

THE IMPORTANCE AND IMPLEMENTATION OF INFORMATION AND COMMUNICATION TECHNOLOGIES

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Abstract

The aim of the article is to point out the need to introduce innovations, digitization and new advanced technologies in the so quickly developed enterprises. We want to define the assess the use of information and communication technologies in the Slovak industrial sector, as well as the implementation of ICT in production processes. This trend has the huge impact on the development of enterprises, countries and ultimately the entire world economy. In the final practise part of our paper, we implement our knowledges to Slovak industry and evaluate the level of their use. In this paper we have used a several scientific methods. Starting with collecting information, especially from scientific works from both, foreign and home authors, too. Subsequently, we have sorted them into individual chapters. From the scientific methods we used mainly paired methods as induction and deduction, analysis and synthesis. We used graphical and mathematical methods, which are mainly used for the clearer presentation of our results in the chart.

Key words:

Information and communication technologies, industry, Internet of Things, Big Data, digitalization, electronic communication, benefits

JEL Classification: D47, L22, L51, M15, M21

<https://doi.org/10.52665/ser20220102>

Introduction

In the modern world, information and communication technologies are becoming an integral part of everyday life, as well as it is therefore essential for any company that wants to find its place in the market to introduce new and new technologies into its processes and thus adapt to the rapid change in the world. (Alter, S.:2005)

The first important notions are data, which have a certain arrangement reflecting reality, but are meaningless in themselves. We know structured data, which are arranged in a certain structure, i.e. a database; unstructured data, whose structure cannot be defined and the computer system is not able to evaluate the data without the help of a human; or semi-structured, in which we can only identify a simple structure. Information can be understood as data that is processed for a purpose and has some importance to the user. (Feather, J. – Sturges, P.,2003) The information system is used to collect data, store it and provide relevant information to the users of the system in carrying out their work. (hereinafter IS) Nowadays this is mainly computers, but in the past the most widely used medium was paper. (Alter, S.,2005)

O'Brien defined an IS as an organised combination of people, technical resources - hardware, software, communication technologies, data, rules, procedures and standards, with the aim of capturing, storing, processing, disseminating and using information. (O'Brien, J.- Marakas, G.,2008)

The electronic IS enables the automation of many activities, thus relieving the burden the human workforce. It also opens the door to the processing of databases with large amounts of data, such as the Internet of Things (hereinafter IoT) or Big Data.

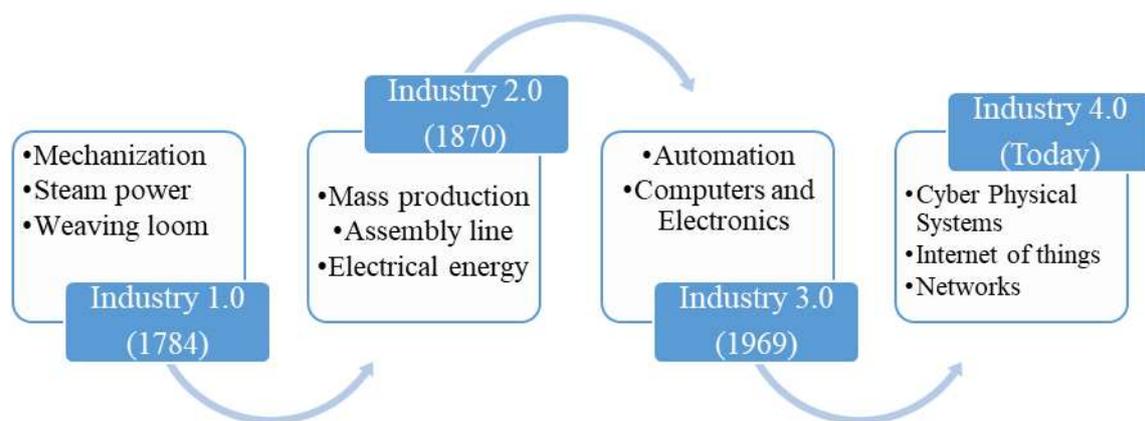
The results of which can then be used by enterprises to make decisions on, for example pricing and finding of gaps in the market, marketing tactics, etc. However, the human factor is still very necessary for the functioning of IS in the enterprise, e.g. for inputting data and evaluation of obtained data. In addition, people are the bearers of personal experience and knowledge, which are necessary in workflows. All these elements created the IS make it an effective whole to support the management and operation of the organisation.

1. First steps of implementation ICT

Scientific and technological change is driving economic progress throughout the world economy. They have been the catalyst for the dynamic growth of international trade, which was driven by the effects of globalisation. The main milestones that have fundamentally changed the

way the world works are the industrial revolutions, which led to the fulfilment of the human desire for develop. This has caused to major inventions in world society that have changed working conditions and people's lifestyles. These changes we can see in the diagram, where is shortly explained the industrial revolutions, which went through four phases.

