SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2023
ORGANIZATION AND MANAGEMENT SERIES NO. 181

THE IMPORTANCE OF DIGITALIZATION IN THE ORGANIZATION OF CYBER-PHYSICAL PRODUCTION NETWORKS OF POLISH SMEs IN INDUSTRY 4.0

Sebastian SANIUK

University of Zielona Gora, Department of Engineering Management and Logistic Systems;
s.saniuk@wez.uz.zgora.pl, ORCID: 0000-0002-0478-3466

Purpose: The paper aims to explore the impact of the digitization of SME sector enterprises on cooperation in cyber-physical networks in the Industry 4.0 environment.
Design/methodology/approach: The literature analysis method and survey of SME sector enterprises were used in the research. 206 manufacturing enterprises took part in the study, including 35 micro, 87 small and 84 medium-sized enterprises. The selection of the sample was purposeful. A statistical analysis was performed using the IBM SPSS v. 28 statistical package in the empirical study. The analysis included the use of, among others, frequency analysis, one-way analysis of variance and linear regression analysis.
Findings: The survey revealed a positive correlation between company size and digitalization level. Larger enterprises report higher levels of digitization. Enterprises declaring a higher level of digitization also expect a correspondingly high level of digitization from their network partner. Moreover, a higher level of digitization of the enterprise is a factor that influences the willingness of the examined enterprise to join a cyber-physical cooperation network. The research also shows that an enterprise's digitization level is associated with the enterprise's declaration of connecting its intelligent resources with an external digital platform that guarantees the security of transmitted digital data and organizes the cyber-physical network in an automated manner.
Research limitations/implications: The research was conducted among selected Polish micro, small and medium-sized production enterprises. Due to the issue of networking and international cooperation of enterprises operating in the Industry 4.0 environment, research should also cover other European countries in the future.
Originality/value: Original achievements obtained during the research include demonstrating the relationship between the level of digitization of enterprises and the tendency to establish cooperation within cyber-physical production networks. Moreover, the survey results proved that investing in digital technologies is an additional motivating factor for enterprises wanting to cooperate within networks in the Industry 4.0 environment.

Keywords: Industry 4.0, digitization of enterprises, cyber-physical production networks, small and medium enterprises.

Category of the paper: Research paper.

1. Introduction

The Industry 4.0 concept means the widespread digitization of economic processes, forcing changes on enterprises, especially in using modern digital communication technologies and building a competitive advantage on the market through intelligent technologies and networking. Therefore, Industry 4.0 assumes creating a fully integrated system of suppliers, producers and customers, creating cyber-physical networks of enterprises, which will constitute open socio-technical systems capable of implementing many new functions and activities imposed by production, logistics and management. As a result, digitally supported production technologies, Data Mining, Big Data Analytics and ICT (Information and Communication Technologies) allow for free machine-machine and machine-human communication in real-time, regardless of the geographical location of resources. According to this concept, all subsystems are fully integrated within Cyber-Physical Systems (CPS) and one value chain, focusing on customer needs (Kagermann et al., 2011; Lee et al., 2015). CPSs ensure data collection, processing, and impact on physical processes within the entire value creation chain or enterprise network thanks to unlimited network connections, simultaneously with little human involvement, performing only supervisory functions. Cyber-physical systems are the integration of computational and physical processes. Embedded computers and networks monitor and control physical processes, usually with feedback loops in which physical processes influence computations and vice versa (Xu et al., 2018).

Industry 4.0 is a vision that comprises nine pillars related to digital technologies, including Big data, Autonomous robots, Simulation, Horizontal and vertical integration, Industrial Internet of Things (IIoT), Cloud Computing, Additive manufacturing, Augmented reality, and Cybersecurity (Rüßmannet et al., 2015). It is widely understood that Industry 4.0 and the opportunities provided by its digital technologies have a long-term impact on global industrial development. As a result, there has been an increasing interest in researching the challenges, solutions, and opportunities related to various aspects of the fourth industrial revolution (Culot et al., 2019).

