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## Article

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## APPLICATION OF DESIGN MANAGEMENT SKILLS TO SUPPORT THE USE OF DESIGN IN PRODUCT INNOVATION

**Abstract.** Although companies in Slovakia achieve value in the use of design at the level of the European Union average, the lack of knowledge and information about the possibilities and potential benefits of design hinders the effective use of design as a key factor in successful innovation. Good design does not just happen by chance. It is usually the result of a well-managed process. Design management is becoming necessary because it allows the company to reflect the market's needs better and adapt to customers. When design management is part of a company's management processes, the design would significantly impact the company's economic performance and help ensure a competitive advantage in the market. Lack of design management skills is a major obstacle to the wider deployment and integration of design into companies. The paper aims to verify the impact of the achieved level of design management skills on the use of design in product innovation. Through a survey of Slovak companies in selected industries, the authors identified the attitude of companies to the use of design in product innovation. The authors used statistical methods to analyse the level of skills achieved in individual areas of design management. They identified the impact of the level of skills on the design use rate in innovation. This study includes factor and regression analysis methods. The design management skills assessment survey confirms the relationship and correlation between the level of design management skills and the intensity of the use of design in product innovation. The ability to engage others has emerged as the weakest in the design management skills assessment survey. Involving customers and suppliers and creating interdisciplinary teams could bring the company effective use of design in product innovation and thus achieve a significant and sustainable competitive advantage. According to the confirmed results, companies' training to gain the necessary skills in individual areas of design management should increase the level of mastery of these skills and consequently support the use of design in product innovations.

**Keywords:** product, innovation, design, design management skills.

**Introduction.** In today's economic conditions, companies are increasingly interested in gaining and maintaining a competitive advantage in the marketplace. As a result of easier access to the same technologies, with firms increasingly competing with the same price and functionality products, design has emerged as a key element bringing differentiation and competitive advantage.

Despite the growing interest in design and its use in product innovation globally, it is not entirely clear to firms what benefits design could bring them and why they should include design in their corporate strategy. Measuring the financial impact of design is a complex and time-consuming discipline. It is difficult to obtain accurate data demonstrating a direct correlation between design and increased product sales or other economic indicators.

Although firms in Slovakia are performing at the European Union average in the use of design, the lack of knowledge and information on the opportunities and potential benefits of design hinders the

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effective use of design as a key factor for successful innovation. The survival and profitability of a company are affected by its ability to innovate quickly to meet the changing requirements of the market, which push the company's growth based on its innovative competence (Knoskova, 2015).

Good design does not just appear by chance. It is mostly the result of a well-managed process. Design management is becoming necessary as it enables a company to reflect the market's needs better and adapt to customers. When design management is part of the firm's management processes, the design would significantly impact the firm's economic performance and help secure a competitive advantage in the marketplace. The lack of design management skills is a major barrier to firms' wider adoption and integration of design.

In his study, Hernandez (2017) concluded that design improves the consumer experience, connecting the company with customer needs, thus creating a link between design and innovation. According to his research, the main reasons for using design in the company were developing high-quality/innovative products and services and their differentiation.

Product innovations include new or substantially improved products or services. Product innovation means a significant improvement in technical specifications, various components and materials, existing software, user-friendliness, or other functional features (Dunska et al., 2018)

A company could gain a competitive advantage through product innovation by differentiating its products and increasing product quality and diversity, allowing it to increase demand and open new growth opportunities (Leon et al., 2005; Brad, 2008; Camison and Lopez, 2010).

The study's results (Alghanmi, 2020) showed a positive correlation between innovation strategies and competitiveness. Innovation strategies significantly affected the competitiveness of SMEs.

**Literature Review.** The growing interest of companies in design benefits has led to the development of various models and tools that aim to understand design in companies depending on how companies use it and their attitude towards it. The effective use of design and design resources available to the firm in line with its objectives is represented by design management. It is directly related to the positioning of design in the organizational structure, the identification of specific design knowledge relevant for addressing key management issues, and the training of managers in the effective use of design.

