

## EMPLOYEES' PERCEPTIONS OF INFORMATION SYSTEMS, AUTOMATION, AND IOT IN PRODUCTION MANAGEMENT: EVIDENCE FROM AN INDUSTRIAL ENTERPRISE

Wojciech ŻARSKI<sup>1\*</sup>, Michał BURCZYK<sup>2</sup>

<sup>1</sup> Politechnika Bydgoska; wojciech.zarski@pbs.edu.pl, ORCID: 0000-0001-7519-6181

<sup>2</sup> burczyk.michal@gmail.com

\*Correspondence author

**Purpose:** The purpose of this paper is to evaluate the effectiveness of implementing modern information systems, automation, and Internet of Things (IoT) solutions in production management within an industrial enterprise. The study aims to assess their impact on production processes and to identify organisational and human-related factors influencing digital transformation.

**Design/methodology/approach:** The research adopts a quantitative approach based on a diagnostic survey method. An original questionnaire consisting of 23 closed-ended questions was conducted among 117 employees representing different organisational positions in a manufacturing enterprise. The study focuses on production management systems, automation, robotisation, and IoT within the Industry 4.0 framework. Data were analysed using descriptive statistics.

**Findings:** The results indicate a high level of integration and effectiveness of the implemented information systems in supporting production planning, monitoring, and control. Digital solutions are generally perceived positively by employees and contribute to improved operational efficiency and production continuity. Automation and robotisation are viewed as supportive tools rather than full substitutes for human labour. IoT solutions are recognised as particularly valuable for process monitoring and predictive maintenance, while cybersecurity emerges as an important challenge.

**Research limitations/implications:** The study is limited to a single industrial enterprise, which restricts the generalisability of the findings. Future research should include comparative studies across multiple organisations or sectors and consider qualitative methods to further explore employee perceptions and organisational readiness for advanced digital solutions.

**Practical implications:** The findings provide practical guidance for enterprises planning or continuing digital transformation initiatives. They highlight the importance of system integration, continuous investment in IT infrastructure, employee training, and maintaining a balance between technological advancement and human involvement.

**Social implications:** The study emphasises the significance of human factors in digital transformation, including employee acceptance, competencies, and cybersecurity awareness, which may contribute to improved working conditions and more sustainable implementation of Industry 4.0 solutions.

**Originality/value:** This paper offers empirical evidence on the effectiveness of integrated information systems, automation, and IoT in production management from the employees' perspective, contributing to research that combines technological and organisational dimensions of digital transformation.

**Keywords:** production management; Industry 4.0; information systems; automation; Internet of Things.

**Category of the paper:** Research paper.

## 1. Introduction

Contemporary manufacturing enterprises operating in an increasingly competitive and demanding market environment are progressively adopting advanced technological solutions to enhance operational efficiency and maintain competitive advantage. Key objectives of these initiatives include reducing operational costs, improving distribution processes, enhancing product quality, and increasing customer service standards (Javaid et al., 2022; Skórnóg, 2023). As a result, digitalisation and automation, which constitute the core of the Industry 4.0 concept, currently permeate nearly all areas of enterprise operations—from production and inventory management to the final stages of distribution (Javaid et al., 2024; Matt et al., 2023; Śledziowska, Włoch, 2020).

This process constitutes the foundation of digital transformation, which underpins the transition toward the Industry 4.0 paradigm. Modern technologies enable the automation of industrial operations, integration of heterogeneous data sources, and optimisation of resource utilisation across the entire value chain. Consequently, highly integrated, flexible, and adaptive production systems emerge, based on solutions such as the Internet of Things, cyber-physical systems, Big Data analytics, cloud computing, and advanced robotics.

At the same time, numerous studies indicate that the effectiveness of Industry 4.0 implementation depends not only on technological advancement but also on organisational and social factors (Xu et al., 2021; Mourtzis et al., 2022). In particular, employee competencies and acceptance of new technologies significantly influence the success of organisational transformation processes. Understanding how employees perceive digital technologies and how these technologies affect their daily work routines is therefore essential for achieving sustainable digital transformation (Zhou et al., 2015, Nowakowska, 2023; Biernikowicz, 2024, Homera, 2024).

In recent years, increasing attention has also been paid to the potential for further intensifying production digitalisation through advanced analytical mechanisms, including elements of artificial intelligence. Operating as an extension of existing ERP, MES, or SCADA systems, AI-based solutions enable a transition from traditional automation toward predictive planning, process optimisation, and real-time decision support (Peres et al., 2020; Gunia, 2019).

At the same time, their implementation introduces new challenges related to data quality, specialist competencies, and information security (Gabsi, 2024; Jagatheesaperumal et al., 2021).

Despite these challenges, the integration of advanced digital technologies, including artificial intelligence, remains one of the most important directions shaping the future of modern manufacturing. In the long term, it lays the foundation for the evolution toward the Industry 5.0 paradigm, in which human–technology collaboration becomes a central element of resilient and sustainable industrial systems (Breque et al., 2021).

