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Article

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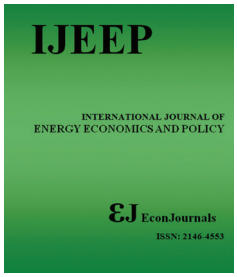

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Identification of the Starting Points of the Environmental Responsibility of a Transport Company Based on Multi-criteria Analysis

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ABSTRACT

Nowadays, the problem of environmental pollution and damage extends beyond the borders of individual countries. Thanks to progress in the scientific and technical field, the impact of human activity on the environment has been significant, which has caused damage and reduced the overall value of the surrounding environment. The paper aims to point out the environmental responsibility of companies in the field of public passenger transport as one of the possible forms of obtaining a better competitive position. An essential step in processing this issue was obtaining theoretical knowledge regarding the environmental responsibility of companies. We gained theoretical knowledge by studying domestic and foreign literature, emphasising scientific works devoted to the solved problem and published in impact journals. We applied the theoretical knowledge to a specific company in Slovakia's public passenger transport field, making it easier to understand the problem. As a result, more ecological and economic measures in the business to prevent environmental damage and reduce costs are to be introduced. To conclude, the analysed company could use saved funds for marketing activities to acquire new and retain current customers or improve its current competitive position.

Keywords: Environmental Responsibility, Environmental Behaviour, Transport Company, Energy Consumption, Emissions, Renewable Energy Sources
JEL Classifications: M1, Q2, Q5

1. INTRODUCTION

According to Keles et al. (2023), Kovac et al. (2020) and Nadanyiova (2017) business is generally considered the main culprit, resulting in mass production, marketing, consumption, and disposal, largely driving environmental degradation.

Experts in business ethics are divided in their opinion about the responsibility of business towards the environment. Some, such as Bowie (1990) and Sinha (2021), argue that corporations have no ethical responsibility to the environment beyond the demands of the law. Under this traditional, homocentric approach, a business is responsible for protecting the environment only if it contributes to the well-being of mankind (Erdogan et al., 2022). Another group of experts are represented with Hoffman (1991) and Zeleny (2008) advocates a deeper environmentalism based on the notion that nature itself has intrinsic value independent of its value to humanity. This assumption leads to a concept of business that is limited by the requirements to preserve the environment and even to the idea that companies should assess their activities in this regard, and limit or renounce them if necessary (Razumova et al., 2022; Horbach, 2008 and Ribeiro et al., 2022).

According to the findings of Li et al. (2018), Chen et al. (2018) and Li et al. (2018) we can say that companies focusing on operational,

but also longer-term goals in the field of environmental protection and responsibility, have an impact on both supplier-customer relations, but also on relations with the competition, which is the most responsive to innovation in terms of ecological management and ecological technology innovations. That allows companies to create a particular competitive advantage in the market (Cainelli et al., 2012).

On the other hand (He et al., 2018), point to a comprehensive conceptual framework that includes the sequence of terms "driver -> source -> position -> performance" (D -> S -> P -> P) of the field of innovation. This framework allows for examining the overall strategies of eco-innovations in the business environment for the organisation to gain competitiveness through their adoption, implementation, evaluation, and investment (Cubilla-Montilla et al., 2019).

As further suggested by Kuhn et al. (2018) and Solano et al. (2016) the efforts of organisations in the field of corporate social responsibility (CSR) should focus intensely on local philanthropy to achieve the highest possible effect from the adopted concept. This can lead to differences from Western CSR approaches.

While environmental responsibility is an important aspect and dimension of CSR, Vogel (2005) and Hussainey and Salama (2010) point to many shortcomings in environmental risk management. He often dis-cusses the emphasis placed on labour standards and argues that environmental management has a smaller share of these errors. It is precisely in applying environmental responsibility within the framework of CSR in developing countries that represent the most serious shortcomings (Arimany-Serrat et al. 2019).

Vogel (2005, p. 94) says that far fewer corporate and industrial codes regulate environmental practices than legal norms in developing countries. Although environmental problems are more serious in developing countries, there are far fewer voluntary corporate programs to minimise environmental risks (Gao and Yang, 2022 and Ghisetti and Rennings, 2014). In developed countries, more extensive government and legal regulations affect business practices. Despite this criticism, CSR is the most widely used global framework for addressing environmental risks and the consequent responsibility of companies (Cheng and Wu, 2015).

