CHANGES AND ISSUES IN HEALTHCARE SECTOR UNDER THE INFLUENCE OF INDUSTRY 4.0 CONCEPT

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Abstract: This research paper is devoted to the issue of changes in healthcare sector under the influence of Industry 4.0. The main objective of the research is to estimate the impact of Industry 4.0 concept elements in healthcare sector on national economy and social environment within the prospects and synergies for bigger use of Industry 4.0 technologies in healthcare sector. The paper draws attention to identifying the synergies brought about by Industry 4.0 in the healthcare sector. To reach this goal, methods such as analysis, comparison, synthesis, and logical deduction are to be used. The results have shown that healthcare sector is a sector that is most in need of the technological convergence regarding the factors of digitization, automation, robotics that have brought the possibility of greater and more transparent data connectivity.

Keywords: surgical robotics, automation and digitization processes, eHealth program Comprehensive Hospital Information Systems, Electronic Health Record, artificial intelligence

1 Introduction

Currently, the issue of the fourth industrial revolution, called "Industry 4.0", in terms of new technology and innovation enhancement is coming to the fore. Slovak and global not only industry, but also the healthcare sector is experiencing the fourth industrial revolution in the form of the Industry 4.0 concept implementation. Companies and organizations are interested in digitization, robotics and automation of their operations to improve workplace conditions and the quality of services provided. This transformation brings about an increase in the potential and productivity of work, as it is innovation that drives the development of businesses, institutions, and the economy. However, companies in industry and organizations in healthcare sector are currently feeling the impact of the economic recession (post-pandemic period, energy crisis, inflationary threats). Opportunities to increase competitiveness through Industry 4.0 are many, from low-cost adjustments and process optimization with quick payback, to the implementation of more detailed analysis of existing data, to training and human resource development. Every innovation and advance technology bring a potential competitive advantage.

By 2050, the world will be home to 10 milliard people, and two in five of those people will be 60 years old or older, including 434 million over the age of 80. This combination of population growth and demographic change will seriously accelerate the challenges we face in delivering healthcare, with global healthcare spending expected to reach 13% of GDP in OECD countries by 2050 (OECD, 2023). Scientific and technological progress is a necessary manifestation in all directions of human activity. In the field of healthcare, this issue is much more sensitive as it directly concerns the care of a person's physical and mental health. The aim of advancing technological progress in this area is to transform health and healthcare so that there is the greatest possible integration, resulting in significantly improved outcomes in all areas of healthcare sector. There are creating new systems where automation and robotics are expected to deliver a more precise approach to patients. In order to understand the scale of scientific and technological breakthroughs and their potential impact on healthcare delivery, it is necessary to identify where particularly fundamental and decisive changes will occur. The healthcare sector is the sector most in need of this technological convergence of the factors regarding the Fourth Industrial Revolution. Industry 4.0 can be understood as a set of technological practices arising from the physical, biological, and digital world that seeks to improve the efficiency and effectiveness of health processes and professionals with guidelines for transforming data into useful and accessible information. Systematically and qualitatively describing the benefits of Industry 4.0 in terms of healthcare sector is a complex task. In healthcare, digital technologies can bring significant changes in healthcare delivery.

Based on the mentioned challenges above, this paper will draw attention to identifying the synergies brought about by Industry 4.0 in the healthcare sector. Therefore, the main goal of the research in the presented paper, is based on the analysis of the Industry 4.0 concept elements regarding the healthcare sector to reveal and estimate the effect of Industry 4.0 concept elements highlighting automation, digitization, and robotics issues implemented in healthcare sector on national economy and social environment within the prospects for bigger use of Industry 4.0 technologies in healthcare sector. Within the stated objective the outline of the paper is as follows. Based on the literature review the issues of Industry 4.0 concept elements are to be illustrated. Within the main part of the paper the issues such as implementing surgical robotics in healthcare, ABB robotic solutions for hospitals of the future, opportunities for the informatics and digitization processes application in healthcare, opportunities for using AI in healthcare will be analyzed and followed by the discussion and conclusions.

