INDUSTRY 4.0: LIMITATION OR BENEFIT FOR SUCCESS?

Isidora Milošević[a*], Sanela Arsić[a], Maja Glogovac[b], Ana Rakić[b] and Jelena Ruso[b]

[a]*University of Belgrade, Technical Faculty in Bor, Vojske Jugoslavije 12, Bor, Serbia*
[b]*University of Belgrade, Faculty of Organizational Sciences, Jove Ilića 154, Belgrade, Serbia*

Abstract

The fourth industrial revolution is a significant driving force framing companies' digital, social, and economic needs. This concept considerably influences the outcomes of businesses by increasing cost-effectiveness, quality, and effectiveness. However, studies on performance outcomes of Industry 4.0 in Serbia are still scarce. The available literature mainly deals with papers that observe Industry 4.0 from only one point of view, most often positive or negative effects on business success. A literature gap was observed that would fulfil the observed Industry 4.0 from two opposite aspects, positive or negative. To overcome the literature gap, this paper aims to observe if Industry 4.0 is perceived as facilitating or limiting for business success. The study provides a more objective approach to observing and decision-making in Industry 4.0 acceptance. To support this contribution, the paper provide a deeper analysis of the factors that impact the financial, operational, and strategic performance outcomes associated with Industry 4.0. Considered factors are attitude toward digitalization, limitations of digitalization, and expected benefits of digitalization. The results gathered through 134 valid questionnaires are evaluated using Structural Equation Model. These results show that all relationships and impacts are confirmed except the influence of internal limitations on performance outcomes. These findings are encouraging for companies wanting to transfer to Industry 4.0.

Keywords: Industry 4.0, digitalization, attitude, limitations, benefits, performance outcomes

1. INTRODUCTION

Industry 4.0, as a Fourth Industrial Revolution, leads to the integration of operations with information and communication technologies (Lee et al., 2016; Dalenogare et al., 2018). Such integrations bring significant space for improvements. The successful acceptance of transformations such as Industry 4.0 is

considered as the core for achieving competitive advantage between companies (Kusiak, 2018).

There are many authors who point out that Industry 4.0 can significantly improve companies' performances, in a wide range of organizational areas. Therefore, the high priority aim of many companies today becomes to identify new opportunities within Industry 4.0 and gain significant organizational results (Ganzarain & Errasti, 2016). Since companies need to make significant decisions, sometimes toward vital changes, it would be useful for them to understand the potential performance outcomes of being a digitally transformed company.

Taking into account that there is more than one type of potential outcome of Industry 4.0 orientation, at least there are those related to financial, operational, and strategic performance, this paper strives to investigate factors that are related to those types of performance outcomes. In order to investigate factors related to performance outcomes of Industry 4.0 acceptance, attitude toward digitalization, limitations of digitalization and expected benefits of digitalization are considered.

The next chapter is dedicated to theoretical review and development of hypothesis and a conceptual model. The third section is committed to the explanation of methodology, and results and discussion are followed. Finally, the conclusion is in the fifth section.

2. THEORETICAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

Industry 4.0 is a Fourth Industrial Revolution that means the incorporation of information technologies into organizational systems (Lasi et al., 2014). As such, it helps companies to gain better performance with stronger processes integration and product connectivity (Dalenogare et al., 2018; Lin et al., 2019). The smart products and processes integration and digital transformation of current value chains result in significant outcomes for companies (Mohamed, 2018; Anshin & Bobyleva, 2021). According to the same author, Industry 4.0 brings many positive outcomes for companies in different dimensions. Masood and Sonntag (2020) pointed out different positive outcomes related to quality, efficiency, cost, flexibility and competitive advantages, but considered at the same time-related factor such as attitude towards Industry 4.0, different challenges for companies, complexity and size of the company. Dalenogare et al. (2018) researched how the adoption of different Industry 4.0 technologies is linked to results in products, operations and side-effects aspects. Kiel et al. (2020) recognized that this industrial revolution has several implications on companies' economic, ecological, and social outcomes. On the other hand, companies with their results contribute significantly to economic growth and social stability (Masood & Sonntag, 2020). Hence, the aim of this paper is to investigate factors related to companies' performances as a result of Industry 4.0 acceptance and utilizing opportunities within it.