The scope of design management ranges from operational management of project design and development, including design teams, operations, processes, and methods, to strategic design scaling across the company (Kramolis and Stankova, 2017).

The European Commission considers design management as a competency that falls under innovation management, recognizing that companies need the ability to innovate to respond to new market opportunities and threats (Kootstra, 2009).

Although the design is increasingly recognized as an important marketing tool, design management is still an ignored component of its success. However, good design does not just occur by coincidence but emerges as a result of a managed process.

Nagy (2010) defined design management as a set of specific activities within a firm's organization that start from the design process through the development and production process to the actual sale or distribution. At the same time, design management is a process between two distinct environments – the creative or creative process and the business environment. Each of these environments has its own goals, values, and culture, and design management should act as a link between them.

A more extensive definition of design management is provided by Gorb (2001). The scholar noted that design management is the integration of design into the firm's overall management and the influence of the firm's overall management on design. Design management is related to the positioning of design within the firm's organizational structure. As long as it is fully integrated into the firm's processes, the firm focuses mainly on so-called user-centered design, and its processes are adjusted in this direction. At the same

time, design management requires certain management practices and skills that enable the firm to achieve the good and effective design.

Ahire and Dreyfus (2000) showed that design management positively impacts product design performance and process quality management. Good design and design investment alone would not automatically lead to a more successful firm. Design enhances firm performance when it is the result of a well-managed process. The right skills are needed to implement an effective and efficient design process. Only then can design have a positive impact on firm performance.

Chiva and Alegre (2009) analyzed the impact of design investment on firm performance and how this relationship is affected by design management skills. Their study suggests that firms that manage design effectively and efficiently perform better than those that manage it inefficiently. Therefore, good design does not emerge by chance or by simply investing in design but rather because of a management process. Many companies currently do not use design consciously, systematically, or strategically. That is, even though design as an innovative activity seems particularly suited for small and medium-sized firms due to the relatively low capital requirements and rapid return on investment (Kootstra, 2009).

According to Best (2006), design management illustrates three main stages:

1) managing design strategy – mainly includes implementing design into organizational strategy, identifying opportunities for design, interpreting customer wants and needs, and finding benefits of design for the business;

2) managing the design process – implementing and making the design visible; it helps the company to identify opportunities for specific projects focused on design, creative team development, and visual communication in the company;

3) design implementation management – focuses on the concrete management of the project in practice, design specification, setting the level of collaboration, ethical responsibility, and project evaluation.

Bruce and Bessant (2002) listed the main benefits of design management: increasing profits by increasing sales or reducing production costs, increasing market share, gaining a competitive advantage, improving failing products, and providing a growth strategy. Gerlitz (2016) uncovered how to design integration and design management manifest themselves within SMEs and to what extent they create value. The author proposed design management as a central domain of smart and sustainable companies. Kramolis et al. (2020) showed that the utility value of a product could be significantly increased by design management.

Caban-Piaskowska (2019) mentioned that firms that use design management share several common characteristics:

1) products are experiential goods; they are unique, innovative, high value-added, and are tailored to individual customer needs;

2) design work is art – artists make products, and their work is considered art; there is a strong connection between the artist/designer and the entrepreneur;

3) collaborative working in interdisciplinary teams – a key determinant of the functioning of design management is interdisciplinary project teams, in which the high qualifications of different professionals could be used simultaneously, leading to synergistic effects;

4) design thinking – firms (where design management is applied) tend to apply the concept of design thinking, which is based on teamwork and collaboration between very different disciplines, such as technology, marketing, or crafts.

**Methodology and research methods.** The paper aimed to verify the impact of the achieved level of design management skills on the use of design in product innovation. In line with the aim of this paper, a hypothesis was set as follows:

H1: The level of design management in a firm influences the intensity of the use of design as product innovation.