Zelený et al. (2011, p. 299) continues by saying that the following two basic and one additional goal, which have the same weight, are expected to the greatest extent from the environmental level of the enterprise. These goals are:

1. Adherence to relevant environmental legislation and standards: Slovak legislation uses the principle "what is not prohibited is permitted," but the question arises whether such behaviour is ethical. The second fact about Slovakia's environmental legislation and standards is that they mainly focus on determining values and limits that should not be exceeded (Huang et al., 2021). According to Zhang et al. (2018), Ruan et al. (2022) and Fabus et al. (2015) environmental regulation, as an important content of public regulation, is an effective approach to correcting market failure. The tightening of environmental regulation is an effective means of guaranteeing economic growth and optimising the quality of the environment.
2. Elimination or an attempt to minimise the environmental impact of the activities and activities carried out by the organisation on its affected surroundings and on itself: The question arises, who and according to what can assess whether a given impact on the environment is or is not acceptable (Wang, 2018)? The organisation often evaluated the same environmental impact as acceptable by the organisation, while the affected entity considered it unacceptable (Farrukh et al., 2022). Based on the research by Peters et al. (2018) and Tuczek et al. (2018), we can say that climate change makes it significantly more challenging to achieve the management goals that managers set their minds to.
3. To support the economic dimension and other dimensions of the development of the organisation and its competitiveness (Oberhofer and Furst, 2013).

According to Huang et al. (2018, p. 16), several non-governmental organisations are dedicated to information about the company's environmental responsibility within the CSR framework in the territory of the Slovak Republic. These organisations include:

- Centre for philanthropy
- Civic association PANET
- Integra Foundation
- Ponti's Foundation
- Institute for Economic and Social Reforms (INEKO).

As Gogova (2013, p. 253) says, the perception of the environmental responsibility of organisation by the Slovak inhabitants is one of the main factors in the success of this concept. Therefore, based on the assumption that the higher the level of awareness of the Slovak public about such a concept, the higher the possibility that people will realise their right to have a significant say in this area, mostly when it affects them (Chiou et al., 2011 and Cainelli et al., 2012).

Such a concept in Slovakia is promoted to the greatest extent, mainly by national and transnational organisations. As OECD (2020, p. 139) says, as Slovakia adapted to changes concerning other countries in a short time during the 1990s, the tasks resulting from the field of international cooperation in terms of environmental protection were considerable. Slovakia has ratified and implemented many international agreements focused on the environmental area (Nadanyiova, 2017). An example can be the Global Compact initiative, which was created within the framework of the UN, Guidelines for Multinational Enterprises established by the OECD, regulations of the Ministry of the Environment of the Slovak Republic and directives adopted by the European Union. Since Slovakia and many other countries are part of several transnational organisations, which were mentioned above, the regulations and centres for the mediation of information in the field of environmental protection are available and apply equally, flat rate for all members of these organisations (OECD, 2020).

The method of conveying information seems to be particularly important for small and medium-sized organisations (Farmer et al., 2007). They often lack knowledge of how to manage the

increasingly complex issue of environmental performance. They may receive guidance on managing these processes from other parties in the network, as suggested by (Graafland, 2018 and Murmura et al., 2018).

2. PURPOSE AND RESEARCH METHODS

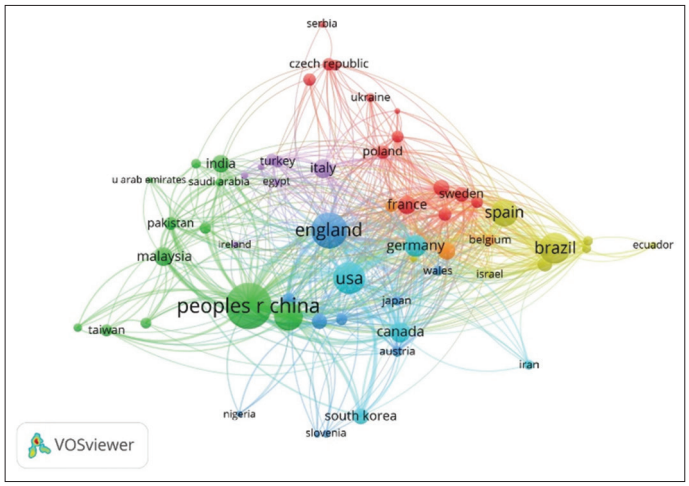
The paper aims to point out the environmental responsibility of companies in the field of public passenger transport as one of the possible forms of obtaining a better competitive position. By introducing more ecological and economic measures in the business, total costs would be reduced (Balsalobre-Lorente et al., 2018). The funds saved in this way could then be used by companies in the field of public passenger transport for marketing activities that would lead to the acquisition of new and retention of current customers or to improve their competitive position in the future (Povraznik et al., 2008).