Against this background, there is a clear need for empirical research aimed at assessing the effectiveness of implementing modern information systems, automation, and IoT solutions in production management, while taking into account the perceptions of employees directly involved in production processes (Benotsmane et al., 2019; Żarski, Borys, 2025). The objective of this paper is to evaluate the impact of these technologies on the functioning of a production system in an industrial enterprise and to identify factors facilitating further development of digital transformation.

Based on the research objective, the study addresses the following research questions:

RQ1: How do employees perceive the effectiveness of information systems in production management?

RQ2: How are automation and IoT assessed as support tools in production processes?

## 2. Materials and Methods

The research was conducted in an enterprise operating in the manufacturing sector and specialising in the production of railway infrastructure components. The enterprise is characterised by a high level of production process complexity and intensive use of modern information and automation technologies, which makes it an appropriate research object for analysing the effectiveness of digital transformation.

A quantitative research method in the form of a questionnaire survey was applied. The research tool was an original questionnaire consisting of 23 closed-ended questions covering issues related to production management, information systems, automation, robotisation, the Internet of Things (IoT), and the assessment of the effectiveness of implemented solutions. Respondents were informed about the purpose of the study and assured of the anonymity of their responses.

The survey was conducted from April 1 to April 30, 2025. The study involved 117 employees of the enterprise representing various positions, including managerial staff, specialists, machine operators, IT department employees, and designers. Such a sample

composition enabled the collection of a multi-perspective view of the functioning of information systems in the production process.

The analysis of results was carried out using descriptive statistics, in particular percentage structure analysis of responses. The collected data were compiled to identify dominant opinions among respondents and key areas of influence of IT systems on production management. Due to the exploratory nature of the study and the focus on employee perceptions, descriptive statistics were considered sufficient for identifying dominant trends and opinions.

**Table 1.**

*Structure of survey questions and their linkage to production management and Industry 4.0 domains*

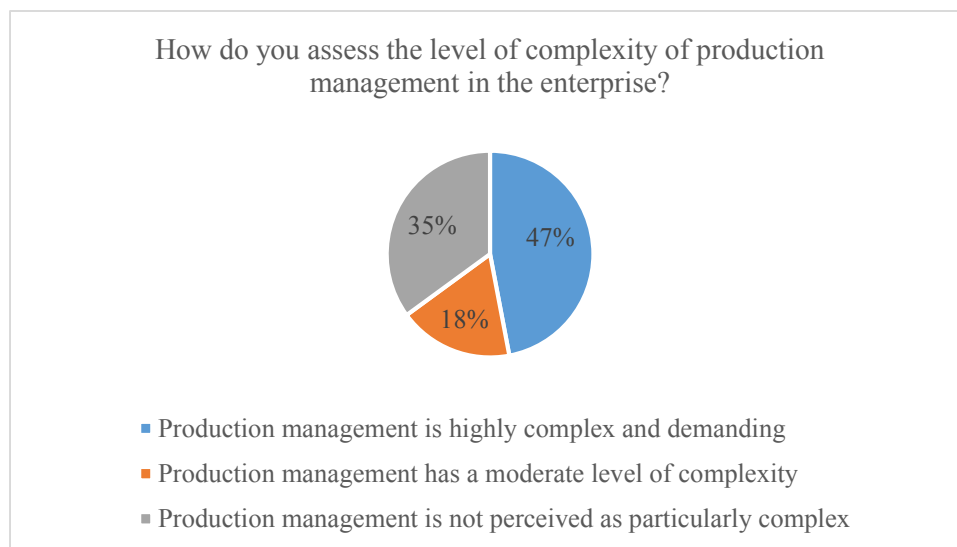
<b>Figure No.</b>	<b>Scope of the survey question (conceptual meaning)</b>	<b>Production management domain</b>	<b>Digitalisation / Industry 4.0 domain</b>
Fig. 1	Employees' perception of the level of complexity of production management	Production planning and coordination	Complexity of digitally supported production systems
Fig. 2	Key elements determining the proper functioning of the production management process	Management functions (planning, organising, directing, control)	System-based and data-driven management
Fig. 3	Availability of information systems supporting production management	Information and production planning management	ERP / MES systems
Fig. 4	Level of alignment and integration of information systems supporting production management	Systems integration and coordination	Interoperability of ERP–MES–SCADA–CMMS systems
Fig. 5	Investment in the development of production management information systems	Strategic production management	Digital transformation and system modernisation
Fig. 6	Development of the machinery park through automation and robotisation	Production execution and operations management	Automation and industrial robotics
Fig. 7	Employees' attitudes toward full automation of production processes	Organisation of work and human involvement	Human–machine interaction
Fig. 8	Perceived importance of the Internet of Things in production management	Maintenance and process monitoring	Internet of Things (IoT)
Fig. 9	Problems related to operating implemented information systems	Human resources and competency management	Digital skills, system usability, cybersecurity awareness
Fig. 10	Perceived benefits of implementing modern information systems in the production process	Process improvement and operational control	Digital efficiency and performance optimisation

Source: own study.