Diagram 1: Genesis of the Industrial Revolutions



Source: Own processing according to Aberdeen Group (2017)(<http://www.aberdeen.com/>)

Digitisation is the use of digital technologies to change the business models and provide new opportunities to generate new sources of income. It is the process of moving towards digital commerce. Digitization is a modern trend that began to develop in the 1980s when the first home, personal computers (hereinafter PC) were introduced to consumer markets. In the twenty-first century, digitalisation is constantly changing society, our everyday life, culture as a whole, information and communication technologies, industrial and commercial activities of enterprises, activities of banks, media, competitiveness and level of education. Digitalization is an opportunity for companies and organizations to improve their business activities, their competitiveness in the market and

to reduce their costs, thus avoiding risks. (Brem A., Viardot E.,2017).

The Fourth Industrial Revolution began to evolve at the beginning of the 21st century, due it's the main factor its was spread the of the Internet and digitalization. This process began developed in Germany and has evolved in a planned manner, with great support of the German government, which analysed the impacts of new technologies on the country's economy.

Its basis is the real-time interconnection of devices, components and people through complex networks which, in cooperation with other technologies such as intelligent robots, huge amounts of data and elements of artificial intelligence, will create a production process with the ability to self-organise and it will be a system

with decentralised control and autonomous decision-making. Digitalisation with using all its functions, can bring revenue growth of up to 30-40%.

(<https://www.machinometrics.com/blog/industry-4-0-advantages-and-disadvantages>)

2. Application of information and communication technologies in industry

Industry is a crucial sector of the world economy, as the modernisation of industrial production determines the development of the whole economy and ultimately of the whole society. Since its beginnings, it has strongly influenced all other sectors, especially the development of transport, agriculture, construction, energy and trade. This phenomenon is still being observed today. Industry can also be called the “engine” of economic growth, as it is key to all advanced economies, although the trend in the most developed countries is now more towards the tertiary sector.

(<https://www.economicshelp.org/tertiary-service-sector/>)

Industry is included in the secondary sector of the economy, sometimes referred to as the manufacturing or processing sector. It includes all sectors of human activity that transform the raw materials into semi products, products or goods. These may be goods destined for final consumers, or products and materials for further used in another production process.

Industrial production in Slovakia has played an important role in the Slovak economy for many years. The most important sector is the automotive industry, which contributes significantly to the GDP and employment in the country. On the second place is the production and processing of metals and the third place belongs to the production of electronic and optical products. In 2020, the industrial sector was significantly affected by the Covid-19 pandemic. Their production was limited due to strict pandemic measures and they had to adapt on material supply disruptions or staff absenteeism. Before the pandemic were digitisation, innovation and the implementation of modern technologies into production processes important part of the industrial sector.

In our paper we can use data from the Slovak Statistical Office, according to SK NACE, belong to section C - Industrial production, which includes divisions 10 - 33.

The basic industries include engineering, automotive, electrical, chemical, energy, metallurgical, construction, food, glass and textile. The modern methods used in the industry mainly include electronic communication, Enterprise Resource Planning (hereafter ERP), Just-in-time (hereafter JIT), Production Part Approval Process (hereafter PPAP), Measurement System Analysis (hereafter MSA) and many others.

Electronic communication (hereinafter EC) is a technology that enables fast and efficient communication throughout the whole supply chain. But another processing is required here using Enterprise Resource Planning, which is an intra-corporate software information system used to manage and coordinate all company resources. It is used for internal company processes, i.e. those in which external suppliers are not involved. It can be used in the areas of production, internal logistics, human resources and economics, with the possibility of selecting additional sub-modules from each area according to the needs of the company. If external processes need to be supported, extended ERP can be used, which also includes supply chain and customer relationship management. (Crandall, W. (2015.))

The Just in Time process was created in Japan, where it applies from the 1970 s. Its essence is the delivery of material directly to the installation line at a precise time and quantity. It is very important because the individual parts are arranged in the order in which they are scheduled for assembly. The main advantage is minimising storage costs, saving time and reducing the cost material, due it is purchased in accordance with need. On the other hand, a major disadvantage is the potential for accidents or closures, which can almost immediately have a negative impact on the continuity of the delivery cycle and thus the entire production process.

(<https://www.ifm.eng.cam.ac.uk/research/dstools/jit-just-in-time-manufacturing/>)

The Production Part Approval Process method is used to approve parts used in production, helping to reduce the risks of production failure and ensure a smoother production process. It is used

to demonstrate that the company correctly understands all the requirements of the product design documentation and all customer specifications and is able to produce the product in compliance with demands of customers. (<https://www.ideagen.com/thought-leadership/blog/what-is-ppap-and-why-is-it-important>)

Measurement System Analysis includes several of procedures, which serve as gauge in the production process. This access serves also as complex measurement system in a production process. The method focuses on the analysis of sources of uncertainty in the whole produce process, as it assumes that it is not sufficient to have only an accurate system for prevent because the external factors may also have an influence. Therefore, it is evaluated the measurement system as a whole, thus avoiding unnecessary loss of time, human capital and to generate waste. (<https://quality-one.com/msa/>)

Among the main IT advantages of Industry 4.0 include the flexibility of production processes, which, thanks to modern technologies, can quickly adapt to market requirements and thus respond more flexibly to customer requirements. It leads to a more efficient division of resources and materials, which the implement is more environmentally friendly processes and procedures, which will also lead to a reduction of the production costs. This change requires new business models. This also leads to the creation of new job positions such as data analysts, digital experts and engineers. As the final impacts of all the above factors will lead to higher living standards in countries, which should mainly benefit their citizens.

