fostering Language Awareness

Fostering language awareness, general (LA) or critical (CLA), involves both teachers and learners being aware of the linguistic, sociolinguistic, social and political factors governing language usage. While the former is usually covered in school, the latter would probably be more appropriately discussed at undergraduate level, in relation to other subjects like Microand Macroeconomics and with the use of advanced skills, like critical thinking.

Kumaravadivelu proposes two microstrategies which can help students develop language awareness, one for each type. The first one focuses on levels of formality (both in speech and in writing), which is really important in terms of doing business with different cultures, while the second is about doublespeak, which can also be employed in the context of doing business abroad and which is vital to be decoded correctly. Before they can use English in an international business context, they need to be aware of what can and can't be done, when and where and also what can and cannot be said, and in what way. It is about saying what you mean to say in such a way that it comes across to other English speakers as clearly and unequivocally as possible, so that communication is efficient and successful. When one's business is on the line, there is a lot of pressure involved, which means that preparation and a good grip on the language basics are key, while also being aware of your linguistic strengths and weaknesses.

2.6 Activating Intuitive Heuristics

Heuristics generally refers to the process of learning by (self) discovery, which in turn involves the teacher's task to create an optimal environment in the classroom, so as to maximize learning opportunities. Inductive teaching is obviously preferable to deductive teaching in this case, but theorists go deeper into intuitive heuristics to describe how the learner's self-discovery process takes place. William Rutherford uses the term *consciousness-raising* (C-R) to describe the teacher's deliberate attempt to draw the learner's explicit attention to features of the target language, while Sharwood Smith suggests the term *input enhancement*, which basically means that the teacher highlights (through various types of exercises) elements in the course material that learners need to focus on in order to improve their knowledge of the language (apud Kumaravadivelu 2003: 187). Another concept, which is interrelated with the former, is *noticing the gap* between what learners already know and what they need to know. While C-R is largely external, being based on the teacher's ability to create the necessary conditions for raising students' consciousness about certain aspects, the act of noticing the gap is completely internal to learners.

Thus, it is for the Business English teacher to identify the areas which require further practice (at undergraduate level, these may be less grammar-related and more field-specific) so that students can easily notice the gap and react accordingly.

2.7 Contextualising Linguistic Input

As we will show below, the extrasituational context (or the context of culture) of linguistic input is specifically important in our Business English classes. Therefore, the macrostrategy of contextualizing linguistic input in this specific case will focus mainly on communicative appropriateness in different social, cultural, political or ideological contexts which influence meaning and less on the linguistic or situational context. Teaching ESP is really about refining general linguistic knowledge and adapting it to specific situations, ideally student-led and work-focussed to ensure maximum relevance. Learning cannot take place in a void, so

context is there to put things into perspective, that is why and how things might be different when using the language in a business context.

2.8 Integrating Language Skills

This has been done more and more nowadays, at all levels of language learning, so it should come as no surprise to university students. Interactive scenarios and project-based activities are the most frequently used in our classroom since the students' level of English permits them to make the most of the opportunity to integrate all four skills. We also ask our second-year students to deliver twenty-minute group presentations, since it gives them a chance to practice multiple skills in the foreign language. Integrating language skills really is the best way to provide authentic learning opportunities, since we do it subconsciously anyway.

2.9 Ensuring Social Relevance

Ensuring social relevance provides a good opportunity for the Business English teacher to discuss the issue of cultural identity and the politics of standardization. As previously stated, the concepts of culture and cultural differences are essential in business language teaching because even though everyone in a meeting may speak English, their cultural background will heavily influence both their social and linguistic behaviour. This kind of situation may prove very difficult to navigate, especially if someone's work is at stake, and while the English teacher may not be particularly trained in the field of cultural anthropology, he or she can at least draw the students' attention to the particular language of business which might help them evaluate the potential risks and react accordingly.

In a globalised world, English has taken over as both the language of socialising (especially among the young generation) and that of business. Consequently, register is worth mentioning when talking to students about cultural appropriateness, both in written and oral communication. Even if it is not their first language, students use or at least are exposed to English on a daily basis, which means they need to be aware of the particularities of usage in each case.

