The Impact of the Covid-19 Pandemic on the Rate of Adaptation of the Industry 4.0 Concept in SMEs

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Abstract. The current trend of digitization processes is referred to as Industry 4.0 - the onset of the fourth industrial revolution was a logical outcome of our progress in science and technology. If businesses want to be successful in today's market, they must respond to the digitalization trend. The pandemic revealed the need for digitization and the implementation of Industry 4.0 concepts in the business sector, where it was not necessary before. The aim of this paper is to describe the attitude of small and medium-sized enterprises to the very implementation of Industry 4.0 elements and the latest impact of the Covid-19 pandemic on the speed of adaptation of small and medium-sized enterprises in Slovakia to Industry 4.0. The survey among companies was carried out using an electronic questionnaire. Only small and medium-sized enterprises from Slovakia will join the survey in the period from November 2021 to February 2022. The questionnaire was sent to 512 enterprises. The return rate of the questionnaire was 42.38%, which corresponds to 217 companies. The aim was to analyze the impact of the Covid-10 pandemic on the speed of adaptation to Industry 4.0 in small and medium-sized enterprises. Based on the conducted research and results, we can claim that companies have started the process of implementing Industry 4.0.

Keywords: Industry 4.0, Covid-19, SMEs

JEL classification: *M20, M21*

1 Introduction

Industry 4.0 reflects the current trend of digitalization of processes in enterprises. The creation of the concept of the fourth industrial revolution was the logical culmination of our progress in science and technology, global competition and the demands of customers that come with it. To achieve long-term success in today's climate, businesses must deliver products of the desired quality, at a price acceptable to their clients, while still pursuing the primary business goal of making a profit. The concept

of Industry 4.0 affects the entire process of enterprise transformation and brings changes that affect the organizational structure of the enterprise, the qualification structure of employees and changes in the way business processes are conducted. Industry 4.0 also includes changes in the external socioeconomic environment, creation of new business sectors, increased intensity of use of the IT sector and changes in the education system. The implementation of Industry 4.0 elements does not only concern multinational, capital-strong organizations, but also small and medium-sized enterprises, which are an integral part of the national industry. In order to maintain their competitiveness, it is essential that they respond to the latest changes in the economic environment. [6] The need for the implementation of Industry 4.0 in small and medium-sized enterprises was highlighted by the Covid-19 pandemic, which revealed the need for digitization even in business sectors that did not need it before. As part of the survey, the questions asked by the company enabled us to find out their attitude towards the implementation of the Industry 4.0 concept and its change due to the Covid-19 pandemic. The main objective of the survey was evaluated based on the question: What impact did the pandemic have on your company's view of the implementation of Industry 4.0 elements? The survey was conducted between November 2021 and February 2022 in order to capture the attitude of businesses at the height of the ongoing pandemic. Due to the shorter duration of the survey, the return of the questionnaire from the enterprises was at the level of 42.38%, which corresponds to 217 enterprises, of which 211 enterprises constituted a usable survey sample. The obtained results will be presented in the following parts of the paper.

2 Theoretical background

Industrial branches of the economy are effected by and subject to constant advancement, which is affects by the level of advancements in science and technology. From a historical point of view, we can highlight the key eras and points of advancements in manufacture. In academic literature, we notice the term industrial revolution. The first industrial revolution started at the end of the 18th century in England and signified the switch from manual manufacture to machine manufacture. The first industrial revolution started a massive wave of industrialization and speeded up the urbanization process. These two concurrent processes radically affected the social categorization of the society, and its way of life. [2]

The second industrial revolution is linked to the turn of the 19th and 20th century and the first use of electricity, advancements in the chemical industry, as well as the car industry. This part of our evolution, in academic literature, is often labeled as Fordism. This label is derived from Henry Ford's car manufacture, started in the year 1913. Apart from the inclusion of conveyor belts in a manufacture, the second industrial revolution is connected to a number of different revolutionary discoveries and inventions: the first flight of a plane, the rise of railway traffic, electrification of cities, inclusion of water systems, and the growth of telecommunications.