Many organizations and their development systems meet difficulties in the innovation and digitalization of their activities (Schlichter & Nielsen, 2022). One recent experiment showed that commitment and participation rules play an essential role in balancing challenges in active business life and provide positive output elements in a

digital innovation environment (Schlichter & Nielsen, 2022). The positive attitude towards the digitalization of the business among people in the company is increasingly expressed in Industry 4.0 because digitalization is the only way to survive in such an environment (Schlichter & Nielsen, 2022) despite many internal and external limitations (Breunig et al., 2016; Kiel et al., 2017; Horváth & Szabó, 2019). There has been some split examination of these limitations (Horváth & Szabó, 2019), for example, some authors pointed out the deficiency of qualified employees and conflicts between people due to modification business environments (Kiel et al., 2017; Müller et al., 2018), information security (Breunig et al., 2016; Kiel et al., 2017) lack of financial resources (Koch et al., 2014; Kiel et al., 2017), immature levels of standardization, weak understanding of integration (Müller et al., 2018) are some of the major limitations to the implementation of Industry 4.0. The acceptance and application of Industry 4.0 is a complex procedure, within which many elements affect each other (Horváth & Szabó, 2019). Therefore, an extensive examination of all these factors is required. The productivity and economic benefits of investment in digitalization have always been arguable (Stolarick, 1999). The productivity contradiction regarding digitalization application thus brings riskiness regarding estimation of its economic benefits (Raj et al., 2019). Investment is the principal issue for most new technology-based transformations in business. The major investment is needed for the adoption of Industry 4.0 initially. The realization of all the essential elements of Industry 4.0 involves an enormous investment for industry (Valdeza et al., 2015). Hofmann and

Rüsch (2017) argue that leadership has fronting difficulties in accepting Industry 4.0 in their organizations because they may not perceive any momentary financial returns. On the other hand, business openness to change in Industry 4.0 enhances an organization's ability to respond to customer requirements and increment business system productivity without redundant costs and unnecessary quantity of resources (Fragapane et al., 2022). Accordingly, the three hypotheses are developed:

H1: "Attitude toward Digitalisation" is related to "Internal Limitations" in Industry 4.0 context

H2: "Attitude toward Digitalization" is related to "External Limitations" in Industry 4.0 context

H3: "Attitude toward Digitalization" is related to "Expected Benefits" in Industry 4.0 context.

Lack of information about existing technical possibilities, a lack of skills and digital literacy of the users, as well as high investment costs make access to technology difficult (Garske et al., 2021). Additionally, cyber security and data issues are perceived as external limitations that can prevent digitalization (Ichimura, 2021). Some of them are regulatory issues, telecommunication capacity, social acceptance, or reliability. Sometimes, digital activities are entangled in physical processes, and it is impossible to digitalize them completely or even partly (Faraj et al., 2021). Regardless of the weaknesses and threats of digitalization, Sahlin and Angelis (2019) said that new technologies can change the way company performance is

measured. Undoubtedly, those limitations should impact company performance outcomes such as financial performance, operational performance or strategic performance. Some of these connections are researched by Şerban (2017), Eller et al. (2020) and Forcadell et al. (2020). Therefore, the two additional hypotheses are supposed to be developed:

H4: "Internal Limitations" of digitalization impact company "Performance Outcomes" in Industry 4.0 context

H5: "External Limitations" of digitalization impact company "Performance Outcomes" in Industry 4.0 context

Even though limitations are always present, the digital technology imposed by Industry 4.0 shows various benefits for companies. For instance, Rosin et al. (2020) highlight resource savings, greater operational efficiency, tracking processes in real-time, flexibility, automatic collection and analysis of data, and better risk identification. Furthermore, the expected benefits of digitalization represent relevant

input elements of company performance (Antonucci et al., 2020). Hence, the H6 is suggested:

H6: "Expected Benefits" of digitalization impacts company "Performance outcomes" in Industry 4.0 context

A conceptual model, presented in Figure 1, depicts relations defined in hypotheses.

