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ENVIRONMENTAL SUSTAINABILITY IN DIGITALIZED SMEs: COMPARATIVE STUDY FROM POLAND AND SERBIA

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Abstract

Pandemic times and an increasing pace of sustainable development have accelerated the process of Industry 4.0 implementation. Digitalization is one of the key issues of Industry 4.0 development. The paper investigates an identified research gap on the perception of digitalization in terms of environmental goals and sustainability in the SME sector. The study features a comparative research design and examines the perception of digitalization in small and medium-sized enterprises in Poland and Serbia. The study gathered 235 responses on the impact of Industry 4.0 and digitalization in SMEs on environmental issues and sustainable development. Findings revealed that digitalizing the company has a positive effect on reducing carbon emissions. However, statistically significant discrimination in reducing harmful emissions was found between Poland and Serbia. Provided research procedure further adds to the practical implication in finding carbon emissions as the most important issue in sustainable development in the SME sector.

Keywords: Industry 4.0, sustainability, digitalization, small and medium-sized enterprises SME, economy

1. INTRODUCTION

The industrial revolution, called Industry 4.0 (I4.0), appears to be developing into a natural element of the present time. I4.0 is beginning to firmly settle down in the economic and social reality and become its integral part. The pandemic times have

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additionally strengthened and accelerated this process.

The pace of development in each subsequent revolution increases, and at the same time, the broader context of sustainable development is emphasized. It is unacceptable to focus solely on maximizing economic profits in today's world without incorporating social and environmental responsibility policies (Baltazar & Lopes, 2021). These processes are introduced into the financial management of entities and reflected in the development of integrated reporting (business model, environmental protection, cybersecurity reporting and others).

Sustainable social and economic development is naturally connected with digitalization issues. Terms "sustainability" and "digitalization" seem closely related and interdependent in many areas. Digitalization is an inevitable phenomenon in the modern world. A similar situation relates to sustainability. Today's world, in which sustainability has become one of the leading goals in practically every dimension, cannot function without digital facilities. The industry is an area where digitalization plays a vital role. Accordingly, these areas can be studied in correlation.

Sustainability steams from an organizational perspective, guiding the direction of organized activities. To transform the world, the United Nations (UN) established an action plan for people, the planet and prosperity within all countries and all stakeholders, acting in collaborative partnership. The main target for this plan is to realize three dimensions of sustainable development: economic, social and environmental (United Nations, 2015). Although digitalization is not directly mentioned in any of the 17 Goals indicated, it is a method needed to achieve almost all of them.

In this perspective, the relationships among digitalization, sustainability, and environmental protection are important, since their relations are twofold. Digitalization is a tool supporting environment protection processes for implementing overarching sustainability goals, and at the same time, a threat to their implementation, itself being the trigger for additional resources and growing energy consumption (Stock et al., 2018; Berg et al., 2021).

An additional research area is setting the above issues in the context of the SME sector. Small and medium-sized enterprises (SMEs) are significant drivers of economic development in almost all countries. SMEs are the "backbone" of Europe's economy, within which they account for approx. 99% of businesses (European Commission, 2014). In turn, these enterprises have weaker development potential than big companies, mainly due to the scale of operation and access to financial resources. Therefore, the European Commission adopted the SME Strategy for a Sustainable and Digital Europe (European Commission, 2020), which aims to "increase the number of SMEs engaging in sustainable business practices and employing digital technologies." Thus, digitalization and sustainability are challenges for SMEs and their competitive advantages but simultaneously require more effort and break the barriers. The digital transition is a central driver towards innovation and business renewal for established SMEs (Denicolai et al., 2021). The above led us to identify the research gap as research dependent on the perception of digitalization in terms of environmental goals and sustainability in the SME sector.

The research aims to identify how Serbian and Polish SMEs perceive digitalization as a phenomenon that affects the implementation of sustainable development goals in environmental protection, including its negative impact on the environment.