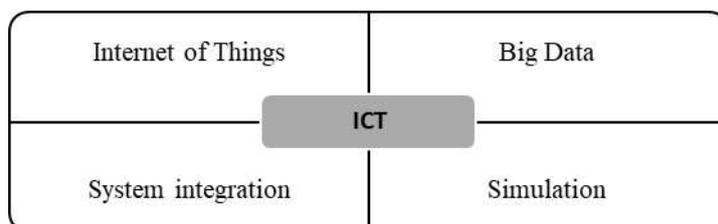
As we can expect, this new process will also bring many disadvantages. Among the main ones belong the lack of financial resources, because the development of sophisticated systems and robots are very costly. Also, a large amount of time will be needed to adapt factories and companies to the new technologies and processes. Another significant disadvantage is to secure highly educated people for new jobs. It is leading to the loss of many working positions for workers with less education, who's will be replaced by robots. https://www.machinometrics.com/blog/industry-4-0-advantages-and-disadvantages_

3. Introducing selected Information and Communication Technologies

Industry 4.0 brings with it many changes for enterprises, because they need to adapt to in order to remain viable in the market. For smaller ones is this process of implementing ICT systems seem easier, because it is usually covering a smaller area, but they have often problems with obtaining financial source. Here we can also see the need for the state, which is an important component in promoting investment in the country, especially in the industrial sector. "Smart" industry will move to developed countries for example to USA, France, Germany. ICT will benefit from rising productivity and reduction of costs and will required skilled workers. (Gilchrist, A.2016)

On the other hand, for larger enterprises, it requires a more complex and involved process and these changes will require the adaptation of infrastructure to more modern technologies. They also expect higher profits and the return of their investments.

Diagram 2: Selected elements of ICT



Source: *Own processing according to: Gilchrist, A.:(2016) Industry 4.0: The Industrial Internet of Things. Berkley: Apress, 2016. p.. 219-222. ISBN 978-1-4842-2046-7.*

Technology became an integral part of our lives a few years ago and it is almost certain that its influence will continue to grow significantly. They create the essence of the whole Industry 4.0 and will therefore be discussed in more depth in next part of paper.

Internet of Things

The Internet of Things (hereafter IoT) is the term most associated with the 4th Industrial Revolution. The British scientist Kevin Ashton was the first to come up with the concept of IoT in 1999. He was the first whom define it from an industrial perspective and he saw its huge potential. At the end of the 20th century, he saw computers as "brains without senses", because they only worked and analysed with data that people "give" them for processing. Based this knowledge the IoT is emerging, making computers much more sensitive and able to handle information without much human cooperation. IoT can be defined as a system of interconnected devices (mostly wirelessly) that are equipped with sensors. These are able collect

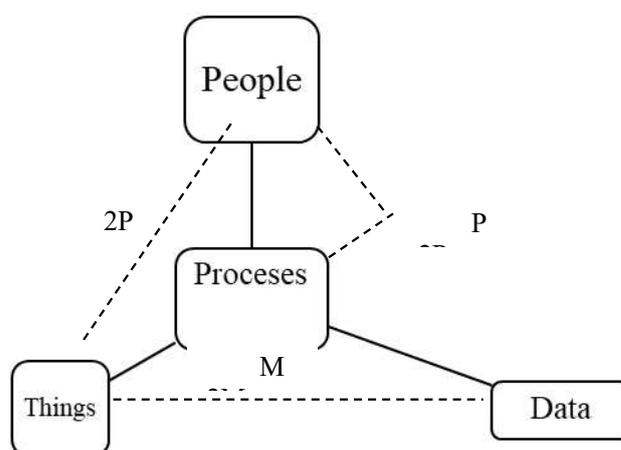
5.

data from surrounding the world around them and communicating with other "smart" devices, thus interconnecting with each other and forming an intelligent network where human intervention is not necessary. (Kramp, T.–Kranenburg, R. – Lange, S. 2013)

IoT creates four basic elements that make up the whole IoT. These are:

1. Things - for IoT to work accurately, they must be connected so that they can communicate. This can be either wired or wireless communication.
2. Data - every second new and new data are created that requires further processing, storage and analysis.
3. People - they are also an important component as they make decisions based on the data they receive.
4. Processes - take place between people, things and data.

Diagram 2: Relations among elements of IoT

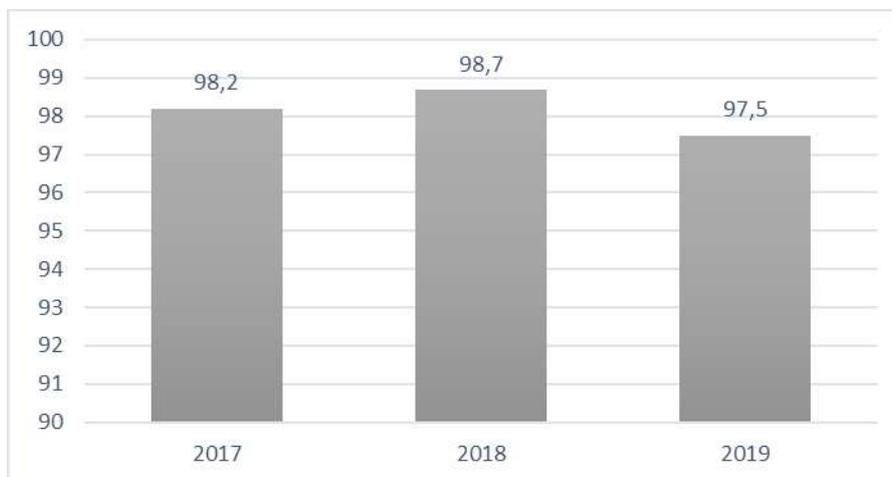


Source: own processing according: Tzafestas, S.:(2018) *Ethics and Law in the Internet of Things World*. In *Smart Cities*. 2018, p. 99. Available at: <https://www.mdpi.com/2624-6511/1/1/6>