2.10 Raising Cultural Consciousness

This macrostrategy is of particular interest to us and our students. Culture is a topic we address early on because it sets the stage for our entire business English course. According to Trompenaars, "every culture distinguishes itself from others by the specific solutions it chooses to certain problems which reveal themselves as dilemmas." (1998: 8) Cultural awareness, in particular, is a concept that first year students are not necessarily familiar with, because their intercultural experiences have been rather limited at this point, both in terms of number and length. We usually start by pointing out that using English socially is quite different than actually relying on it for work in terms of the consequences that cultural misunderstanding might have on the quality and the success of their work. Most of our students would like to set up their own business or work in a multinational company after graduation, so the need for further clarification on the topic is normally present. Luckily, teaching materials provide more and more information on this topic and, to stress its importance, we require our second-year students to prepare and deliver team presentations on Hofstede and Trompenaars' cultural dimensions and how they are illustrated in two different cultures of their choice.

A good topic for classroom discussion would also be the language used in intercultural communication. "Although English is becoming a global language, bear in mind that many speak it as a second language" (Harris, Moran & Moran 2004: 61) warn the authors of a book on managing cultural differences, providing a list of twenty guidelines on how to use English in order to limit misunderstandings, choose the right words or tone and get the message across

in a business situation. Businesspeople are advised, for example, to restrict their use of English words to their most common meaning, to use maximum punctuation that helps clarify meaning, to conform to basic grammar rules more strictly than in common everyday conversation, to keep things formal, especially in writing, or to become aware of words whose primary meaning is restricted in some cultures. These are things that can be inferred from various types of exercises or case studies and they provide students with practical examples of how things can go wrong in such situations.

Whether we approach cultural training from Robinson's (1991) color purple or Kramsch's (1993) third culture perspectives, we reach the same conclusion as Kumaravadivelu: learners first need to develop their critical cultural consciousness (2003: 271). In order to do that, he points out that we need to treat both the teacher and the learner as cultural informants, in a process of both self-reflection and self-renewal. Moreover, "one of the goals of cross-cultural training must therefore be to alert people to the fact that they are constantly involved in a process of assigning meaning to the actions and objects they observe. For cross-cultural training to be successful, it must not be limited to delivering more or less detailed information about other countries and cultures." (Trompenaars 1998: 196)

3. Conclusions

Hitting the right note in teaching is a permanent struggle because of all the variables involved. It requires flexibility and the constant search for the right materials, methods and relevant assessment procedures, all within the given financial and time constraints. Business English sometimes feels like a completely different subject than what teachers were trained for, but it offers instant satisfaction when realising that we have contributed directly to our students' success at work and, in some ways, the connection between theory and practice is more visible when teaching adult learners.

As we've seen, all ten macrostrategies should be considered when designing a Business English course, from the most general to the more specific (like number ten), since doing business in English automatically requires a certain level of cultural awareness which students might experience for the first time. Therefore, the last macrostrategy carries the most weight in this context. While the focus shifts from grammar to function, students need to see the bigger picture of how they can use the English they already know in order to achieve their business goals. It is for the teacher to point this out at the beginning of the course, so that he or she can then formulate, together with the students, the goals to be achieved by the end of it. At this level, the course will be less about general listening and reading comprehension or studying grammatical structures and more about inferring meaning, choosing the right register, learning specialised vocabulary and practising formal writing. It will require the use of higher-level cognitive functions but also open-mindedness, flexibility and adaptability. The ultimate goal of any teacher is to help students internalize input meaningfully to the point that they can create internal connections and be able to solve problems or deliver their own output, which translates, in our case, in successfully using English in a business context.