The paper is presented in 4 parts. The following part provides a theoretical background of the presented research for the hypotheses development. The next section presents the methodology used, sample description and descriptive analysis. The third part consists of results and discussion. In the final section, the main conclusions are listed.

2. THEORETICAL BACKGROUND

The industry 4.0 (I4.0) concept has become an extensive research topic. There are many attempts to classify and define this idea and its components. The main aim of I4.0 is to increase the firm's efficiency, production rate, and manufacturing quality (Shet & Pereira, 2021). I4.0 consists of four leading, advanced key elements: technology, processes, organization, and knowledge (Kayikci, 2018). Advances in sensor technology, connectivity of production machines, data storage, edge computing, encryption and authentication have laid the technological foundations for the industrial digitalization process. Others support these technologies that are not central to the concept of Industry 4.0, like artificial intelligence (AI), Internet of Things (IoT), distributed ledger technology (DLT) (Berg et al., 2021). What distinguished this industrial revolution (the 4th) from the previous ones is that it integrates these developed technologies (Shet & Pereira, 2021). Technologies that make up the framework of I4.0 enable entrepreneurs to introduce the business models and modes of production while implementing innovations in technology, product design, and revenue model (Berg et al., 2021), but also to reduce the use of raw materials and recycle more products (De Man & Strandhagen, 2017). Digital technologies are not only a kind of resource. I4.0 has much broader potential while being considered a value-creating strategy, which boosts and sustains a company's market power. Accordingly, I4.0, which relies on digitalization, enables sustainable development (Beier et al., 2018; Felsberger & Reiner, 2020; Kamble et al., 2020).

The scientific literature research on the topic of I4.0 shows that the dominant concepts are: industry, manufacturing technologies (data, digital), production and sustainability (Baltazar & Lopes, 2021; Felsberger & Reiner, 2020). This constitutes our research as important and grounded in the literature.

From the sustainability point of view, I4.0 technologies are crucial for the transition to a circular economy (Khan et al., 2021). These are key objectives related to more efficient use of natural resources, ensuring more sustainable consumption and production activities, reducing greenhouse gas emissions, and limiting the depletion of natural capital. It is assumed that digitalization has an important role in enabling circularity and transitioning to more sustainable activities and processes (Marre et al., 2015; Berg et al., 2021). This transition mainly affects production processes, including, for example, fast fashion (Happonen & Ghoreishi, 2022).

Research on relations between sustainability and digitalization focuses on many different areas. It may be analyzed concerning three main sustainability functions – economic, environmental and social. From these perspectives, the research may be divided into an area of:

- I4.0 effects on sustainable business models and detailed economic aspects (De Man & Strandhagen, 2017; Kayikci, 2018; Stock et al., 2018; Happonen et al., 2020; Berg et al., 2021; Palmaccio et al., 2021),
- I4.0, digitalization and environmental issues (Ozcan & Apergis, 2018; Kayikci, 2018; Park et al., 2018; Altinoz et al., 2021),
- influences of the development of the I4.0 on social aspects (Kayikci, 2018; Stock et al., 2018; Shet & Pereira, 2021; James et al., 2022), and finally
- digitalization and its impact on the development of circular economy (Marre et al., 2015; Berg et al., 2021; Khan et al., 2021), which, in a holistic approach, covers all three areas mentioned above.

The position of small and medium-sized enterprises in digital industrialization is a particular challenge. Undoubtedly, just like other spheres of the economy, these entities will have to face implementing the digital economy. Rehm and Goel (2017) indicated that SMEs need to implement digital processes to join business networks. Although it is argued that I4.0 is not integrated into SMEs (Dossou, 2018), the processes of implementing the twin (digitalization and sustainability) in the SMEs sector are carried out. The degree of this implementation varies and is characterized by many difficulties.

