8th INTERNATIONAL CONFERENCE ON INDUSTRIAL ENGINEERING

INNOVATION CENTER OF THE FACULTY OF MECHANICAL ENGINEERING
&
INDUSTRIAL ENGINEERING DEPARTMENT, FACULTY OF MECHANICAL ENGINEERING, UNIVERSITY OF BELGRADE, SERBIA

PROCEEDINGS

Editors:

Vesna Spasojević Brkić
Mirjana Misita
Uglješa Bugarić

29th-30th September 2022
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Vesna Spasojević Brkić
Mirjana Misita
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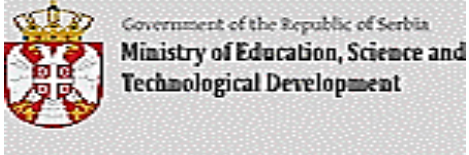

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PREFACE

Since the first event in Belgrade, Serbia more than 25 years ago, in 1996, International Conference on Industrial Engineering - SIE has been held regularly every 3 years. This time we are one year late due to pandemic conditions. It represents an opportunity for researchers in the Industrial Engineering community to review and evaluate their scientific achievements over the period since the previous SIE, share their most recent results and ideas, and discuss possibilities for new directions in research, joint experiments and observing campaigns.

The first aim of the 8th International Conference on Industrial Engineering – SIE 2022 is to celebrate 70 years from founding of our department by prof. dr Vukan Dešić! We are proud of professor Dešić who, as stated in one of the archive documents was "a man of excellent professional abilities and one of the best experts" and thank him for all his immeasurable contributions! The second aim of SIE 2022 is to contribute to a better comprehension of the role and importance of Industrial Engineering and to point out to the future trends in the field of Industrial Engineering. The conference is also expected to foster networking, collaboration and joint effort among the conference participants to advance the theory and practice as well as to identify major trends in Industrial Engineering today. According to these goals the conference addresses itself to all experts in all fields of Industrial Engineering to make their contribution to success and show capabilities achieved in the work that has been done are very welcomed. SIE 2022 traditionally provides an international forum for the dissemination and exchange of scientific information in industrial engineering fields through the large number of multidisciplinary topics and continues tradition established by prof. Dešić to gather and bring together experts in the field.

The book brought together almost 200 authors from 20 countries, namely from Canada, Croatia, Finland, Germany, Iran, Italy, Libya, Montenegro, Netherlands, North Macedonia, Poland, Portugal, Russia, Bosnia & Herzegovina, Singapore, Slovakia, Switzerland, Turkey and USA and Serbia. The 84 submitted full length manuscripts were peer-reviewed, and 81 of them were selected for publication by experts in their respective fields. The authors ranged from senior and renowned scientists to young researchers. Only unpublished papers were accepted and the first author is responsible for the originality of the paper. All papers are classified into five chapters, including plenary lectures and numerous results of national and EU projects are there presented (financed by MESTD, PSHESR ARV, SF RS, EC, EF RD, TUKE, INAIL etc.).

We expect that papers and discussions will contribute to better comprehension the role and importance of Industrial Engineering in this and other countries, both in domain of scientific work and everyday practice.

Our efforts in organizing would not succeed without the considerable help of the members of Scientific Program and the financial help of Ministry of Education, Science and Technological Development was greatly supportive for the success of the entire project.

At the end, the editors hope, and would like, that this book to be useful, meeting the expectation of the authors and wider readership and to incentive further scientific development and creation of new papers in the field of Industrial Engineering.

Welcome to the 8th International Conference on Industrial Engineering – SIE 2022! We wish to all participants a pleasant stay in Belgrade and are looking forward to seeing you all together at the 9th Conference on Industrial Engineering – SIE 2025.