Nowadays, concepts such as the computer and the internet have become an integral part of the modern and digitised world, and it is hard to imagine society functioning without their everyday presence. In Chart 1, we can see how the use of computers and computer networks has

evolved in Slovak industry from 2017 to 2019. It can be said that this is not a very dramatic development. There is only a 0.5 percentage point difference between the first and second year under review. Subsequently, in 2019 we observe a slight decline of 1.2 percentage points.

Chart 1: Use of computers and computer networks 2017-2019

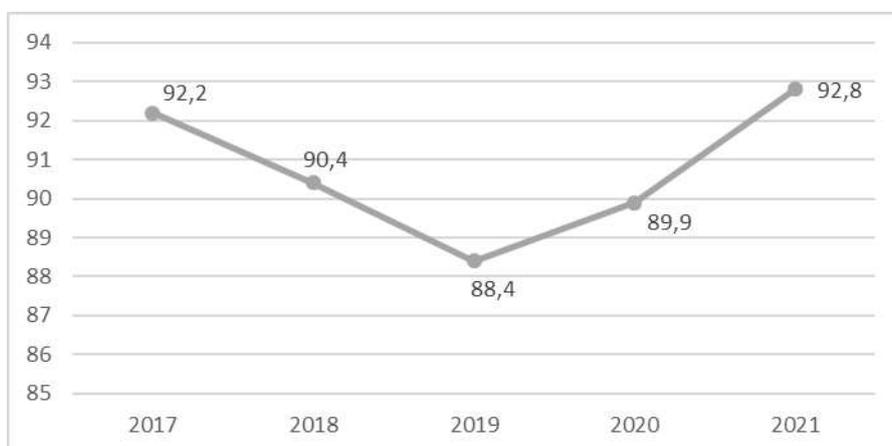


Source: own processing according data of Slovak Statistical Office

The second essential aspect in today's modern industry is the ability to connect to the internet. Its most important role is to connect devices, materials and products – mean physical reality

with virtual reality. The rise of digitalisation is leading enterprises to choose the appropriate form of internet connection, which is currently broadband. Its use can be seen in chart 2.

Chart 2: Broadband internet usage 2017-2021



Source: own processing according data of Slovak Statistical Office

In 2017, 92.2% of enterprises belonging to the industrial production sector used this type of internet connection. In 2018 and 2019, we observe a sharp decline, with the number of enterprises using internet was falling to only 88.4%. Gradually, during 2020 and 2021, this share will increase again to 92.8%. This positive

development was the result of the strict Covid - 19 measures. Online relations between businesses and customers, but also between businesses and each other, also developed positively.

Digital technology has a significant impact on changing the behaviour of businesses and

consumers, because ensure them to have direct contact via the internet, thereby reducing their costs. This digitalisation wave is also characterised by the creation of new jobs in the production, distribution and management of the digital industry, which create new relations as M2M, P2P or P2M models. (Brynjolfsson. E.,-Mcafee A. (2014)

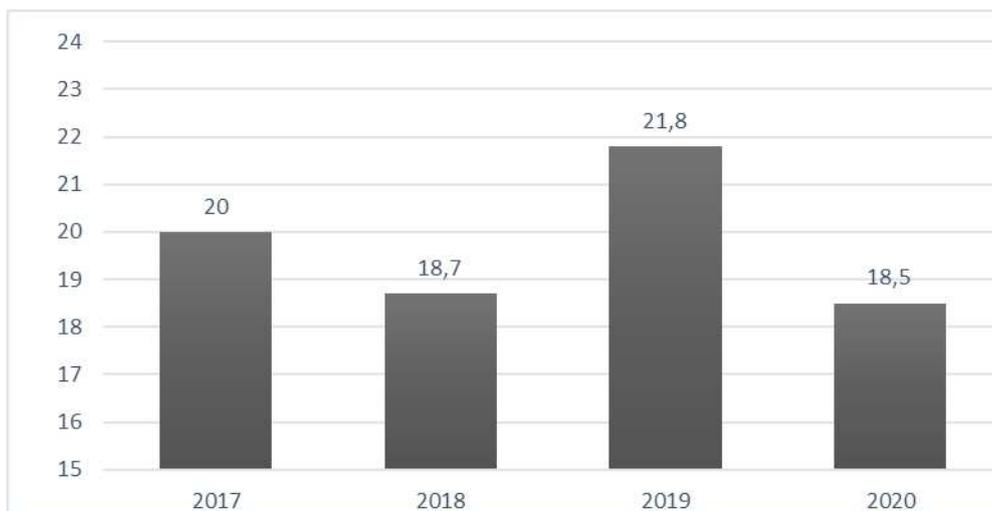
The concept of Machine-to-Machine (hereinafter M2M) is a process where two or more devices communicate with each other, i.e. they exchange the processed data on the basis of which they further perform the given activities. Nowadays, most of the time, at least minimal human involvement is required. M2M communication can be divided into wired, where devices are connected by cable. This form is becoming rarer. But most popular is wireless communication. In this case, devices are connected for example via Wi-Fi or Cellular Network (this includes 3G, 4G and more recently 5G network. <https://control.com/technical-articles/what-is-machine-to-machine-communication-m2m/>