Research on sustainability with digital technologies in SMEs concerns many areas. These most often relate to organizational resistance to change, resistance to introducing innovations, lack of competencies (Madrid-Guijarro et al., 2009; Ruchkina et al., 2017; de Jesus Pacheco et al., 2019; Ogrean & Herciu, 2021), and perceived risk and uncertainty (Radziwon et al., 2014; Liu, 2020). A significant barrier to implementation is the limited economies of scale and the availability of different resources and funding forms (Brkanovic, 2005; Ogrean & Herciu, 2021). Denicolai et al. (2021) demonstrated that digitalization and sustainability, although positively related to each other, may be competing for growth paths when SMEs internationalize. Similar results by Ardito et al. (2021) indicated that SMEs' digital and environmental orientation positively affects product and process innovation performance, while a dual strategy towards digitization and environmental sustainability negatively affects process innovation performance and is not significant for product innovations. Another important issue adheres to environmental sustainability goals (European Commission, 2019). The intensifying practices, habits, and pressures to implement sustainability measures in everyday business are desirable. As Kolk and Pinkse (2008) indicated, sustainable growth will also be a standard among SMEs.

Today's enterprises operate in specific economic, social and environmental surroundings. The effects of this activity focused on generating profits, cost reduction, and creating added value of another dimension that is more and more often exposed to benefit the community and society. Battisti and Perry (2011) concluded that SMEs have a lower level of environmental awareness than larger companies and believe that their business activity has a negligible impact on the environment. It is often described that SMEs' understanding of environmental sustainability is reflected in their attributes as turnover, size, and others. Still, the profit orientation dimension dominates in that group of companies.

In the area of environmental goals, digitalization is supposed to be a driver of changes to protect the environment, reduce resource consumption, reduce carbon emission, reduce waste, and introduce many other business activities that support green investments and events (Happonen et al., 2020). It also ensures the sustainable development of SMEs by extending the lifecycle of the products (Klymenko et al., 2021), adjusting the SME business model to the environmental needs. Therefore, changes in the orientation of enterprises will result in the integration of sustainable development goals (SDG) into their long-term strategy (Rozak et al., 2021).

Despite many advantages, digitalization is indicated as a danger to environment protection and impact on reduction goals. The development of new digitalized technologies affects climate protection, causes energy and resource consumption, and negatively affects the whole environment (Karlsson, 2017). From this point of view, it is essential to focus on a circular economy that may reduce this negative impact and ensure the sustainability of digital manufacturing (Berg et al., 2021). Digital activities result in an increased amount of e-waste and a significantly increased demand for electricity, which raises serious doubts in countries where the energy economy is based on the combustion of fossil fuels. The development of modern technologies also results in a growing depletion of natural resources. The increasing demand for energy supply for digitalization and data centers generates abundant emissions.

On the contrary, easy and quick access to data reduces their acquisition emissions. It isn't easy to achieve a balance, but renewable forms of energy may make digitalization carbon neutral. This area has not been sufficiently explored (Patsavellas & Salonitis, 2019).

On the other hand, the environmental sustainability of digitalization also ensures the reduction of pollution. Digitalization positively impacts environmental quality in Asia due to green globalization (Ramos-Meza et al., 2021). The research by Altinoz et al. (2021), based on the data from the top 10 emerging market economies, suggested that internet usage positively impacts environmental pollution and carbon emissions. Ozcan and Apergis (2018) showed that the increase in internet access results in a lower level of air pollution. Opposite results, but in a broader meaning, by Park et al. (2018), implied that internet use poses a threat to sustainable development. Reducing electricity consumption and CO_2 emissions related to internet use takes time to maintain this development in EU countries.

Environmental pollution is a major issue in Poland, as is public awareness, particularly among those who heat their homes with solid fuels. The study uses data from Poland, as this country has one of the highest levels of environmental pollution among European countries. It is directly connected with the fact that Poland is the largest hard coal producer in the EU (Kolasa-Więcek, 2015).