An essential step in processing this issue was obtaining theoretical knowledge regarding the environmental responsibility of companies in Slovakia and abroad. We gained theoretical knowledge by studying domestic and foreign literature, emphasising scientific works devoted to the solved problem and published in impact journals. In the literature search, we ourselves to introducing the environmental responsibility of companies in Slovakia and abroad into the business environment, emphasising social responsibility and a selected problem in the given area.The VosViewer software was employed for an overview of connections between countries dealing with the topic of environmental responsibility. Six clusters were created based on Figure 1.

China dominates the green cluster. Brazil is the most important country in the yellow cluster. France plays an important role in this topic for the red cluster. The turquoise cluster is impacted by the United States. England is ruling in the blue one. Italy is the country discussing Environmental responsibility for purple cluster.

The bibliometric study also concentrated on the keywords linked with the supplied phrase that was used the most frequently.

Figure 1: Bibliometric analysis of countries dealing with the topic of environmental responsibility



Source: Own analysis as per WOS 2023

Figure 2, which was created based on more than 3000 papers discovered on the WoS website and published over the last 10 years (2013-2023), accurately depicts this reality. There were five clusters. Sustainability represented the green cluster.

We applied the theoretical knowledge to a specific company in Slovakia's public passenger transport field, making it easier to understand the problem. Additional information specifically focused on the selected company in the area of public passenger transport was obtained from the company primarily in the form of reports and annual reports (Internal Company Materials, 2021-2022).

Analysis was used to obtain the necessary data from the given issue. Through analysis, we have selected the most important ones from several facts. We used the analysis to define the environmental responsibility of the chosen company in the field of public passenger transport and its perception by interested parties, including their expectations of environmentally responsible business (Chocholac, 2017). Subsequently, with the help of synthesis, we summarised information from several areas of perception of the company's environmental responsibility, organised them into a clear and understandable whole and formulated the main benefits of environmental responsibility for the selected company. The result is a list of the selected company's strengths, weaknesses, opportunities, and threats in the field of environmental responsibility in Slovakia.

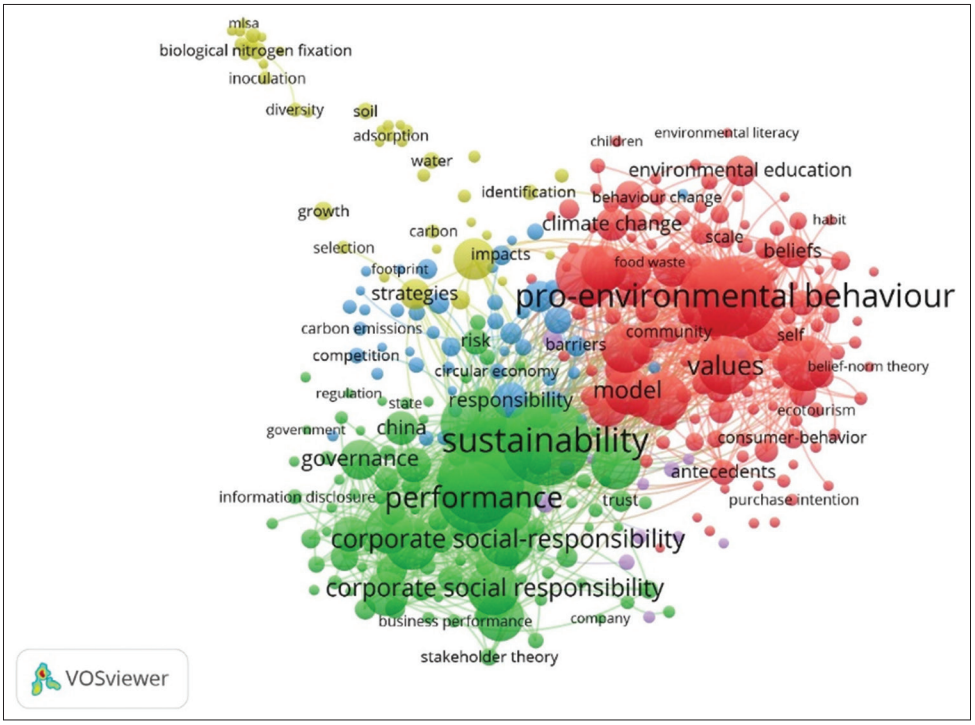
Based on data analysis from reports and annual reports (Internal Company Materials, 2021-2022), we economically evaluated the selected company from the point of view of energy resources. Among the indicators, we chose the indicator of diesel consumption, diesel engine emissions and the energy balance of the engine.

Based on the indicators of environmentally responsible businesses chosen by us and their non-compliance, we used mathematical and statistical methods, thanks to which we were able to express the subsequent effects on the chosen one in the area of environmental responsibility through graphs (Chocholac et al., 2017; Boratto et al., 2020 and Chapman, 2007). Among the selected indicators of the environmentally responsible business of the chosen company in the field of public passenger transport, we chose the indicators of the use of thermal energy, the reduction of the need for diesel and the use of electricity (Dogan et al., 2022 and Veterník and Gogola, 2017). Subsequently, we economically evaluated the selected proposals and classified them into three areas of solutions: Cost-free solutions, low-cost solutions and high-cost solutions (Global reporting Initiative, 2016).