Enterprises operating in the modern market are beginning to understand the need for changes, especially in implementing modern technologies and broadly understood digitization of processes. A competitive advantage in the market should be achieved through know-how, high market flexibility and the ability to communicate in real-time with business partners and customers. Therefore, companies should be aware of the need to invest in digital technologies and the use of new business models and decision-making systems generated by the challenges of Industry 4.0. According to the new concept of Industry 4.0, the way of building a competitive advantage in the market is changing. A new, more modern and innovative approach to production management is needed, which will significantly increase efficiency and help build fast, efficiently managed supply chains (Młody, 2018; Grabowska, Saniuk, 2023). This may

particularly apply to the sector of small and medium-sized enterprises, which, unlike large enterprises with high development potential, see an opportunity for development in the conditions of Industry 4.0 in cooperation and narrow specialization (Schröder, 2016; Wolniak, 2023; Adamik et al., 2023). Hence, there is a need to research the development of these areas of activity, especially considering the challenges posed by the fourth industrial revolution. Particular attention should be paid to small and medium-sized enterprises, which, as shown above, are the driving force of the economy and constitute the workplace of an essential part of society. Small and medium-sized enterprises unfortunately do not have access to knowledge, sources of financing, the possibility of investing in new technologies and the use of appropriate business models like large enterprises (Cotrino et al., 2020). Developing a network form of cooperation becomes a development opportunity for small and medium-sized enterprises. Currently, small and medium-sized enterprises are perceived as intelligent modules that can be used to jointly create value for the customer and create cyber-physical production networks (Grabowska, Saniuk, 2023).

The idea of a cyber-physical production network means the production order execution within shared intelligent resources of the individual network partners, and communication between resources takes place using real-time data and IoT (Saniuk, 2020). An essential feature of the cyber-physical network is that all network partners have access to the necessary information in real time, regardless of the geographic location of the required resources. Thanks to the direct communication of intelligent resources, partnership development is intensified based on combining essential resources and competencies. Incorporating the help of various enterprises into a network contributes to gaining a competitive advantage in the market and better orientation to the customer's needs (Czakon, 2015).

The participation of enterprises in the network is desirable for the SME sector. Enterprises in this sector can overcome the main competitive advantage of large enterprises in terms of access to all kinds of resources (capital, competencies, know-how, etc.) (Mahmood et al., 2018). Creating networks of SMEs is an excellent opportunity to increase the competitiveness of enterprises and knowledge transfer. Moreover, the main advantages of such structures are the mutual support of partners, more significant potential for market expansion, sharing of resources and a more favourable position in contact with the financial and administrative environment (Lachiewicz, Zakrzewska-Bielawska, 2012). One of the problems of the SME sector is the still low use of intelligent services, such as computer-aided systems for advanced production planning and control, as well as data analytics. There is a lack of integration of existing IT systems enabling external exchange of information and knowledge between partners or contractors (Perechuda, Sobińska, 2015). In the future, communication between various systems must be organized through cloud services, such as business e-platforms (Platform as a Service) and software (Software as a Service) (Hyrynsalmi, 2022). This means there is a need to research the digitization of enterprises and the development of cooperation in combining intelligent resources, especially micro, small and medium enterprises.

Hence, the article's main aim is to explore the impact of the level of digitization of SME sector enterprises on the cooperation of enterprises within cyber-physical networks in the Industry 4.0 environment. The article assessed the level of digitization of the surveyed micro, small and medium-sized enterprises, identified the most frequently used digital technologies identified with the fourth industrial revolution, and demonstrated the impact of enterprise digitization on cooperation within cyber-physical production networks. The article considered three hypotheses related to the digitization of micro, small and medium-sized enterprises:

H1: The declared level of digitization of an enterprise is related to the size of the enterprise.

H2: The enterprise's digitisation level affects the expected level of digitization of partners for network cooperation.

H3: There is a relationship between an enterprise's declared level of digitization and the enterprise's willingness to participate in cyber-physical enterprise networks to implement a joint production.