Belgrade, September 2022

EDITORS

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PLENARY SESSION

SMEs' DIGITALIZATION IMPACT ON ECONOMIC DEVELOPMENT

Anđelka Stojanović[1], Nenad Milijić[1], Isidora Milošević[1], Ivan Mihajlović[2]
[1]Technical Faculty in Bor, University of Belgrade, Serbia
[2]Faculty of Mechanical Engineering, University of Belgrade, Serbia
anstojanovic@tfbor.bg.ac.rs

Abstract. *The accelerated development of information and communication technologies has caused notable changes in all spheres of life and business. In order to contribute to their own economic goals and the economy in general, companies are forced to embrace technological innovations. This study aims to test a hypothesis that the digitalization of business operations in small and medium-sized enterprises (SMEs) positively influences economic development. Since the degree of digitization is a complex phenomenon, it is approached through several quantitative indicators. The data from the Eurostat database were used for the research. The analysis results obtained using the structural equations modeling confirm the positive relationship between the level of digitization of SMEs and gross domestic product (GDP).*
Key words: *Digitalization, Small and medium-sized enterprises, Economic development.*

1.INTRODUCTION

A key component of competitiveness and sustainability in the severe conditions of modern business is the digitalization of business in all its aspects. The concept of digitalization of business operations and the emergence of new information and communication technologies (ICT) that uniquely integrate business systems is known as Industry 4.0. With their ability to collect, store, analyze and share large amounts of data, digital technologies play a crucial role in transforming business and providing new opportunities for companies to establish their business on a much broader scale and with significantly improved productivity and results. Accepting digitalization accelerates resource utilization and improves the ability to operate sustainably in a new business environment. However, changes in production and how values are created in modern business can pose serious challenges for enterprises. Acceptance of the new global business reality in the case of small and medium-sized enterprises (SMEs) is still in the early stages as many companies hesitate and run the risk of falling behind in the global race [2, 6]. Digital technologies, on the one hand, reduce business barriers, increase resources and market availability, and SMEs can have significant benefits if embracing these changes. On the other hand, despite the great potential of digitalization, there is an impression that there are several limitations related to the application in SMEs. Small and medium-sized enterprises that employ less than 250 employees have a significant share in local economies and the world economy. The European Union was assessed to have 22.6 million SMEs in 2021, with an average contribution to the economy of around 56% (https://www.statista.com). Baring these facts in mind, it is important to overview the challenges and drivers for adopting digitalization in SMEs and examine how much impact the digital level has on economic indicators.

2. LITERATURE REVIEW

The limitation of SMEs' to exploiting IT technologies at the level that derives significant benefits is the readiness reflected in the lack of technological, human and financial resources. Those features stand out as key in many studies when analyzing the degree of digitalization in SMEs compared with large companies [11]. Integrating data in whole value chain creation requires using networks and various information technology systems. In fact, there are many relations between the size of the company and the degree of acceptance of Industry 4.0. The share of automation in SMEs is significantly lower, as well as

the production volume. SMEs usually operate on specific smaller market segments and opt for specialization as a business strategy. On the other hand, tools developed for digitizing business-production processes are most often designed for large companies with the ability to receive and process vast amounts of data from different processes and various sources. Therefore, it is not easy for SMEs to reach a certain technological level in order to be able to use solutions offered by Industry 4.0.

Implementing existing solutions can be problematic for SMEs. Small and medium-sized enterprises usually do not have particular IT or research and development departments, and in addition to the lack of resources, there are shortcomings in know-how, both when choosing the appropriate technology and during its use. Thus, the introduction of Industry 4.0 requires dramatic changes in SMEs' structure, strategy, and mindset, which causes SME owners and managers to be suspicious towards the full integration of digitalization in business [8, 10].

In addition to changes in the structure and appearance of the workplace for the successful implementation of new business models, adequate employees and adequate exchange of knowledge and information are necessary. A skilled employee is still the backbone of a successful and sustainable business in Industry 4.0 because it is indispensable for managing the increasing complexity of tasks, interaction and initiative, coordination and problem solving, and decision-making [5].

Another significant restraint related to the implementation of Industry 4.0 concerns data access. Namely, in addition to installing new technologies, additional investments are needed to ensure the security of all network users in the value chain. In fact, the most important obstacle to the full utilization of cloud services in SMEs is the security of the company's sensitive data and the fear that third parties could access it [10].