The third industrial revolution is often connected to the changes happening during the 70s, in the 20th century. This era is connected to automation of manufacture and its control by computers, and the inclusion of IT systems and electrical systems into

manufacture. The third industrial revolution also brought about the growth of the internet, computers, and mobile phones. For this reason, it is often labeled by the name 'digital revolution. [7]
The third industrial revolution is characterized by a number of phenomena:
- de-industrialization, which systematically lowers the investments into the industry, and the growth of banking, finance, insurance, sciences and tech, telecommunications, and advertisement,
- reindustrialization, in terms of structural changes in the industry,
- the increase of the purpose of IKT, innovation, science and technology, the growth of technological advancements leads to the shortening of the life cycle of the products, which speeds up the implementation of innovations,
- globalization of socio-economic bonds,
- changes in economic thinking, behavior, and motivation,
- organizational and institutional changes are connected with the increase of importance of small and medium enterprises. [8]
The concept of the fourth industrial revolution was firstly specified in 2011 in Germany, in the Hannover Messe market. E. Hofmann and M. Rusch define the fourth industrial revolution as being included in the advancements, growth, sale, and manufacture of autonomous manufacture systems based on knowledge and sensors. This era brings about a number of expected opportunities for enterprises:
- highly flexible mass manufacture,
- optimization of value chains,
- creation of brand-new services,
- real-time coordination,
- lowered costs. [4]
The fourth industrial revolution is based on the use of new technologies in the transformation process of enterprises. The authors of the Industry 4.0 (Hermann, Pentek, Otto) include these as the key elements of the concept:
- cyber-physical system, which integrates computing and physical processes, which means that computers and networks control and monitor physical processes,
- the Internet of things, which is the initiation of Industry 4.0. It is a system, in which objects can be controlled remotely and between each other, due to microchips, sensors, and software,
- the internet of services, which includes systems based in the online space, and the use of cloud storage. Its biggest upside is its connectivity, thanks to which you only really need an internet search engine to use it. This makes the storage of data on personal hard disks obsolete,
- intelligent factories include the previous three elements of Industry 4.0, and are based on the idea of decentralized manufacturing systems. In intelligent factories based on the Industry 4.0 concept, we see the term digital logistics – logistics which integrate the manufacture, storage, and transport systems of the business. [3]

This paper is aimed at small and medium enterprises in the Slovak Republic. According to the advice of the European commission no. 2003/361/ES from 6.5.2003, about the definition of micro, small, and medium enterprises, this size category includes

enterprises that have up to 250 employees, in addition to a financial criterium – an annual turnover of 50 mil. € or less, or the entire annual balance sheet budget of 43 mil. € or less. If a small or a medium enterprise fails to adhere to one of these financial criteria, it still remains a small or a medium enterprise. The changes to the enterprise happen after breaking the financial criteria for two consecutive financial intervals. [1]

3 Methodology

The aim of this paper is to examine the effect of the Covid-19 pandemic on the speed of adaptation of small and medium enterprises to Industry 4.0 To complete the given task, the following research questions have been formulated:
RQ1: What is the current state of the implementation of Industry 4.0 in your business?
RQ2: What are the reasons for the implementation of Industry 4.0 in your business?
RQ3: What are the reasons for the lack of interest in the implementation of Industry 4.0 in your business?
RQ4: What impact did the pandemic have on your business' view on implementing Industry 4.0 elements?
The questions and possible answers were explained in the questionnaire.

The necessary information was obtained using an electronic questionnaire, which was sent to the chosen respondents (small and medium enterprises in Slovakia) in the time from November 2021 to February 2022. The questionnaire was sent to 512 companies, which filled the requirements of the selection process. The return rate of the questionnaire was 42,38%, which reflects to 217 companies. 6 questionnaires were unusable due to incomplete information. The final information was collected from a sample of 211 small and medium enterprises.

Data from individual questions were analyzed by statistical methods. Correlations in individual responses were sought using statistical methods. Pearson correlation was used to evaluate the data, statistical tests were performed at $\alpha = 0.10$.