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The Real Needs of Foreign Language Teachers as Practitioners within Teacher Education and Professional Development Process

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Abstract:

The study investigates real needs for education and collaborative development of foreign language (FL) teachers and the problems they as practitioners come across when dealing with the contemporary theoretical grounds. The aim of the research was to investigate FL teachers' attitudes and reflections on: (1) the importance of contemporary theoretical research use in the classroom comparing to the use of the knowledge acquired through personal teaching experience; (2) the most frequent forms of their personal education and professional development; (3) the contemporary knowledge in the field of teacher education and development research that would be the most helpful in the classroom, (4) as well as the segments of their own teaching practice the aforementioned knowledge would improve to the greatest extent. The subjects of the research were 36 FL teachers in primary schools of Čačak. The type of the research was exploratory, quantitative and interpretative. The results showed that for 91.67% of the participants, theoretical knowledge use is as important as practical knowledge use when considering teaching practice generally; as much as 77.78% of their professional development derived from personal experience within the teaching practice; 88.89% of the teachers would be most interested in learning the theoretical grounds and methods for conducting class research; the teaching segment that needed the greatest improvement was learning the methods for exploring students' real needs and expectations in the process of FL learning (44.45%).

Keywords: FL teacher education and development, researchers, practitioners

1. Introduction

The research within the field of foreign language teacher education has been developing since the 1960s but it was not until the 1990s that the authors started to conduct lavish research aiming at making teacher education and development an independent field of study. They stressed the fact that practical experience had always been of the utmost importance when forming individual teaching philosophy and theory of each individual teacher. Since then the concrete suggestions for the range of activities and techniques for improving teaching practice have appeared in order to stimulate teachers to consider their profession as a continuous process suitable for the development, reflection, research, investigation, evaluation and collaboration. The challenges in the contemporary context include the necessity for recognizing the complex role of foreign language teachers not only through their linguistic, pedagogical and practical knowledge and skills, but also through their personal ideas, individual attitudes, beliefs and reflections they have about teaching, peer cooperation, theoretical knowledge realisation in the

teaching context, hands-on activities and techniques that can be applied within the research and evaluation of their own practice as well as the practice of their colleagues.

Therefore, in the contemporary context of continuous professional development a teacher never stops to be a student as well. In line with these facts, the aim of this research is to investigate the degree of practical usefulness of the previously mentioned challenges that are both expected and obligatory for foreign language teachers. To that purpose, the paper will deal with the regulations of professional development that are prescribed by the Ministry of Education, Science and Technological Development of the Republic of Serbia and in-class context that teachers of the primary schools in Čačak might have within the process of fine-tuning their teaching practice with the prescribed regulations. The findings of the study could serve as directions for further investigations of the teachers' professional development segments that need most help and search for possible solutions to bridge the gap that might exist between the teachers as practitioners and the researchers.

The first segment of the paper contains the historical development, the definitions and discussions in the field of foreign language teacher education and development as an independent research field. The paper also compares the prescribed actions of "Act of Regulations on continuous professional development and promotions into the higher rank of teachers, nursery teachers and expert assistants" of the Republic of Serbia to theoretical framework presented in the first section of the paper. The main part of the study investigates the real needs for education and collaborative development of foreign language (FL) teachers as well as the problems they as practitioners come across when dealing with the contemporary theoretical grounds. The discussion of the results and the conclusion are presented in the final segment of the paper. The limitations of the study concern a small sample of the participants, so that the obtained results cannot affect language teaching policies and documents in the mentioned domain.

2. Foreign language teacher education and development - the field of study

When the field of foreign language teacher education first emerged in the 1960s, the implications that a teacher's knowledge of the teaching methods immediately made the students learn and acquire a foreign language were widely accepted. However, due to the significant impact of the applied linguistics, FL teachers' education and development field shifted its focus to the application of the language theories in real life teaching context. In other words, the main objective of the field research was directed towards designing trainings and courses with the purpose to educate teachers how to adopt the methods for application of their sociolinguistic, psycholinguistic and second language acquisition knowledge practically (Tsui, 2011, p. 21). Within the two following decades Richards and Rodgers (2001) intensified and enlarged the research related to the methods, approaches and techniques of FL teaching so that the impact of their research results in the field of teacher education and development was prominent. Regardless of the efforts for the field to be improved, it can be concluded that at the end of the 20th century there were no significant tendencies for the development of the very field as an independent study area.

The very end of the 20th century was more fruitful concerning the considerable changes within the mentioned field. Nunan and Richards (1990) published the proceedings on the second language teacher education and development which contained findings of the experts engaged in the field research. The authors made inferences that there were a scarce number of investigations within that field comparing to the research in the fields of FL teaching methods. The authors also stressed an important difference between training and education, which had further impact on the development of the field mentioned afore as an independent study area.

