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ORIGINAL PAPER

APPLICATION OF INDUSTRIAL INTERNET OF THINGS (IIOT) IN THE PACKAGING INDUSTRY IN POLAND

Beata Paliwoda[1], Justyna Górna[1], Marta Biegańska[2], Krzysztof Wójcicki[2]

1) Poznań University of Economics and Business, Institute of Management, Poznań, **Poland**
2) Poznań University of Economics and Business, Institute of Quality Sciencem, Poznań, **Poland**

ABSTRACT. Background: This paper explains the concept of the Industrial Internet of Things (IIoT) and highlights the benefits of its adoption. The purpose of the study was to identify and evaluate practices and approaches of organisations toward the implementation of IIoT solutions in the packaging industry in Poland.
Methods: The results are based on non-sensitive quantitative data collected with the use of a survey questionnaire method and CATI (Computer Assisted Telephone Interview) as a data collection technique. Participants completed anonymous survey questionnaires, with responses analysed collectively without the identification of individuals. No continuous tracking or observation methods were used, and the data did not include personal information such as health, genetics, beliefs, or political views.
Results: The results reveal that companies within this industry are not early adopters of IIoT, but they are rather digitally immature, with a poor degree of IIoT implementation, poor degree of quality systems digitisation, and no plan towards transformation to enterprise systems such as MRP, ERP, or CRM. The application of IIoT has potential for improvement. The paper outlines the analysis of organisational culture in terms of supporting innovation and continuous improvement, showing that the level of support is moderate, however, the bigger company is, the more supporting the organisational culture it has.
Conclusions: Data reveal that the application of IIoT solutions in the packaging industry in Poland is still not very common. Poor adoption of IIoT may be related to fear of technology, budgetary issues, or lack of qualified staff. Although digitisation already changed the software and the hardware side of organisations, most of them are not digitally mature enough to be able to take advantage of the fourth industrial revolution, which can be a strategic advantage for early adopters.

Key Words: Industrial Internet of Things (IIoT), Radio-frequency identification (RFID), sensors, packaging industry, quality control

INTRODUCTION

The Internet of Things (IoT) is one of the key technologies of the fourth industrial revolution (Industry 4.0), which is focused on real-time data monitoring [Almada-Lobo, 2016; Vaidya, Ambad, Bhosle, 2018]. IoT consists of various multiple devices with embedded systems that are connected to the telecommunication network, the Internet, and have the ability to generate and automatically send information without direct human intervention [Wójcicki et al., 2022]. Connecting devices to the Internet has started a new era of data analysis, automation, and opportunities for innovation. IoT is being widely implemented in many areas of our life, including healthcare, agriculture, manufacturing, quality control, transport and logistics, and energy, and has already passed the stage of being seen only as an exploratory technology [Deloitte, 2021]. The use of IoT is on an ascending curve, with predictions that by 2030 more than 500 billion devices will be connected to the Internet [Cisco, 2021].

Industry 4.0 and digital transformation change the world and societies into modern and super-smart, where everything is readily available at hand. To catch up with the growing trend, industries must invest in IoT technologies [Zikria et al., 2021)]. The application of IoT in the industry is called the Industrial Internet of Things (IIoT). IIoT is an extension of IoT, providing industries with tools to create a

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competitive advantage. As IIoT serves the industry, it has to meet requirements higher than IoT which serves the consumer domain. IIoT leads to the creation of Smart Factories where objects such as machinery, devices, and products are equipped with sensors that are connected to each other and to the Internet [Gebremichael et al., 2020]. Data collection, analysis, and exchange enable machine-to-machine learning (M2M) and changing modes and settings without the need for human intervention. The IIoT uses sensors and actuators to a great extent, for example, position sensors, motion sensors, biosensors, mass or volume sensors,, measurement sensors and environment sensors [Alexopoulos et al., 2018]. Different authors point to different advantages of the IIoT application, including access to real-time online data that enhance decision making, improve performance, productivity, efficiency, and quality [Fatorachian and Kazemi, 2021]; tracking the status and positions of raw materials, work-in-progress, and final products [Almada-Lobo, 2016]; controlling production processes [Vaidya, Ambad, Bhosle, 2018]; reducing human errors [Rejeb and Keogh, 2019]; reducing equipment maintenance time and costs [Peng et al., 2021]; reducing manufacturing costs through optimised assets and inventory management; reducing machine downtime; controlling the workplace environment [Garg et. al., 2022]. Incorporating IIoT solutions in organisations allows for moving from a reactive approach to a proactive approach in areas such as maintenance of equipment and tooling, quality, inventory management, and operations. Additionally, a better understanding of the processes can contribute to efficient and sustainable manufacturing by minimising scraps, losses, and wastes.

One of the IIoT solutions is Radio Frequency Identification (RFID). RFID aims at automatic object identification via radio waves, where a tag transmits its identity to the tag reader [Wójcicki et al., 2022]. The tag can be either attached to a product or embedded e.g. within the device or machine. The tag is a carrier of a unique code that contains information. When an item (e.g. product, device, packaging) equipped with an RFID tag moves through the tag reader (e.g. installed on the warehouse gate or racks), data are collected, grouped, and send to a database [Grimaldi et al., 2020], which can be connected to software such Manufacturing Resource Planning (MRP), Enterprise Resource Planning (ERP), or Warehouse Management System [Arulogun, Falohun, Akande, 2016; Liukkonen, 2015]. RFID can be applied in various areas, including [Liukkonen, 2015]: warehouse and inventory management; tool management; supply chain management; process monitoring, management and control; life cycle management. The application of RFID enhances transparency within the supply chain; facilitates inventory management; helps detect variations in production [Rejeb and Keogh, 2019)]; improves traceability; and prevent counterfeiting.