2. Materials and methods

The conducted research used the method of literature analysis and survey of enterprises. Polish micro, small and medium-sized enterprises were selected for the empirical study. The study involved selecting enterprises that indicated industrial production as their primary industry profile (mechanical processing, assembly, etc.). A total of 600 enterprises were selected for the study. The CAWI (Computer-Assisted Web Interview) data collection technique was used. Ultimately, a total of 206 responses were obtained. Therefore, the study involved N = 206 enterprises represented by employees, including n = 35 people representing micro-enterprises (17%), n = 87 people in small enterprises (42.2%) and n = 84 employees representing medium-sized enterprises (40.8%). The research was conducted between December 2022 and April 2023.

The SME sector (micro, small and medium-sized enterprises) constitutes the overwhelming majority of enterprises in Poland - 99.8%. Among them, the largest group (97.0%; 2.2 million) are micro-enterprises. Small companies' share in Polish enterprises' structure is 2.2% (49.5 thousand), and medium-sized companies 0.6% (14.4 thousand). Data from the Central Statistical Office show that only 10% of enterprises conduct industrial activities (PARP, 2022). Therefore, it can be considered that the number of industrial enterprises constitutes a total of 226,390 enterprises as the size of the population. Due to the above, the required number of companies in the research is a minimum of 196 companies for the fraction size assumed at 0.5. The maximum error was 7%, and the confidence level was 95%. The selection of companies was purposeful.

The article presents selected empirical research results using statistical analyses performed in the IBM SPSS v. 28 statistical package (Meyers et al., 2013). The research used, among others, frequency analysis, one-way analysis of variance and linear regression analysis.

3. Results of research

During the survey, the participants were asked to evaluate the degree of digitization in their company. The analysis revealed that 36.4% of the respondents considered their enterprise to have a high level of digitization, whereas only 17% of them rated it as an average level. On the other hand, 47% of the enterprises stated that the level of digitization was low or very low. The results of this evaluation are illustrated in Figure 1.

A one-way analysis of variance was performed to test the H1 hypothesis regarding the relationship between the size of the enterprise and the level of digitization of a given enterprise. As a result, it turned out that the compared groups of enterprises differ statistically significantly, which means that the size of the enterprise differentiates the level of advancement of the enterprise's digitization $F(2;203) = 206{,}802$; $p < .001$; $\eta 2 = 0{,}671$. The observed effect is a strong effect. It explains 67% of the total variability in the results obtained in terms of the measured level of enterprise digitization.

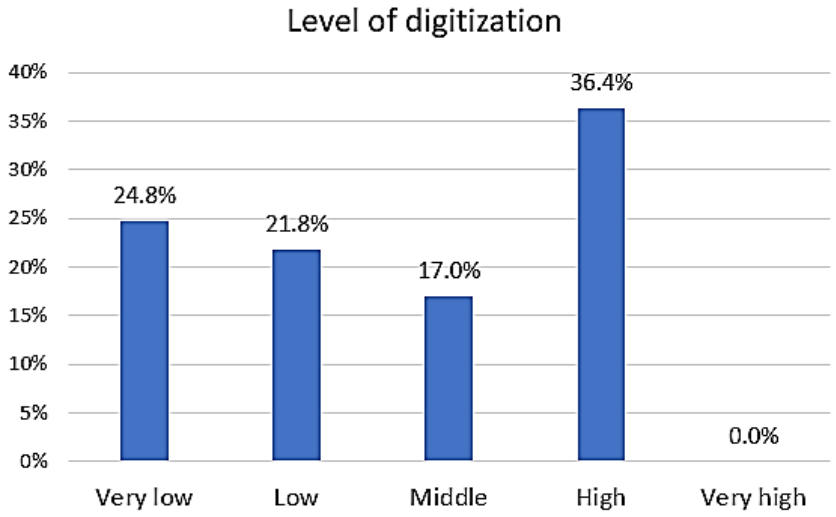

Figure 1. Declared level of digitization of the surveyed enterprise.