3. RESULTS AND DISCUSSION

In the context of the GRI standards, the environmental framework refers to an organisation's impacts on living and non-living natural systems, including air, land, water, and ecosystems. The analysed company carries out various activities to protect the elements of the environmental framework of the GRI standards. For example, from the point of view of waste management,

Figure 2: Bibliometric analysis of keywords dealing with the topic of environmental responsibility



Source: Own analysis as per WOS 2023

the company we monitor has storage facilities for separable waste (BAE, 2016). From the point of view of biodiversity, the company uses organic mowing equipment that has zero emissions and contributes to the development of the flora in the purchased area.

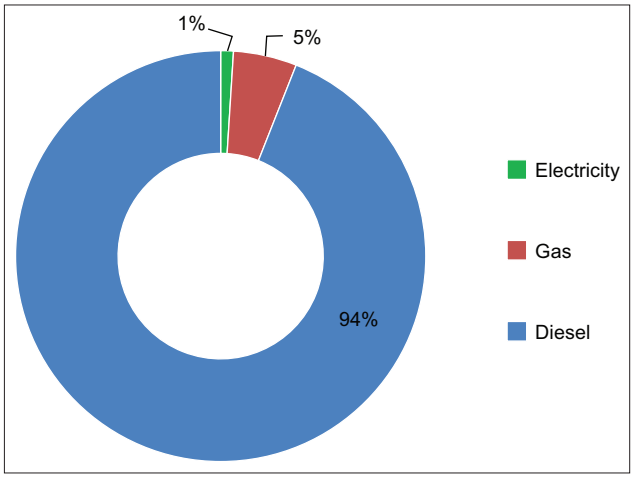
Since the company focuses on providing services in the field of transport, the most monitored component of environmental pollution is vehicle exhaust gases in the form of greenhouse gases, substances that damage the ozone layer, nitrogen oxides and sulphur oxides, which are harmful to the human body. Such exhalates are produced during the combustion of fuels, in our case, diesel (Internal Company Materials, 2021-2022).

Figure 3 visualises the percentage distribution of energy consumption in the analysed enterprise, where the most significant part of energy consumption is represented by diesel consumption, amounting to 94%. Another 5% of the consumption in specialised units is natural gas, and only 1% of the total consumed energy of the analysed enterprise is recorded by electricity.

Figure 4 points to the fact that 97% of the financial resources intended for energy consumption go towards the payment of diesel consumption.

Diesel is supplied to the company to the tank, from where it is pumped to individual buses via two dispensers. The advantage of such a form of pumping, i.e. on the premises of the company, consists in the fact that there is no need to go by bus directly to the sup-plier's gas stations, which reduces the total consumption of diesel fuel and, consequently, the number of emissions released into the air.

Figure 3: Percentage distribution of energy consumption in technical units



Source: Own processing based on internal company materials, 2021-2022

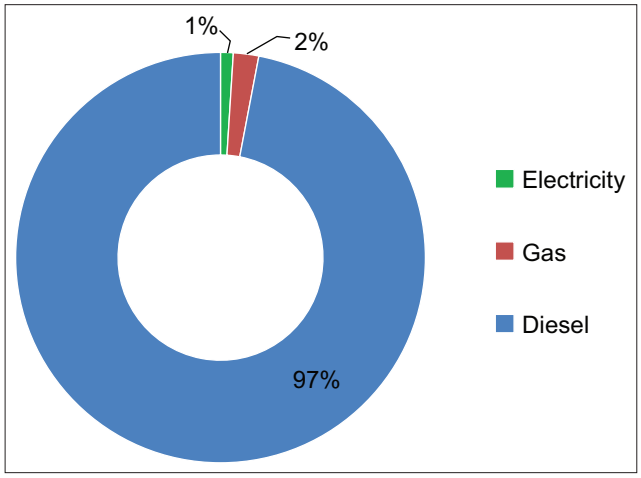
Figure 5 shows the diesel consumption by companies over 5 years in m^3. The consumption reached the highest value in the year Y1 and, conversely, the lowest in the year Y4. The reasons are the decrease in passengers transported by the company's buses and the gradual introduction of more economical and at the same time more ecological engines into operation.

The price for diesel in the years Y1 to Y2 is expressed in € per m^3 for a better picture of the situation on the fuel market. The exact values of diesel prices for the company are indicative, as they fall under the economic secrecy of the company. Figure 6 offers us an overview of the individual prices for diesel in a certain year.