Packing is one of the operations that take place in most of the production process [Wolniak and Zadura, 2012)]. Packaging products can be made of various material types, such as paper, plastic, metal, or glass. Packaging has many functions, such as [Sykut, Kowalik and Droździel, 2013]: protecting the product during storage, transportation and use; facilitating production, wholesale and retail; informing consumers, for example, on the product composition or shelf life, and marketing. Packaging provides protection from chemical, biological, and physical threats [Marsh and Bugusu, 2007], can influence the shelf life of the product, and maintain or increase the quality and safety of packaged products. Packaging is an important part of most products and is still subject to innovation.

The purpose of this paper is the identification and evaluation of the practices and approaches towards the implementation of IIoT solutions in the packaging industry in Poland. The paper presents an outline of the status of the digitisation of production and quality assurance systems; the application of IIoT in a production environment; and the utilisation of wireless communication to enhance traceability.

MATERIALS AND METHODS

The study has been conducted in 2021. Research has been divided into two major parts: the theoretical part, and the empirical part as shown in Figure 1. The results of the theoretical part have been published in the article titled *Internet of Things in Industry: Research Profiling, Application, Challenges and*

Opportunities [Wójcicki et al., 2022]. The main study was conducted with the application of a triangulation strategy. The triangulation strategy consists in combining various methods while examining one research problem, aiming to increase the amount of knowledge collected and the value of the data. The data was collected using a combination of three methods: Computer Assisted Web Interview (CATI), Individual In-depth Interview (IDI), and Case Study.

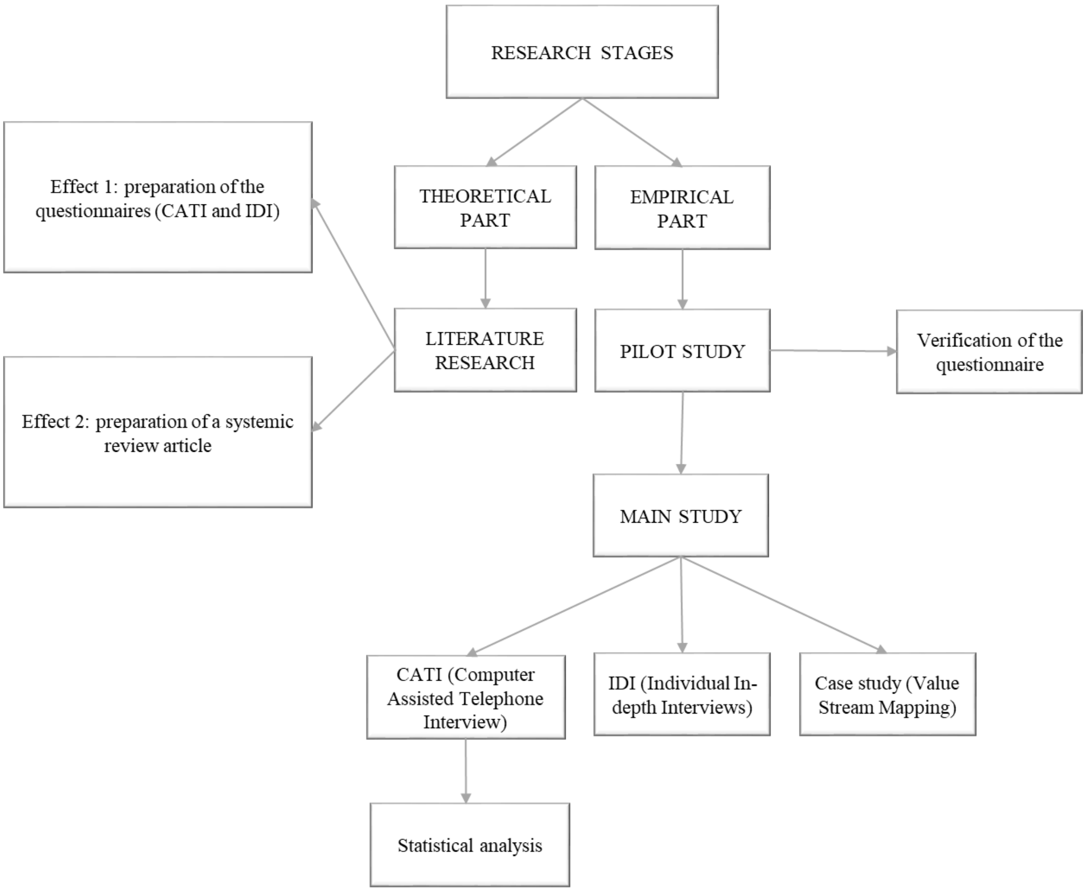

Fig. 1. Research plan

During the first stage of the main study, quantitative data have been collected using a survey questionnaire and the CATI (Computer Assisted Telephone Interview) method as a technique of data collection. The research population consisted of 132 companies located in Poland in the Greater Poland Voivodeship and classified under the following classification codes:

17.21.Z manufacture of corrugated and corrugated cardboard as well as paper and cardboard packaging;

22.22.Z Production of plastic packaging.