Then, to examine which compared groups differ statistically significantly, a post hoc test with the least significant differences (LSD) correction was performed. The correction was applied due to the assumption of homogeneity of variances in the compared groups. The results obtained indicate that all groups differ from each other. The enterprise's digitisation level is the highest among medium-sized enterprises, employing 50 to 250 employees ($M = 3.74$; $SD = 0.442$). The average level of digitalization in this group of enterprises was statistically

significantly higher than in other small enterprises employing up to 50 people (M = 2.23; SD = 0.961), p < 0.05, d Cohena = -2.005, 95%CIdifference[-2.37; -1.63] and micro enterprises employing up to 5 people (M = 1.09; SD = 0.284), p < 0.05, d Cohena = -6.585, 95% CI difference [-7.51; -5.65]. Therefore, it can be concluded that the larger the enterprise, the higher the level of digitization shown by enterprises. The result of the average level of digitalization for individual groups of enterprises is presented in Figure 2.

The answers regarding the technologies used in digitalization are also interesting. The respondents indicated Cloud Computing (81.1%), digital system integration (79.5%) and Internet of Things (52.5%) as the most frequently implemented digital technologies. However, the respondents indicated that additive manufacturing was the least frequently implemented digital technology (20.4%). None of the respondents stated the implementation of a digital twin. The result of the most commonly implemented digital technologies is presented in Figure 3.

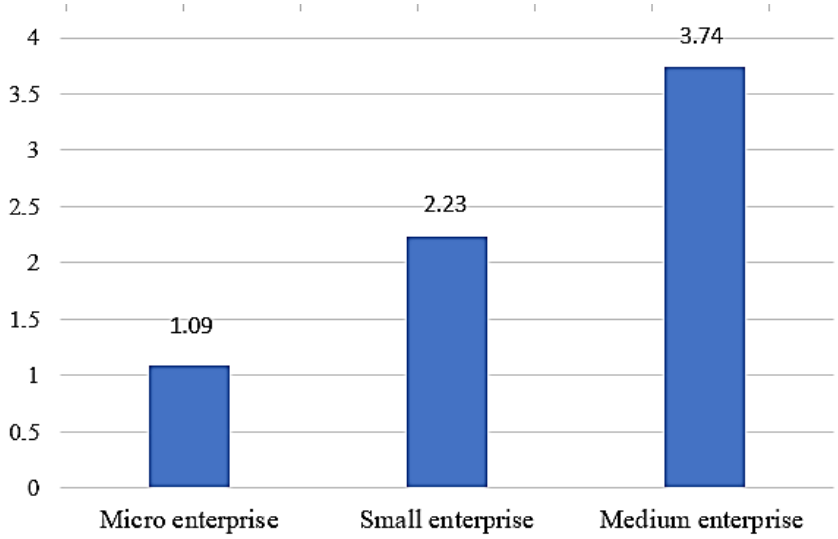

Figure 2. The average level of digitization of the micro, small and medium enterprises.

An interesting observation was also the examination of hypothesis H2, which states the influence of the declared level of digitization of the enterprise on the expected level of digitization of the network cooperation partner. Those enterprises that utilised machines and equipment at up to 80% in a calendar year were selected for the study. This means they have the production capacity to be made available through network collaboration. First, it was checked how the declared level of digitization of the examined enterprise was related to the expected level of digitization of a potential cooperator (network partner). For this purpose, a regression analysis was performed, where the declared level of digitization of the enterprise acted as a predictor, and the expected level of digitalization of the cooperator acted as a dependent variable. The proposed regression model was highly statistically significant $F(1;190) = 422.720$, $p < .001$. The declared level of digitization of the company turned out to be a significant positive predictor of the represented level of digitization of the cooperator ($\beta = 0.69$).