In other words, as they emphasized, a training enables applying the knowledge about the skills and techniques that the teachers have acquired. In contrast continuous education enables gaining deeper insight into the very nature of self-study, building one's own teaching theory and the development of critical thinking and evaluating one's own work on the basis of the insight of self-study practice (Nunan & Richards, 1990, p. xi).

In the following decade, Freeman and Johnson (1998) published the research paper in which they asked for the prompt reinvestigation of the theory that defined and directed teachers' education. They suggested that the main direction for the future studies should concentrate on the teacher and their work, real context where the teaching took place and the teachers' pedagogical knowledge. Teacher's own reflections and knowledge about teaching practice, as well as the impact of the cognitive and educational knowledge acquired through previous formal education were considered crucial for further filed development (Freeman & Johnson, 1998, pp. 397-400). The results of Borg's research only confirmed Freeman and Johnson's stances related to the role of the cognitive processes and the previous teachers' knowledge (Borg in Burns & Richards, 2009, pp. 163-168). In addition, his findings showed that teachers' reflections and their previous teaching experience considerably affected their teaching practice. Therefore, scholars agreed upon the scientific need to investigate and explicitly formulate the base of the teachers' knowledge. To serve that purpose, a number of methodological procedures were suggested: questionnaires and tests as research instruments about one's own reflections and comments on their results, observations related to real and simulated classroom activities, introspective diaries, autobiographies, retrospective surveys, etc. On the other hand, some scholars found such effort inadequate. Miller opposed Borg's opinion, claiming that his studies did not into account the impact of the professional identity on the teaching practice. According to this author, the professional identity is not only connected with teachers 'own reflections, beliefs and the real life context, but also with the educational and institutional policy, bilingual policy, cultural differences, teaching syllabus and aids, availability of professional development, which are outside one's personal domain (Miller in Burns & Richards, 2009, p. 175).

The previously mentioned discussion confirmed that the field of FL teacher education and development is supported by complex investigations which helped to define the state-of-the-art conditions. The literature review shows the definitions and theories of the FL teachers' education and development field. The chronological insight shows that there were slight discrepancies among the approaches within the field development, but that different investigations only helped to build rich and complex theoretical grounds in its domain. The challenge for further research remains to create the conditions for continuous teacher education and professional development designed to be available and suitable for the real life teaching context application.

Due to the significant contributions of different approaches, it is considered that the continuous education today consists of the teachers' critical thinking on their own work and professional activities, reflection, analysis, investigation of their own practice and conducting peer cooperation and peer-coaching (Richards, 2008, pp. 160-162). Pilipović and Glušac (2018: 41) only support the previous considerations claiming that the real life teaching contexts consist of different conditions, needs and requirements, so that in order to be capable of meeting professional demands and challenges as practitioners, teachers should be taught how to conduct self-study forms of professional development. They suggest some of the following: learning how to take responsibility for the improvement of their students' as well as of their own work; solving real problems on the grounds of the knowledge and skills they have acquired; gaining the opportunity for continuous education and development and collecting the data as the basis

for coping with problems rather than employing various activities on the basis of mere observations.

3. Professional education and development of Serbian foreign language teachers

The education and development of the teachers in the Republic of Serbia is regulated by "Act on Regulations on continuous professional development and promotion into the posts of teachers, nursery teachers and expert assistants" (Official National Law Binding Acts of the Republic of Serbia, no. 81/2017 48/2018) (in further text the Act). For the purpose of this survey, the articles 4, 16, 17, and 22 will be considered with particular attention considering the fact that they directly refer to the formal procedures for tracking the teachers' professional development.

The article 4 prescribes that the continuous professional development should be realized on an institutional level which includes experimental teaching to students and colleagues (attendees), i.e. the analysis and discussions follow-ups; organizing experts' committee meetings with journal articles presentations, different types of the research, or study trips and visits; doing the research, educational projects within the institution, etc. The professional development of a teacher is also supervised by the Improvement in Education Institute as well as The Quality of Education Institute through the following programmes: training programmes, expert committees and associations, summer and winter schools, study trips organized internationally or by a teacher's independent and self-created plans for the professional development. As the article 16 prescribes, in order to evaluate the success of their own professional development, a teacher systematically monitors, analyses and evaluates their own educational activities, competencies development, the improvement and professional development and keeps the records of the most important values of the experience acquired through the process of education, as well as their own plan of professional development (portfolio).