68 companies participated in the study, which constitutes 51% of the surveyed population. The structure of the sample based on the product, the size of the company, and the origin of the capital is presented in Figures 2-6. Based on the sample structure, most of the researched companies were in the SMEs (98.5%) with solely or the majority of polish capital (94.1%). More than half of the companies surveyed declared production of packaging intended to have direct or indirect contact with food (51.5%) and realisation of printing on packaging (58.8%). 44.1% of companies specialise in plastic packaging, 38.2% of companies in paper packaging, and 17.6% produce packaging from different packaging materials.

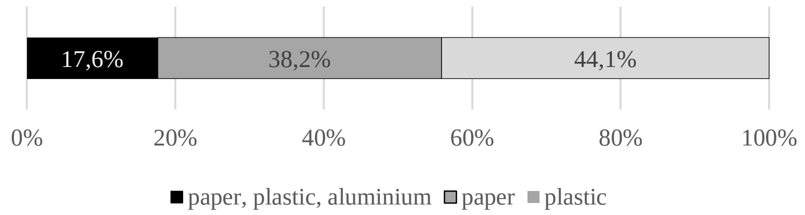

Fig. 2. Structure of a sample based on produced packaging material

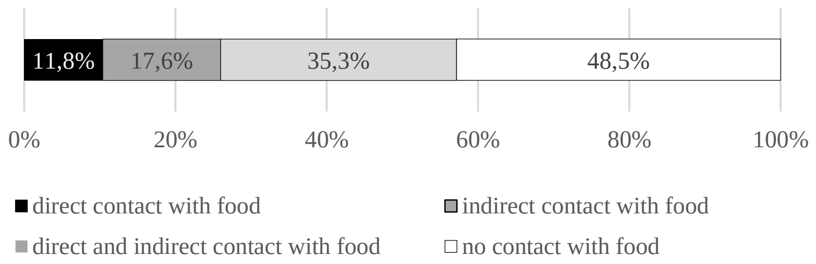

Fig. 3. Structure of a sample based on the packaging purpose

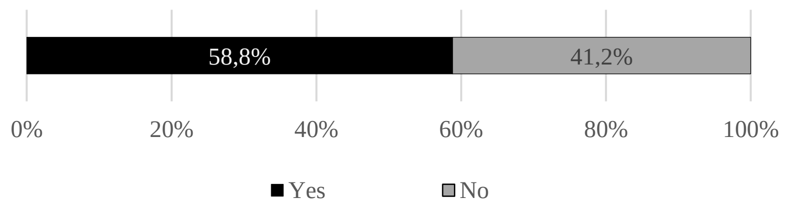

Fig. 4. Structure of a sample based on the realisation of printing processes on packaging

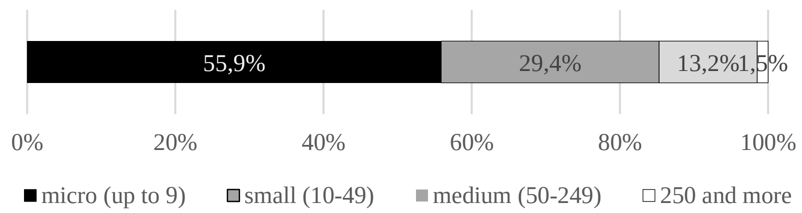

Fig. 5. Structure of a sample based on the number of employees

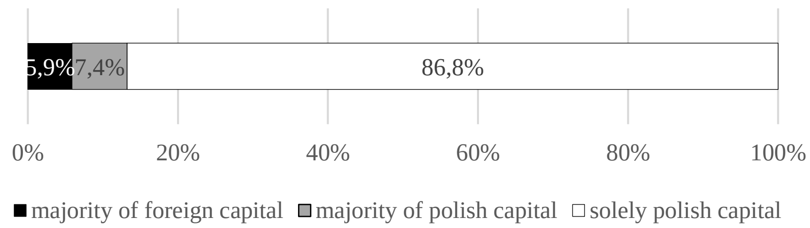

Fig. 6. Structure of a sample based on the origin of the capital

Telephone interviews were conducted only with employees at selected positions within the organisations that are competent to provide information on the subject matter (company owners, quality directors or managers production directors or managers, and technologists) as presented in Figure 7. The questionnaire contained 17 questions related to quality control methods and techniques, the use of optical sensors, the application of systems, and IIoT.

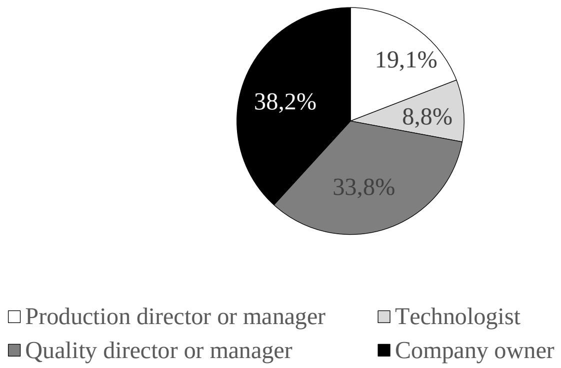

Fig. 7. Respondents structure

Most of surveyed companies have implemented a quality management system according to ISO 9001 (88.1%). Only 21.4% of companies have implemented environmental management systems according to ISO 14001 or EMAS, and only 11.9% of companies implemented the BRC Packaging Materials standard.

The second stage of the main study was conducted using IDI (Individual In-Depth Interviews) with representatives of three companies. IDI data acquisition methodology is a discussion-orientated form of qualitative research. The questions are open-ended, which does not allow the respondent to answer just in one word. Interviews were conducted with company representatives – employees selected based on their knowledge, experience, and position in organisations. The third stage of the main study contained the preparation of a value stream map based on a case study.