The concept of People-to-People (hereafter P2P) includes communication between people within an enterprise, supply or customer chain, necessary

to secure all processes. It is about accepting different types of decisions (managerial, production) based on the data collected and subsequently analysed. A third concept that is associated with this issue is People-to-Machines communication (hereafter P2M), which means the allocation of tasks by people towards devices and machines, while at the same time the providing of the data by people. The interconnections between the different elements, together with the aforementioned types of communication between them. (Tzafestas, S.2018).

The high level of digitalisation in enterprises creates places for new jobs, namely for ICT specialists. They are trained professionals who are able to maintain, operate and develop ICT technologies and the whole systems. It is important to continuously educated, advance their skills and have learned the new trends. Such workers on the Slovak labour market, are missed because most of them leave for more interesting job offers abroad. Here arises a significant problem for companies, but also for Slovakia as a whole, which should not be ignored - the lack of a workforce to take care of the digital revolution already underway in our country. These negative trends are showed on next chart.

Chart 3: Employment of ICT specialists in 2017-2020



Source: own processing according data of Slovak Statistical Office

In Chart 3 we can see how many industrial enterprises employed ICT specialists in 2017-2020. The highest share - of 21.8% of businesses was reached in 2019, while in 2020 we saw a rapid decline of 3.3 percentage points.

The Internet of Things is an integral part of a future, because "things" will become active participants in business, information and social processes. In 2025 it is predicted that up to 21 billion devices will be able to belong into the "smart" category. They will have the ability to connect to a network and interact with each other without human interaction. We will see increasing use of smart devices in both the manufacturing and service sectors. As can be expected, the interconnectedness of "everything" will bring many benefits, but also bring various risks, such as attacks by hackers trying to access sensitive data. This led the European Union in 2018 to implement the General Data Protection Regulation (hereafter GDPR), which should ensure a higher degree of data protection on the internet. <https://us.norton.com/internetsecurity-iot-5-predictions-for-the-future-of-iot.html>

In the twenty-first century, digitalisation is constantly changing society, our daily lives, culture and information and communication technologies enter to industrial and commercial activities of enterprises, banking, media, competitiveness and education. In the literature, we can also meet with the terms "digital disruption", "digital revolution", "digital storm" which are associated with a large and diversified database. This fact leads companies, which to use of modern technologies in processing amounts of data, which has led to the involving new term **Big Data**. (in diagram 2)

If Data are correctly processed and analysed, we can use them to optimise products, identify where the production process is failing the most, to prevent anomalies and product defects. Big Data make able to take full advantage of new opportunities and ultimately enable "smart" decisions to be made. (Davenport, T.– Barth, P.– Bean, R.:(2012)

Another important part of ICT is **simulation** (in diagram 2), which allows to predict the production process. It is a software tool that allows to detect the dynamic behaviour of a production system where static calculations cannot be implemented or would not produce a

usable result. Using simulation can be complicated processes that would take weeks or months, but on a computer are made in few minutes. It is an ideal tool for decision-making at different levels of a company. It has found its use in testing and modelling new processes, helping to detect potential errors early and thus speeding up the implementation of new and improved processes in the enterprise. (Bali, V. 2021)

System integration means the effective interconnection of specialised IT systems into a single functional unit and to them of the common organisation. The aim is to create a network of systems, both in-company and those from outside the company, which are closely interconnected and are able to communicate with each other and thus accelerate the process of exchanging necessary information. There are two types of system integration: vertical and horizontal. Vertical integration involves a network of a large number of smaller subsystems in an enterprise that are hierarchically arranged. This integration leads to the emergence of intelligent facilities that are able to communicate with each other rapidly and to exchange large amounts of data. Horizontal integration, on the other hand, is not just about communication within a single enterprise, but about collaboration between multiple organisations. It involves the exchange of information between suppliers, customers and service providers, ensuring the smooth running of the entire production process. (Sony, M. (2018)

4. Evaluation ICT in Slovak industry

In this part of the article we present the practical application of selected information and communication technologies in the Slovak industrial sector. We use available data from the Slovak Statistical Office. As the statistical unit we chose a unit the enterprises which, according to SK NACE, belong to section C - Industrial production, which includes divisions 10 - 33. Due to the limited volume of data we can work with the selected ICT.