The primary research object was Slovak companies with predominant activity in the industrial production sectors. The target set was created from the Finstat register of firms and consisted of 1516 Slovak firms. The firms were selected randomly from each layer of the technology sector. The size category of the firm and the regional representation (Bratislava region, West Slovakia, Central Slovakia, East Slovakia) were also taken into account. Complete data and valid email contacts were a prerequisite for the inclusion of a company in the target set. The online survey was conducted between July and September 2021, when we distributed the questionnaire to the selected firms. The survey sample was supplemented with the results of the face-to-face data collection, which occurred in October-November 2021. After data cleaning, we worked with a sample of 239 firms from different areas of industrial production.

The survey aimed to determine the attitude of firms operating in the Slovak Republic in selected industrial sectors at the high, medium, and low technology levels towards innovation, the use of design in product innovation, and the level of skills attained in particular areas of design management. The survey was carried out by asking the respondents through a standardized structured questionnaire. The questionnaire was divided into several sections that focused on the areas of (1) the use of design in innovation, the benefits of design in product innovation for the firm; (2) the five factors of design management; (3) the economic benefits of design for the firm.

The firms were analyzed according to several segmentation criteria: 1. technological intensity of the industry (low, medium, and high technology), 2. legal form of the firm, 3. a number of employees, 4. length of the firm's presence on the market, 4. average annual turnover, 5. headquarters of the firm in Slovakia.

The technology sector grades are defined according to the R&D intensity of the industry (R&D expenditure/value-added). In total, 134 firms (56%) participating in our survey are in the low-technology sector, 42 firms (18%) are in the medium-technology sector, and 63 firms (26%) are in the high-technology sector.

To evaluate the data, we used graphical methods of data processing, which gave us a clear display of the results obtained. From the mathematical-statistical methods, we used factor analysis.

Factor analysis is a multivariate statistical method aimed at creating new variables and tries to reduce the scale (reduction) of data with the least loss of information. Factor analysis identifies those correlated with each other based on the correlations between multiple pre-variables. It creates so-called factors from closely interrelated factors, thereby reducing the number of variables into a smaller number of factor-tors. There are two types of factor analysis: exploratory and confirmatory. Exploratory factor analysis was designed to discover hidden factors within a group of pre-variables when we do not know in advance exactly what relationships to expect between them. In contrast, confirmatory factor analysis was designed to verify the already known, expected existence of factors in advance (Soukup, 2021).

Other important concepts include factor loading, saturation, or factor charge, which refers to how much of the variability in a particular variable  $X_i$  is explained by a particular factor. Halama (2011) also describes it as correlation with the factor, which, like the correlation coefficient, takes values from -1 to 0 in the case of an indirect relationship or from 0 to 1 in the case of a direct relationship. The closer the values are to 1, the more the variable saturates a given factor. Confirmatory factor analysis, which assumes that the factor structure is known, was used to check the validity of the measurement scales. The factor structure for design management is based on a study by Dickson et al. (1995) and by Chiva and Alegre (2009).