### 3. Research Results

#### 3.1. Perception of the complexity of production management

The analysis of respondents' answers indicates that production management in the analysed enterprise is perceived as a complex process requiring coordination of many interrelated activities. A significant proportion of employees assessed that contemporary production management may generate difficulties both for managerial staff and operational employees. This results primarily from the need to simultaneously consider technical, organisational, logistical, and quality-related aspects.

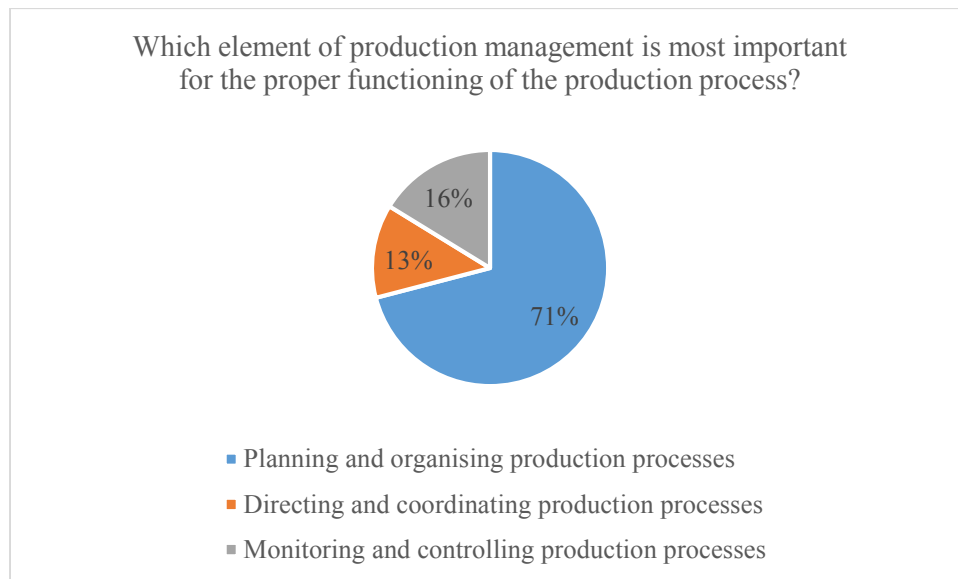


**Figure 1.** Assessment of the level of complexity of production management in the enterprise according to employees' opinions (n = 117).

Source: own study.

At the same time, a substantial group of respondents indicated that despite the high level of complexity, the production management process in the enterprise operates in a stable manner and does not cause significant operational problems. This may indicate the effectiveness of implemented information tools and the organisational maturity of the enterprise.

Respondents were also asked about the key elements determining the proper course of the production management process. The vast majority pointed to the importance of planning and organising production, which highlights the role of a systemic approach to resource management, scheduling, and synchronisation of production activities. Less importance was attributed to directing and control functions, which may suggest that well-designed information systems partially assume these roles by automating supervisory processes.

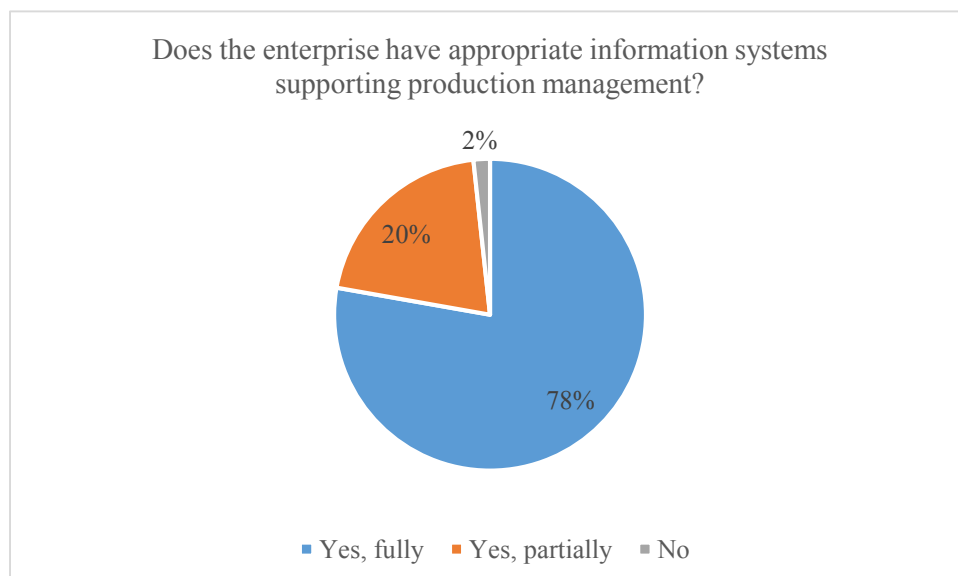


**Figure 2.** Key elements of production management determining the proper functioning of the production process in the enterprise – employees' opinions (n = 117).