The article 17 implies that the school does the monitoring of the professional development plan and informs the Ministry of Education, Science and Technological Development of the Republic of Serbia about the obtained results. The Institution further cooperates with the school boards and the centres for professional development analyzing the accomplishments of the prescribed programmes and the implications they may have on the development of the teaching competencies. The article 22 prescribes that the rights and obligations of each teacher should include publicly an individually presented form of professional development acquired during the school year, as well as the application of the acquired skills, didactic materials, the results of their own research published, to give an experimental lesson, hold a workshop, participate within the research or professional studies and educational projects within their own institution, etc.

It is obvious that the articles 4, 16, 17 and 22 of the "Act on Regulations on continuous professional development and improvement of the professions of teachers, nursery teachers and expert assistants" of the Republic of Serbia are generally in accordance with the theoretical bases of the research field concerned with the continuous professional education and development of foreign language teachers generally. However, they do not specifically denote the field of FL teacher education and development concerning their real needs and attitudes towards the prescribed activities and forms of professional improvement.

Attitudes, which are a commonplace variable in survey research, are general evaluations that people hold regarding a particular entity, an issue or an object (Lavrakas 2008), and investigation of people's attitudes is essential due to people's attitudes influencing their actions, interpretations and notions. Therefore, the necessity to explore actual teaching needs refers not

only to the teachers' pedagogical and linguistic knowledge and practical skills, but also to their individual attitudes, beliefs and reflections about teaching and peer-cooperation.

A similar- context research conducted with primary and secondary FL teachers in Crna Gora showed that the majority of teachers considered that professional development should be based on the teacher's individual free will to improve and promote their further development, as well as that the study visits to foreign countries and survey of English-as-a-foreign-language literature would be the most useful sources for employing in professional development. On the other hand, the research proved that the most frequent forms of professional education in Crna Gora were (1) participating in the seminars, and (2) peer-collaboration in the form of professional opinion exchange (Vukotić, 2018, pp. 148-154).

4. The method of the research and the participants

The aim of the present research is to explore the reflections and attitudes of the Serbian primary school FL teachers related to their professional education and development; the degree to which they consider the importance of theoretically postulated knowledge comparing to the practical and experiential knowledge is important for teaching practice; real needs for theoretical grounds and the fields that would me most helpful in their teaching practice.

4.1 The research context and participants

The research was conducted during 2016/2017 school year. Thirty-six FL teachers participated in the survey, two teachers of Italian, two teachers of Russian, six teachers of German and twenty-six teachers of English in seven primary schools in the city area of Čačak. Their work experience ranged from one to twenty-two years, while one third of the teachers were almost novice, up to four years of teaching experience. A closed-answer questionnaire as an empirical research method was employed in order to gather the data for the quantitative analysis (Raičević, 2009, p. 69). The research type was exploratory, quantitative and interpretative.

5. The results and analysis

The questionnaire consists of four questions constructed in order to explore for which segments of professional education and development the teachers showed the greatest interest, regardless the forms they had already been conducting and which aspects might represent the obstacles to further improvement. The purpose was also to collect the data which would detect the teachers' beliefs about the fields where theoretically-postulated and practical knowledge would provide most benefit.

The results obtained by the quantitative analysis were given perceptually with the appropriate interpretation. The first question was constructed in order to check the most frequent form of professional development employed by the research participants. More than one option was possible to be selected.