3. METHODOLOGY

This study aimed to determine the key factors that influence performance outcomes of Industry 4.0. Accordingly, the research was conducted through the survey method from July to November 2021 using an anonymous survey questionnaire. Respondents were interviewed exclusively online due to the current COVID-19 epidemiological situation. The target group of respondents, which consisted of employees, managers and owners of companies in Serbia, was reached through the social network Linkedin and Chamber of Commerce of Serbia. The keywords for
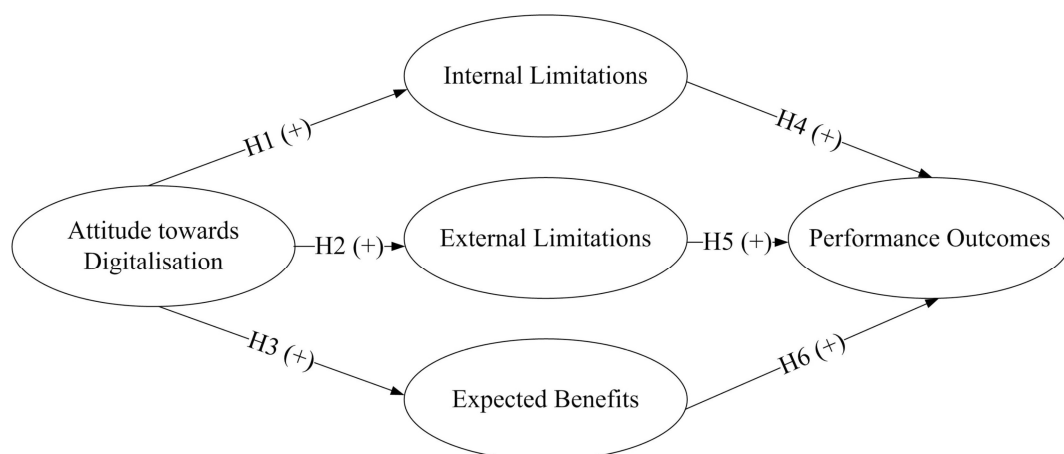

Figure 1. Conceptual model

research by Linkedin were manager, owners, and CEO with the focus on SME organizations in the IT and automotive industry. The total number of respondents who participated in the survey were 134. The distributed questionnaire consisted of two parts. The first part was related to determining the demographic characteristics of respondents' and companies (gender, age, education, number of employees, company sector, etc.). The second part of the questionnaire focused on key factors for identifying Performance Outcomes in Industry 4.0: Attitude towards digitalization, Internal Limitations, External Limitations,

and Expected Benefits. All factors were measured through some indicators. Each indicator was illustrated by one question in the survey. For gradation of answers, a five-point Likert scale was used where 5 means strongly agree, 4 means agree, 3 means neutral, 2 means disagree, and 1 means strongly disagree. SPSS v. 17.0 and AMOS v. 18.0s software packages were used for data processing.

3.1. Respondents' demographic information

The demographic characteristics of the

Table 1. Demographic characteristics of respondents and companies

Characteristics		Percentage
Respondents		
Gender	Male	67.2
	Female	32.8
The position in the companies	The owner	20.9
	Manager	42.5
	Employee	36.6
Age	18-30	26.9
	31-45	49.3
	46-60	21.6
	61 and more	2.2
Level of education	High school	13.4
	BSc	37.3
	MSc	41.0
	PhD	8.2
Companies		
Number of employees	Up to 9	32.1
	10-49	14.2
	50-250	16.4
	More than 250	37.3
Dominant type of industry	Production	49.3
	Services	50.7
Your companies operate	Up to 2 years	11.2
	3-5 years	18.7
	6-10 years	18.7
	11-20 years	18.7
	More than 21 years	32.8
Your business is focused on	Exclusively domestic market	12.69
	Mostly on the domestic market	22.39
	Equally on the domestic and foreign markets	20.90
	Mostly on the foreign market	15.67
	Exclusively to foreign markets	8.96
	Our company is a multinational enterprise (MNE) – a member of a group of companies	19.40

survey participants are presented in Table 1. It can be noticed that of a total of 134 respondents included in the survey, 67.2% of respondents were male, while 32.8 were female. The largest number of respondents worked in the manager position (42.5%), then employees took 36.6% of the total sample, while the smallest number of respondents was the owners of companies (20.9%).

Almost half of the respondents (49.3%) are predominantly young people aged 31-45 who have the potential to face the new market challenges imposed by Industry 4.0. In addition, this is supported by the fact that the majority of respondents (41%) are highly educated, i.e. have completed an MSc degree.

When it comes to demographic information of companies in the survey, most respondents were from large enterprises (37.3%) with over 250 employees which operating on the market for more than 21 years (32.8%) and whose focus of business is mainly on the domestic market (22.39%).

Structural Equation Modelling (SEM) was used in this research to evaluate the impact of the endogenous dimensions (Attitude towards digitalization, Internal Limitation, External Limitation, Expected Benefits) on the exogenous dimension (Performance Outcomes).