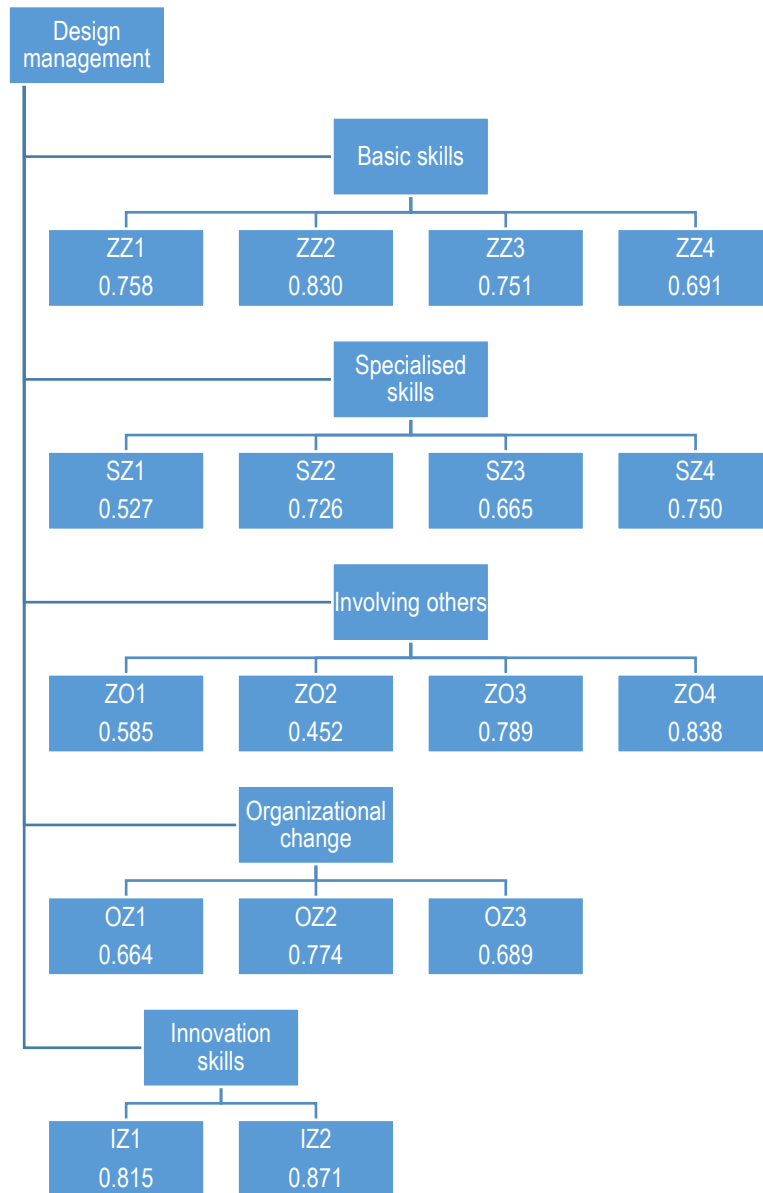
The relationships among variables were expressed using correlation coefficients which were tested for statistical significance of the model. The Pearson's sample correlation coefficient takes values from the interval  $(-1 ; 1)$  and expresses the degree of linear correlation-dependence between variables  $X$  and  $Y$ . The closer the value of  $|r|$  is to 1, the stronger the linear dependence, and the closer the value of  $r$  is to 0,

the weaker the linear dependence. There is an orientation scale to assess the tightness of the linear dependence of the variables between X and Y: (1) Weak dependence if  $0 < |r| \leq 0.3$ ; (2) Moderate (medium) dependence if  $0.3 < |r| \leq 0.8$ ; (3) Strong dependence if  $0.8 < |r| \leq 1$  (Ostertag, 2013). Using statistical significance tests of regression analysis, we tested the accepted hypothesis.

**Results.** Seven-point Likert scales were used to assess the five factors of design management skills based on the work of Dickson et al. (1995) and confirmed in the study by Chiva and Alegre (2009). The authors propose five factors in design management. The factors have similar levels of importance, include many of the skills and activities highlighted in the literature, and are empirically supported. This research rests on these five types of factors: (1) basic skills, (2) specialized skills, (3) involving others, (4) organizational change, and (5) innovation skills. Core skills represent mastery of the basic activities in the design process. Among the basic skills in the design process are activities such as designing products for high quality, manufacturability, and low cost, faster design process, and bringing new products to market. All of these skills are considered essential for the design process. Roy and Riedel (1997) found that commercially successful product development projects focus on product performance and quality and, where appropriate, on technical or design innovation and pay more attention to actual product improvements than to cost reduction alone. Specialized skills include mastering certain specialized activities, such as estimating the cost of a new product during the design process, using the latest computer-aided design tools effectively, testing the manufacturability of new products during the design process, and finding people with excellent design skills. The third skill, involving others, is involving customers and suppliers in the design process and soliciting new product ideas from customers. Gorb and Dumas (1997) emphasize that the product design process requires the presence and active involvement of various actors such as customers and suppliers. Organizational change management skill is the ability to manage change, change the established ways of doing things, and collaborate different functions in the enterprise. Some authors stress the importance of communication between design and marketing, sales, engineering, or research departments to stimulate dialogue with other areas around product development. The fifth skill is the ability to drive innovation by thoroughly and quickly learning about competitors' innovations and advances and finding new design ideas. According to Chiva and Alegre (2009), one of the most important aspects of design management is a thorough knowledge of the company and its competitors. This aspect is an input to the innovation process. Each of the above skills was surveyed by a certain range of questions in the questionnaire. Confirmatory factor analysis was used to confirm the correctness of the structure of each skill.