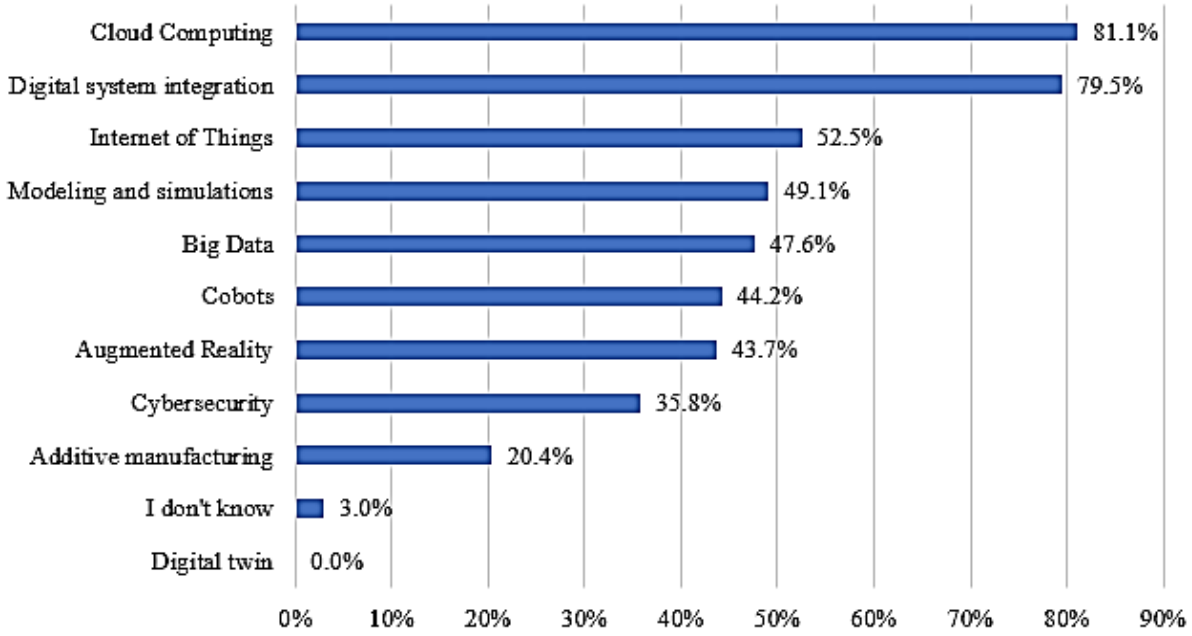

Figure 3. Digital technologies implemented in the surveyed enterprises.

In the next step, hypothesis H3 was tested regarding the existence of a relationship between the declared level of digitization of the enterprise and the company's tendency to join a network of enterprises to implement a joint venture, thereby increasing the degree of production capacity utilization. For this purpose, a regression analysis was performed, where the declared level of digitization of the enterprise acted as a predictor, and the tendency of the examined enterprise to join the network as a dependent variable. The regression model for this case was highly statistically significant $F(1;190) = 226.409$, $p < .001$. The declared level of enterprise digitization was a significant positive predictor of the willingness to join a business network ($\beta = 0.38$).

In the next step, it was checked how the level of digitization of the enterprise is related to the enterprise's declaration of connecting its intelligent resources with an external digital platform that guarantees the security of transmitted digital data and organizes the cyber-physical network in an automated manner. For this purpose, a regression analysis was performed, where the declared level of digitization of the enterprise acted as a predictor, and the declaration of connecting its intelligent external resources with an external e-business platform acted as a dependent variable. The considered regression model was highly statistically significant $F(1;190) = 478.715$, $p < .001$. The declared level of enterprise digitization turned out to be a significant positive predictor of the declared connection of one's intelligent resources with an external business e-platform that guarantees the security of transferred digital data and organizes the cyber-physical network in an automated manner ($\beta = 0.36$).

Also noteworthy is a significant percentage of enterprises that see the possibility of connecting their intelligent resources with an external business e-platform that will guarantee the security of transmitted digital data and organize a cyber-physical network in an automated manner. This answer was given by almost 53% of respondents. This represents a significant potential for developing intelligent resources, which result from the fourth industrial revolution and are increasingly found in the equipment of mainly medium-sized enterprises. However, such a variant requires a significant improvement in the level of digitization of Polish micro, small and medium-sized enterprises. Detailed analysis results are presented in Figure 4.