This paper aims to review and evaluate the application of Industrial Internet of Things (IIoT) solutions in the packaging industry in Poland. Data presented in the results and discussion chapter are prepared based on qualitative research – CATI (first stage). The collected data are not sensitive, do not concern health, genetic information, intimate life, political views, ethnicity, beliefs, and religious beliefs and the study did not involve methods of continuous tracking or observation of participants. Participants were involved in completing survey questionnaires (anonymous responses analysed collectively without the identification of individual respondents).

RESULTS AND DISCUSSION

Digitisation of production systems

The first question concerned recording data during quality control processes, including verification of raw materials quality during delivery and incoming inspection processes, verification of product quality during the production process, and verification of product quality at the end of the production process, during the product release stage. As shown in Figure 8. 77.3% of the companies surveyed still use a manual recording of the quality inspection results, and 30.6% do not even analyse those results. Only 22.8% of the organisations surveyed use electronic records, but only 2.8% are connected to the IT system. Many organisations use a manual recording of quality inspection results but fail to analyse them. In many cases, this can be due to a lack of resources or expertise.

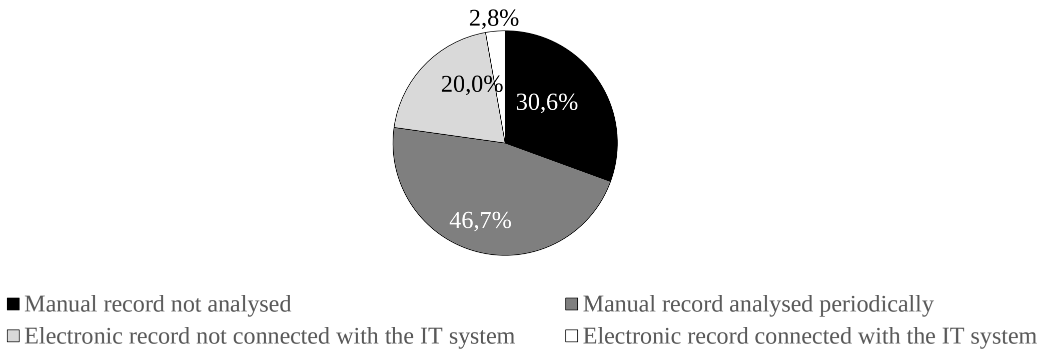

Fig. 8. Types of records in quality control processes

Those companies where records are coupled with the IT system also declared that they have implemented dedicated software for creating processes and managing Quality Management System (QMS) documentation (e.g., Adonis, Qualio, MasterControl, Q-Pulse, Pando, or other) and dedicated software enabling digital operating instructions (e.g., Visual Factory, VKS, Aegis Paperless Shopfloor, or other). Most of surveyed companies do not use such dedicated software and do not plan to implement it in the near future (Figure 9).

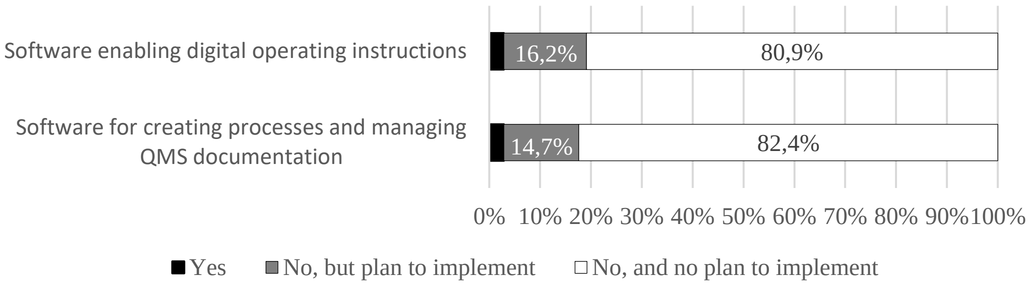

Fig. 9. Use of dedicated software for QMS and paperless Shopfloor

Although only 2.9% of companies use dedicated QMS software for documentation management, most of them (79.4%) do provide electronic documents on workstations. In these companies, workstations are equipped with screens, monitors, or mobile interfaces; however, only 13.2% implemented paperless shop floor (Figure 10). The paperless factory aims to eliminate paper-based processes and digitise the entire manufacturing process. In a paperless shopfloor, all information related to production, such as work orders, instructions, and quality control data, would be stored and accessed electronically. Eliminating paper-based processes can improve communication and collaboration between departments, reduce errors, increase productivity, save time, and improve product quality.

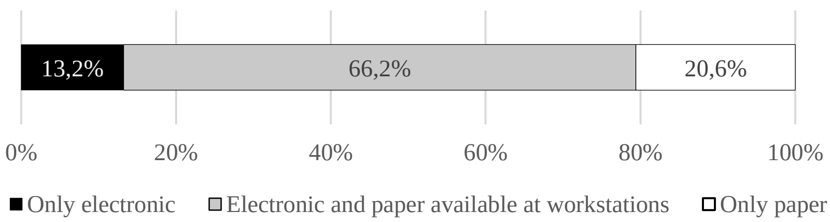

Fig. 10. Use of electronic documentation at work stations

Digitisation of a production system requires the implementation of some enterprise systems. The largest percentage of companies declared the implementation of Material Requirements Planning (23.5%), Enterprise Resource Planning (19.1%), and Customer Relationship Management (16.2%). Warehouse Management Systems and Supply Chain Management were the least popular, with only 11.8% of the implementation (Figure 11).