Confirmatory factor analysis of a 5-factor model of design management. The confirmatory factor analysis aimed to empirically test and confirm the factor structure based on grounded theory. Figure 1 shows the 5-factor model of design management validated by confirmatory factor analysis with the indicated single factor loading values for each variable.

Explanations of abbreviations of individual variables: ZZ1 = Design with a focus on product quality, ZZ2 = Design with a focus on product manufacturability, ZZ3 = Consideration of costs in product design, ZZ4 = Faster design and launch of new products, SZ1 = Effective use of the latest computer design tools, SZ2 = Estimation of actual costs for new products during the design process, SZ3 = Finding people with excellent design skills, SZ4 = Testability of new products during the design process, ZO1 = Involving customers in the design process, ZO2 = Involvement of suppliers in the design process, ZO3 = Getting new product ideas from customers, ZO4 = Getting new marketing and sales ideas, OZ1 = Change of traditional ways of work (external cooperation, online systems, etc.), OZ2 = Joint work of various functions/departments in the company in creating a new product, OZ3 = Involving employees in the creative process - in creating new ideas. IZ1 = Searching for new design ideas - not just imitations, IZ2 = The study rapidly aware of the innovations and imitations that competitors are making.



**Figure 1. 5-factor model of design management validated by confirmatory factor analysis**  
Sources: developed by the authors.

The values of the selected confirmatory factor analysis indices and the chi-square test show acceptable values (Table 1) and enable us to conclude that the developed 5-factor model presents a good fit with the real data and is, in this form, applicable and suitable for the processed data.

**Table 1. Model characteristics**

Index	Value
Comparative Fit Index (CFI)	0,982
Bentler-Bonett Normed Fit Index (NFI)	0,969
Bentler-Bonett Non-normed Fit Index (NNFI)	0,977
RMSEA	0,088
Chi-square test	$\chi = 260.385$ ; ( $p < 0.001$ ); df = 109

Sources: developed by the authors.

Evaluation of design management factors. The survey findings suggest (Table 2) that firms are best at managing the area of core skills, which includes designing high-quality, easy-to-manufacture, low-cost products, faster design processes, and new product launches. It is followed by the area of innovation skills, which includes the area of finding new design ideas - not just imitations and awareness of innovations and imitations of their competitors. As rated by firms, the least managed area can be identified as the design management area, which includes the ability to involve others (customers and suppliers) in the design process.

Comparable results have been obtained in surveys of some foreign studies. Dickson et al. (1995) showed that CEOs of top USA companies have the greatest difficulty designing manufacturable products, involving suppliers in the design process, and estimating costs. Respondents were more confident in handling marketing tasks such as generating new design ideas and involving customers in the design process. Chiva and Alegre (2009) investigated the design management skills of Italian and Spanish ceramic tile manufacturers. They scored the lowest on specialization skills (estimating actual costs, testing new products during the design process) and the best on innovation skills (searching for new ideas, information about competitors' ideas).