After the determined consumption of diesel in m3 and the price per unit of diesel, we obtain the total indicative costs spent by the company on diesel (Figure 7).

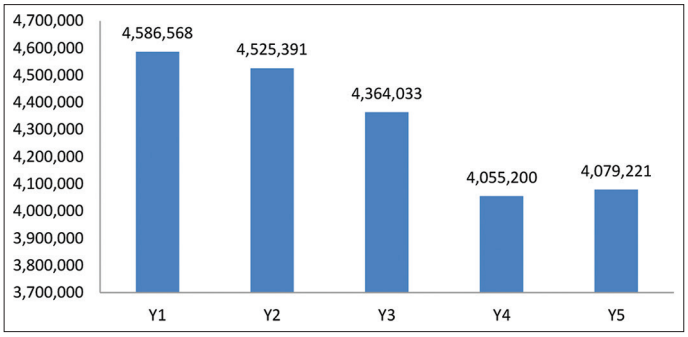
To develop an emission analysis of the enterprise, it is necessary to determine the number of passengers for the monitored period from year Y1 to year Y5 (Table 1). Based on the following table, we can say that individual numbers of passengers decreased over the years.

Figure 4: Percentage distribution of energy consumption in EUR



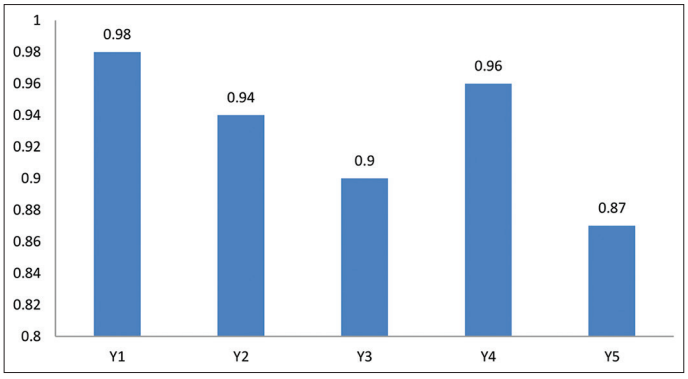
Source: Own processing based on internal company materials, 2021-2022

Figure 5: Diesel consumption in m^3



Source: Own processing based on internal company materials, 2021-2022

Figure 6: The diesel price in EUR per $1m^3$



Source: Own processing based on internal company materials, 2021-2022

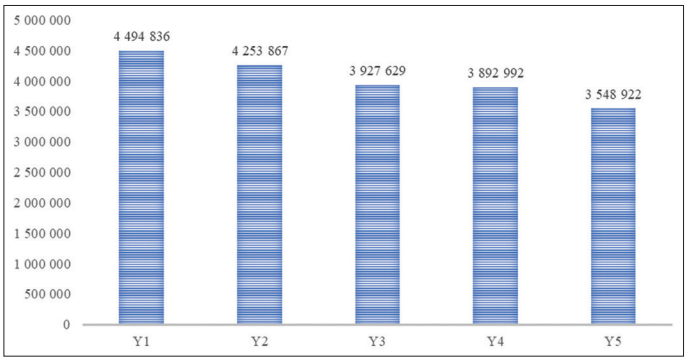
The current vehicle park of the analysed company consists of 241 diesel buses. It is necessary to point out that the gradual renewal of the vehicle park contributes to a large extent to the reduction of emissions produced by public mass transport vehicles. The composition of the current fleet is shown in the following table, from which we can read that 62 buses belong to the Euro III group, 119 to the Euro IV group, 6 buses to the EEV, and 54 buses belong to the Euro VI group, which are both the most economical and the most ecological (Table 2).

Each bus diesel engine of a certain emission class mentioned above has prescribed relatively strict limits that must be met to qualify for a specific emission class. These emission limits are shown in Figure 8, based on which we cannot deny the fact that Euro VI engines are among the most ecological, based on the smallest amount of pollution re-leased into the air per km.

Based on the obtained information (Table 3) regarding the level of diesel demand in the monitored years Y1 to Y5, the emission limits for individual diesel engines of the groups and the number of kilometres travelled by buses, we can calculate the total emissions released into the air by combustion engines for the monitored years (Figure 9).