Source: own study.

### 3.2. Availability and integration of information systems

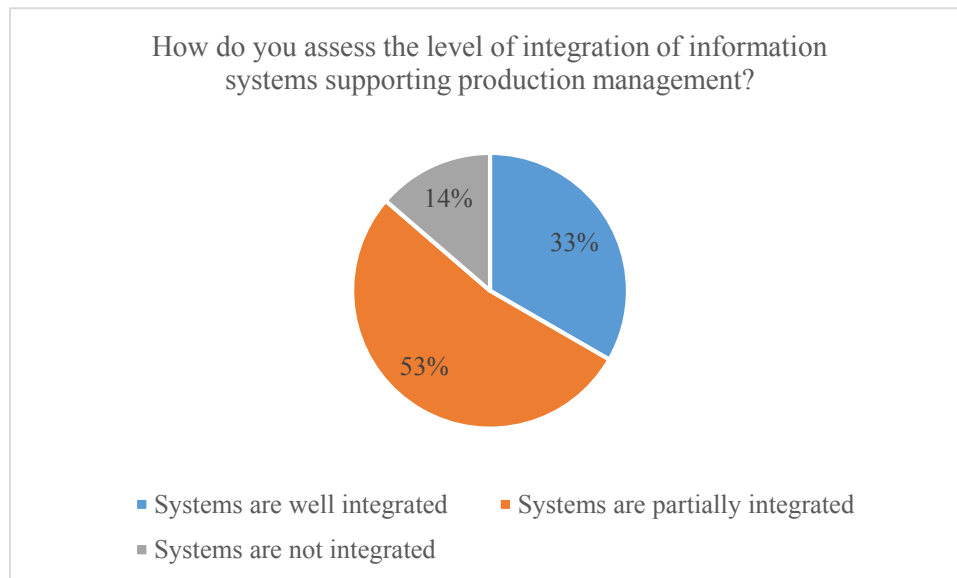
The research results clearly indicate that the analysed enterprise possesses an extensive set of information systems supporting production management. The vast majority of respondents confirmed the existence of appropriate IT tools enabling effective planning, monitoring, and control of production processes. Only a small proportion of respondents indicated limited availability of such solutions.



**Figure 3.** Availability of information systems supporting production management in the enterprise – employees' opinions (n = 117).

Source: own study.

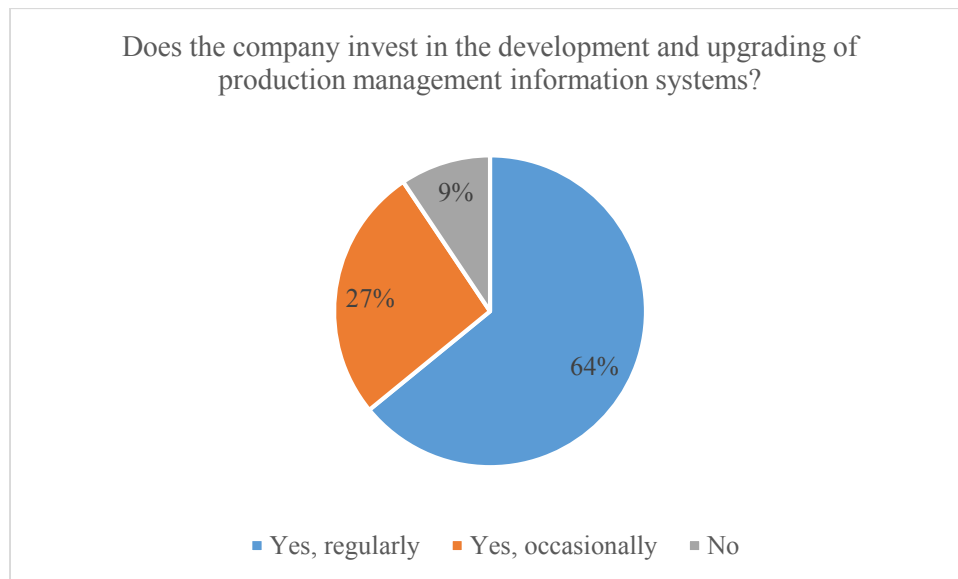
A particularly important aspect emphasised by respondents was the degree of alignment and mutual integration of the applied information systems. Most employees assessed that the existing solutions form a coherent information ecosystem enabling smooth data flow between individual areas of enterprise activity. The integration of ERP, MES, SCADA, and CMMS systems allows for reduction of data redundancy, minimisation of error risks, and shortening reaction times to production irregularities.



**Figure 4.** Assessment of the level of integration of information systems supporting production management in the enterprise (n = 117).

Source: own study.