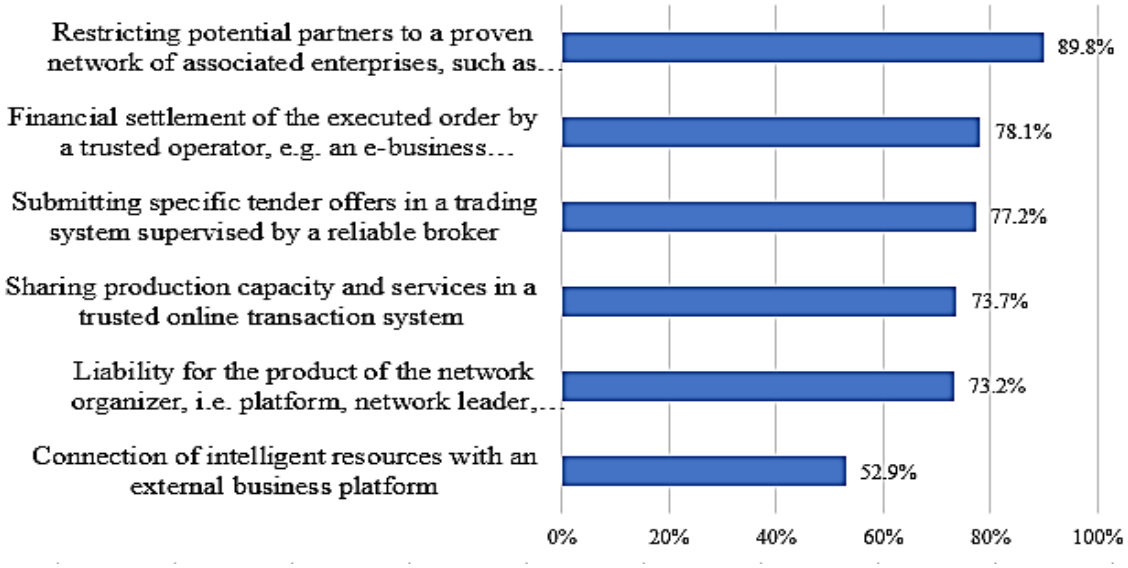

Figure 4. Variants of enterprise participation in cyber-physical production networks.

The study aimed to gather opinions from participants on cooperation in cyber-physical production networks. The majority of respondents (89.9%) expressed a preference for working with partners from a verified group of associated enterprises, such as a cluster or common business platform. This indicates a significant lack of trust when it comes to working with unverified partners. The survey also inquired about the difficulties participants faced while working with others in their network. The results showed that most respondents experienced disruptions in their production (95.7%), staff shortages, and a lack of knowledge and competence among employees (78.1%). Additionally, problems with settlements after completing a production order (69.4%), timely execution of orders (56.8%), product liability (43.3%), and complaint problems (42.3%) were reported as challenges.

The survey asked respondents about the challenges companies face while searching for and establishing cooperation with partners. The results showed that 100% of the respondents found it challenging to find partners. Additionally, 96% of the surveyed respondents faced problems due to a lack of information about the availability of resources. A high percentage of respondents also reported that a potential partner's assistance cost was too high (85%), and negotiations with potential partners were often long-term (85%). The surveyed companies also drew attention to the problem of financial settlements between partners, which

consequently leads to the choice of a variant in which the responsibility for the financial settlement of a jointly executed order will be taken over by a trusted external operator, e.g. a broker or an organization that will organize the network and contact the external client. As many as 78.1% of the surveyed enterprises represented this position. Over 77% of enterprises would prefer responding to a specific request for quotation from a reliable broker (network organizer) in the transaction system. Many enterprises (73.7%) are interested in offering spare production capacity and services in a trusted online transaction system. Product liability is often a significant problem in the case of joint execution of orders in production networks. Hence, the survey asked about the possibility of the entity organizing the network taking over responsibility for the product. As a result, over 73% of enterprises would be willing to use such an option.

4. Discussion

Creating network forms of cooperation is an excellent opportunity to dynamize the development of the SME sector within the concept of Industry 4.0 and increase enterprises' competitiveness (Birkel e al., 2019). This is confirmed by the presented results, which show that the technologies of Industry 4.0 enable and even facilitate and intensify the establishment of cooperation between companies within industrial networks. Creating a network for businesses has many benefits, but it's not an easy process and raises concerns for companies in the SME sector. Choosing the right partners for the network is a difficult task that requires consideration of several factors, including production capacity, technology, service quality, financial stability, experience, and communication skills (Baraldi, et. al., 2012; Xu and Duan, 2019). These factors have a significant impact on the success of joint tasks (Napoleone et al. 2020).