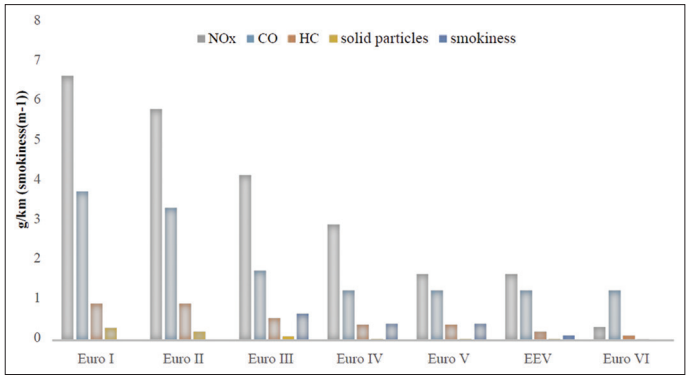
We can identify the decreasing tendency of the measured total emissions (Figure 10). This fact is a consequence of the company's

Figure 7: The diesel costs of the company in EUR



Source: Own processing based on Internal company materials, 2021-2022

Figure 8: Emission limits for diesel engines of buses



Source: Own processing based on internal company materials, 2021-2022

Table 1: The number of passengers

Year	Number of passengers
Y1	18,987,000
Y2	17,784,000
Y3	16,826,000
Y4	16,267,000
Y5	15,598,000

Source: Own processing based on Internal Company Materials, 2021-2022

Table 2: Content redistribution of buses based on emission class

Emission class	Number of vehicles
Euro III	62
Euro IV	119
EEV	6
Euro VI	54
Total	241

Source: Own processing based on Internal Company Materials, 2021-2022

Table 3: Number of kilometres driven by the company's buses

Year	Kilometres per year
Y1	14,459,476
Y2	14,406,770
Y3	14,095,617
Y4	14,146,421
Y5	14,226,565

Source: Own processing based on Internal Company Materials, 2021-2022

innovative and ecologically oriented policy, which replaces older buses using less ecological combustion engines (Euro I, Euro II and Euro III) with more ecological ones, namely buses with Euro IV, Euro V and Euro VI engines, which they achieve significantly lower emissions of harmful substances into the air for each kilometre driven.

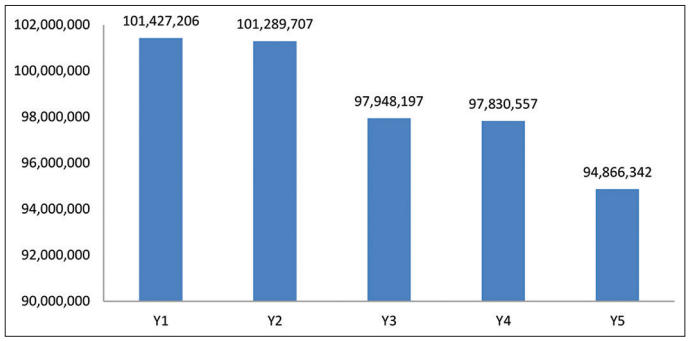
Through the obtained data on the number of passengers transported by the analysed company, the kilometres driven by the company's buses and the total amount of emissions of the buses that they achieved while performing such transportation, we get a picture showing the emissions per passenger in g/km for the monitored years Y1 to Y5.

Emissions per passenger for the monitored years show a growing character, as the number of passengers decreased by an average of 847, 250 each year. Still, the kilometres travelled by buses fluctuated around 14,266,970 km. From a practical point of view, we can say that there is no efficient use of the analysed transport company's bus capacities.

4. CONCLUSION, SUMMARY, RECOMMENDATIONS

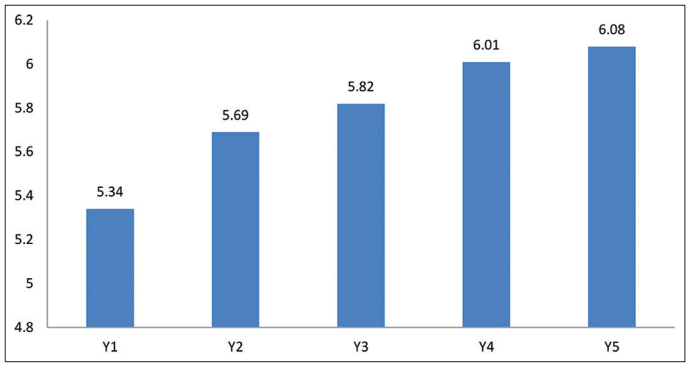
The current state of the environment is among the most recent topics of conversation in all sectors of every society that belongs to the developed world. Such problem extends beyond the borders of individual countries, and one cannot continue to close one's eyes or turn one's gaze away from it. Thanks to the progress in

Figure 9: Total emissions released into the air by buses for the relevant year in grams



Source: Own processing based on internal company materials, 2021-2022

Figure 10: Emissions per passenger produced by buses of the given company in grams per kilometre



Source: Own processing based on Internal company materials, 2021-2022

the scientific and technical fields, the impact of human activity on the environment has significantly deepened. That has damaged the environment considerably and reduced the overall value of the surroundings. Air, water, and soil contamination and pollution are the most severe consequences.