Poland has a relatively high level of ICT development in terms of access to digital technology. Although, from the view of business process digitalization, the overall situation is not so positive. Indicators that show the amount of digitalization and robotization help to demonstrate this. Poland is ranked as 24th out of 28 countries in the Digital Economy and Society Index (DESI) (average for Poland in 2021 was 41, against 50.7 in the EU). A similar association can be seen in the Networked Readiness Index NRI. Poland is ranked 33rd in this index (with 130 all). Polish businesses are not highly engaged when it comes to Industry 4.0 initiatives. It is particularly evident in the small and medium-sized firm sector, where resistance to change and restricted access to financial sources have been observed.

In industrial robotics, Polish enterprises have a poor track record. While other countries are getting closer to the European average, Poland's dynamics are limited and unambiguously suggests that the country lags behind (Michałowski et al., 2018). Entrepreneurs are aware of the benefits and risks associated with Industry 4.0 adoption. Still, limited social awareness of the concept is one of the reasons why it has not been widely adopted (Żywiołek et al., 2021).

From the point of view of the environmental state, the Republic of Serbia has an unenviable position. Air pollution is currently one of the most important environmental risks to human health. There are several hot spots where industry pollutes air (thermal power plants, ironwork and cement factories, mining, etc.). At the same time, traffic and transport in large cities and individual (household) heating pollute the air in almost all municipalities (Popović, 2020). According to the Environmental Protection Report, about 85% of sulphur oxide emissions and close to 60% of nitrogen oxides are generated by energy production and distribution. Consumption is dominated by fossil fuels with 87.9%, while the share of renewable energy is 12.1% (SEPA, 2019).

Although Serbia started adopting information and communication technologies (ICT) relatively late, due to its belated transition and economic closure during the 1990s, its population is showing great interest in using ICT products and services, especially after 2005. On the upside, the people of Serbia very quickly and spontaneously has accepted new information and communication technologies. The main weaknesses in this area are mainly due to the slow implementation of the adopted legislation, lack of adequate human resources, inappropriate regulatory bodies, high costs of internet access, insufficient participation of the population with higher education and low level of electronic content in Serbian on the internet (Mitrović, 2017).

Studies on the linkage between digitalization and sustainability related to Industry 4.0 are still kind of novel. The subject of this research is the environmental impact of digitalization. This study will gather opinions from owners and employees on the potential opportunities for Industry 4.0 to improve sustainability. Also, respondents will present their attitudes to the potential dangers to the environment that digitalization brings. The main goal is to identify similarities and differences in the perception of environmental impacts of digitalization in small and medium enterprises located in Poland and Serbia. Based on the above, the following hypothesis was formulated:

H: Digitalization positively impacts the environment in the perception of Serbian and Polish SMEs.

To obtain relevant, robust, reliable, and valid content, we asked the following research questions:

RQ1: Whether there is a positive or negative attitude to the subject of digitalization in terms of sustainable impact on the environment?

RQ2: What are the similarities and differences in the perception of the environmental impact of digitalization on the environment between respondents living in Poland and Serbia?

RQ3: Does the level of implementation of digital technologies in a country affect the knowledge of the population on the environmental impact of digitalization?

3. EXPERIMENTAL

Data collection for this research was performed by a survey method. The survey was conducted through an online platform and direct contact with respondents during June - September 2021. Employees and owners of small and medium enterprises were the target group. The research was conducted in Poland and the Republic of Serbia. The questionnaire consisted of thirteen statements about different environmental impacts of digitalization (Table 1).

The questions referred to potential environmental benefits that can be achieved through digitalization, SMEs' strategic commitment to achieving sustainable development goals while conducting business activities, and negative consequences of digitalization. The respondents expressed the level of agreement with the statements in the questionnaire by selecting the number on a five-point Likert scale. In this case, number one indicated complete disagreement and five complete agreement with the specific item. The survey collected 235 correctly completed questionnaires, of which 101 are from Poland and 134 from Serbia. For processing the data, gretl v.2021d (Baiocchi & Distaso, 2003),SPSS v.17 and Statistica v. 13. 3 software were used.

4. RESULTS AND DISCUSSION

For comparison of the perception of the respondents from Poland and Serbia, descriptive analysis was performed (Table 2).