4 Results

The next section of this paper will closely examine the results. It will analyse the gained information, which will lead towards answering the main question of the paper – the effect of the Covid-19 pandemic on the speed of Industry 4.0 adaptation of small and medium enterprises in Slovakia.
From the point of view of the enterprises size, small enterprises (10-49 employees) had the biggest representation. They made up nearly 46% of the sample. Micro-enterprises (less than 10 employees) made up 37% of the sample, and medium enterprises (50-249 employees) made up nearly 17% of the sample.
The biggest part of the sample was made up from small and medium enterprises in the branch of small sales, they made up nearly 46% of the sample (98 enterprises).

Enterprises in the wholesale branch represented the second largest part of the sample, 25% (53 companies) to be specific. Other branches had smaller representations – 22 advertisement companies, 18 food companies, 10 financial and 10 transport and logistics companies.
Despite them being enterprises from different industrial branches, they were all affected (directly or indirectly) by the current crisis caused by the Covid-19 pandemic. Therefore, the next subchapter will analyse how the pandemic affected these enterprises approach to digitalization and adaptation to Industry 4.0

4.1 State of implementation of Industry 4.0 elements in SMEs

To allow for the analysis of how the pandemic affected the speed of Industry 4.0 adaptations for small and medium enterprises in Slovakia, it was necessary to find out the state of the adaptation in the chosen enterprises. The goal of the question (RQ1: What is the current state of the implementation of Industry 4.0 in your business?) was to find out, whether the enterprises already include adaptations to Industry 4.0 in their actions, or whether they plan to in the future. The next graph shows the information about the current state of Industry 4.0 implementation for small and medium enterprises.

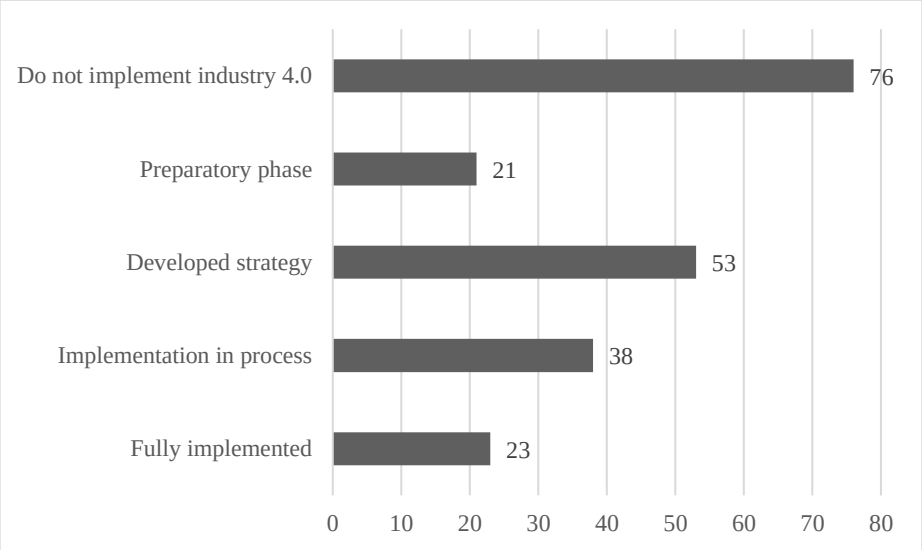

Fig. 1. Current state of implementation of Industry 4.0 elements.

Source: author's research

Out of the 211 companies, only 38 (18%) currently practice the implementation of Industry 4.0 elements. 23 companies (11%) had a fully implemented strategy comprised of Industry 4.0 elements. These were companies in wholesale (13), small sales (8), and logistics and transport (2). 53 companies (25%) have a fully designed strategy to implement Industry 4.0, but have not yet implemented it. 21 companies (10%) stated that they are currently in a preparation phase to implement Industry 4.0. The amount of enterprises with no interest in implementing Industry 4.0 so far was an unpleasant surprise – 36%, or 76 out of 211 companies.

