

ANALYSIS OF INTERNAL PROCESS INNOVATIONS WITH EMPHASIS ON THE INTRODUCTION OF TECHNOLOGIES ASSOCIATED WITH INDUSTRY 4.0 AND THE DIGITALIZATION

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Abstract

The paper contains new knowledge about the expansion of technologies associated with Industry 4.0 and digitalization in selected companies including metallurgical companies in the Czech Republic and evaluates the intensity of business process innovation with a focus on internal processes implemented in companies. A probe was implemented which was purposefully focused on the analysis of statistical data on innovation activities in innovative companies including metallurgical companies in the Czech Republic in the period under study by. The processing of statistical data obtained by the CZSO by a survey made it possible to obtain more detailed overviews of the relative frequencies of enterprises that implemented individual types of process innovations in the period under study and that have introduced some of the elements or tools of Industry 4.0 and the digitalization. The importance of innovation for the continued existence and development of the company is recognized especially by large companies and companies under foreign control. Many of these companies are already applying technologies associated with Industry 4.0 and the digitalization and they are moving towards the creation of a digital enterprise. On the contrary, the implementation of innovation activities and the use of technologies associated with Industry 4.0 in small and medium-sized companies is low. The main obstacle is insufficient funding for new technologies and human resources.

Keywords: Innovation activity, business process Innovation, internal process Innovation, Industry 4.0, digitalization of business processes

1. INTRODUCTION

Currently, business process innovations are based primarily on technologies that are associated with Industry 4.0 and the digitalization. Digitalization contributes to the strengthening intelligent automation, replace human activity with robots, cobots or computer programs. It is the digitalization of business processes that is reflected in lower costs and higher quality of production [1]. It allows you to respond quickly to individualized customer requirements, while achieving costs as in mass production. Digitalization enables companies in the manufacturing industry to simulate, test and optimize processes. Automated data collection and evaluation allows processes to be constantly monitored and improved [2].

Implementation of the Industry 4.0 concept leads to the creation of a digital enterprise in which digitalization is introduced in all phases of the value chain, including subsequent smart analysis and evaluation [3]. This process allows us to obtain feedback in the form of recommendations for digitalization. Digitalization also represents an opportunity for companies to modernize business models, activities and strategies in order to increase competitiveness and profitability [4,5].

The coronavirus crisis has caused a sudden need for a significant intensification of innovation activities - product portfolio transformation and especially changes in processes (reducing the need for physical human presence, the need for remote human interaction in processes, increasing the clarity of complex processes, etc.) or process location changes. The question arises in this context - how intensively companies have developed the innovation activities of their processes in previous years and whether they have a solid base to build on [6].

The aim of the paper is to establish more detailed knowledge on the intensity of the use of technologies related to Industry 4.0 and the digitalization of business processes in different sectors of the economy and in innovative firms with regard to their size and ownership and in companies producing metals, metallurgical and metalworking products (24-25). At the same time, to investigate in innovative firms how different types of internal process innovation are represented and to what extent the intensity of these activities varies according to the size and ownership of the company.

2. METHODOLOGY AND METHODS

The subject of research is innovation activities in the field of business process innovation with a focus on internal process innovation. According to the subject-matter, the innovation of internal processes is divided into four groups on the basis of the Oslo Manual [7]. The first group consists of innovations in the method of production and provision of services. The second group includes innovations in the method of supply, storage, distribution and other logistics activities. The third group includes innovations in the processing of corporate information or communication within the company and the fourth group includes innovations in the administrative processing or business accounting.

The data for the analysis are based on a survey on innovation activities by the Czech Statistical Office for the period 2016-2018, which was published in June 2020. The survey is conducted in two-year cycles and is coordinated by Eurostat, subject to Commission Implementing Regulation (EU) No. 995/2012 of 26 October 2012 Implementation Decision No 1608/2003 / EC of the European Parliament and of the Council concerning the production and development of Community statistics on innovation. The Czech Statistical Office used a harmonized Eurostat model questionnaire to collect data on companies' innovation activities. CZSO edited the questionnaire to a national (shorter) version with several national questions. 6,685 companies from selected areas of industry and services (financial and non-financial) with at least 10 employees based in the Czech Republic were contacted. The net rate of return (number of questionnaires used) was 85 %. The questionnaire and the results prepared by the CZSO in tabular form are published according to the following aspects: the Czech Republic as a whole, by company ownership (domestic enterprises - foreign enterprises), by enterprise size (small: 10-49 employees; medium: 50-249 employees; large: 250 and more employees), by field of business (sections according to CZ-NACE), by regions of cohesion (CZ-NUTS).