The average values of the statements related to the benefits of digitalization are around four. That indicates a generally positive attitude of the respondents towards

Table 1. Statements from the questionnaire

Label	Item
S_1	Digitalizing the company helps to optimize and reduce the use of resources.
S_2	Digitalizing the company helps to reduce costs.
S_3	Digitalizing the company helps to adjust the business model to the environmental needs/requirements.
S_4	Digitalizing the company helps to reduce carbon emissions.
S_5	Digitalizing the company helps generate value to perform fair business practices to benefit the community and society.
S_6	Digitalizing the company helps to extend the lifecycle of our products.
S_7	Digitalizing the company helps to relocate funding for green investments
S_8	Digitalizing the company helps to achieve higher productivity and less waste.
S_9	Digitalizing the company helps to achieve customized production
S_10	Our company has integrated SDGs into its long-term strategy.
S_11	Electronic equipment and devices produce a high amount of e-waste.
S_12	The production and use of ICT consume a growing amount of materials, which speeds up the depletion of natural resources.
S_13	The increasing demand for energy supply on digitalization and data centres generates abundant emissions.

Table 2. Descriptive analysis

						Percentiles		
		N	**Mean**	**Std. Deviation**	**Std. Error**	**25**	**50**	**75**
S_1	Poland	101	3.9406	1.12979	.11242	4.0000	4.0000	5.0000
	Serbia	134	4.3657	.92209	.07966	4.0000	5.0000	5.0000
	Total	235	4.1830	1.03596	.06758			
S_2	Poland	101	3.9604	1.16551	.11597	3.0000	4.0000	5.0000
	Serbia	134	4.2836	.89788	.07757	4.0000	5.0000	5.0000
	Total	235	4.1447	1.03172	.06730			
S_3	Poland	101	3.9307	1.10686	.11014	3.0000	4.0000	5.0000
	Serbia	134	4.0970	1.03959	.08981	4.0000	4.0000	5.0000
	Total	235	4.0255	1.06988	.06979			
S_4	Poland	101	3.2970	1.30801	.13015	3.0000	3.0000	4.5000
	Serbia	134	3.8657	1.14898	.09926	3.0000	4.0000	5.0000
	Total	235	3.6213	1.24943	.08150			
S_5	Poland	101	3.4059	1.26632	.12600	3.0000	4.0000	4.0000
	Serbia	134	3.9478	1.13268	.09785	3.0000	4.0000	5.0000
	Total	235	3.7149	1.21932	.07954			
S_6	Poland	101	3.4059	1.20148	.11955	3.0000	3.0000	4.0000
	Serbia	134	3.8955	1.11226	.09608	3.0000	4.0000	5.0000
	Total	235	3.6851	1.17433	.07660			
S_7	Poland	101	3.3069	1.26287	.12566	3.0000	3.0000	4.0000
	Serbia	134	3.8060	1.14693	.09908	3.0000	4.0000	5.0000
	Total	235	3.5915	1.22087	.07964			
S_8	Poland	101	3.6733	1.20921	.12032	3.0000	4.0000	5.0000
	Serbia	134	4.1045	1.04966	.09068	4.0000	4.0000	5.0000
	Total	235	3.9191	1.13879	.07429			
S_9	Poland	101	3.8020	1.20017	.11942	3.0000	4.0000	5.0000
	Serbia	134	4.0821	1.02633	.08866	3.7500	4.0000	5.0000
	Total	235	3.9617	1.11066	.07245			
S_10	Poland	101	2.9901	1.36011	.13534	2.0000	3.0000	4.0000
	Serbia	134	3.3731	1.47496	.12742	2.0000	4.0000	5.0000
	Total	235	3.2085	1.43638	.09370			
S_11	Poland	101	3.3465	1.29950	.12931	2.0000	3.0000	5.0000
	Serbia	134	3.5896	1.22758	.10605	3.0000	4.0000	5.0000
	Total	235	3.4851	1.26203	.08233			
S_12	Poland	101	3.0396	1.05755	.10523	2.0000	3.0000	4.0000
	Serbia	134	3.1343	1.30811	.11300	2.0000	3.0000	4.0000
	Total	235	3.0936	1.20530	.07862			
S_13	Poland	101	3.3366	1.12496	.11194	3.0000	3.0000	4.0000
	Serbia	134	3.1791	1.30269	.11254	2.0000	3.0000	4.0000
	Total	235	3.2468	1.22942	.08020			