3.2. Structural equation modelling (SEM)

Structural Equation Modeling (SEM) is one of the important quantitative data analysis techniques and, in recent years, is increasingly used among researchers dealing with Industry 4.0 concept (Kiraz et al., 2020). This multivariate technique is used to test theoretically set hypotheses. When

theoretical assumptions are expressed by the relationships between observed and latent variables, the SEM methodology makes it possible to determine the extent to which the theory corresponds to the reality presented through the collected data. The SEM methodology consists of two essential components: a measurement model and a structural model. The measurement model essentially represents a Confirmatory Factor Analysis (CFA), and the structural model estimates the assumed relationships between latent constructs. Modelling of structural equations allows testing theoretical assumptions about how constructs are connected, the direction of connections as well as their significance. The advantage of structural modelling concerning other statistical techniques of experiments is that it is possible to simultaneously examine the interdependencies of a series of relationships between variables (Hair et al., 2014; Yin & Huang, 2021).

3.2.1. Measurement model

The validity of the model was assessed utilizing a CFA. There is no universal indicator that best reflects how reliable a model is, therefore, several types of fitting indices are used, at least one of which each group should confirm the fit. The goodness of fit tests for the CFA model represented in Table 2 is Root Mean Square Error of Approximation (RMSEA=0.051), Comparative Fit Indeks (CFI=0.967), Normed Fit Index (NFI=0.909), Tucker-Lewis Index (TLI=0.958), and Incremental Fit Indeks (IFI=0.968). All indicators are in accordance with the recommended values (Udo et al., 2010).

Factor loads and *t* values for each observed variable is presented in Table 3.

After the general validity, the validity of the construct is checked individually. The internal consistency of each factor was measured using Cronbach's Alpha. The results depicted in Table 3 indicated that the internal consistency values are more than 0.8 (Nunnally, 1978). The observed standardized factor loads have values in the range 0.593-0.947 while t values are in the range 7.156-15.642 with statistical significance $p<0.001$.

To assess the validity of the measurement scale, convergent validity for each construct and discriminant validity for different constructs are used, using the Average

Table 2. Fit indices for the measurement model

χ^2(p<0.05)	χ^2/df	RMSEA	CFI	NFI	TLI	IFI
χ^2=398.7 df=295	1.351	0.051	0.967	0.909	0.958	0.968
Accepted fit	<3	<0.08	>0.90	>0.90	>0.90	>0.90

Table 3. Measurement Model

Constructs	n	Standardized factor loading	Critical ratio (t - value)	AVE	Cronbach Alfa
Attitude towards Digitalization					
Q1 Good idea		0.857	/		
Q2 More interesting		0.790	10.449		
Q3 Fan	5	0.745	9.591	0.662	0.917
Q4 Pleasent working enviroment		0.791	10.669		
Q5 Competitivness		0.877	14.910		
Internal Limitation					
Q1 Tech. resources		0.779	/		
Q2 Finance		0.752	12.019		
Q3 Huma resources		0.817	9.894		
Q4 Knowledge	7	0.786	9.643	0.632	0.925
Q5 Motivation		0.788	9.861		
Q6 Leadership		0.812	10.353		
Q7 Strategy		0.830	10.319		
External Limitation					
Q1 Supply		0.593	/		
Q2 Internet		0.642	10.722	0.600	0.877
Q3 Service provider	4	0.947	7.808		
Q4 External funds		0.861	7.636		
Expected Benefits					
Q1 Optimised resources		0.598	/		
Q2 Reduced cost		0.758	9.924		
Q3 Met environmental needs		0.772	7.156		
Q4 Reduced carbon emissions		0.730	7.269		
Q5 Fair business	9	0.871	7.823	0.606	0.929
Q6 Extended product lifecycle		0.742	7.477		
Q7 Green investments		0.737	7.379		
Q8 Higher productivity and less waste		0.902	8.046		
Q9 Customised production		0.855	7.687		
Performance Outcomes			/		
Q1 Financial		0.888			
Q2 Operational	3	0.887	15.642	0.770	0.911
Q3 Strategic		0.858	13.987		

Variance Estimate (AVE), which results are presented in Table 4. All AVE values are higher than the limit value of 0.50, indicating that the validity of the convergence was achieved. Discriminant validity is confirmed based on the square root of the estimated AVE, whose value should be greater than the correlations between the constructs (Fornel & Larcker, 1981). Considering the values in the correlation matrix, Table 4, it was found that discriminant validity was confirmed for all constructs.

Considering all indicators, it can be concluded that the proposed measurement model is acceptable both in terms of reliability and validity.

3.2.2. Structural model

The following research step employed the structural analysis to test the hypotheses. The goodness-of-fit model to the data resulted from structural analysis with satisfactory values (χ^2=1.642. CFI=0.918. IFI=0.919. TLI=0.905. RMSEA=0.070) and fit well.