In evaluating the current state of Industry 4.0 implementation for small and medium enterprises, a correlation was identified between the size of the enterprise and the level of implementation of the Industry 4.0 elements. The smaller the number of employees, the less important the implementation of Industry 4.0 elements. The correlation coefficient was $r = 0.728$ (p-value = .029).

To better understand the stance of small and medium enterprises towards the implementation of Industry 4.0, the questionnaire included a section which asked to enterprises the reasons for implementing (or not implementing) elements of Industry 4.0.

Out of the 135 companies which actively implement, or plan to implement Industry 4.0, 70 (52%) stated that the main reason was keeping up with the competition. This is a logical response from small and medium enterprises, as they often have to compete with large, multinational competitors. It is exactly these corporations, that include technological advancements in their enterprises first. Therefore, small and medium enterprises need to react swiftly, to keep their ability to compete in the market. However, not all small and medium enterprises only want to follow stronger competitors – some want to bring their own technological advancements. Out of the chosen companies, 38 (28%) stated that the main reason for implementing Industry 4.0 was to gain a competitive upper hand. The other 27 (20%) stated that their motivation was to improve their service for their clients. This reason also reflects the effort of small and medium enterprises to keep their ability to compete.

It was surprising to find out that out of the 211 companies, 76 have no yet shown interest in implementing the concepts of Industry 4.0 into their processes.

As with the companies that actively do implement Industry 4.0, we also wanted to know the reasons why the other companies have not shown any interest in doing this.

The most common reason for the lack of interest, as stated by 41 companies, was that they do not see the point of it. This may be caused by the fact that not all businessmen and managers have enough information about their options in implementing Industry 4.0 in their businesses. Small and medium enterprises are also put off implementing Industry 4.0 due to the high investment difficulty (26). We can find a positive in the fact that 9 companies have shown interest in examining their options of implementing Industry 4.0 in the future.

The main aim was to analyse the effect of the Covid-10 pandemic on the speed of adaptation to Industry 4.0 in small and medium enterprises. After examining the current state of the implementation of Industry 4.0, it was necessary to find out in which way has the pandemic affected small and medium enterprises relationship with the concept

of Industry 4.0. The answers of the companies to this question are shown in the following graph.

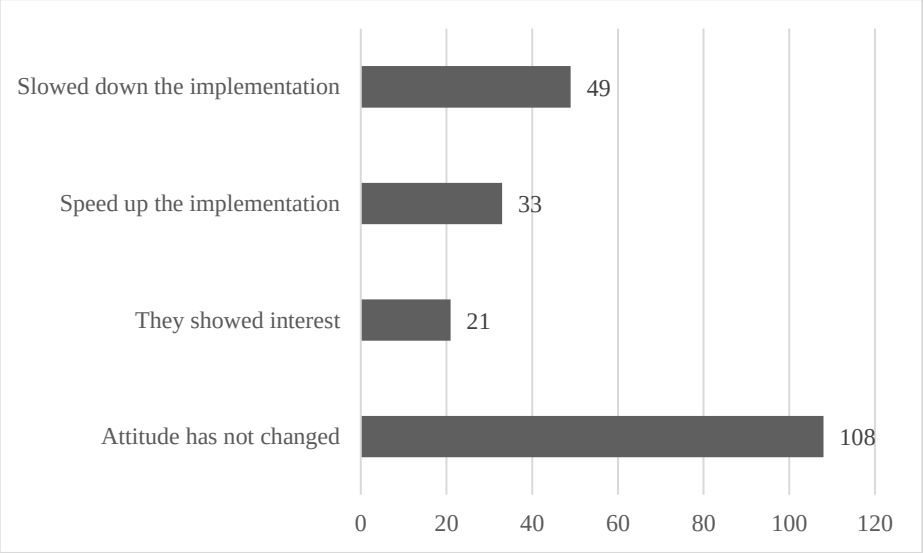

Fig. 2. The impact of the Covid-19 pandemic on attitudes towards the implementation of Industry 4.0 elements.