There was performed its own probe carried out purposefully focused on business process innovations and specifically on internal process innovations for the period 2016-2018 based on the data published by the CZSO. Comparison was made in some aspects within the period 2014-2016. Attention is also focused on metallurgical enterprises, which according to the CZ-NACE classification of economic activities are classified in the manufacturing industry section and in sections 24 and 25. Enterprises in these sections are technologically interlinked and, with regard to the technologies used, are part of the MEDIUM LOW-TECH sector.

3. RESULTS OF THE PERFORMED ANALYZES

The results of the statistical survey of innovations for the period 2016-2018 show that companies in the Czech Republic implemented more innovations in business processes (40 % of companies) than product innovations (27 % of companies) in the implementation of innovation activities. Companies focused mostly on internal

process innovations (32.3 %), followed by innovations related to organizational changes (23.10%) and innovations in marketing methods (22.20%) within business process innovations.

The paper pays attention to internal process innovations which in 2016-2018 were implemented in 32.30 % of companies according to CZSO data. That is an increase of 4.6 percentage points compared to the previous period 2014-2016 (i.e., 27.70 % companies).

3.1. Analysis of the frequency of companies with internal process innovations

It was found that the relative frequency of companies with internal process innovations that are under foreign control is more pronounced (43.00 %) than in companies with domestic owners (29.30 %). The share of companies innovating internal processes differs according to size. While in the category of small enterprises were introduced internal process innovations only in 27.50 % of enterprises and more than half (57.50 %) in large companies.

Figure 1 shows the differences in the representation of enterprises with internal process innovations according to economy sectors, including a comparison with the national data for the period 2014-2016 and 2016-2018.

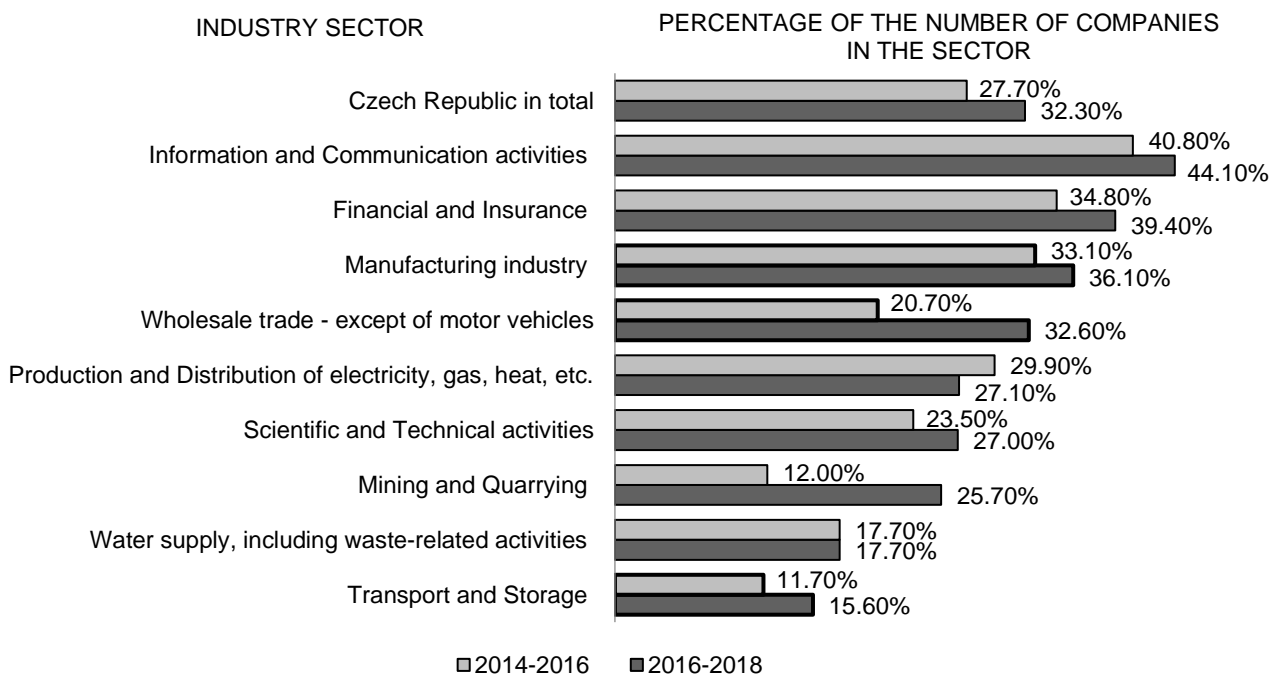


Figure 1 Comparison of shares of companies that introduced internal process innovations in 2014-2016 and 2016-2018 - by sector of industry [8]