However, Li et al. (2019) highlight the benefits of digitalization for SMEs [5]. The authors consider the process of overcoming the challenges faced by SMEs to be a source of competitive advantage. As Industry 4.0 supports flexibility and transforms mass production in the direction of the business closer to meeting individual customer requirements and new levels of integration between people, technology and resources are being formed [6]. Many researchers were evaluating the relationship between digitalization and economic growth, and concluded that the influence is positive [3, 4]. Brodny and Tutak (2022) emphasize the importance of the link between the implementation of digital technologies in SMEs and economic parameters [1]. In addition to economic parameters, digitalization affects productivity, competitiveness and sustainable development [9].

Analyzing the literature, the link between digital level and economic development remains ambiguous [7, 13]. The research hypothesis in the study states: It is possible to establish a positive connection between the level of digitalization of SMEs and economic development.

3. METHODOLOGY

The implementation of digital technologies in business is a result of the development of the internet and the almost unlimited connectivity opportunities that the network offers. Intensifying ICT use improves business performance and conditions the company's economic growth [12]. This research focuses on the implementation of digital technologies in SMEs and the impact of digitalization on economic development. The study is based on qualitative data on the level of digitization of SMEs and its comparison with economic changes. Digitization is considered a complex phenomenon, and seven indicators from the Eurostat database related to SMEs (10-249 employees and self-employed persons) are used for assessment, Table 1 (https://ec.europa.eu/).

Table 1. Indicators of SMEs level of digitization

Indicator	**Description**
E-commerce sales	Enterprises with e-commerce sales
Website	Enterprises with a website
Website functionalities	Enterprises where the website provided online ordering or reservation or booking
Pay to advertise	Pay to advertise on the internet
Social media	Use any social media
ERP software	Enterprises who have ERP software package to share information between different functional areas
ICT specialists	Enterprises that employ ICT specialists

For accessing economic development, Gross Domestic Product (GDP) per capita (current US$) from the World Development Indicators database was used (https://datatopics.worldbank.org/world-development-indicators/). Changes in indicator

values from 35 European countries in the period 2014-2020 were observed.

In order to confirm that the selected indicators adequately describe the researched phenomenon and to assess the effect of the level of digitization of SEMs on GDP, the methodology of structural equation modeling using SmartPLS software was applied.

4. RESULTS

The conducted confirmatory factor analysis indicates a strong internal consistency of the selected indicators for SMEs' digital level, given that the value of the Cronbach's alpha coefficient is .854 (acceptable above .7). Composite reliability is achieved since all factor loadings are greater than .5 (acceptable above .5, preferable above .7), as well as the convergent validity measured with Average Variance extracted (AVE) with a value of .545 (acceptable above .5). Namely, the indicators "ERP software" and "ICT specialists" are retained in the model, although they do not have preferable values of factor loadings over .7 because the AVE value is acceptable as well as the composite reliability value of .891 (acceptable above .7).

The analysis of the results of testing the hypothesis on the impact of the digital level of SMEs on economic development indicates a strong and statistically significant relationship between the observed variables (*t-value*=14,261, *p-value*=.000), which is shown on Figure 1 and Table 2. The digital level of SMEs can explain 36.7% of GDP variability.

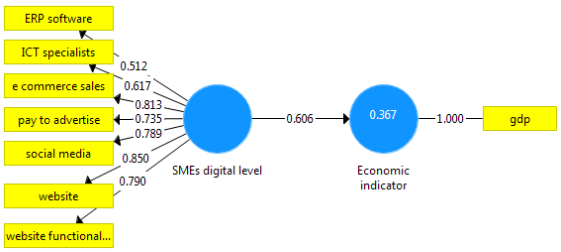

Figure 1. Results of research model testing

Table 2. Results of hypothesis testing

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
SMEs digital level -> Economic indicator	.606	.613	.043	14.261	.000

5. CONCLUSION

Sustainable economic development has become the predominant paradigm of modern society. An integral part of the sustainability of economic development is digital technology and its extensive implementation in all spheres of life and around the world. As not every aspect of digitalization is simple and requires significant changes in business operations, some segments as SMEs showed difficulties and lagging in successfully adopting ICT. Based on a review of literature focusing on SMEs' business operations, this study aimed to evaluate the effects of digitalization in SMEs on economic growth. The paper defines the digital level of SMEs as a multi-dimensional phenomenon that includes both the availability of information and communication technologies and solutions offered by Industry 4.0 and the application and level of skills to use these technologies. The single Eurostat database is used to assess all digital level indicators using quantitative measures. In addition, structural equation modeling was used to test the assumed relationship between the digital level of SMEs and economic development.