The key criteria for assessing the structural model were the coefficient of determination R^2 for the endogenous latent variable Performance Outcomes, whose satisfactory level is considered to be 0.30 (Loke et al., 2018). The combined effect of Internal Limitation, External Limitation, and Expected Benefits, realized in the direct model, explains 46.2% of the variability of Performance Outcomes (Table 5).

The obtained results of path analysis in the SEM model are shown in Figure 2 and Table 6, indicating that all hypotheses can be accepted except H4, which is not confirmed.

Significant results were obtained by

Table 4. Correlation Matrix and Discriminant Validity

Constructs	Attitude towards digitalization	Internal Limitation	External Limitation	Expected Benefits	Performance Outcomes
Attitude towards digitalisation	**0.814**				
Internal Limitation	0.264	**0.795**			
External Limitation	0.217	0.622	**0.775**		
Expected Benefits	0.515	0.011	0.018	**0.778**	
Performance Outcomes	0.805	0.215	0.297	0.559	**0.878**

p<0.01

Table 5. Standardised factor loading and t-values

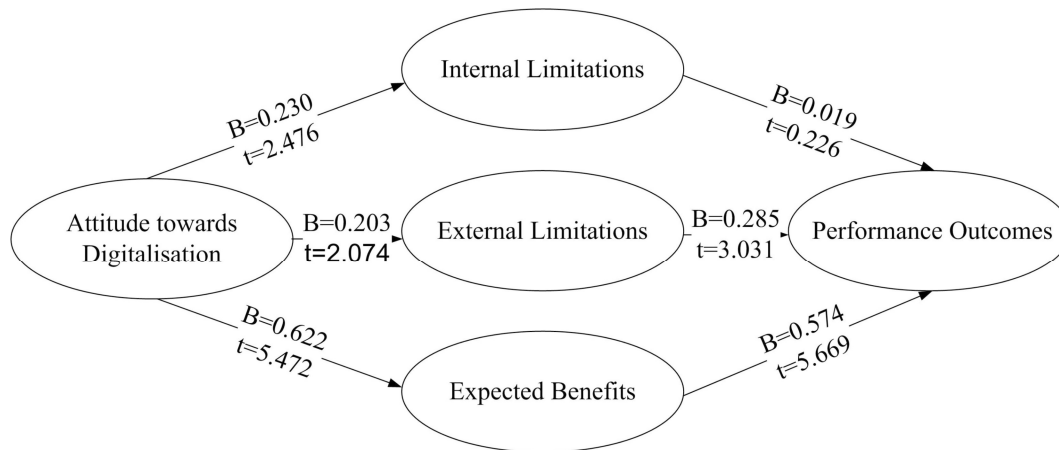| Variables	n	Standardised factor loading	Critical ratio or (t-value)	R^2
Attitude towards Digitalisation	5	0.797-0.830	9.702-10.331	/
Internal Limitations	7	0.719-0.887	9.330-14.071	0.052
External Limitations	4	0.568-0.955	7.218-10.267	0.041
Expected Benefits	13	0.724-0.822	0.858-9.463	0.386
Performance Outcomes	3	0.854-0.899	13.672-15.255	0.462

Figure 2. The results of the structural equation model

Table 6. Path coefficients and T-values

The relationship or path	Standardized parameters	T-value	Support
H1. Attitude towards digitalisation – Internal Limitations	0.230 (b)	2.476	Accepted
H2. Attitude towards digitalisation – External Limitations	0.203 (b)	2.074	Accepted
H3. Attitude towards digitalization – Expected Benefits	0.622 (a)	5.472	Accepted
H4. Internal Limitations – Performance Outcomes	0.019	0.226	Rejected
H5. External Limitations – Performance Outcomes	0.285 (b)	3.031	Accepted
H6. Expected Benefits – Performance Outcomes	0.574 (a)	5.669	Accepted

(a) Significant at the 99% level; (b) Significant at the 95% level

analyzing five defined hypotheses (Table 6 and Figure 2). Attitude towards Digitalisation is related to the Internal Limitations of Industry 4.0 (β=0.230, t=2.476, p<0.05), and External Limitations (β=0.203, t=2.074, p<0.05). These facts indicate that hypotheses H1 and H2 were accepted. Moreover, the findings also confirm the relation between the Attitude towards Digitalisation and Expected Benefits at a 99% confidence interval (β=0.622, t=5.472, p<0.01). Therefore, hypothesis H3 was accepted. The obtained results show that the impact of the Internal Limitations on the Performance Outcomes exists but without statistical significance (β=0.019, t=0.226, p>0.05). This indicates that hypothesis H4 is rejected.