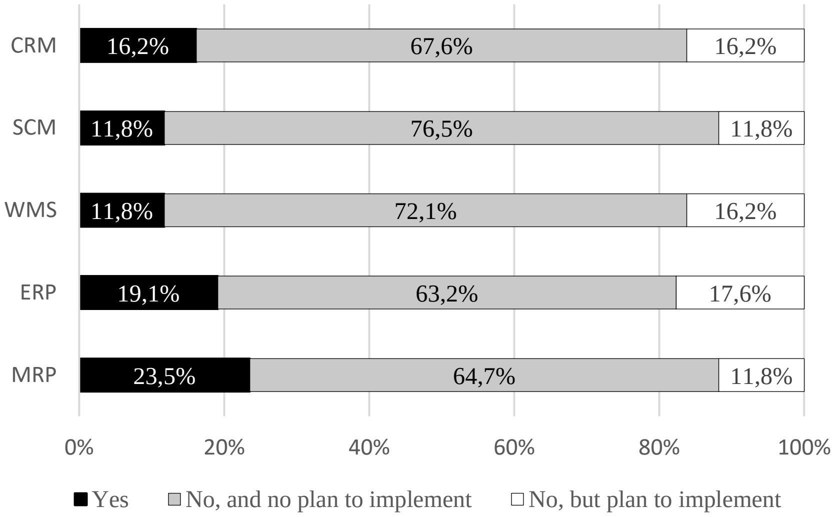

Fig. 11. Application of enterprise systems

The authors examined company relationship between the size and the implementation of MRP, ERP, WSM, SCM, and CRM systems. Due to the fact that only 9 companies employing 50-249 people and 1 company employing 250 or more people took part in the survey, the size of companies was divided into two categories: up to 9 employees and above 10 employees. Therefore, the last category included companies that employ at least 10 people, including companies employing 10-49 people, 50-249 people and 250 and more people. The same approach was applied to all other tests examining the influence of company size on different factors. On the other hand, with regard to whether the company has an appropriate system implemented, two categories were distinguished: 'yes' and "no". The second of these categories included companies that do not have an implemented system and do not plan to implement it, and those that do not have it but plan to do so in the future. Such a procedure was necessary to be able to apply the chi-square test of independence. The p-value analysis (Table 1) reveals that there are no significant dependencies between the size of the company and whether the company has an appropriate system implemented or not (regardless of the type of system). In each case, the p-value was higher than the commonly accepted significance level of 0.05. It can be concluded that regardless of the size of the company, the vast majority of companies do not have an appropriate system implemented.

Table 1. Size of the company vs. implemented enterprise systems

		Yes	**No**	**p-value**
	> 10	26.7%	73.3%	
ERP	< 9	13.2%	86.8%	p=0.160
	> 10	26.7%	73.3%	
WMS	< 9	7.9%	92.1%	p=0.265
	> 10	16.7%	83.3%	
SMC	< 9	10.5%	89.5%	p=0.721
	> 10	13.3%	86.7%	
CRM	< 9	13.2%	86.8%	p=0.447
	> 10	20.0%	80.0%	

It can be observed that even if a company has more than one system implemented, they are not always connected with each other to share or exchange information (Figure 12).

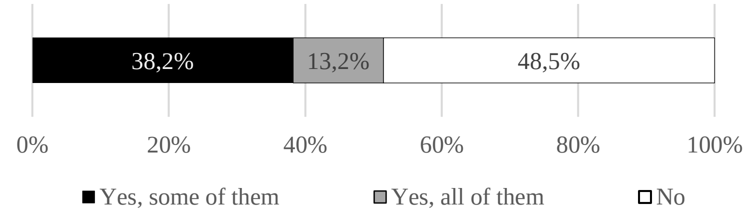

Fig. 12. Integration of IT systems (exchange and share information between systems)

Most companies store records on a central server in the company (75.0%) and only 5.9% store data on a server outside the company (Figure 13). We examined whether the size of the company or the origin of the capital influences the place where the data is stored. The size of the company, similar to the previous analysis was divided into two categories. Regarding where the collected data from IT systems is stored, only two categories were considered: on workstations and on a server in the company (centrally). Due to the fact that only 4 companies declared that the data collected from IT systems is stored in the cloud, answers from this category were excluded from the correlation analysis. P-value analysis shows that there is no statistically significant relationship between company size and whether the collected data from IT systems is stored on workstations or centrally on the company's servers (Table 2). This is due to the fact that in each case the calculated p-value is higher than the commonly established significance level of 0.05. Cloud computing technologies provide borderless sharing and access to information [Esmaeilian et al., 2020], however, it can be noticed that, regardless of the size of the company, the vast majority of data collected from IT systems is not stored in Cloud, but centrally on a server in the company. This is in line with the data in [Szozda, 2017], where it was indicated that companies in the US, Germany, and Japan are not eager to store their data on external servers (outside the country) (19, 14 and 12%, respectively).