Upon the survey of the answers given in Table 1, we can make the inferences that the greatest source for the teachers' further professional development is their personal teaching experience (77.78 %), and that attending the seminars and workshops is approximately very close to their first choice (75.00%). The organized exchange of professional accomplishments is present in slightly lesser degree (72.22%), while the other forms such as research of teachers' own work and presenting their results at conferences is done on rare occasions, i.e. the former being present in 36.11% of the total number of cases, and the latter in even lesser degree, 16.67%. A small number of teachers (13.89 %) admitted to keep up with the contemporary literature in the fields relevant for foreign language teaching profession, while the least employed source

of education is study visits to foreign countries, only 5.55%. Overall, it can be concluded that professional development mostly BENEFITIAL the events and forms organized or required by the institutions, i.e. gaining experience from everyday teaching experience at schools, seminars and workshops offered or organized exchange of professional accomplishments. The forms for professional development where self-organized methods of improvement are required are present in considerably lesser degree compared to the organized ones.

Table 1 Forms of the executed professional development

The options offered	Chosen answers	Percentage
a) Research of one's own work	13	36.11%
b) Keeping up with the contemporary literature relevant for the foreign language teaching field	5	13.89%
c) Attending seminars and workshops	27	75.00%
d) Presenting your own work at conferences	6	16.67%
e) Organized exchange of professional accomplishments	26	72.22%
f) Personal teaching experience	28	77.78 %
g) Study visits to foreign countries	2	5.55%

The second question was composed in order to investigate the teachers' opinions on the components of continuous professional education and development that would be most helpful for them as practitioners. More than one option was possible to be picked.

The results given in Table 2 show that the greatest majority of teachers consider that information about methodology and methods for conducting classroom research would be the most useful knowledge that would improve their work. What seems of almost equal importance is the knowledge that would arise from training about the methods for the survey of the contemporary literature, while the participants were a little less interested in training on presentation skills for revealing their own results of the conducted research (61.11%) and collaboration between the researchers and the teachers (44.45%). The survey clearly shows that the teachers need more knowledge on the skills that would help them learn the methods for doing self-supporting research.

Table 2 The most helpful components of continuous professional education and development

The options offered	Chosen answers	Percentage of chosen answers
Professional development should consist of acquiring knowledge about methodology and methods for conducting classroom research	32	88.89%
Professional development should consist of collaboration between the researchers and the teachers	16	44.45%
Professional development should consist of acquiring knowledge about the methods for the survey of the contemporary literature	31	86.11%
Professional development should consist of training on presentation skills for revealing personal results of the conducted research	22	61.11%

The third question was posted to explore the participants' opinions on the importance of the theoretically-grounded knowledge comparing to the practically- grounded knowledge within the teaching process. Only one option was possible to be chosen.

Table 3 Theoretically- grounded knowledge comparing to the practically-grounded knowledge

The options offered	Chosen answers	Percentage of chosen answers
Theoretically-grounded knowledge is more important than practically-grounded knowledge for the teaching practice	0	0%
Theoretically-grounded knowledge is less important than practically-grounded knowledge for the teaching practice	3	8.33%
Theoretically-grounded knowledge is as important as practically-grounded knowledge for the teaching practice	33	91.67%

Upon the analysis of the answers presented in Table 3, it is apparent that theoretically-postulated knowledge is considered very important for the teaching process, i.e. significant number of teachers declared that theoretical knowledge was as important as practical experience (91.67 %). Only 8.33% considered practically-grounded knowledge more important, while there was no teacher who considered that theoretically grounded knowledge was more important.

The fourth question was designed with the intention to explore the concrete teaching segment that would have most benefit for conducting different segments of continuous professional development if the teachers had more opportunity to learn how to do it. More than one option was possible to be chosen.

Table 4 Teaching segments that would have most benefit from more thorough professional education

The options offered	Chosen answers	Percentage of chosen answers
I would be more efficient in motivating my L2 students	11	30.55%
I would adjust my teaching better to mixed-ability classes	12	33.33%
I would be able to give more appropriate feedback to my students	6	16.67
I would be able to explore real learning needs of my L2 students	16	44.45%
I would be able to explore learning strategies of my students	14	38.89%
I would have more knowledge about what hinders and what promotes L2 learning	9	25.00%

The question posted to investigate the teaching segment that would have most benefit from continuous professional development showed that the participants had the greatest need for improving the segment concerned with exploring real learning needs of their L2 students (44.45%) as well as exploring learning strategies of their students (38.89%).