the impact of digitalization on the environment. On the other hand, statements that do not support digitalization have a slightly lower average score. Therefore, it can be concluded that negative impacts are less recognizable than positive ones. A comparative analysis of the mean values of the responses from Poland and Serbia showed a higher degree of agreement with the statements when it comes to respondents from Serbia. The exception is statement S_13. However, it can be noticed that these differences are not significant, which leads to the conclusion that SMEs in Poland and Serbia have almost equal attitudes towards the impact of digitalization on the environment.

In order to examine the existence of a statistically significant impact of the country on the perception of the environmental effects of digitalization, ANOVA analysis was conducted. The independent variable was the country of origin, while the dependent variables were the statements from the questionnaire.

The ANOVA analysis results indicated that the country's statistically significant impact on the answers of respondents ($p<0.05$) is for the following items: S_1, S_2, S_4, S_5 S_6, S_7, S_8, S_9, and S_10 (Table 3). On the other hand, there were no statistically significant differences between the country and items S_3, S_11, S_12, and S_13. The questions in which the country's statistically significant impact is recognized mostly deal with the positive aspects of digitalization in its relation to the environment.

Further, to identify the statements that best reflect the differences in the degree of agreement depending on the respondents' country of origin, a discriminatory analysis was conducted. For performing discriminant analysis, nine items for ANOVA analysis confirmed the statistically significant differences between the country of origin (S_1; S_2; S_4; S_5; S_6; S_7; S_8; S_9 and S10) were used as input variables. The grouping variable was the country of respondents (Poland and Serbia).

A commonly used procedure for reducing the number of variables in linear discriminant analysis is the stepwise method for variable selection (Todorov, 2007). Standard, forward stepwise and backward stepwise methods were used to set the discriminant functions. The discrimination model's stepwise forward approach is developed step by step. All variables are reviewed, and discriminatory ones are evaluated at each stage. The Backward stepwise method is used to take a step back. The variables that contribute the least to prediction are thus eliminated. According to the successful discriminatory function result, the variables that have the most significant impact on group division remain.

The validity of each discriminant function was performed using Wilk's lambda test. Values of this test follow the group or total F-value, which transforms them to the approximate F-distribution. It tests the null hypothesis in the sense that there are no significant differences between the arithmetic means of the groups formed as categories of independent variables. Hypothetical df and df errors are used to obtain the realized significance p. If $p <0.050$, there is a significant interaction between the tested factors or interaction conditions in the model, which produces significant differences for that level of probability. Wilks's lambda varies from "0" to "1" and, unlike its use in the analysis of variance, tests the significance of the discriminant function as a whole in discriminant analysis. It measures the difference between the Poland and Serbia subsamples in the entire sample of respondents expressed through the centroids (vectors) of the arithmetic means of the analyzed statements, with the ratio: smaller lambda - larger differences. The significance of the isolated discriminant function for