Internet of Things and robotics

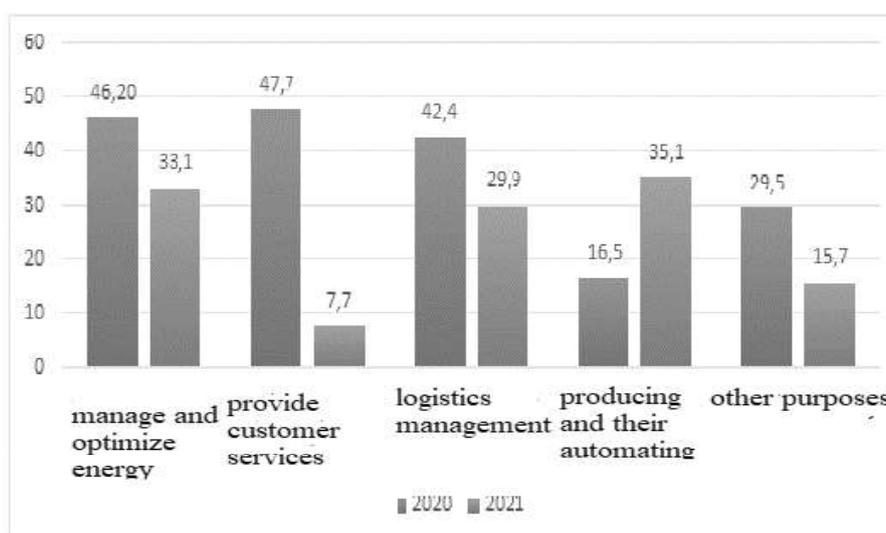
With the help of the Internet of Things are the individual devices, processes and workers are connected. This is one of the most important innovations, which can improve the operation of a business, optimise and automate individual processes, thereby reducing operating costs,

minimising downtime and improving the overall quality of output.

Only 18.2% of industrial enterprises were using IoT in 2020, and this share has almost doubled to 30.7% of enterprises in 2021. In the chart below, we can see a comparison of how IoT is being used in the industrial manufacturing sector. Overall, it can be observed, that the trend tends to decrease. IoT was mainly used for manage and optimize energy consumption in 46.2% of

enterprises in 2020, and the share dropped to 33.1% in 2021. To provide customer service with of smart cameras to monitor customer activity, 47.7% in 2020, but only 7.7% of businesses in 2021. For logistics management was used in 42.4% of enterprises, but in 2021 it dropped to 29.9%. For producing and their automating, IoT was used in only 16.5% of enterprises in 2020, and then it roses to 35.1%, what is more than doubling. IoT use for other purposes fell by 13.8 percentage points to 15.7% from 29.5%.

Chart 4: Comparison of manner of IoT in 2020 and 2021

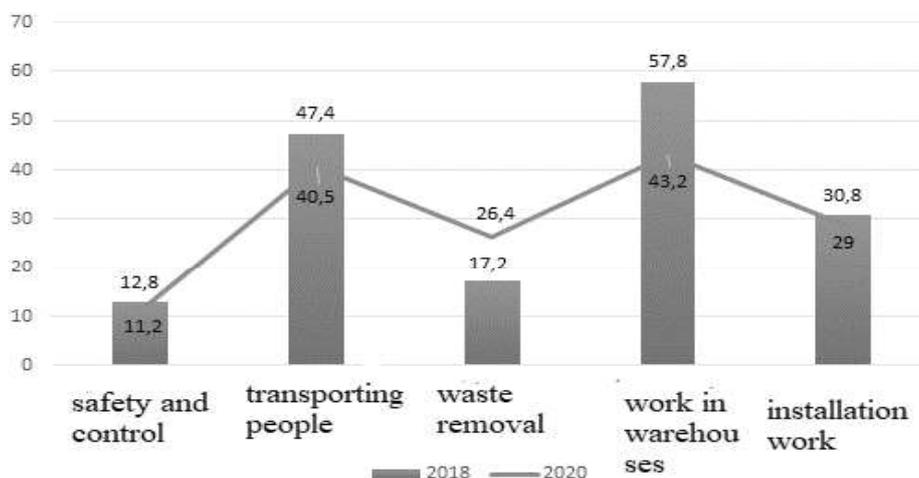


Source: own processing according data of Slovak Statistical Office

The use of robotics is becoming increasingly popular in industrial enterprises, due intelligent and autonomous robots can significantly change an ease monotonous and strenuous activities, which had been performed by humans. The Internet of Things plays an important role here, as

it ensures communication between robots and data transmission. In the chart 5 we explored the various uses of robotics in industrial enterprises. The data is collected from the enterprises that use robotics.

Chart 5: Comparison of uses of robotics for 2018 and 2020



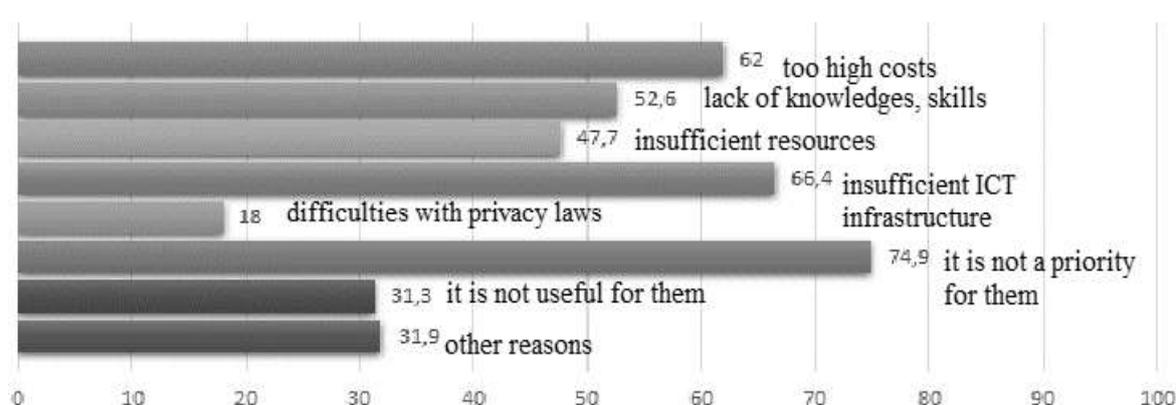
Source: own processing according data of Slovak Statistical Office