The current state ruling the Earth is more than critical, and to change it, the cooperation of all members of society at the global level is needed. It is the responsibility of companies for their activities at the environmental level that is one of the first steps to helping change the mentality of the community and, consequently, the overall environmental situation in the region, the country, and the whole world. Businesses can accept responsibility for their actions that can ultimately positively affect them at the market level, through increased competitiveness and a positive perception in the minds of potential and current customers.

The motivation for writing this paper was to offer a perspective on the environmental responsibility of companies as one of the possible forms of obtaining a better competitive position. Such position can be obtained through both the perception of customers and by introducing more ecological and economic measures into business, which would lower the overall costs of proper functioning in the future of the enterprise. The company could subsequently use these saved funds for marketing activities that

would lead to acquiring new and retaining current customers, or to improve its current competitive position.

4.1. Use of Thermal Energy

The following solutions represent the possibilities of measures to achieve a lower thermal energy requirement for the enterprise:

1. Hydraulic regulation: In addition to the fact that it is a legally prescribed part of businesses, it is a device that can reduce total energy costs
2. Replacing the current gas boilers with condensing ones: By replacing the cur-rent boiler in the boiler room and the boiler in the gas station with condensing ones, a re-duction in natural gas consumption will be achieved due to the higher efficiency of condensing boilers compared to the current gas boiler
3. Thermal insulation of the building: By thermally insulating the building - walls, roof and floor from the basement side - a substantial reduction in heating costs and better working conditions in winter and summer will be achieved
4. Replacement of door windows with better ones: Replacement of current low-quality windows with better ones with triple glazing, while most of them should be skylights, non-openable windows, and a minor part of openable windows.

4.2. Reduction of Diesel Consumption

In terms of energy consumption, diesel fuel, used in bus engines, is in the first place. Typical appliances are machines for transporting people, i.e. buses. A higher rate of diesel use, or diesel engines, in transport is justified by higher efficiency and torque than gasoline engines. The efficiency of diesel engines ranges from 38% to 51%, where 51% is achieved by engine sets used in large cargo ships and submarines - they are not produced for small volumes. Diesel engines are ranked among the less efficient than electric motors, whose efficiency is 85% to 95%, and their torque is significantly higher. Since no affordable and powerful accumulators on the market could store the energy equivalent of at least 100 litres of diesel in a diesel engine, diesel engines will still be used in the long term. Op-tions for reducing diesel consumption include:

- Switch to the use of biodiesel
- Hybrid buses
- Hybrid buses using brake force recuperation
- Only electric buses (mainly urban transport in the centre and housing estates).

Transition to biodiesel: Biodiesel is used and added to diesel at the supplier. The permitted standards for conventional diesel engines are 5% biodiesel and 95% diesel, but it is possible to obtain engines with 30% and up to 100% possibility of using biodiesel in combustion engines. These are Scania and Volkswagen engines.

Hybrid buses: Hybrid buses combine a classic diesel engine and an electric motor. The diesel engine can participate directly in the traction of the bus, and the electric motor helps in starting and braking. The second option is that the diesel engine operates in the optimal mode of power, torque, and lowest emissions, produces electricity that directly drives the electric motors, and part of it is stored in the accumulators. An electric motor provides traction (Figure 11). Advantages: longer range, access to cities with moderately strict ecological criteria (city centres). Disadvantages: higher price, weight.

The following image shows an illustrative photo of a hybrid bus offered by Solaris.

Hybrid buses using brake force recovery: Once the hybrid drive is built into the bus, the brake force can be used for recuperation. By recuperation, we understand the production of electrical energy by braking, which is stored in the accumulator and primarily used during the start-up, the most energy-demanding part of the drive. Advantages: longer range, access to cities with moderately strict ecological criteria (city centres), lower diesel consumption thanks to energy recovery. Disadvantages: higher price, weight.

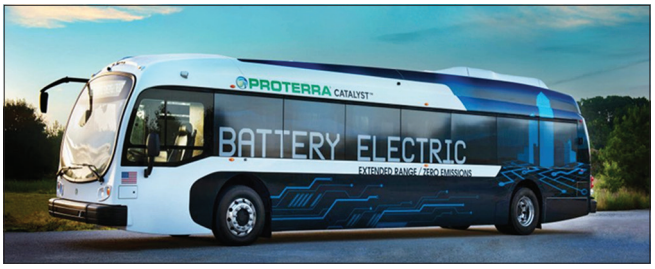
Only electric buses: Where, from the point of view of environmental protection, it is not possible to use classic combustion engines, buses with an electric drive are the most suitable. The energy supply is only in the accumulator, where it is replenished from the network at night, during the day from photovoltaic power plants and from the recovery of braking power while driving (Figure 12). Advantages: access to cities with strict ecological criteria (city centres), thanks to energy recovery, lower energy consumption per 1 km. Dis-advantages: still shorter range, higher price, weight.