The survey also showed that professional education would help teachers to be more efficient at teaching mixed-ability classes (33.33%), motivate their students in the process of L2 learning (30.55%), find out about obstacles and boosters for L2 learning (25.00%) and give more appropriate feedback (16.674%).

6. Conclusion

One of the aims of the study was to track the contemporary forms of FL teachers' professional education and development in primary schools in Serbia in relation to the regulations prescribed by the official educational institutions. The main purpose was to detect the real needs that teachers as practitioners might have in real life teaching context in order to suggest some directions for further research in the field of FL continuous education.

The paper presented the literature review of the professional education and development with the most important theoretical stances, its application in the regulations prescribed for Serbian teaches' continuous education and development and its application in real-life teaching context. The results of the survey showed that primary school teachers had great interest for all forms of improvement and development but that on the other hand, they had the intense needs for more theoretical knowledge that would enable their self-regulated activities towards: research of their own teaching, keeping up with the contemporary literature relevant for the foreign language teaching field, collaboration between the researchers and the teachers, using knowledge to find out about real learning needs of their L2 students, learning strategies of their students, more efficient methods for teaching mixed-ability classes, motivation techniques for their students in the process of L2, obstacles and boosters for L2 learning and more appropriate feedback forms.

The findings of the study only confirm that teaching experience is one of the most fruitful sources of FL teachers learning, but that theoretical knowledge is necessary for making a solid scientific base out of variety of different pieces of information acquired thorough practical experience (Larsen-Freeman, 1990, p. 261). Identifying FL teachers' attitudes provides a basis for future improvements in the field, and helps overturn common misconceptions of the usefulness of the prescribed teachers' professional development agenda.

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Additional Abstracts

Strategic Quality Destination Management as a Tourist Product

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Abstract. In order to properly approach the strategic management of tourist product, it is necessary to define first the terms that are involved in this issue. Each term can be defined in many ways, depending on the point of view, the paradigm of the person defining it, its experience, beliefs and other factors. There are contradictions in the term "tourist product". Tourism is a tertiary activity and at its core are services, not products, while the concept of the product itself is predominantly related to tangible material structures of primary and secondary activities, so from this approach the above mentioned differences are obvious. The complexity of strategic quality management of the tourist product is reflected, on the one hand, in the implementation, harmonization, control and development of all elements of the tourist product in order to achieve the same quality level of all units of the tourist product, and, on the another hand, in creating conditions for efficient coordination of the public and private sectors. A quality tourist product implies a high degree of excellence, i.e. that all its elements have been developed, ready and able to provide such a quality service. In addition, in order to get a high quality tourist product, it is necessary to have the coherence of all involved holders of the tourist offers, a good organization in the tourist destination, a strong brand and image, and it is necessary to fulfill or even exceed the tourist expectations by ensuring a positive experience..

Key words: destination management, tourist product, strategic quality, organization, development

Reducing the Impact of Systematic Errors in the Direct Measurement of Electrical Quantities with a Digital Multimeter

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Abstract. A digital multimeter is sometimes an indispensable part of the measurement process. However, direct measurements of physical values performed by a digital multimeter cannot be accurate and precise through whole measurement ranges. Sometimes these deviations can be so significant that the quality of the measurement process becomes disputable. The final measuring result in those ranges have greater deviation than true value. The aim of this paper is to analyze the boundary areas and conditions which are connected with suspicious correctness of the measurement process, as well as to find solutions for reducing.

Key words: digital multimeter, measurement range, systematic error, gross measurement error, measurement result

The Interplay of Anxiety and Motivation in German Language Classrooms

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Abstract. It is a common belief among researchers that foreign language anxiety, along with other affective variables such as motivation, has a substantial impact on the process of language learning. The most research studies on the individual variables target learners of English as a foreign language. However, current trends towards multiculturalism and multilingualism have resulted in learning languages other than English. In Croatia, English is the most commonly studied language, followed by German. For this reason, the research presented in this paper aimed at exploring German language classroom anxiety (GLCA) and level of motivation to learn German language. The following questions are of particular interest:

- 1. To what extent do the students feel anxious in the process of German language learning?
- 2. What are the causes of GLCA?
- 3. Is learning German more anxiety-provoking than learning English?
- 4. To what extent do the students feel motivated to learn German?