Another critical issue is building trust between partners, investing in digitalization and information technologies and addressing any problems that may arise—SMEs, in particular, face challenges in implementing advanced digital technologies due to high costs. The survey indicates that small and medium-sized enterprises face difficulties cooperating and forming networks. Hence, there is a need to conduct future research on models of cooperation of small and medium-sized enterprises in cyber-physical networks, the creation of e-platforms and network planning methods oriented towards the joint implementation of production tasks.

The presented research shows the significant impact of digitalization on the possibility of cooperation between enterprises within cyber-physical production networks. The research confirmed the hypothesis that an enterprise's declared level of digitization is related to the size of the enterprise. This means focusing more on smaller entities and supporting these enterprises in digitization. Moreover, it has been proven that the level of digitization of an enterprise affects

the expected level of digitization of network cooperation partners, which means putting pressure on network partners in the future to use digital technologies. Also noteworthy is the confirmation of a strong relationship between the level of digitization declared by the company and its willingness to participate in the organization of cyber-physical networks of enterprises to implement joint production.

5. Conclusions

Many enterprises in today's market are realizing the need for change, particularly in implementing modern technologies and digitising processes. The emergence of Industry 4.0 and the growth of network cooperation provide development opportunities for small and medium-sized enterprises. Micro, small, and medium-sized enterprises are seen as intelligent modules that can work together to create customer value and establish temporary production networks facilitated by e-platforms.

The research shows that the digitization of micro, small and medium-sized enterprises is one of the critical conditions facilitating cooperation within cyber-physical production networks. Implementing digital technologies will allow for better communication between enterprises and collaboration with e-business platforms, allowing for the quick organization of temporary networks capable of taking advantage of emerging business opportunities. Especially in the case of production orders requiring knowledge, competencies and distributed production resources of micro, small and medium-sized enterprises.The companies that were surveyed also highlighted the issue of financial settlements between partners. As a result, they opted for a solution where a trusted external operator, such as a broker or an organization that manages the network and communicates with the external client, takes responsibility for the financial settlement of a joint order. It's worth noting that many companies are interested in connecting their intelligent resources with an external business e-platform.

The article tested three hypotheses, which were confirmed. The survey revealed that there is a positive correlation between company size and digitalization level, with larger enterprises reporting higher levels of digitization. Enterprises declaring a higher level of digitization also expect a correspondingly high level of digitization from their network partner. Moreover, a higher level of digitization of the enterprise is a factor that influences the willingness of the examined enterprise to join a cyber-physical cooperation network. The research also shows that an enterprise's digitization level is associated with the enterprise's declaration of connecting its intelligent resources with an external e-platform that guarantees the security of transmitted digital data and organizes the cyber-physical network in an automated manner.

Future research will focus on developing cyber-physical network planning methods and business models describing the functioning of micro, small and medium-sized enterprises operating within e-business platforms responsible for network coordination and cooperation with external clients.

References

1. Adamik, A., Grabowska, S., Saniuk, S. (2023). *Model biznesu w środowisku Smart World*. Warszawa: PWE, p. 304.
2. Baraldi, E., Gressetvold, E., Harrison, D. (2012). Resource interaction in inter-organizational networks: Foundations, comparison, and a research agenda. *Journal of Business Research, 65(2),* 266-276.
3. Birkel, H.S., Veile, J.W., Müller, J.M., Hartmann, E., Voigt, K.I. (2019). Development of a risk framework for Industry 4.0 in the context of sustainability for established manufacturers. *Sustainability, 11(2),* 384.
4. Cotrino, A., Sebastián, M.A., González-Gaya, C. (2020). Industry 4.0 roadmap: Implementation for small and medium-sized enterprises. *Applied sciences, 10(23),* 8566.
5. Culot, G., Fattori, F., Podrecca, M., Sartor, M. (2019). Addressing industry 4.0 cybersecurity challenges. *IEEE Engineering Management Review, 47(3),* 79-86.
6. Czakon, W. (2015). Sieci międzyorganizacyjne w naukach o zarządzaniu – w kierunku sieciowych modeli biznesu, Studia Ekonomiczne. *Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach, No. 217*.
7. Grabowska, S., Saniuk, S. (2023). *Business Models for Industry 4.0: Concepts and Challenges in SME Organizations.* London: Routledge - Taylor & Francis Group, p. 176.
8. Hyrynsalmi, S.M. (2022). *Definition of the Enterprise Integration Platforms as a Service—Towards a Common Understanding.* International Conference on Software Business. Cham: Springer International Publishing, pp. 167-181.
9. Kagermann, H., Wahlster, W., Helbig, J. (Eds.) (2011). *Recommendations for Implementing the Strategic Initiative Industrie 4.0: Final Report of the Industrie 4.0 Working Group.* Industrie 4.0: Mit dem Internet der Dinge auf dem Weg zur 4. Industriellen Revolution. Frankfurt, Germany: VDINachrichten.
10. Lachiewicz, S., Zakrzewska-Bielawska, A. (2012). Sieć przedsiębiorstw jako skuteczna forma organizacyjna w warunkach kryzysu gospodarczego. *Management and Business Administration. Central Europe, 20(4),* 34-45.
11. Lee, J., Bagheri, B., Kao, H. (2015). Research Letters: A Cyber-Physical Systems architecture for Industry 4.0-based manufacturing systems. *Manuf. Lett., 3,* 18-23.