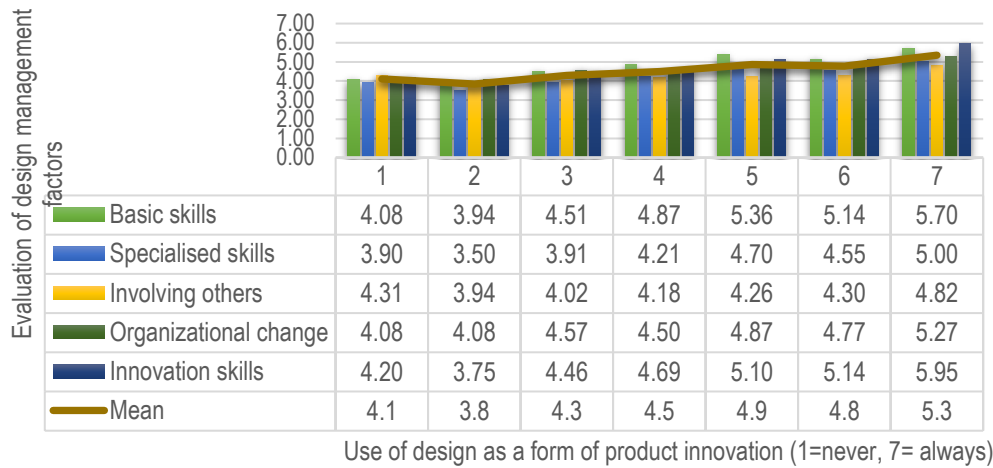
**Table 2. Evaluation of design management factors - mean, standard deviation, and distribution of responses**

Design management factor	Mean	S.D.	Min	Max	25 <sup>th</sup> percentile	50 <sup>th</sup> percentile	75 <sup>th</sup> percentile
Basic skills	5.20	1.47	1	7	4	5	6
Specialized skills	4.57	1.65	1	7	4	5	6
Involving others	4.37	1.59	1	7	3	4	6
Organizational change	4.86	1.58	1	7	4	5	6
Innovation skills	5.15	1.55	1	7	4	5	6

Sources: developed by the authors.

In our research, we investigated the impact of the achieved level of design management skills on the intensity of design use in product innovation. The findings showed the level of achieved skills in each area of design management increases, and the frequency of using design used in innovation increases at the same time (Figure 2). Firms that reported that they always or almost always use design in product innovation rated their design management skills on average 4.8-5.3 out of a 7-point rating scale. Firms that indicated that they use design very often or often in product innovation rated their design management skills on average 4.3-4.9 out of a 7-point rating scale. Firms that reported that they use design only occasionally or never in product innovation rated their design management skills the lowest. These firms averaged 3.8-4.1 on a 7-point rating scale.





**Figure 2. The relationship between the achieved level of design management and the extent to which design used as a form of product innovation**

Sources: developed by the authors.

Based on the model characteristics presented in Table 3, we can test the stated hypothesis.

H1 The level of design management in a firm influences the intensity of the use of design as product innovation.

The study hypothesis was whether the level of design management achieved in a firm influences the intensity of the use of design as product innovation. The findings established the null hypothesis, which was subsequently tested.

H0 – There is no relationship between the use of design in product innovation and the level of design management.

The correlation coefficient between the two variables shows a moderate positive correlation with a value of 30.5%. The correlation coefficient is statistically significant at a 1% significance level. Thus, the null hypothesis H0 was rejected. There is a statistically significant relationship between the level of design management knowledge attained and the use of design as a form of product innovation in firms. The hypothesis H1 was accepted.

**Table 3. Model characteristics**

MODEL	Summary of the model		Anova		Coefficients of the regression equation		
	R	R <sup>2</sup>	F-test	p-value	b <sub>0</sub> , b <sub>1</sub>	t-test	p-value
dependent variable = design as innovation	0.305	0.093	18.219	<0,001	b <sub>0</sub> = 2.437	4.003	<0,001
independent variable = design management					b <sub>1</sub> = 0.527	4.268	<0,001

Sources: developed by the authors.