Regarding the research questions, students are expected to feel motivated to learn German mainly for career purposes, but also more anxious while learning German than English due to their linguistic differences, the dominant status of English language and longer previous learning experience. The sample was composed of 70 business and engineering students from the University Department of Professional Studies, University of Split, Croatia, and data were collected by means of questionnaires and semi-structured interviews. If multilingualism is to be encouraged, investigating individual factors in learning languages other than English is a serious matter specifically in terms of practical implications for language education.

Key words: multilingualism, German language classroom anxiety, motivation

A Mixed Integer Programming Model for Product Mix Optimization Based on Time-driven Activity-based Costing

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Abstract. The ability to deal with external and internal uncertainties determines a company's development and future. Management accounting and the use of optimization models can have a positive contribution to the success of any organization. Although very studied, the product mix problem, the research on models for determining the optimal product mix using information from Activity-Based Costing (ABC) and Time-Driven Activity-Based Costing (TDABC) is still scarce. In the present work, a mixed integer programming model for product mix was developed and implemented in a Portuguese company specialized in manufacturing of shoe soles. The presented methodology incorporates information from the ABC and TDABC. Using real data from the company it was possible, making use of a tool develop in excel, to determine the quantities to produce, in order to obtain the maximum profit. This a tool that can assist the company's manager for deciding on which products to produce and in what quantities, as well as it provided information on the unused capacity of the resources. In fact, this new resource allows the company to adopt strategic measures to increase the demand for the product under analysis and, consequently, increase its production.

Key words: Activity-Based Costing; Time-Driven Activity-Based Costing; Product Mix; Optimization; Shoe Industry

Country Income Levels and Entrepreneur's Perceptions

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Abstract. In this study, entrepreneur's perceptions about national entrepreneurship framework conditions are analyzed in particular their significance in the Income Level of countries. For that multivariate statistical analysis tools are used and GEM 2015 NES Global National Level Data are considered. Then the results are compared with similar studies using previous GEM data sets, and with previous data. Also the Entrepreneurship Intentions GEM indicator was considered and the main national entrepreneurship framework conditions for improvement of these intentions are analyzed and their relation with income level.

Key words: Entrepreneur's perceptions, income level, entrepreneurship interntions

Innovation in the IPSS with Social Responses to the Older People in the North of Portugal

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Abstract. Innovation is born from the real value of its own word, as something new, revolutionary, that implies change and creates newness, which demonstrates the genuine involvement of interventions in its sense. To innovate is a visible result that represents a solution to a problem, more than the use of the word innovate, it is important to do differently and to walk effectively towards a resolution for the problems. With the creation of a positive impact in people, in their mentalities, in the processes, in the organizations and the results, i.e., in the quality of life and human development. As such, it has become pertinent to approach innovation in the social sector, with the goal to promote the knowledge of innovation in the Private Social Solidarity Institutions (IPSS) with social response to the older people in the north region of Portugal, wide-ranging the districts of Braga, Bragança, Porto, Vila Real and Viana do Castelo. The study includes two methods of investigation: quantitative and qualitative. The given results assess that the IPSS with social answers to older people show innovation, relating the several types of innovation. They also suggest that in those IPSS with social responses to older people, the orientation towards the apprenticeship, the risk taking, and work satisfaction have a positive impact on innovation. The study development cooperates towards a better decision call in the management of the IPSS, as well as in the decision call in the time to innovate in the IPSS.

Key words: Innovation, Social, Third Sector, IPSS, Social Responses, Older people.

Project Based Learning to Create Social Change amongst Millennial Students

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Abstract. In order to developed different skills in millennial bachelor students, universities need to use different and innovative practices. This paper analyses the use of a project branding classes, in which students had to develop a new socially responsible brand aiming to decrease the use of smart phones while driving. Students motivations such as collaborating, connecting with other groups from outside the university and the motivation to create social change, were the main motives for the project success. The benefits seen by senior staff is pointed as the main motive for implementing the innovative practice and the lack of recognition is considered the biggest disadvantage for senior lecturers.

Key words: Project based learning, case study, innovative teaching methodology.