Additionally, the construct Expected Benefits is proved to have an impact on Performance Outcomes, pointing out the obtained results have high statistical significance at a 99% confidence interval (β=0.574, t=5.669, p<0.05). This confirms that hypothesis H5 is supported.

4. DISCUSSION OF RESULTS

After analyzing the results and the relationships between the constructs, we noticed that all hypotheses were confirmed

except for hypothesis four. The first and second hypotheses that consider the relationship between attitudes towards digitalization and internal and external limitations have been confirmed. Different respondents' attitudes towards digitalization such as new knowledge, interesting digital environment, and competitive advantage in the market have to do with both internal and external limitations. Positive attitudes of employees can influence the overcoming of various constraints within the company or environment. For instance, most of the respondents were managers who initiate changes in the organization so that their positive attitudes towards digitalization can influence the transformation of limitations into the company's opportunities to respond to the demands of Industry 4.0. On the other hand, managers may have resistance to new technologies because they do not see short-term profits for the company so they themselves may be limiting factors (Hofmann & Rüsch, 2017). Additionally, positive attitudes towards digitalization are in direct relationship with expected benefits which is confirmed by hypothesis three. Recent research by Fragapane et al. (2022) shows that the openness of employees towards digital changes positively impacts organizations to utilize the best of technology changes caused by Industry 4.0. Further, the opinions are divided considering the impacts of limitations and expected benefits on performance outcomes. Results show that external limitations and expected benefits impact the performance outcomes indicating that hypotheses five and six are confirmed. Even thouth the same conclusion is not find in literature, the study make difference between internal and external limitations confirming there is significant difference between them. Results show that

internal limitations such as constrained resources, lack of knowledge and lack of motivation do not significant influence performance outcome. The obtained results are logical considering that the positive attitude of managers towards digitalization neutralizes all the shortcomings that companies have and leads to overcoming them in order to achieve benefits and competitive advantage in the digital market.

This study shows that the digital work environment and Industry 4.0 is still a big challenge for companies, and a lot of effort is needed to remove internal and external limitations. Indeed, these limitations are justified and more complex than this research showed. For example, ethical and security issues are not considered. In order to remove barriers, an effort needs to be made to confirm the benefits of Industry 4.0, which will certainly have the most significant impact on changing attitudes and motivating people to accept digitalization in an everyday working environment.

5. CONCLUSION

Since Industry 4.0 is emerging and since it can bring significant opportunities and space for improvement, it is crucial for practitioners and academics to explore how companies can achieve performance outcomes depending on attitude towards digitalization, internal and external limitations, and expected benefits. This study provides an understanding of mentioned factors that are related to achieving Performance Outcomes regarding Industry 4.0 application in companies in Serbia. This paper focuses on Industry 4.0 concept and contributes to its clarification and further understanding of the benefits and limitations

of this complex technological system. Namely, the paper aims to observe if Industry 4.0 is perceived as facilitating or limiting for business success.

Investigating the literature regarding Industry 4.0, it was noticed that there are a few studies dealing with this segment in companies in Serbia (Glogovac et al., 2020; Milošević et al., 2021). Despite the fact that there are objective limitations in the application of Industry 4.0, all these and similar studies show that the positive effects of the application of new digital technologies are becoming more noticeable. Also, Industry 4.0 has a number of limitations that organizations are increasingly facing today. However, studies on the subject of objective observation should also be encouraged, as there are unequivocally problems such as ethical aspects that have been neglected in the application of technologies imposed by Industry 4.0.

For the practitioners, it is important to note that the results of this study can be used to properly view existing limitations in the acceptance of Industry 4.0 in their working environment. Limitations are observed as both internal and external since attitude towards Industry 4.0 acceptance can make or overcome not only internal but also external limitations. Since every decision-making process relies on limitation-benefits analysis, this study can make this process more clear, taking into account expected benefits of Industry 4.0 acceptance also. Better relation between limitations and benefits can be achieved with positive attitude companies towards digitalization and its adoption which finally leads companies towards achieving better financial, operational, and strategic performances.

The limitation of this study is that the response of the respondents was not evenly distributed in relation to the size of the organizations. However, this situation is expected considering that large companies are more resources-provided, and thus are more familiar with new technologies and have more experience in their application.

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References

Anshin, V., & Bobyleva, A. (2021). The digital transformation program management in medium-sized businesses: A network approach. Serbian Journal of Management, 16 (1), 147- 159.

Antonucci, Y.L., Fortune, A., & Kirchmer, M. (2020). An examination of associations between business process management capabilities and the benefits of digitalization: all capabilities are not equal. Business Process Management Journal, 27 (1), 124-144.