The sectors are arranged in the chart for the period 2016-2018 in descending order according to the shares of companies with internal process innovations in the total number of companies in the given sector. By sector of the industry, the sector of information and communication activities dominates in the period 2016-2018 with 44.10 % of companies in this sector introducing internal process innovations. This is followed by the financial and insurance sectors (39.40 % of enterprises) and the manufacturing industry (36.10 % of enterprises). The share of companies with internal process innovations significantly exceeds the national share in these three sectors even in previous period 2014-2016. On the other hand, the least (well below the total share of companies in the Czech Republic innovating internal processes) are represented in 2016-2018 internal process innovations in the transport and storage sectors (15.60 %), water supply, including water waste-related activities (17.70 %) and mining and quarrying (25.70 %). There was a significant improvement in the mining

and quarrying sector (by 13.7 percentage points) and in wholesale trade, with the exception of motor vehicles (by 11.7 percentage points) compared to the period 2014-2016.

According to statistical data for the period 2016-2018, enterprises producing metals, metallurgical and metalworking products (24-25) implemented internal process innovations more (38.4 %) than enterprises in the manufacturing industry (36.1 %). When innovating internal processes, enterprises producing metals, metallurgical and metalworking products (24-25) focused most on innovating production or services provided (30.2 %), followed by processing of business information e.g. new information system, better security of existing IS, etc. (18.8 %), processing of administration or accounting of the enterprise (14.9 %), and implementation of logistics activities (10.5 %).

3.2. Analysis of the use of technologies associated with Industry 4.0 and the digitalization of business processes

The analysis of the use of technologies related to Industry 4.0 and the digitalization of business processes was carried out with regard to the size and ownership of the innovative company and at the same time to selected industries in the manufacturing industry. It was found that non-innovative companies also use technologies related to Industry 4.0, mainly data collection using digital sensors (19.10 %) and cloud computing (11.90 %), but the share of non-innovative companies in the use of other researched technologies is very low and did not exceed 4 %. Therefore, we will focus only on innovative companies. **Table 2** represents occurrence of individual technologies in innovative companies for the Czech Republic as a whole. The survey shows data collection (using digital sensors, cameras, GPS, etc.) is the most represented technology in Czech innovative companies (44.10 %). However, it shows that not even half of the companies owned this technology at the date of the survey. 34 % of companies use cloud computing services, followed by the application of devices for the Internet of Things, big data analysis, the use of industrial and service robots and 3D printing. More than 10 % of companies have these technologies mentioned above but their share does not exceed 15 %. The use of artificial intelligence elements is still very low (5.90 % of companies).

Table 2 Representation of individual technologies associated with Industry 4.0 and the digitalization of business processes [8]

Selected technologies associated with Industry 4.0 and the digitalization of business processes	The share of innovative enterprises that have introduced tools 4.0 and digitalization in the total number of enterprises with innovation activities
Data collection using digital sensors, cameras, GPS, etc.	44.10 %
Cloud computing services	34.00 %
Deployment and development of devices with connectivity for the Internet of Things	14.20 %
Analysis and work with big data	13.40 %
Industrial or service robots	13.90 %
3D Print	11.00 %
Use of elements of Artificial Intelligence	5.90 %

The relative frequencies of companies that used selected technologies expressed as a percentage of companies with innovation activities are shown in **Figure 3**. Companies could list more than one type of technology and therefore the sum of the relative frequencies does not give 100%. **Figure 3** shows that selected technologies associated with Industry 4.0 and the digitalization of business processes were mostly used by large companies and companies under foreign control. Large companies mainly used from the selected technologies - data collection using digital sensors, cameras, GPS, etc. devices (76.90 %), with a greater

distance of cloud computing services (48 %) and industrial or service robots (44.70 %), as well as analysis and work with big data (33 %), 3D printing (29.10 %) and the introduction and development of devices with connectivity for the Internet of Things (24.80 %) and the least used elements of artificial intelligence (9.50 %). Small companies mostly used data collection using digital sensors, cameras, GPS, etc. devices (34.10 %) and cloud computing services (31.90 %). Other technologies such as the deployment and development of devices with connectivity for the Internet of Things, analysis and work with big data, and the use of artificial intelligence elements were used twice less in small companies than in large enterprises. 3D printing (6.90 %) and elements of artificial intelligence (4.90 %) were used the least.