Robots, for safety and control, were used by only 12.8% of industrial enterprises in 2018, but it dropped to 11.2% of enterprises in 2020. As more as 47.4% of enterprises used robotics for transporting people and goods, but we see this dropping to 40.5%. In 2018 for cleaning and waste removal, 17.2% in 2020, this rose by 9.2 percentage points to 26.4% of businesses. In 2018, 57.8% of firms used robots for work in warehouses, what declined to 43.2%. For installation work, we see a decrease of 1.8 percentage points year-on-year, from 30,8% to 29%.

Big Data and Cloud computing

As we mentioned above, Big Data represents the huge amounts of data collected from various activities in an enterprise, for example: the production process, financial activities or marketing communications. In Slovakia in 2020, only 3.9% of industrial enterprises were using this modern processing of data. Due this negative fact, the Slovak Statistical Office made a survey with question, why enterprises do not use Big Data. The results were collected from enterprises, which were considering of using this technology.

Chart 6: Reasons for not using Big Data in 2020



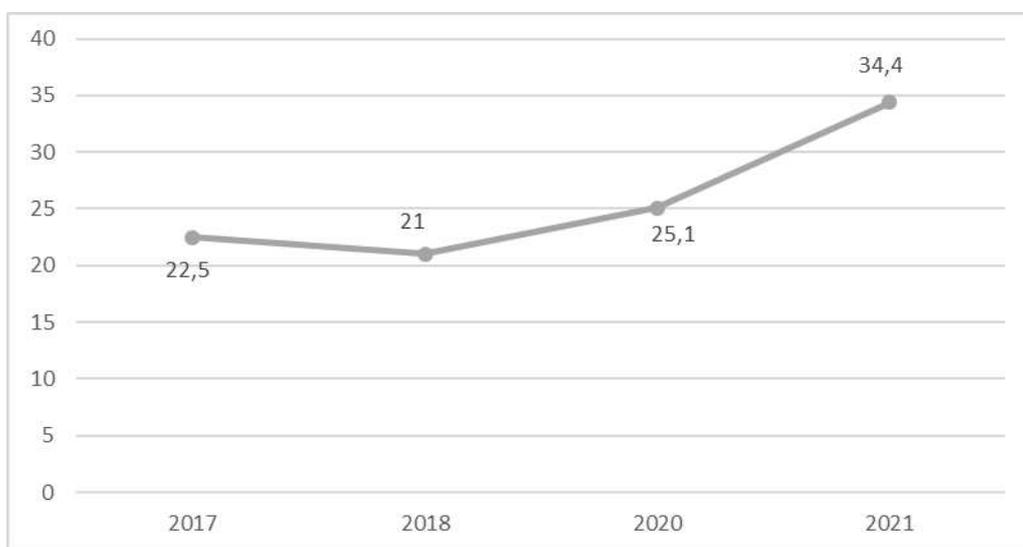
Source: own processing according data of Slovak Statistical Office

As many as 74.9% of analysed enterprises answered, that it is not a priority for them. As the second most common reason was insufficient ICT infrastructure - till 66.4% of enterprises. Closely followed by too high costs for 62% of enterprises. Other important reasons were lack of human resources, knowledge and skills (52.6%), insufficient resources of Big Data (47.7%), difficulties with legal framework with privacy

laws (18%), then other reasons (31,9%), finally it is not useful for the enterprises (31.3%).

The evolution of the use of cloud computing has been monitored in industrial enterprises – how are connected to the Internet. During analysed years, we can see that the development had an increasing trend from 22,5% to 34,4%, with the exception of 2018, when it drops of 1.5 percentage points.

Chart 7: Use of cloud computing in 2017-2021

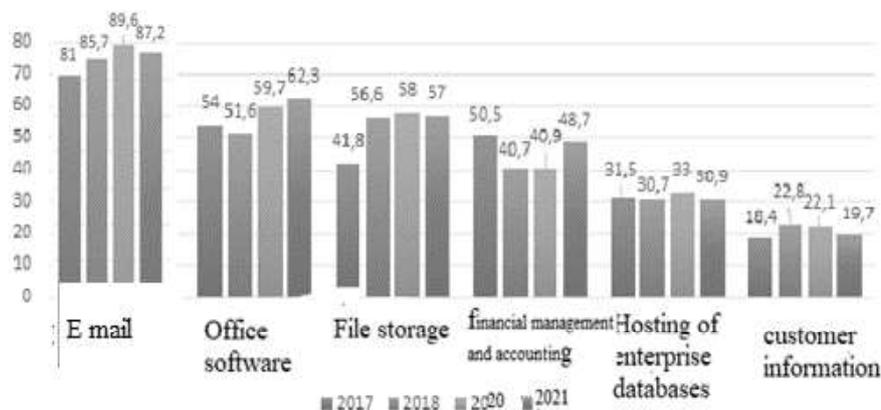


Source: own processing according data of Slovak Statistical Office

The different uses of cloud computing can be seen in chart 8. We can state, that enterprises use it on:

- Email: had positive increasing trend, in 2017 from 87,2% till to 81% and further to 87.2%
- Office software, which in 2017 was used by 54% of businesses, then saw a slight decline of 3.6 percentage points in 2018, but rising to 62.3% of businesses during 2020 and 2021.
- File storage was used by 41.8% of enterprises using cloud computing in 2017. In the next years, the values grew and ended up at 57% in 2021, which is an increase of 15.2 %.
- Software applications for financial management and accounting. For this purpose, in 2017 was used more than 50.5% of businesses. In 2018, we observe a significant drop to 40.7%. Subsequently, the values increase by 7.8 percentage points in 2021, ultimately representing 48.7% of industrial enterprises.
- Hosting of enterprise databases was used approximately 31% of enterprises, then this rose to 33% in 2020 and decreased to 30.9% of enterprises in 2021.
- For storing customer information, had slow increased trend, from only 18,4% with slightly increase to 19,7%.

Chart 8: Using of cloud computing for 2017-2021

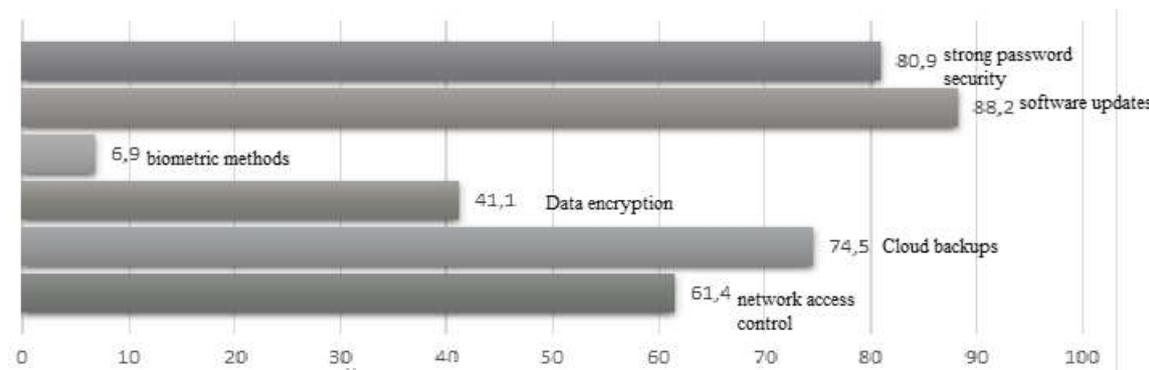


Source: own processing according data of Slovak Statistical Office

Information and communication technologies bring many benefits to the enterprise mainly in their processes, but it should not be forgotten that they also bring potential risks and threats. ICT security means applying various methods,

procedures and measures to ensure their confidentiality, integrity and availability. Without their implementation the ICT could very easily be disrupted due to widespread cyber-attacks and cybercrime.

Chart 9: ICT security measures



Source: own processing according data of Slovak Statistical Office

The chart shows that enterprises use software updates very frequently, with to 88.2% share. A large number of enterprises (80.9%) use strong password security as a protection method. Cloud backups are frequently used to protect data (74.5%). Popular is Data encryption (41.1%) and computer network access control (61.4%), too. User identification through biometric methods was used very little in enterprises (6.9%).

Conclusion

The implementation of ICT in enterprises has a significant impact on economic growth and the progress of society as a whole. The correct information using at the right time and right place creates the basis for an enterprise's ability to compete in the market. The using of ICT improves the management of information and knowledge in the firm, helps to reduce transaction costs and increases the speed of firm to respond to customer demand. The whole society,

especially the industrial sectors, is undergoing significant changes, while the growing use of ICT significantly affecting the development and functioning of the company's environment.

Now the application of ICT in production processes is one of the most important factors in evaluating the competitiveness of a company and, ultimately, the economy of a country as a whole. The rapid development of ICT and its growing importance for society also requires educated economists and managers to understand ICT. They have to make important decisions at all levels of management, leading to the higher efficiency of production and installation processes.

On the other hand, in addition to significant positive effects, the introduction of ICT also brings several disadvantages. These significant

changes have an impact on production enterprises, which have insufficient experiences in using ICT. Another negative aspect is the lack of financial resources needed to build newer and more modern infrastructure. The last, but not least, disadvantage is that enterprises often becoming a victim to cyber-attacks, which are very frequent in the digital sphere.

Acknowledgements

The contribution is processed as an output of a research project Financial risks and their impact on the credit cycle and their financial stability of the economy in the Slovak Republic. (Finančné riziká a ich vplyv na úverový cyklus a ich finančnú stabilitu ekonomiky v SR) registered by the Ministry of Education of SR under the registration number : 1/0688/20.

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