The following image gives us a glimpse of Proterra's Catalyst all-electric bus, which provides zero air emissions while driving and an extended battery capacity that results in a longer range per charge.

Minimum energy balance of the electric bus: If we start from the assumed route we used as part of the analysis, then the electric bus should reach the minimum energy balance in € for the same path, described in the following figure. Compared to a regular diesel engine, we can say that even with a minimum engine balance, there is a more important use of invested funds for work, specifically by

Figure 11: Solaris hybrid bus

Figure 12: Proterra catalyst pure electric bus



85% and with a 15% loss of invested funds in engine operation (Figure 13).

Maximum energy balance of an electric bus: The following figure shows the maximum energy balance of an electric bus in € that can be achieved (Figure 14).

Comparing a bus with a diesel engine and a bus with an electric motor, the savings range from €43.80 to €52.40, a percentage of 48-53%. Assuming the average consumption for the last three monitored years of 2014, 2015 and 2016 in the amount of €3,789,848, the savings potential is €1,819,127 to €2,008,619.

4.3. Use of Electricity

In this section, we offer individual options for solving the energy requirements of the company Slovenská autobusová doprava Žilina, a joint-stock company from the point of view of electricity. Among these solutions, we can include:

1. Replacement of the current transformer with a more efficient one: Replacement of the current morally and technically outdated transformers with more modern and economic ones. The new directive of the European Union no. 548/2014 talks about the need to increase the efficiency of transformers by 20%. Current transformers with a power of 200kVA can be replaced with the same power, but with lower consumption.
2. Lighting: the possibility of gradually switching to more powerful lamps in the form of modern fluorescent lamps and efficient LED lighting with the greatest possible light flux ratio. When designing and purchasing new lighting, paying attention to the ratio of luminous flux and lifetime is necessary. The prices of light sources with LED sources are falling, and their return is more than considerable in a short time horizon. It is also crucial to regulate the lighting so that the lighting at the windows is switched off during the day and is left on only in office spaces and in spaces where there is no daylight.
3. Solar collectors: In our geographical area, solar collectors can be used for heating hot, processing water, or cooling in the summer. The use of solar radiation is described in the following figure.
4. Photovoltaic power plant: Photovoltaic power plant is one of the best renewable energy sources. Current legislation limits the performance of resources that distribution companies purchase or give extra. Thus, there is a possibility of building such a power plant on the roof of the main building, where there is sufficient space. This electrical energy would not be sold; it would serve for direct business consumption.

Figure 13: Minimum energy balance of the electric bus in EUR

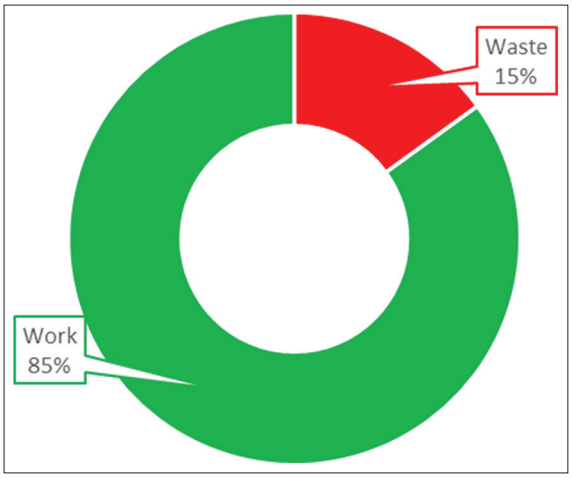
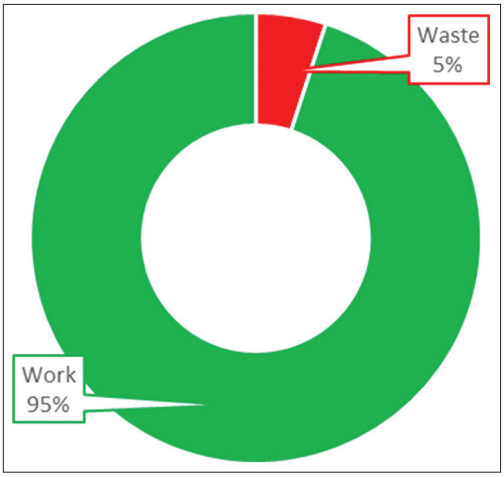


Figure 14: Maximum energy balance of the electric bus in EUR



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