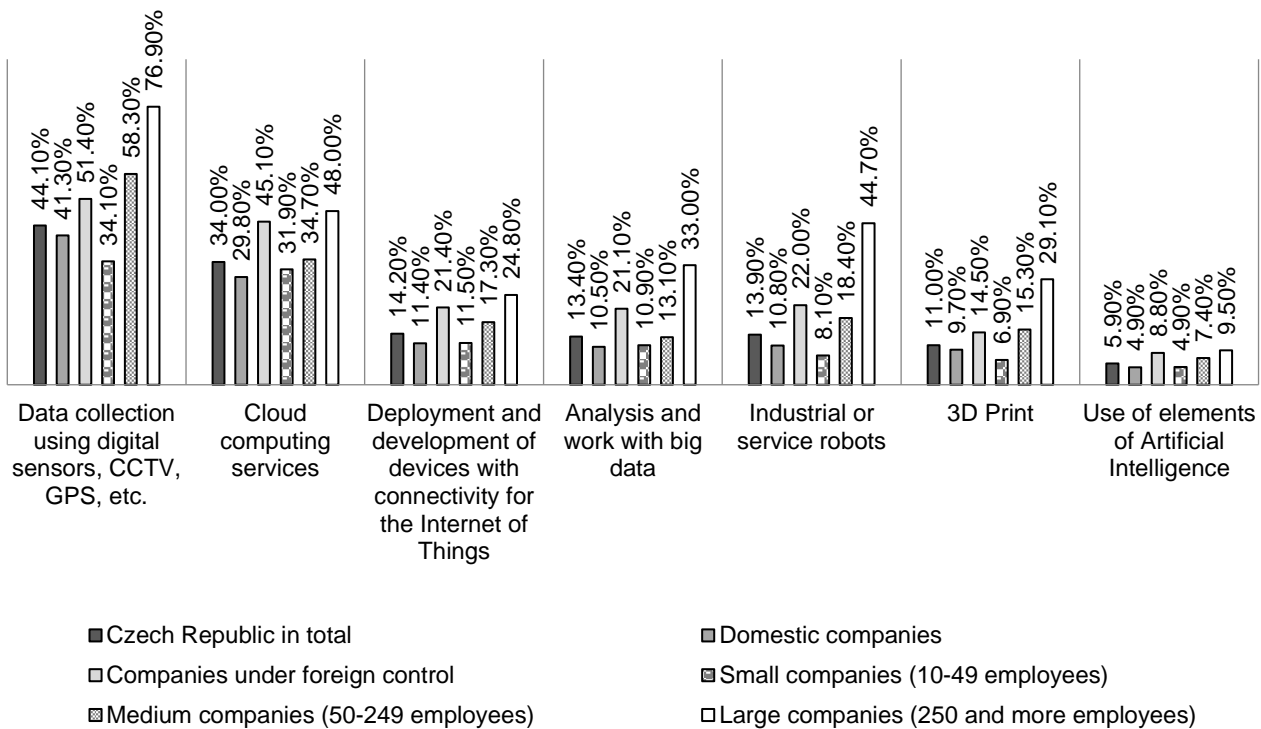


Figure 3 Share of innovative companies that used individual technologies associated with Industry 4.0 and the digitalization of business processes - by ownership and size of the innovative company

After detailed analysis of the use of selected technologies with regard to Industry 4.0 and the digitalization of business processes (**Figure 4**) it was found that three sectors (production and distribution of electricity, gas, heat and air; water supply; mining and quarrying) do not use industrial or service robots, 3D printing and artificial intelligence elements at all.