Respondents also highlighted the importance of systematic investments in the development of information systems. Regular updates and implementation of new solutions are perceived as a condition for maintaining the enterprise's competitiveness and adapting to changing market conditions. At the same time, it was indicated that the lack of IT investments may lead to system obsolescence and reduced effectiveness of production management.



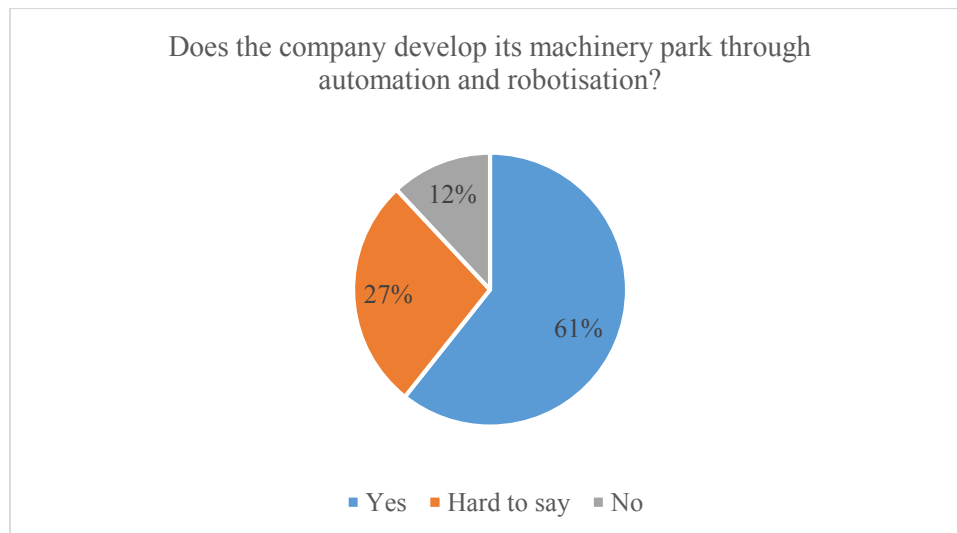
**Figure 5.** Investment in the development of production management information systems in the enterprise – employees’ opinions (n = 117).

Source: own study.

An important complement to the obtained results is employees’ declared perception of the enterprise’s readiness for further development of digital infrastructure and updating of applied information systems. The high level of integration of existing solutions creates favourable conditions for the next stage of digital transformation, namely the intensification of the use of tools based on artificial intelligence.

### 3.3. Automation and robotisation of production processes

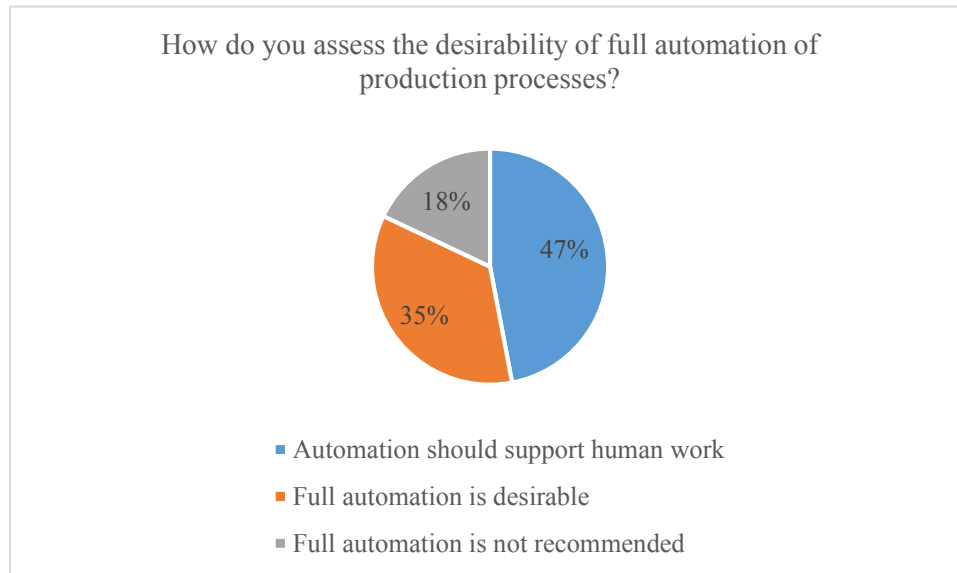
The analysis of results concerning automation and robotisation indicates that the enterprise consistently develops its machinery park by implementing modern technological solutions. A significant proportion of respondents confirmed that the company plans or carries out investments in industrial robots and intelligent machines, which demonstrates its efforts to increase productivity and stability of production processes.



**Figure 6.** Development of the machinery park through automation and robotisation in the enterprise – employees' opinions (n = 117).

Source: own study.

At the same time, employees' opinions regarding full automation of production are diversified. The largest group of respondents indicated that automation should play a complementary role to human work rather than fully replace it. This approach may result both from practical experience and from concerns related to loss of flexibility or excessive dependence of processes on technology.