The obtained results confirmed the connection between the digital level of SMEs and GDP per capita. Thus, there is no doubt that the digital economy substantially impacts economic development and that this assumption applies to SMEs as well. Digitization of business processes stimulates economic growth through the improvement of production infrastructure and productivity as well as increasing employment and the level of competencies of employees.

It is important to point out the weaker influence of "ERP software" and "ICT specialists" indicators on the observed variable "Digital level SMEs", which are retained in the model. This result and previous research indicate that a skilled workforce is required to adopt and implement new technologies in SMEs. Appropriate qualifications are related to knowledge and skills in electrical engineering, informatics and software development [10].

Furthermore, adequate economic and policy support is necessary for developing critical competencies in SMEs for Industry 4.0 tolls and its implementation in order to face both the demand generated by large companies and competing SMEs.

REFERENCES

[1] Brodny, J., &Tutak, M. (2022). Digitalization of Small and Medium-Sized Enterprises and Economic Growth: Evidence for the EU-27 Countries. Journal of Open Innovation: Technology, Market, and Complexity, 8(2), 67.

[2] Calvinseng. (2019). Industry 4.0-How SMEs Can Thrive In The Battle Of Digital Transformation 2019? Retrieved from:

https://grandeurpinnacle.com/industry-4-0-smes-thrive-digital-transformation/
[3] Frey, C.B. (2015). The End of Economic Growth? Scientific American, 312(1), 12.
[4] Jiao, S., & Sun, Q. (2021). Digital Economic Development and Its Impact on Econimic Growth in China: Research Based on the Prespective of Sustainability. Sustainability, 13, 10245.
[5] Li, D., Fast-Berglund, Å.,&Paulin, D. (2019). Current and future Industry 4.0 capabilities for information and knowledge sharing Case of two Swedish SMEs. The International Journal of Advanced Manufacturing Technology, 105, 3951–3963.
[6] Moeuf, A., Pellerin, R., Lamouri, S., Tamayo-Giraldo, S., &Barbaray, R. (2018). The industrial management of SMEs in the era of Industry 4.0. International Journal of Production Research, 56 (3), 1118–1136.
[7] Mubarak, F., Suomi, R., &Kantola, S.-P. (2020). Confirming the links between socio-economic variables and digitalization worldwide: the unsettled debate on digital divide. Journal of Information, Communication and Ethics in Society, 18(3), 415-430.
[8] Pech, M., &Vaněček, D. (2022). Barriers of new technology introduction and disadvantages of Industry 4.0 for industrial enterprises. Serbian Journal of Management, 17(1), 197-206.
[9] Popkova, E.G., DeBernardi, P., Tyurina, Y.G., &Sergi, B.S. (2022). A theory of digital technology advancement to address the grand challenges of sustainable development.Technology in Society, 68, 101831.
[10] Schröder, C. (2017). The Challenges of Industry 4.0 for Small and Medium-sized Enterprises. FRIEDRICH-EBERT-STIFTUNG, Germany
[11] Stentoft, J., Jensen, K. W., Philipsen, K., &Haug, A. (2019). Drivers and Barriers for Industry 4.0 Readiness and Practice: A SME Perspective with Empirical Evidence. Proceedings of the 52nd Hawaii International Conference on System Sciences, 5155-5164.
[12] Traşcă, D.L., Ştefan, G.M., Sahlian, D.N., Hoinaru, R., &Şerban-Oprescu, G.-L. (2019). Digitalization and Business Activity.The Struggle to Catch Up in CEE Countries.Sustainability, 11, 2204.
[13] Zhang, J., Zhao, W., Cheng, B., Li, A., Wang, Y., Yang, N., &Tian, Y. (2022). The Impact of Digital Economy on the Economic Growth and the Development Strategies in the post-COVID-19 Era: Evidence From Countries Along the “Belt and Road”. Frontiers in Public Health, 10, 856142.