Table 3. ANOVA results

		Sum of squares	df	Mean square	F	Sig.
S_1	Between groups	10.406	1	10.406	10.072	**.002**
	Within groups	240.726	233	1.033		
	Total	251.132	234			
S_2	Between groups	6.015	1	6.015	5.766	**.017**
	Within groups	243.065	233	1.043		
	Total	249.081	234			
S_3	Between groups	1.593	1	1.593	1.394	.239
	Within groups	266.254	233	1.143		
	Total	267.847	234			
S_4	Between groups	18.622	1	18.622	12.516	**.000**
	Within groups	346.671	233	1.488		
	Total	365.294	234			
S_5	Between groups	16.907	1	16.907	11.902	**.001**
	Within groups	330.991	233	1.421		
	Total	347.898	234			
S_6	Between groups	13.804	1	13.804	10.413	**.001**
	Within groups	308.894	233	1.326		
	Total	322.698	234			
S_7	Between groups	14.343	1	14.343	9.992	**.002**
	Within groups	334.440	233	1.435		
	Total	348.783	234			
S_8	Between groups	10.709	1	10.709	8.523	**.004**
	Within groups	292.755	233	1.256		
	Total	303.464	234			
S_9	Between groups	4.519	1	4.519	3.705	**.045**
	Within groups	284.137	233	1.219		
	Total	288.655	234			
S_10	Between groups	8.450	1	8.450	4.151	**.043**
	Within groups	474.333	233	2.036		
	Total	482.783	234			
S_11	Between groups	3.401	1	3.401	2.146	.144
	Within groups	369.297	233	1.585		
	Total	372.698	234			
S_12	Between groups	.517	1	.517	.355	.552
	Within groups	339.424	233	1.457		
	Total	339.940	234			
S_13	Between groups	1.429	1	1.429	.945	.332
	Within groups	352.256	233	1.512		
	Total	353.685	234			

standard, stepwise and forward modes is 0.923, 0.93 and 0.949, and they were confirmed at p=0.0318, p=0.0022 and p=0.0005, respectively (Table 4). Accordingly, we can conclude that the differences between the two subgroups are not so meaningful.

The standard model applied to the nine analyzed statements constructed discriminatory functions - DFs, to which approximately 65.1% of cases were correctly assigned (Table 5). In the next step, using the forward stepwise modality of discriminatory analysis, four statements were included from the initial nine (Table 6), with a hit ratio of 63.8% (Table 5). Backward stepwise modality yielded classification matrices with 59.1% of correctly classified cases and one discriminatory statement.

Discriminatory analysis indicated that out of the starting nine, only one statement in which the respondents' country of origin can be best predicted based on the answer (the level of (dis) agreement). The stepwise discriminant analysis conducted through three steps (standard, forward and backward) extracted the item S_4 (Digitalizing the company helps reduce carbon emissions) as discriminating between Poland and Serbia. It means that the most significant difference between these two countries is reflected in the answers to this question.

The last step of research procedure was to find whenever Serbian and Polish SMEs perceive the impact on the environment in the same way. Proportion tests were issued for item S_4 as discriminating. Serbian and Polish respondents both supported the statement that digitalizing the company positively impacts reducing carbon emissions. Results are presented in Table 7.

In the perspective of high oil and gas

Table 4. Discrimination coefficients

	Wilks' Lambda	F	Sig.
Standard mode	.923	2.085694	p < .0318
Stepwise mode	.930	4.323186	p < .0022
Backward mode	.949	12.51625	p < .0005

Table 5. Discriminant matrix

	% Accuracy	Country: Poland	Country: Serbia
Standard DA mode			
Poland	42.6	43	58
Serbia	79.9	27	107
Total	63.8	70	165
Forward stepwise DA mode			
Poland	44.6	45	56
Serbia	80.6	26	108
Total	65.1	71	164
Backward stepwise DA mode			
Poland	23.8	24	77
Serbia	85.8	19	115
Total	59.1	43	192

Table 6. Classification Functions: grouping – Country

	Standard mode		Forward stepwise mode		Backward stepwise mode	
Item	**Poland**	**Serbia**	**Poland**	**Serbia**	**Poland**	**Serbia**
S_1	1.8760	2.1566	2.74680	2.9752		
S_2	1.4843	1.2765				
S_4	-0.1999	-0.0324	-0.03032	0.2089	2.21596	2.59814
S_5	-0.4186	-0.2903				
S_6	0.3681	0.5573	0.41157	0.6812		
S_7	0.2643	0.2877				
S_8	-0.1373	0.0190				
S_9	1.2640	0.9985	1.52900	1.3115		
S_10	0.5138	0.5745				
Constant	-10.4201	-12.0466	-9.81399	-11.4635	-4.49750	-5.58353