Breunig, M., Kelly, R., Mathis, R., & Wee, D. (2016). Getting the most out of Industry 4.0. McKinsey & Company. Retrieved from https://www.mckinsey.com/business-functions/operations/our-insights/industry-40-looking-beyond-the-initial-hype

Dalenogare, L.S., Benitez, G.B., Ayala, N.F., & Frank, A.G. (2018). The expected contribution of Industry 4.0 technologies for industrial performance. International Journal of Production Economics, 204, 383-394.

Eller, R., Alford, P., Kallmünzer, A., &

ИНДУСТРИЈА 4.0: ОГРАНИЧЕЊЕ ИЛИ КОРИСТ ЗА УСПЕХ?

Исидора Милошевић, Санела Арсић, Маја Глоговац, Ана Ракић, Јелена Русо

Извод

Четврта индустријска револуција је значајна покретачка снага која уоквирује дигиталне, друштвене и економске потребе компанија. Овај концепт значајно утиче на резултате пословања повећавајући економичност, квалитет и ефективност. Међутим, студије о резултатима учинка Индустрије 4.0 у Србији су још увек оскудне. Доступна литература се углавном бави радовима који посматрају индустрију 4.0 само са једне тачке гледишта, најчешће позитивних или негативних ефеката на пословни успех. Уочен је јаз у литератури који би био попуњен посматрањем Индустрије 4.0 са два супротна аспекта, позитивног или негативног. Да би се превазишао јаз у литератури, овај рад има за циљ да уочи да ли се Индустрија 4.0 доживљава као олакшавајућа или ограничавајућа за пословни успех. Студија пружа објективнији приступ посматрању и доношењу одлука у прихватању Индустрије 4.0. Да би подржао овај допринос, овај рад пружа дубљу анализу фактора који утичу на финансијске, оперативне и стратешке резултате у вези са Индустријом 4.0. Разматрани фактори су однос према дигитализацији, ограничења дигитализације и очекиване користи од дигитализације. Резултати прикупљени кроз 134 валидна упитника су процењени коришћењем модела структурних једначина. Ови резултати показују да су сви односи и утицаји потврђени осим утицаја интерних ограничења на резултате учинка. Ови налази су охрабрујући за компаније које желе да пређу на Индустрију 4.0.

Кључне речи: Индустрија 4.0, дигитализација, став, ограничења, предности, резултати учинка

Peters, M. (2020). Antecedents, consequences, and challenges of small and medium-sized enterprise digitalization. Journal of Business Research, 112, 119-127.

Faraj, S., Renno, W., & Bhardwaj, A. (2021). Unto the breach: What the COVID-19 pandemic exposes about digitalization. Information and Organization, 31 (1), 100337.

Forcadell, F.J., Aracil, E., & Úbeda, F. (2020). The impact of corporate sustainability and digitalization on international banks' performance. Global Policy, 11 (S1), 18-27.

Fornell, C., & Larcker, D.F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. Journal of Marketing Research, 18 (1), 39-50.

Fragapane, G., Ivanov, D., & Peron, M. (2022). Increasing flexibility and productivity in Industry 4.0 production networks with autonomous mobile robots and smart intralogistics. Annals of Operations Research, 308 (1-2), 125–143.

Ganzarain, J., & Errasti, N. (2016). Three stage maturity model in SME's towards Industry 4.0. Journal of Industrial Engineering and Management, 9 (5), 1119-1128.

Garske, B., Bau, A., & Ekardt, F. (2021). Digitalization and AI in European

Agriculture: A Strategy for Achieving Climate and Biodiversity Targets?. Sustainability, 13 (9), 4652.

Glogovac, M., Ruso, J., & Maricic, M. (2020). ISO 9004 maturity model for quality in industry 4.0. Total Quality Management & Business Excellence, in press.

Hair, J.F., Black, W.C., Babin, B.J., & Anderson, R.E. (2014). Multivariate Data Analysis (Seventh Edition). Pearson Education Limited. Harlow, England.

Hofmann, E., & Rüsch, M. (2017). Industry 4.0 and the current status as well as future prospects on logistics. Computers in Industry, 89, 23-34.

Horváth, D., & Szabó, R.Z. (2019). Driving forces and barriers of Industry 4.0: Do multinational and small and medium-sized companies have equal opportunities?. Technological Forecasting and Social Change, 146, 119-132.

Ichimura, Y. (2021). Evaluating the impacts of digitalization on ship operation: examining how to enhance maritime safety (Doctoral dissertation). Retrieved from https://commons.wmu.se/cgi/viewcontent.cgi?article=2700&context=all_dissertations

Kiel, D., Arnold, C., & Voigt, K.I. (2017). The influence of the Industrial Internet of Things on business models of established manufacturing companies–A business level perspective. Technovation, 68, 4-19.