Source: author's research

108 companies have not changed their stance on Industry 4.0 as a result of the pandemic. The rest of the companies have been affected by the pandemic enough to change their opinion on the implementation of Industry 4.0 standards. 33 companies have sped up the process of implementing Industry 4.0. This is an understandable step, as the pandemic and its related heightened security measures increased the need for digitalization in branches, where it was not necessary before. This is also reflected in the change of opinion of 21 companies, who have only shown interest in Industry 4.0 because of the Covid-19 pandemic. Unfortunately, we need to mention that some companies (49) and their view on Industry 4.0 have been negatively affected by Covid-19. These companies have stated that the pandemic has slowed down the implementation of Industry 4.0 standards into their enterprises.

5 Conclusions

The aim of this paper was to show the effect of the Covid-19 pandemic on the speed of implementation of Industry 4.0 standards in small and medium enterprises. To fulfill this goal, it was necessary to gather information on the current state of the Industry 4.0 implementation in small and medium enterprises, and how was their stance on digitalization affected by the pandemic. The results from the research done have been presented in the previous part of this paper.

Annually, since 2017, the initiative of the ambassadors of Industry4UM creates a questionnaire for enterprises, in which it finds out the current state of digitalization in enterprises in the Slovak Republic. Last year, this questionnaire revealed the negative trend of perceiving the importance of Industry 4.0 implementation from the view of the enterprises. [5]

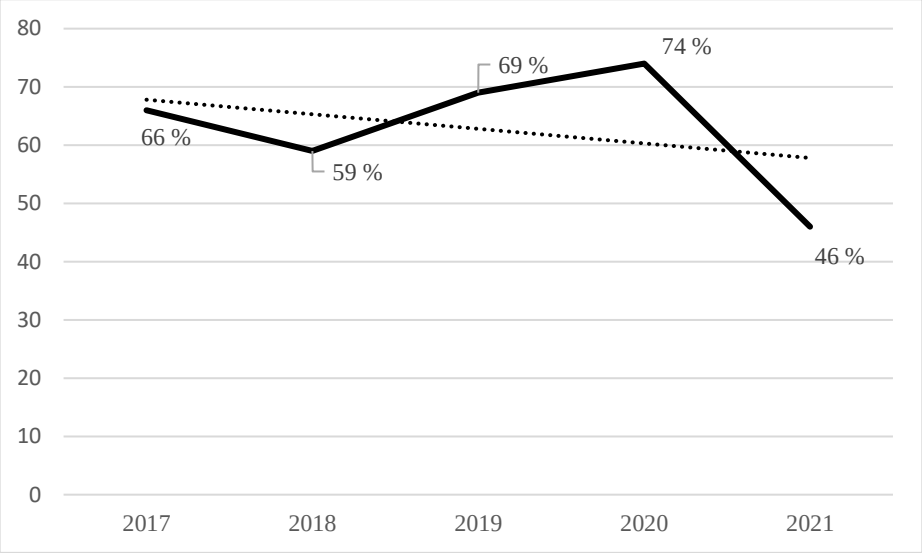

Fig. 3. The importance of implementing Industry 4.0 for the future of the company - the opinion of companies.

Source: author's processing according to Industry4UM

In the first year, two thirds of enterprises considered the implementation of Industry 4.0 standards important for their future. In the next few years, the view remained relatively unchanged, with two thirds considering Industry 4.0 important for their future. Most companies changed their stance on the importance of implementing Industry 4.0 in the year 2021 – only 46% considered Industry 4.0 important for their future. In the research done for this paper, 36% of companies asked showed no interest in the implementation of Industry 4.0 standards. We can state that companies have two main reasons for not being interested in Industry 4.0 and its implementation – they do not see the point of Industry 4.0 for their business, or they feel threatened by the investment difficulty of Industry 4.0.

The topic of adaptation of the Industry 4.0 concept in small and medium enterprises is a very current theme, which is determined by a myriad factors. Some of the most important factors include the stance of small and medium enterprises themselves, on the implementation of the Industry 4.0 concept, and also their placement in the national industry, which is tightly connected with the institutional support of small and medium enterprises, under the terms and conditions of the Slovak Republic.

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