Data collection using digital sensors, cameras, GPS, etc. are mostly used by four sectors (transport and storage; water supply including waste - related activities; manufacturing; mining and quarrying). Cloud computing services are mostly used by four sectors (information and communication technologies; finance and insurance; production and distribution of electricity, heat and air; scientific and technical activities). Information and communication sector (19 %) uses the elements of artificial intelligence most intensively. To this can be added the knowledge according to the publication Slávik [9] that currently artificial intelligence is used mainly in communication with the customer through a virtual assistant or there are introduced chatbots. Chatbots are used for automated communication with people, replacing e. g. workers in call centre. Another sector that makes significant use of artificial intelligence is the financial and insurance sectors (10.80 %) - e.g. in determining premiums, tariffing products or speeding up claims, i.e. activities that have clear rules and can be standardize.

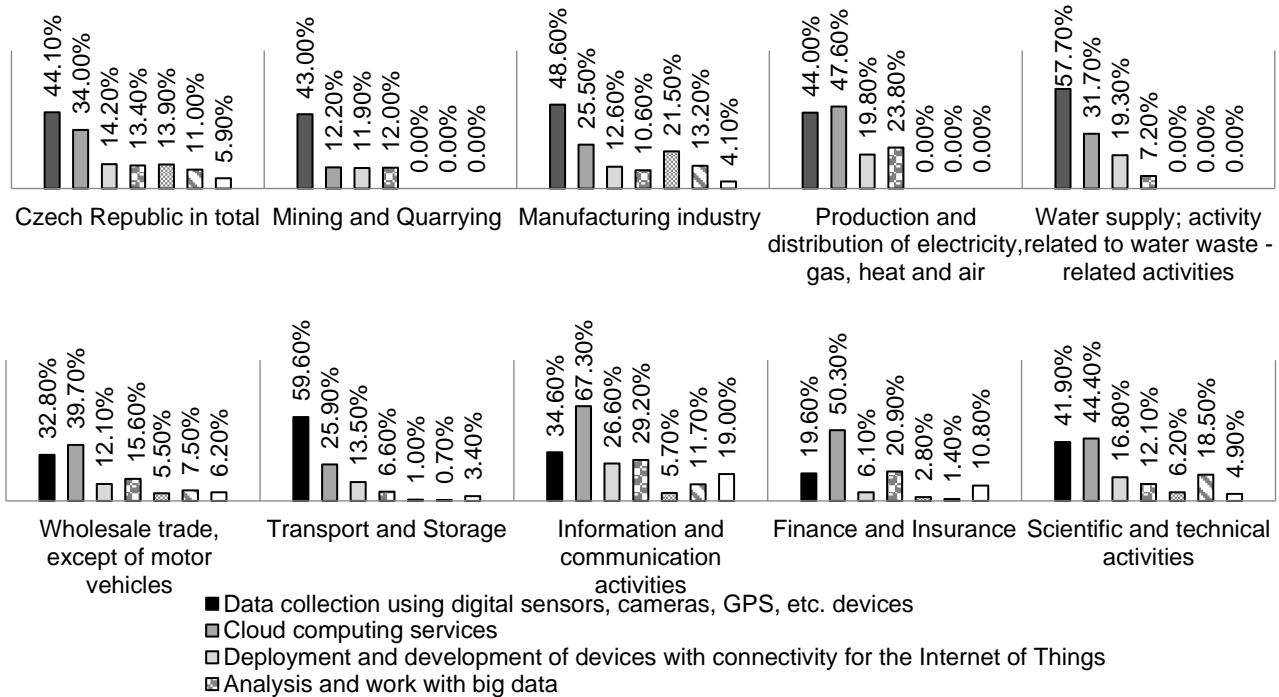


Figure 4 Share of innovative companies that used technologies related to Industry 4.0 and the digitalization of business processes by industry sectors

A closer comparison of enterprises producing metals, metallurgical and metalworking products (24-25) with the total number of enterprises in manufacturing (**Figure 5**) shows differences in the use of technologies related to Industry 4.0. Compared to the total number of enterprises in the manufacturing industry, enterprises producing metals, metallurgical and metalworking products (24-25) are more likely to implement data collection using digital sensors, cameras, GPS, etc. devices, use industrial or service robots, use artificial intelligence elements and analyze and work with big data. Conversely, they make less use of cloud computing services, deployment and development of devices with connectivity of things and 3D Print.