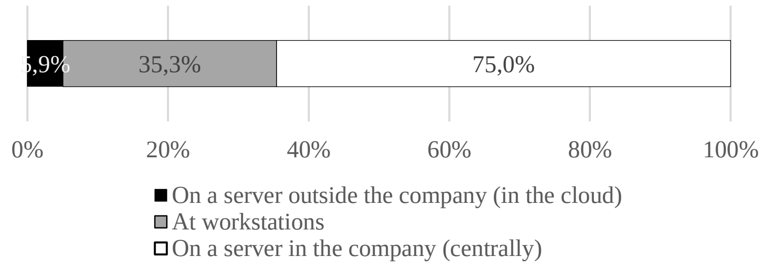

Fig. 13. Place of storing data from IT system

Table 2. Size of the company vs. place of data storage

		Yes	No	p-value
At workstations	< 9	31.6%	68.4%	p=0.471
	> 10	40.0%	60.0%	
On a central server	< 9	76.3%	23.7%	p=0.778
	> 10	73.3%	26.7%	

The origin of the capital data was divided into two categories: enterprises with only Polish capital and others. Such a procedure was necessary in order to be able to apply the chi-square test of independence, and it was applied for all other tests examining the correlation between the origin of the capital and other factors. Regarding where the collected data from IT systems is stored, similarly, as in the above analysis, two categories were considered: on workstations and on a server in the company (centrally). The p-value analysis shows that there is no statistically significant relationship between the origin of capital and whether the data collected from IT systems is stored on workstations or centrally on servers in the company. This is due to the fact that in each case the p-value was higher than the commonly established significance level of 0.05. Regardless of the the origin of capital, the vast majority of companies store data centrally on a server in the company (Table 3).

Table 3. Origin of the capital vs. place of data storage

		Yes	No	p-value
At workstations	Polish	39.0%	61.0%	p=0.103
	others	11.1%	88.9%	
On a central server	Polish	72.9%	27.1%	p=0.302
	others	88.9%	11.1%	

It can be concluded that the digitization level of the companies surveyed is low. According to other research studies [Szopa & Cyplik, 2020], SMEs show a rather low level of digitisation. This suggests that Polish companies are not yet ready for digital transformation. It can also be noted that the bigger the company, the higher the digitisation level of the surveyed companies.

Internet of Things in a production environment

36.8% of the companies declared that their production environment is connected to the Internet, 35.3% declared the usage of optical sensors, but only 23.5% of the companies use sensors that are connected over the Internet to devices (Figure 14). We examined whether there is a correlation between the size of the company and the connection of the production environment to the Internet or the use of optical sensors. Regarding whether the company's production environment is connected to the Internet and whether the company uses optical sensors, two categories were taken into account: ‘yes' and “no”. The p-value analysis performed for the chi-square test of independence reveals that there is no statistically significant correlation between the size of the company and whether the production environment in the company is connected to the Internet and between the size of the company and the use of optical sensors. The data presented in Table 4 confirm that there is no correlation between the size of the company and whether its production environment is connected to the Internet and whether they use optical sensors. It can be seen that, regardless of the size of the company, most of them do not use optical sensors, and the production environment is generally not connected to the Internet. Although the percentage of companies in the group of small and medium companies (+10 employees) is greater than in the group of micro companies, these differences are not statistically significant.

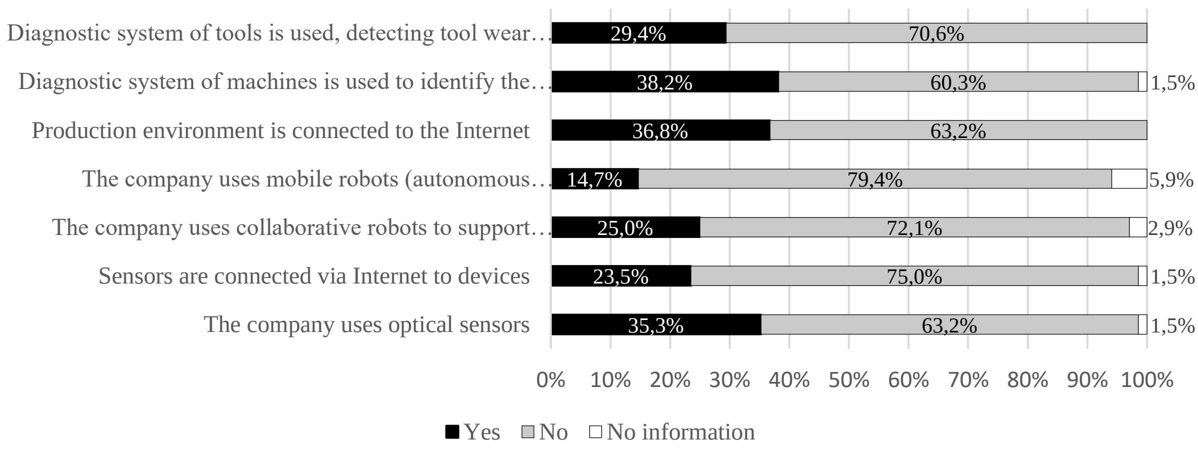

Fig. 14. Connection of work environment to the Internet

Table 4. The size of the company vs. connection of the production environment to the Internet or the use of optical sensors

		Yes	No	p-value
Connection to Internet	< 9	34.2%	65.8%	p=0.623
	> 10	40.0%	60.0%	
Use of sensors	< 9	28.9%	71.1%	p=0.179
	> 10	44.8%	55.2%	

Regarding the correlation between capital origin and the connection of the production environment to the Internet, the p-value analysis shows that there is no statistically significant correlation between factors examined. When analysing Table 5, it might seem that such a relationship exists. In the group of enterprises with only Polish capital, more than 66% do not have a production environment connected to the Internet. The opposite situation is observed in the group of other companies, among which over 55% declared that the production environment is connected to the Internet. However, the lack of dependence results from the fact that the majority of the companies in the sample had only Polish capital. In the group of other companies, there were only 9 enterprises, hence the chi-square test of independence did not reject the hypothesis of independence between the analysed features (the origin of capital vs. whether the production environment is connected to the Internet).