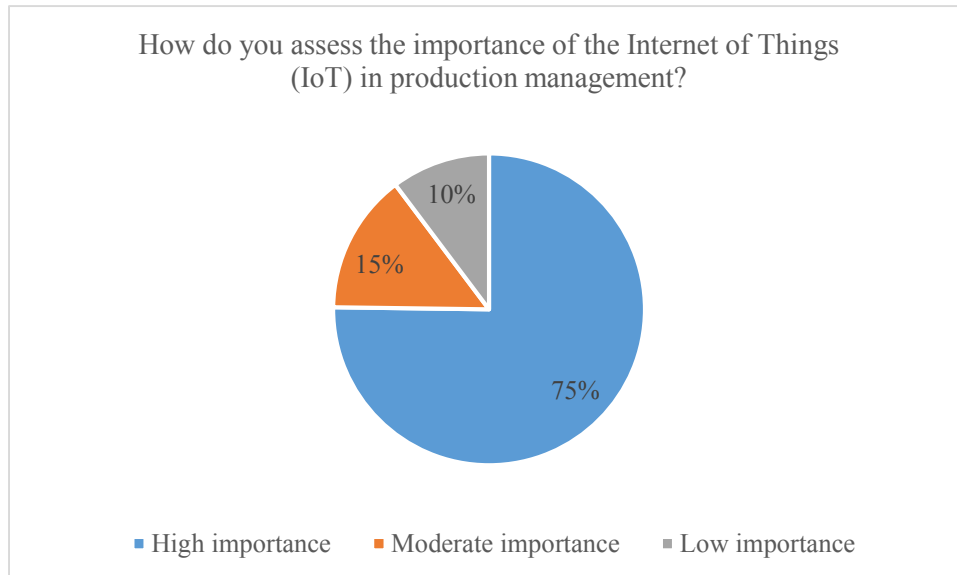
**Figure 7.** Employees' opinions on the desirability of full automation of production processes in the enterprise (n = 117).

Source: own study.

Nevertheless, some respondents perceive the potential of full automation in the context of accelerating production task execution and reducing human errors. These results indicate the need for gradual and well-considered implementation of robotic solutions, taking into account process specificity and employee competencies.

### 3.4. The role of the Internet of Things in production management

The Internet of Things was assessed by respondents as one of the most promising solutions supporting production management. The vast majority of respondents indicated that IoT implementation contributes to faster production processes, improved machine monitoring, and increased operational efficiency. Particular emphasis was placed on the importance of IoT in the context of predictive maintenance and rapid response to irregularities.



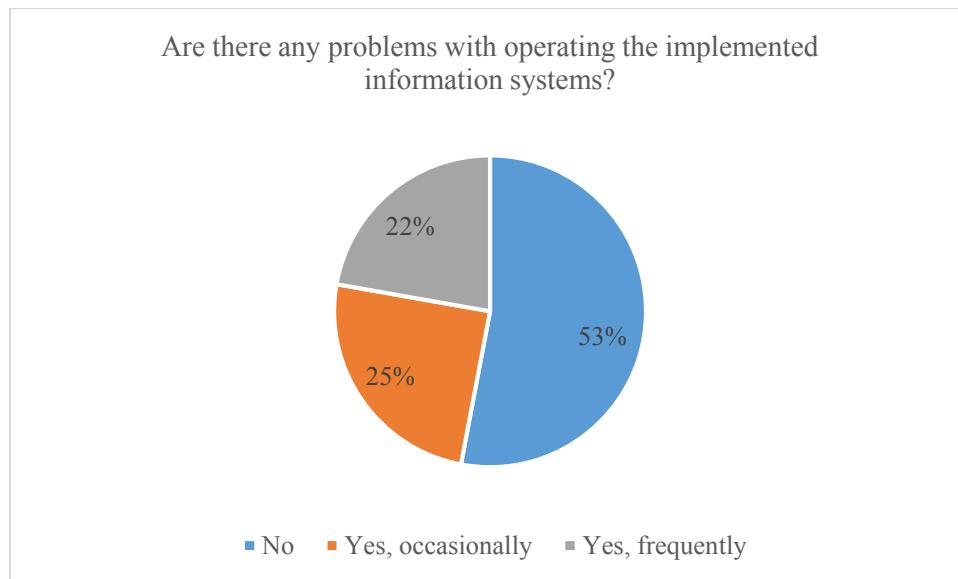
**Figure 8.** Assessment of the importance of the Internet of Things (IoT) in production management in the enterprise – employees' opinions (n = 117).

Source: own study.

At the same time, some respondents pointed to high costs and complexity of IoT implementation, which may constitute a barrier to further development in this area. These concerns relate to both technical and organisational aspects, including the necessity to ensure an adequate level of data security.