2 Theoretical Background and Literature Review

According to Hlušková (2020) Industry 4.0 is a new philosophy that brings society-wide change and affects a wide range of areas from industry through technical standardization, security, education system, legal framework, science and research to the labor market healthcare sector, and social system. The transition from the isolated use of computer and robotic support for production or administrative tasks is technologically enabled by rapid developments in the fields of communication technologies, information and computer technologies, cybernetics and artificial intelligence methods and techniques, and new materials and biotechnologies. The current trend towards automation and data exchange, reflecting rapid technological and technical progress, can also be defined as deep industrial integration through information technology and the associated data processing. Staněk, Pauhofová (2019) argue that the 4.0 revolution is already underway by connecting the internet, things, services and people and the associated huge volume of data generated, moving towards machine-to-machine, human-to-machine, or human-to-human communication. Industry 4.0 will transform manufacturing from stand-alone automated units to fully integrated automated and continuously optimized production environments. New global networks will emerge based on the interconnection of production facilities into cyber-physical systems. These will be the building blocks of smart factories being able to exchange information independently, trigger necessary actions in response to current conditions and control each other independently (Fifeková, Nemcová, 2016). This revolution is about connecting IT and the dominance of robots that will transform manufacturing, bringing in an increased degree of both qualitative and quantitative just-in-time method. This would help shift European companies' production from Asia back to Europe to be more flexible. Digitization will enable the production of products tailored to the customer, and there will be an increased emphasis on product quality. Industry 4.0 is also characterized by interoperability, hence the interconnection and communication of machines, equipment, sensors and people, the sharing of information and virtualization. It will also enable decentralized decision making, allowing cyber and physical systems to make simple decisions and become more autonomous (Technický Týdeník, 2022). Industry 4.0 is already focusing on the complete digitization of all physical assets and their integration into digital ecosystems that will communicate to each other, including partners along the value chain. Within this chain, there is a vertical integration, which represents digitization in the direction from product development, through purchasing, to production, logistics and services. This data will be supported by augmented reality and optimized by the information systems infrastructure within the manufacturing company. Horizontal integration will link internal operations to suppliers, customers, and other key partners in the value chain. This includes technologies ranging from tracking and traceability devices, to integrated real-time planning, to the execution of specific activities (Dobrosotskiy, et al. 2019).

Müller, Kiel (2018) argue that Industry 4.0 is based on the boom of digitization, robotics, automation and is one of the priorities for the development of industry not only in Europe, but also in the world. It is a necessary reindustrialization - the spread of highly productive industrial production methods to all areas of the economy and the economy. The basic components are the processes of digitization, automation, and robotics. Digitization is an Industry 4.0 concept built on the fact that people, machines, equipment, logistics systems and products can directly communicate and cooperate with each other. Everything is moving towards complete networking. Enterprises are thus moving towards the so-called Smart Factory, which is built on the following technologies. CPS (Cyber-Physical Systems) - these are the basis for the Internet of Things (IoT) and, together with Internet services, form the basis of Industry 4.0. These are physical devices complemented by embedded devices for digital data collection, distribution and processing and are interconnected online. Communication via CPS is called M2M (Machine to Machine). IoS (Internet of Services) is an infrastructure that uses the Internet as a medium for offering and selling services (eBay, Amazon). IoS provides the business and technical basis for advanced business models focused on the provision and use of services (MESR, 2023). According to Mura (2019) Product Lifecycle Management systems (PLM) allows to integrate processes, data, people inside the company, but also suppliers or customers. Digital twin processes data from physical objects, which are used to optimize them. It has three main parts: physical objects in real space, digital objects in virtual space, and the data and information link that ties real and virtual products together. Physical production only occurs when the product is ready digitally, i.e., a digital model is created, it is restimulated, and the processes are optimized. Exponential technologies are technologies that support rapid growth in efficiency and productivity (nanotechnologies, biotechnologies, 3D printing, sensing, ICT and mobile technologies, artificial intelligence, advanced robotics or drones). The smart factory operates in an intelligent environment and the result is an intelligent product that meets the individual needs and requirements of the customer and is at the same time profitable for the manufacturer. Robotics has long been a reality in industry and is an important factor in gaining competitiveness (for example, the shortage of skilled workers today is one of the biggest problems that can be solved by robotics). Automation means production based on the principle of interconnecting all components via the Internet with a cyber superstructure that allows full automation of the entire process; the superstructure computer system can manage and optimise the entire production process based on data, while also solving unpredictable problems (Ahmad, Seman, 2019).

Bilan, et al. (2019) state the Industry 4.0 era will need people with technical training and analytical skills. New positions will need creative employees with specialist skills and innovative engineering. The value of these skills to people will also change. People with low educational attainment and low digital skills will be particularly at risk as well as people over 50 years of age. Occupations that consist of routine activities are particularly at risk. These will be clerks processing numerical data, administrative workers, drivers in transport and logistics, employees in services, sales, construction and so on. Occupations that will not be replaced by automation and digitization are the least at risk such as jobs in education, healthcare and creative fields. The most in demand will be specialists in databases and networks, managers in information and communication technologies, software, and computer application developers. Preference will be given to staff with a high degree of apprenticeship who will be encouraged to continue their development. These staff will need to learn new skills in order to be continuously employable. Healthcare organizations and institutions will also need to move towards a learning organization and put knowledge management into practice (Sidak, Hajnisova, Fabus, 2021).