**Conclusions.** Creativity and design are linked to innovation. The role of design is to turn creative thoughts and ideas into products and make products commercially acceptable, friendly, and appealing. Product designers focus on improving the ease of use of products, and their graphic and aesthetic features

help differentiate competing for product offerings and attract customers. Increasing competition, technological change, and consumer behavior changes require new solutions and unconventional approaches to product design. Of the managerial skills in design, firms are best at mastering the core skills area, which includes designing products for high quality, manufacturability and low cost, faster design process, and new product launches. It is followed by the area of innovation skills, which includes the area of finding new design ideas, but not just imitations and awareness of their competitors' innovations and imitations. The least managed area, as rated by the firms, is the area of design management, which includes the ability to involve others (customers and suppliers) in the design-new process. Confirmatory factor analysis confirmed that the developed 5-factor model of design management skills presents a good level of fit with the real data and is applicable and suitable for the processed data in this form. The findings showed that product design needs to result from a well-managed process for which the right skills are needed. The impact of product design on firm performance varies depending on the skills and capabilities of the people involved in the design process. These skills, believed to facilitate the design process, are considered design management skills. Although business managers recognize the importance of design, design management is an often ignored component of design success. The companies' training to achieve the necessary skills in the individual areas of design management should increase the level of mastery of these skills and consequently promote the use of design in product innovation. The ability to engage others came out as the lowest-ranked in our design management skills assessment survey. Involving customers and suppliers and forming interdisciplinary teams can bring about a firm's effective use of design in product innovation and thus achieve a significant and sustainable competitive advantage.

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**Дизайн-менеджмент як інструмент створення інноваційного продукту**

У рамках даного дослідження, авторами розглянуто питання щодо дизайн-менеджменту. У статті зазначено, що рівень дизайн-менеджменту в Словаччині є середньостатистичним у порівнянні з країнами Європейського Союзу. Однак, брак знань та інформації про можливості та потенційні переваги дизайну заважає ефективному його використанню як ключового фактору успішного впровадження інновацій. Авторами відмічено, що влучний дизайн є результатом добре керованого процесу та не виникає випадково. Управління дизайном стає необхідністю, оскільки дозволяє компанії більш повною мірою задовольняти потребам ринку та адаптуватися до клієнтів. Авторами наголошено, що дизайн матиме значний вплив на економічні показники компанії та сприятиме забезпеченню конкурентних переваг на ринку, за умов інтеграції дизайн-менеджменту у процес управління компанією. Метою статті є перевірка впливу досягнутого рівня навичок в дизайн-менеджменті на ефективність розроблення дизайну інноваційного продукту. Для досягнення поставленої мети проведено опитування словацьких компаній у вибраних галузях. За отриманими результатами визначено ставлення компаній до дизайну в інноваційних продуктах. За допомогою статистичних методів проаналізовано рівень навичок, досягнутих в окремих сферах дизайн-менеджменту, а також виявлено вплив рівня навичок на процес розроблення дизайну інноваційного продукту. Емпіричне дослідження проведено з використанням інструментарію факторного та регресійного аналізів. Результати опитування підтвердили взаємозв'язок і кореляцію між рівнем навичок в дизайн-менеджменті та інтенсивністю використання дизайну інноваційних продуктах. Авторами зазначено, що залучення клієнтів та постачальників, а також створення міждисциплінарних команд може забезпечити компанії ефективне використання дизайну при розробленні інноваційного продукту і, таким чином, досягти значної та стійкої конкурентної переваги на ринку. За результатами дослідження встановлено, що навчання працівників необхідним навичкам в окремих сферах дизайн-менеджменту сприятиме підвищенню рівня конкурентоспроможності компанії.

**Ключові слова:** продукт, інновації, дизайн, навички управління дизайном.