### 3.5. Employee competencies, system effectiveness, and security

The research results indicate that most employees do not experience significant problems in operating the implemented information systems, which is the result of conducted training and activities aimed at improving digital competencies. Respondents emphasised that proper staff preparation is crucial for effective utilisation of the potential of IT systems.

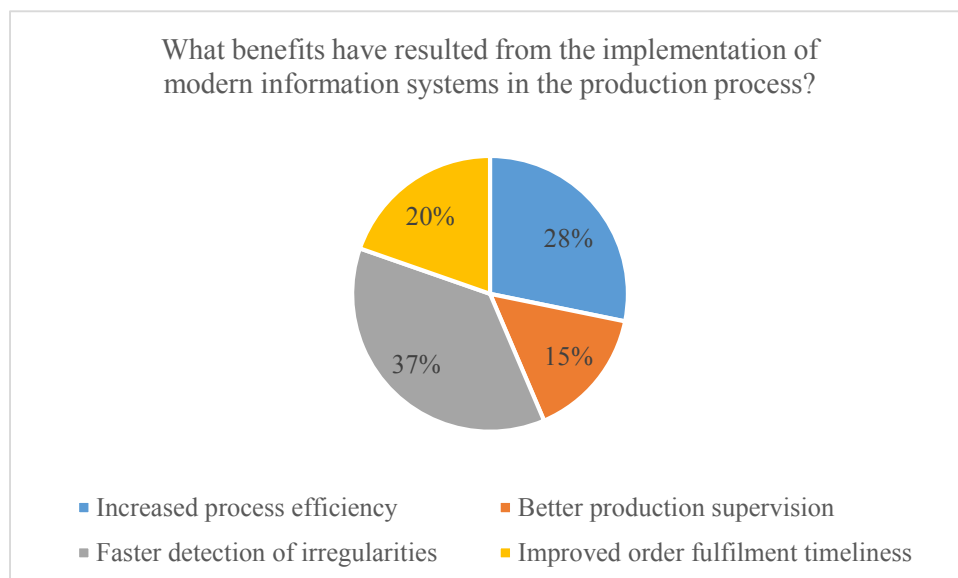


**Figure 9.** Problems with operating information systems implemented in the enterprise – employees' opinions (n = 117).

Source: own study.

At the same time, cases of losses and disruptions in the production process related to the functioning of information systems were identified, including incidents of a cyber nature. These results indicate the growing importance of cybersecurity as an integral element of production management in the Industry 4.0 environment.

Respondents unequivocally assessed modern information systems as more effective than traditional production management methods. Among the most frequently indicated benefits were faster fault detection, increased precision of order execution, better production supervision, and improved work efficiency.



**Figure 10.** Benefits of implementing modern information systems in the production process in the enterprise – employees' opinions (n = 117).

Source: own study.

## 4. Discussion of Results

The obtained results confirm that information systems, automation, and IoT constitute an important element of modern production management, which is consistent with the assumptions of the Industry 4.0 concept. The high level of system integration and their positive evaluation by users indicate the digital maturity of the analysed enterprise.

At the same time, the research results reveal the significant role of the human factor in the digital transformation process. Employees' cautious approach to full automation confirms the need to maintain a balance between technology and human competencies. Similar conclusions are presented in the literature, which emphasises the importance of user acceptance for the success of technological implementations.

The identified threats in the area of cybersecurity indicate the necessity to treat the security of industrial systems as an integral element of production management. The development of IoT and system integration increase enterprises' susceptibility to cyber incidents, which requires continuous improvement of protection procedures and raising employee awareness.

An important conclusion drawn from the analysis is also the openness of the analysed enterprise to further investments in the development of production digitalisation. Respondents' declared orientation toward updating information systems and implementing new technological solutions indicates that the digital transformation process is not treated as a one-time initiative but as a continuous and long-term activity. Such an approach supports gradual growth of the organisation's digital maturity and enables flexible response to changing market and technological conditions.

In this context, further intensification of production digitalisation may primarily focus on extending the functionality of existing information systems with advanced analytical mechanisms, including solutions using elements of artificial intelligence. These technologies, functioning as a complement to current ERP, MES, or SCADA systems, may support predictive planning processes, schedule optimisation, and early detection of process deviations. The research results suggest that regular investments in IT infrastructure development and positive employee attitudes toward new technologies create favourable conditions for the gradual implementation of such solutions without disturbing the balance between automation and the human role in the production system. Despite its single-case design, the study provides valuable insights into digital transformation processes in complex manufacturing environments.

## Conclusions

The conducted empirical research confirms that modern information systems, automation, and Internet of Things solutions play a significant role in production management in the analysed industrial enterprise. The high level of integration of applied IT systems and their positive evaluation by employees indicate the organisation's digital maturity and the effectiveness of undertaken transformation activities.