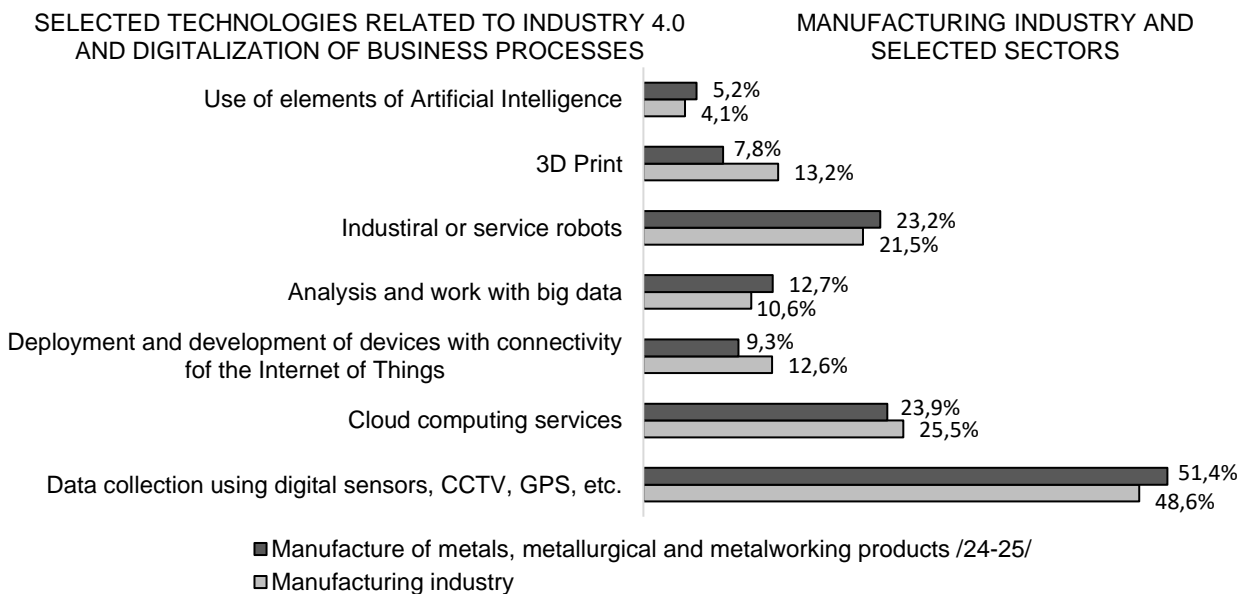


Figure 5 Share of innovative companies that used technologies related to Industry 4.0 and the digitalization of business processes by manufacturing industry

4. DISCUSSION AND CONCLUSION

The processing of statistical data obtained by the CZSO by a survey made it possible to obtain more detailed overviews of the relative frequencies of enterprises including metallurgical enterprises that implemented individual types of process innovations in the period under study and that have introduced some of the elements or tools of Industry 4.0 and the digitalization.

The representation of individual elements of Industry 4.0 and the digitalization is greatly influenced by the peculiarities of individual fields of activity. For example, 3D printing has been included among the least used technologies in comparison. Companies consider using 3D printing especially in production sectors and in those sectors of services where they use tangible products or tools. Therefore, absolute conclusions cannot be made from the performed analyses. Furthermore, it is quite logical that in the period under study when the technologies of Industry 4.0 and the digitalization in companies began to take off gradually, data collection using digital sensors, cameras and GPS were the most represented. Businesses must first be able to obtain detailed data on real processes in order to start using more advanced tools such as Internet of Things, digital twins, artificial intelligence. For metallurgical enterprises (24-25), the most used technologies associated with Industry 4.0 are: data collection using digital sensors, cameras, GPS, etc. devices and, at roughly the same level, cloud computing services and the use of industrial or service robots.

The importance of innovation for the continued existence and development of the company is recognized especially by large companies and companies under foreign control. Many of these companies are already applying technologies associated with Industry 4.0 and the digitalization and they are moving towards the creation of a digital enterprise. On the contrary, the implementation of innovation activities and the use of technologies associated with Industry 4.0 in small and medium-sized companies is low. The main obstacle is insufficient funding for new technologies and human resources. According to a survey by the Confederation of Industry of the Czech Republic [10] small and medium-sized enterprises with a turnover of over CZK 30 million engaged in serial production, such as suppliers to the automotive industry, invest in automation and robotization. Automation is disadvantageous in terms of return on investment for owners of smaller companies operating in the custom production segment.

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