At the adopted significance level of 0.05, the hypothesis that there is no relationship between the origin of capital and whether the company uses optical sensors should be rejected in favour of the hypothesis that there is such a relationship (the calculated p-value was p=0.038 and is lower than the commonly established significance level of 0.05). Data presented in Table 5 confirm capital relationship between the origin and the usage of optical sensor use. In the group of enterprises with only Polish capital, the vast majority (69.0%) do not use optical sensors, while in the group of other enterprises (with foreign capital), the majority (66.7%) declared that such sensors are used. Wahab S. et al. [2021] pointed out that in the implementation of IoT in the Malaysian industry a significant role in supporting the process lies in external partners (through mergers and acquisitions).

Table 5. The capital origin vs. connection of the production environment to the Internet or the use of optical sensors

		Yes	No	p-value
Connection to Internet	Polish	33.9%	66.1%	p=0.209
	Other	55.6%	44.4%	
Use of sensors	Polish	31.0%	69.0%	p=0.038
	other	66.7%	33.3%	

Sensors connected via the Internet to production devices allow parameters of production to be changed with human intervention (23.5%) or without human intervention (19.1%).

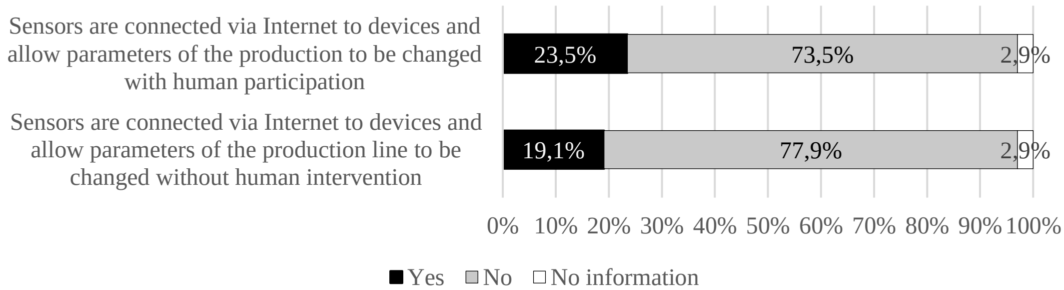

Fig. 15. IoT enabling production parameters to be changed with / without human intervention

Wireless communication ensuring traceability

RFID tags are used to ensure traceability in 22.1% of companies. These companies use wireless communication to identify and locating products at all stages of production, from raw materials, through semi-finished products (work-in-progress), to finished products (Figure 16).

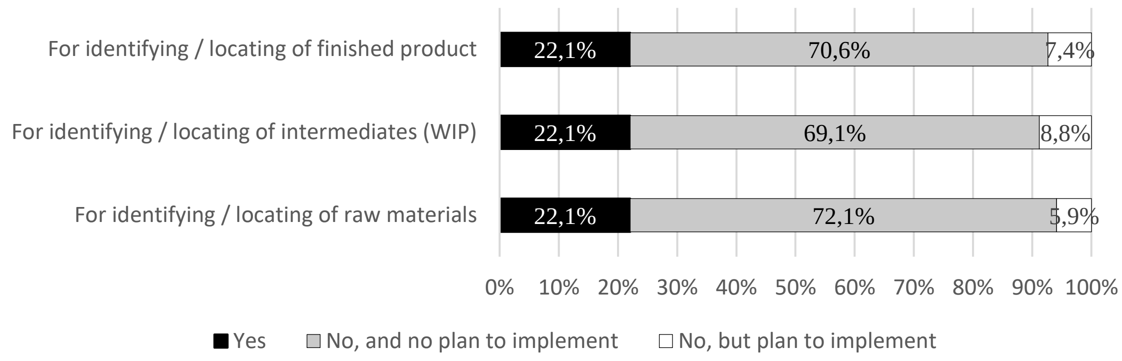

Fig. 16. Application of data carriers (e.g. RFID tags) to ensure traceability

RFID has been widely implemented in industries where machines monitor and control the speed and statuses of assembly parts, such as automotive, car parts, machine, heavy industry, electronic, food industry, and pharmaceutical industries [Liukkonen, 2015; Masniak et al., 2019]. Although the RFID solution is well known and is low cost, it is not used on a large scale in the packaging industry in Poland.

We examined the correlation between the size of the company and the use of RFID. Regarding whether the company uses RFID data carriers to ensure traceability, two categories were distinguished: "yes" and "no". The second of these categories included companies that do not use them and do not plan to do so and those that do not use them but plan to do so in the future. Such a procedure was necessary to be able to apply the chi-square test of independence. When performing the p-value analysis, it can be noticed that there is no statistically significant relationship between the size of the company and whether the company uses data carriers to ensure traceability (regardless of whether it concerns raw materials, semi-finished products or finished products). In each case, the p-value took values higher than the commonly established significance level of 0.05. This is confirmed by the data in Table 6. It can be seen that, regardless of the size of the company, the vast majority of them do not use data carriers to ensure traceability.