12. Mahmood, K., Lanz, M., Toivonen, V., Otto, T. (2018). A performance evaluation concept for production systems in an SME network. *Procedia CIRP, 72,* 603-608.
13. Meyers, L.S., Gamst, G.C., Guarino, A.J. (2013). *Performing data analysis using IBM SPSS.* John Wiley & Sons.
14. Młody, M. (2018). *Product personalization and Industry 4.0 - assessment of the rightness of the implementation of modern technologies in the manufacturing industry from the consumers' perspective.* Ekonomika i Organizacja Przedsiębiorstwa.
15. Napoleone, A., Macchi, M., Pozzetti, A. (2020). A review on the characteristics of cyber-physical systems for the future smart factories. *Journal of Manufacturing Systems, 54*, 305-335.
16. Perechuda, K., Sobińska, M. (2015). *Challenges for knowledge management in the context of it global sourcing models implementation.* In: Artificial Intelligence for Knowledge Management: Second IFIP WG 12.6 International Workshop, AI4KM 2014. Warsaw, Poland, September 7-10, 2014, Revised Selected Papers, no. 2 (pp. 58-74). Springer International Publishing.
17. Polska Agencja Rozwoju Przedsiębiorczości (2022) *Raport o stanie sektora małych i średnich przedsiębiorstw w Polsce,* https://www.parp.gov.pl/storage/publications/pdf/Raport-o-stanie-sektora-maych-i-rednich-przedsibiorstw_13_10_2022.pdf, 10.06.2023.
18. Rüßmann, M., Lorenz, M., Gerbert, P., Waldner, M., Engel, P., Harnisch, M., Justus, J., (2015). *Industry 4.0: The future of productivity and growth in manufacturing industries.* Boston Consulting Group (BCG), pp. 1-14. https://www.bcg.com/publications/2015/engineered_products_project_business_industry_4_future_productivity_growth_manufacturing_industries, 2.09.2023.
19. Saniuk, S. (2020). The concept of utilizing SMES network e-business platforms for customized production in the industry 4.0 perspective. *Scientific Papers of Silesian University of Technology. Organization and Management Series, No. 136,* 523-533, ISSN: 1641-3466.
20. Schröder, C. (2016). The challenges of industry 4.0 for small and medium-sized enterprises. *Friedrich-Ebert-Stiftung: Bonn, Germany*, *7*, 1-28.
21. Wolniak, R. (2023). Innovations in industry 4.0 conditions. *Silesian University of Technology Scientific Papers. Organization and Management Series, 169,* 725-742.
22. Xu, H., Yu, W., Griffith, D., Golmie, N. (2018). A survey on industrial Internet of Things: A cyber-physical systems perspective. *IEEE, 6,* 78238-78259.
23. Xu, L.D., Duan, L. (2019). Big data for cyber physical systems in industry 4.0: a survey. *Enterprise Information Systems, 13(2),* 148-169.