3 The Goal and Research Methodology

The research task is focused on the analysis of the problematic aspects of healthcare sector development in Slovak economy in terms of the robotics and automation issues affected by Industry 4.0 elements implementation and to find out their consequences. The research will be focused on exploring the Slovak healthcare sector analyses and the further development under the Industry 4.0 conditions. To put in other words, the main goal of this paper is by means of analysis, comparative analysis methods followed by logical deduction to figure out the potential benefits for Slovak national economy and society development coming out of Industry 4.0 aspects being implemented in Slovak healthcare sector. The paper is focused on problematic aspect analyses such as the current status of Slovak healthcare sector environment and possibilities to implement Industry 4.0 technologies like robotics and communication and information technologies into Slovak hospitals. The issue is to figure out whether and to what measure the robotics, new technologies might affect the services enhancement along with the labor force supply adaptability to it. For the most objective assessment of the changes being awaited by Slovak healthcare sector due to the implementation of Industry 4.0,

To accomplish this goal, methods such as analysis, comparison, synthesis, and logical deduction are to be used. Subsequently the analysis will lead to synthesis and prognosis by means of abstraction method eliminating the less important factors in order to set general statements and opinions. Data and for the analysis are withdrawn from the respected and reliable institutions such as OECD and WHO have achieved high recognition from the governments of countries being evaluated as well as businesses, and therefore they are considered as authoritative sources in this field.

4 Results and Findings

Over the past century, various advances have been made across different aspects of health and healthcare. From the promotion of antiseptic surgery and the use of antibiotics in the early 20th century to genome editing in the 2000s, new disciplines and innovations have led to substantial improvements in healthcare delivery and outcomes. Specific examples of breakthroughs include, for example, in biotechnology: genetic engineering, regenerative medicine and stem cells, immunotherapy, precision medicine. Nanotechnology and IoT have also contributed to improving human health and quality of life, as have advanced medical devices such as 3D printing, robotics, and drones. Last but certainly not least, virtual reality and better diagnostics. The rapid pace of progress in science and technology in the fourth industrial revolution has significant implications for health and medicine. Advances in areas such as genetics, genetic engineering, precision medicine and others are leading to new diagnostic and therapeutic modalities that offer the possibility of curing diseases, reducing suffering, prolonging lives, and other benefits. The opportunities to incorporate intelligent IT tools in healthcare are also continuously growing. Data can be used in the diagnosis and subsequent therapy of patients, which is what smart healthcare is all about.

4.1 Implementing Surgical Robotics in Healthcare

According to Matuščáková (2018) one of the areas, where robots are used in the field of medicine, is surgery. Surgical robotics is the direct or indirect use of robotics in the planning and execution of surgical procedures. Surgical robotics can be divided into two main categories. The first consists of surgical workplaces where robots directly perform surgical procedures. This category can be divided into two subcategories. In the first, the robot directly performs the surgery pre-planned by the surgeon, who has entered it into the robot's control system in the form of a program. The robot is then supervised by a human during the surgical procedure. The second subcategory is telepresence robotic surgery. Here, the robot is controlled remotely by a human. The operation does not need to be programmed in advance, the surgeon performs the individual actions using controllers, the data is transmitted via a control system to the robot, and it directly performs the procedure. Telepresence robotics makes it possible to control the robot so that the surgeon may or may not be present in the operating room. The second major category of surgical robotics is robot-assisted surgery. Here, robots are not directly involved in modifying the human body, but perform other surgery-related activities, such as administering instruments. Surgical procedures performed by robots need to be well planned and flawlessly executed. Different methods are used to allow two- and three-dimensional views of the human body and its interior. 2D techniques include ultrasonography, fluoroscopy, or X-ray radiography. 3D imaging techniques used include computed tomography - CT - and magnetic resonance imaging - MRI. The next step is surgical planning, which is done by viewing models of the human body constructed using visualization techniques. The surgeon plans the procedure so that the healthy tissue is damaged as little as possible when the diseased tissue is accessed and modified. Robotic surgery has found its place in fields such as orthopedics, neurology, urology, or cardiology. In orthopedics, robots are used to acquire pre-operative data, as well as to assist in operations and perform the surgery by itself. Examples include total hip replacements, knee components or soft tissue replacements, with robots primarily assisting in the precise placement of tissues and replacements. In the field of neurosurgery, the limitations of humans in terms of being able to use their hands to perform procedures at microscopic scales have become a significant argument in favor of deploying robots. At the same time, neurosurgery has become the first area of medicine where robots have become established for their precision (Technicom, 2019; Vasylieva et al. 2020).