Table 6. The size of the company vs. the use of data carriers such as RFID

		Yes	No	p-value
Raw materials	< 9	15.8%	84.2%	p=0,161
	> 10	30.0%	70.0%	
WIP	< 9	21.1%	78.9%	p=0,822
	> 10	23.3%	76.7%	
Finished products	< 9	18.4%	81.6%	p=0,416
	> 10	26.7%	73.3%	

Respondents have been asked to assess their organisational culture in terms of supporting innovation and continuous improvement on a 5-point Likert scale, where: 1 – strongly disagree, 2 – rather disagree, 3 – neither agree, nor disagree, 4 – rather agree, 5 – strongly agree. The average value of all factors for all organisations was a=3.34. The mean and standard deviation for individual factors are presented in Figure 17. After the analysis of data differentiated by company size, it appears that the bigger the company, the more supportive the organisational culture in terms of innovation and improvement it has. Although the differences are not significant, a slight improvement can be noticed. The average for micro-companies with up to 9 employees was a=3.29, for small companies, between 10, and 49 employees a=3.34, and for medium-sized and large companies, with a number of employees above 50, the average was a=3.49.

Fig. 17. Organisational culture supporting innovation and improvement

The results are similar to findings on change readiness [Batz et al., 2018; Hizam-Hanafiah et al., 2021], which demonstrate that although there are tools allowing for technology readiness (digitization, IoT, Industry 4.0), an even greater impact on companies transformation towards Industry 4.0 has organisational change readiness. Although there is technology that allows this change, the organisations surveyed are not ready for that change. It may be assumed that the reasons for this are among others fear of change of individual employees, management, and the entire organisation. These barriers are interrelated and can have a compounding effect on each other. Overcoming these barriers requires a holistic approach that addresses both the technical and nontechnical aspects of IIoT implementation, and involves collaboration across different functions and stakeholders within the organisation.

CONCLUSION

The manual recording of quality inspection results is common practice in the majority of companies surveyed (77.3%). 1/3 of those surveyed do not analyse the results of inspections. These results are surprising due to the fact that 88.1% of the sample declared the implementation of the ISO 9001 system, in which much emphasis is placed on performance evaluation, including monitoring, measurement, analysis, and evaluation [ISO 9001:2015]. Only 22.8% of organisations use electronic records and a negligible percentage of respondents declared that the electronic record is connected to the IT system. Facing the fourth industrial revolution, it is alarming that this form of recording is still not common. Furthermore, a marginal percentage of respondents implemented dedicated digital QMS software or entirely paperless Shopfloor. The MRP system has been implemented by 23.5%, ERP by 19.1% and CRM by 16.2%. and there are no significant dependencies between the size of the company and whether the company has any system implemented or not. Systems connectivity still seems to be an issue, as 48.5% of the respondents did not connect their systems with each other to share or exchange information within the company.

The conducted research showed marginal use of optical sensors in the analysis group of companies. Regardless of the size of the company, most of them do not use optical sensors, and their production environment is generally not connected to the Internet. Similarly, regardless of the size of the company, RFID tags are used to ensure traceability only in 22.1% of those surveyed. Those companies use wireless communication for identifying and locating products at all stages of production, from raw materials, through semifinished products (work-in-progress), and finished products. However, there is a relationship between the origin of capital and whether the company uses optical sensors. In the group of companies with only Polish capital, the vast majority do not use optical sensors, whereas, in the group of companies with foreign capital, the majority declared that such sensors are used. It can be concluded that the usage of optical sensors and the application of RFID have potential for improvement for companies operating in the packaging industry, in particular those with entirely Polish capital.

The analysis of an organisational culture in terms of supporting innovation and continuous improvement shows that the larger company is, the more supporting organisational culture it has in terms of innovation and improvement. Although the differences are not significant and the general level of support culture is moderate, a slight difference can be noticed.

Data reveal that the application of IIoT solutions in the packaging industry in Poland is still not very common. It can be assumed that surveyed companies are in the aspiration phase when it comes to the implementation of Smart Factory [Odważny et al.; 2018]. This may be related to a technology fear, but also to budgetary and staff qualification issues. According to Microsoft's IoT Signals Report [Microsoft, 2021], 26% of organisations reported that lack of budget and staff was one of the reasons for holding off on IoT adoption. Companies have problems employing adequately skilled and experienced employees to drive digital transformation projects. Also, an organisational culture that does not support innovation may be a factor influencing the inhibition of changes. Digitisation has already changed the software and the hardware side of organisations, however, as data shows, not all of them are digitally mature enough to be able to take advantage of the fourth industrial revolution [Pegn et al., 2021, Rejeb,, Keogh & Treiblmaier, 2019], which can be a strategic advantage for early adopters. Furthermore, most of the actions taken are rather spontaneous rather than systematic [Ministerstwo Przedsiębiorczości i Technologii; 2019].

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Beata Paliwoda ORCID ID: https://orcid.org/0000-0003-3095-1547
Institute of Management,
Poznań University of Economics and Business, Poznań, **Poland**
e-mail: beata.paliwoda@ue.poznan.pl
Correspondence author

Justyna Górna ORCID ID: https://orcid.org/0000-0002-2763-5810
Institute of Management,
Poznań University of Economics and Business, Poznań, **Poland**
e-mail: justyna.gorna@ue.poznan.pl

Marta Biegańska ORCID ID: https://orcid.org/0000-0003-3001-4879
Institute of Quality Science,
Poznań University of Economics and Business, Poznań, **Poland**
e-mail: marta.bieganska@ue.poznan.pl

Krzysztof Wójcicki ORCID ID: https://orcid.org/0000-0002-1799-3358
Institute of Quality Science,
Poznań University of Economics and Business, Poznań, **Poland**
e-mail: krzysztof.wojcicki@ue.poznan.pl