Kiel, D., Müller, J.M., Arnold, C., & Voigt, K.I. (2020). Sustainable Industrial Value Creation: Benefits and Challenges of Industry 4.0. International Journal of Innovation Management, 21 (8), 1-34.

Kiraz, A., Canpolat, O., Özkurt, C., & Taşkın, H. (2020). Analysis of the factors affecting the Industry 4.0 tendency with the structural equation model and an application. Computers & Industrial Engineering, 150, 106911.

Koch, V., Kuge. S., Geissbauer, R., & Schrauf, S. (2014). Industry 4.0: Opportunities and Challenges of Industrial Internet, Strategy& PwC. Retrieved from http://www.g20ys.org/upload/auto/03d10e20d681c1cfb40d3d9275704e2e9df16391.pdf

Kusiak, A. (2018). Smart manufacturing. International Journal of Production Research, 56 (1-2), 508-517.

Lasi, H., Fettke, P., Kemper, H. G., Feld, T., & Hoffmann, M. (2014). Industry 4.0. Business & Information Systems Engineering, 6 (4), 239-242.

Lee, J., Bagheri, B., & Jin, C. (2016). Introduction to cyber manufacturing. Manufacturing Letters, 8 (C), 11-15.

Lin, B., Wu, W., & Song, M. (2019). Industry 4.0: driving factors and impacts on firm's performance: an empirical study on China's manufacturing industry. Annals of Operations Research, in press.

Loke, W., Abu, N.H.B., & Lim, F. (2018). Electrical and Electronics Global Supply Chain: The Significance Effect of Psychological Empowerment on Organizational Business Performance. International Journal of Supply Chain Management, 7 (1), 65-76.

Masood, T., & Sonntag, P. (2020). Industry 4.0: Adoption challenges and benefits for SMEs. Computers in Industry, 121, 103261.

Milošević, I., Ruso, J., Glogovac, M., Arsić, S., & Rakić, A. (2021). An integrated SEM-ANN approach for predicting QMS achievements in Industry 4.0. Total Quality Management & Business Excellence, in press.

Mohamed, M. (2018). Challenges and Benefits of Industry 4.0: An overview. International Journal of Supply and Operations Management, 5 (3), 256-265.

Müller, J.M., Kiel, D., & Voigt, K.I.

(2018). What Drives the Implementation of Industry 4.0? The Role of Opportunities and Challenges in the Context of Sustainability. Sustainability, 10 (1), 247.

Nunnally, J. C. (1978). Psychometric theory (2nd ed.). McGraw-Hill, New York.

Raj, A., Dwivedi G., Sharma, A., de Sousa Jabbour, A.B.L., & Rajak, S. (2019). Barriers to the Adoption of Industry 4.0 Technologies in the Manufacturing Sector: An Inter-Country Comparative Perspective, International Journal of Production Economics, 224, 107546.

Rosin, A.F., Proksch, D., Stubner, S., & Pinkwart, A. (2020). Digital new ventures: Assessing the benefits of digitalization in entrepreneurship. Journal of Small Business Strategy, 30 (2), 59-71.

Sahlin, J., & Angelis, J. (2019). Performance management systems: reviewing the rise of dynamics and digitalization. Cogent Business & Management, 6 (1), 1642293.

Schlichter, B.R., & Nielsen, I.J. (2022). Diversity of Seniority in a Digital Innovation Challenge Experiment. Procedia Computer Science, 196, 142–150.

Șerban, R.A. (2017). The impact of big data, sustainability, and digitalization on company performance. Studies in Business and Economics, 12 (3), 181-189.

Stolarick, K. (1999). IT spending and firm productivity: Additional evidence from the manufacturing sector. Working Papers 99-10. Center for Economic Studies, US Department of Commerce, Bureau of the Census

Udo, G.J., Bagchi, K.K., & Kir, P.J. (2010). An assessment of customers' e-service quality perception, satisfaction and intention. International Journal of Information Management, 30 (6), 481-492.

Valdeza, A.C., Braunera, P., & Schaara, A.K. (2015). Reducing Complexity with Simplicity - Usability Methods for Industry 4.0. Proceedings 19th Triennial Congress of the IEA, Melbourne.

Yin, H., & Huang, S. (2021). Applying structural equation modelling to research on teaching and teacher education: Looking back and forward. Teaching and Teacher Education, 107, 103438.