Table 7. Proportion tests results

	Serbian	**Polish**
n	134	101
Proportion of positive answers	0.686567	0.415842
Z statistic	18.078	4.20806
One-sided p	2.377e-073	1,288e-005

prices, the discussion about negative externalities (e.g. emissions) impacting the environment is highly anticipated. Findings revealed that the most significant differences in the perception of Industry 4.0 could be found by analyzing carbon emissions. While the difference is significant for Serbian and Polish SMEs, they agree that implementing Industry 4.0 solutions positively influences reducing emissions. From the practical point of view, results confirm previous case studies like Miśkiewicz and Wolniak (2020) and the impact of Industry 4.0 elements like business model innovation to reduce harmful emission reduction (Ghobakhloo, 2020). The procedure for finding the most discriminating issue between countries provides directions for future research.

In conclusion, both Polish and Serbian respondents, even when they differ in their responses for the S_4 item, support hypothesis that digitalization positively impacts the environment in the perception of Serbian and Polish SMEs.

5. CONCLUSIONS

The expansion of digitalization and the development of digital infrastructure carries potential environmental risks. It is important to prevent an exponential increase in energy consumption and e-waste and a negative environmental impact across digital technology supply chains. However, the growing integration of physical and digital networks into industrial production processes promises efforts to achieve the goals of social and environmentally sustainable development. Recent technological advancements provide game-changing opportunities to monitor and protect the environment. The digital revolution can be steered to advance global sustainability, environmental stewardship, and human well-being by harnessing these appropriately.

Digitalization and sustainability are two of the most powerful market trends in today's corporate landscape. However, their intersection is still not explored enough. The best indicators of their integration in business are clean technologies, greening production processes and creating a company's brand equity as a sustainable company. Flexibility, autonomy, self-organization, and greater interconnectivity between humans, machines, and other manufacturing systems are the expected outcomes of Industry 4.0. It is frequently claimed that Industry 4.0 will result in increased sustainability if integrated production processes are expected to be more efficient and less resource-intensive. While the greatest potential of the economies is small and medium-sized enterprises, our research shows that Industry 4.0 is not sufficiently implemented and researched in this area.

The presented research has practical implications. It is a guideline for regulators and sectoral institutions to strengthen the promotion of the opportunities and benefits of digitalization in the SME sector. The strength of our research is to make the issue of digitalization more popular among small and medium-sized enterprises.

The limitation of the study is the relatively short period of its implementation and selective sample. Nonetheless, it may be a good basis for comparisons for other studies and the starting point for future in-depth research.

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ЕКОЛОШКА ОДРЖИВОСТ У ДИГИТАЛИЗОВАНИМ МСП: КОМПАРАТИВНА АНАЛИЗА ПОЉСКЕ И СРБИЈЕ

Danijela Voza, Aleksandra Szewieczek, Dariusz Grabara

Извод

Пандемија COVID-19 и развој концепта одрживости су убрзали процес имплементације Индустрије 4.0. Дигитализација је једно од кључних питања у оквиру Индустрије 4.0. У овом раду се испитује истраживачки јаз на тему перцепције значаја дигитализације из угла постизања еколошких циљева и одрживости у сектору малих и средњих предузећа. У раду је извршена компаративна анализа перцепције дигитализације у малим и средњим предузећима у Пољској и Србији. Прикупљено је 235 исправно попуњених упитника на тему утицаја Индустрије 4.0 и дигитализације на животну средину и одрживи развој. Закључци су указали на постојање позитивног утицаја степена дигитализације компаније на смањење емисије угљен-диоксида. Међутим, између Пољске и Србије препозната је и значајна дискриминација у погледу редукције штетних емисија увођењем дигитализације. Спроведено истраживање има практичан допринос у виду истицања емисије угљен-диоксида као најважнијег проблема у одрживом развоју МСП сектора.

Кључне речи: индустрија 4.0, одрживост, дигитализација, мала и средња предузећа, економија

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