The obtained results simultaneously emphasise the key importance of the human factor in the production digitalisation process. User acceptance, appropriate digital competencies, and training activities significantly influence the effectiveness of implemented technological solutions. Respondents perceive automation and robotisation as important support for production processes, while recognising the need to maintain a balance between technology and the human role.

Another important conclusion is the enterprise's openness to further investments in the development of digital infrastructure and updating information systems. This creates conditions for gradual intensification of production digitalisation, including extending the functionality of existing systems with advanced analytical mechanisms. In this context, solutions using elements of artificial intelligence may constitute a natural complement to current production management systems.

At the same time, the research results indicate the growing importance of cybersecurity issues in the environment of integrated production systems. Effective digital transformation therefore requires a balanced approach combining technological development with risk management and conscious shaping of employee competencies.

A limitation of this study is its focus on a single enterprise, which justifies the need for further empirical research, particularly of a comparative nature.

## References

1. Benotmane, R., Kovács, G., Dudás, L. (2019). Economic, social impacts and operation of smart factories in Industry 4.0 focusing on simulation and artificial intelligence of collaborating robots. *Social Sciences*, 8(5), 143.
2. Biernikowicz, A. (2024). *Asymilacja technologii informatycznych w organizacjach*. Warszawa: Sekcja Wydawnicza Wydziału Zarządzania Uniwersytetu Warszawskiego
3. Breque, M., De Nul, L., Petridis, A. (2021). *Industry 5.0: towards a sustainable, human-centric and resilient European industry* (No. KI-BD-20-021-EN-N). Directorate General for Research and Innovation (DG RTD) of the European Commission.

4. Gabsi, A.E.H. (2024). Integrating artificial intelligence in industry 4.0: insights, challenges, and future prospects—a literature review. *Annals of Operations Research*, 1-28.
5. Gunia, G. (2019). Zintegrowane systemy informatyczne przedsiębiorstw w kontekście przemysłu 4.0. *Zarządzanie Przedsiębiorstwem*, 22(2), 7-12.
6. Hamera, A. (2024). Rola doświadczeń użytkownika w erze Przemysłu 5.0. *Zarządzanie Przedsiębiorstwem*, 27(2), 7-15.
7. Jagatheesaperumal, S.K., Rahouti, M., Ahmad, K., Al-Fuqaha, A., Guizani, M. (2021). The duo of artificial intelligence and big data for industry 4.0: Applications, techniques, challenges, and future research directions. *IEEE Internet of Things Journal*, 9(15), 12861-12885.
8. Javaid, M., Haleem, A., Singh, R.P., Sinha, A.K. (2024). Digital economy to improve the culture of industry 4.0: A study on features, implementation and challenges. *Green Technologies and Sustainability*, 2(2), 100083.
9. Javaid, M., Haleem, A., Singh, R.P., Suman, R., Gonzalez, E.S. (2022). Understanding the adoption of Industry 4.0 technologies in improving environmental sustainability. *Sustainable operations and computers*, 3, 203-217.
10. Matt, D.T., Pedrini, G., Bonfanti, A., Orzes, G. (2023). Industrial digitalization. A systematic literature review and research agenda. *European Management Journal*, 41(1), 47-78.
11. Mourtzis, D., Angelopoulos, J., Panopoulos, N. (2022). A Literature Review of the Challenges and Opportunities of the Transition from Industry 4.0 to Society 5.0. *Energies*, 15(17), 6276.
12. Nowakowska, P. (2023). Nowe technologie w rozwoju i zarządzaniu przedsiębiorstwem. *Zarządzanie Innowacyjne w Gospodarce i Biznesie*, 36(1), 63-74.
13. Peres, R.S., Jia, X., Lee, J., Sun, K., Colombo, A.W., Barata, J. (2020). Industrial artificial intelligence in industry 4.0-systematic review, challenges and outlook. *IEEE Access*, 8, 220121-220139.
14. Skórnóg, D. (2023). Wpływ innowacyjnych rozwiązań Przemysłu 4.0 na zarządzanie jakością. *Zarządzanie i Jakość*, 5(1).
15. Śledziowska, K., Włoch, R. (2020). *Gospodarka cyfrowa. Jak technologie zmieniają świat*. Warszawa: Wydawnictwa Uniwersytetu Warszawskiego.
16. Xu, X., Lu, Y., Vogel-Heuser, B., Wang, L. (2021). Industry 4.0 and Industry 5.0—Inception, conception and perception. *Journal of Manufacturing Systems*, 61, 530-535.
17. Żarski, W., Borys, K. (2025). Ocena akceptacji technologii przemysłu 4.0 i ich wpływ na efektywność pracy w wybranym przedsiębiorstwie produkcyjnym. *Management & Quality [Zarządzanie i Jakość]*, 7(3).
18. Zhou, K., Liu, T., Zhou, L. (2015, August). Industry 4.0: Towards future industrial opportunities and challenges. In: *2015 12th International conference on fuzzy systems and knowledge discovery (FSKD)* (pp. 2147-2152). IEEE.