Senhance, a robotic surgical assistant developed by TransEnterix, allows surgeons to control surgical instruments via computer. Senhance is controlled by the surgeon from a platform resembling the cockpit of an airplane. The visual connection is mediated by a special 3D interface that captures the body part being operated on in detail. The doctor thus remotely controls up to three robotic arms equipped with different surgical instruments. *Robear* is a caregiver robot developed by RIKEN-SRK in Japan. The robot assists especially elderly patients in moving and transferring. Robear is strong enough to lift patients out of bed, but also gentle and gentle enough to provide support when they are sitting in wheelchairs. In 2016, Professor Robert MacLaren successfully performed the world's first robotic eye surgery at the John Radcliffe Hospital in Oxford. He used a remote-controlled robot to lift micro-membranes directly into the retina at the back of the eye. Scientists at Imperial College London developed a *'smart' knife to identify tumor tissue* in 2013. The knife tests the tissue during surgery and instantly provides information on whether the tissue contains cancer cells. During surgery, this information is continuously communicated to the surgeon, greatly speeding up the analysis of biological tissue and allowing virtually all cancerous cells to be removed. *The da Vinci Surgical System* is a surgical robot that combines the expert work of a surgeon with state-of-the-art technologies - micromechanics, three-dimensional visualization and computer control. It was designed by the American company Intuitive Surgical. It is controlled by the surgeon and allows to perform very sensitive surgical interventions and procedures. Today it is used in hospitals around the world. Robotic-assisted surgery is a common method abroad, as it allows for more precise surgeries with faster wound healing. In Slovakia, however, this technology is used in only one medical facility so far. The F.D. Roosevelt University Hospital in Banská Bystrica has been using the Da Vinci robotic system since 2011. It is most often used in urology. As Vladimír Baláž, the head of the Robotic Assisted Surgery Centre at the hospital explains, the robot consists of a control console, an operating console, and a video console, it can control instruments beyond the limits of the human hand and can enlarge the image as needed (Izakovičová. 2019; SOVA Digital, 2018; WEC, 2016; Barto, 2020).

4.2 ABB Robotic Solutions for Hospitals of the Future

ABB has analyzed a range of manual processes currently carried out in medical laboratories and estimates that 50% more tests could be performed annually by implementing automation. Robots performing repetitive processes would relieve highly specialized staff and also help to eliminate the potential overloading of the musculoskeletal and nervous systems that often arises in humans from repetitive tasks and inappropriate body postures. These are collaborative robots that do not require any protective fences or special spaces. They can move and work in close proximity to humans, and assist with every day, routine activities. It is estimated that by 2025, their use will increase in medical environments, with nearly 60,000 non-surgical robots working there. The intention to gradually introduce automation into the medical environment was currently announced by a leader in technological innovation - ABB in cooperation with the largest medical science center in the world - Texas Medical Center (TMC) in Houston. This huge city within a city at the forefront of life sciences development treats 10 million patients annually, performs more than 180,000 surgeries, 25,000 deliveries and handles more than 750,000 emergency admissions. When opened in October 2019, the new center at TMC is ABB's first dedicated medical research center. Houston is a hub for global medical technology research, making TMC an ideal location for ABB's new medical technology research facility. On an area of 500 m^2 is located an automated laboratory and robotic "training" equipment. Running a site that sees 10 million patients a year requires efficiency and precision and standardized processes. TMC is precisely pursuing this goal by incorporating ABB's research center for the development of robotic solutions in healthcare into its group of strategic partnerships. ABB is a leading technology company with a comprehensive offering for the digital industry. With more than 130 years of history, today ABB is writing the future of industrial digitization with its four businesses: electrification, industrial automation, drives and robotics, and automation, supported by the ABB Ability™ common digital platform. The ABB Group employs around 147,000 people in more than 100 countries around the world. It has been operating in Slovakia since 1991 and is currently represented in seven cities in Slovakia. It employs a total of just over 280 people. The ABB Group in Slovakia also includes the Pucaro company in Piešt'any (MHSR, 2020; Hoerbst, et al. 2011; Soltes, Gavurova,2014).

4.3 Opportunities for the Informatics and Digitization Processes Application in Healthcare

Healthcare informatization will improve the quality of communication between several actors: the patient, cross-border healthcare staff, home healthcare staff, laboratories, pharmacies and other healthcare institutions. The level of healthcare is thus naturally increased and self-regulated, thus creating a certain self-control of the system. The whole system can be controlled and analyzed in this way, in terms of the flow of finances, costs, revenues and the performance of the parties involved. The main mission of *the eHealth program* is to support and streamline the healthcare system based on the use of information and communication technologies. In Slovakia, the eHealth implementation program is documented in the strategy proposed by the Ministry of Health of Slovak Republic since 2008. eHealth is a relatively new term, which is part of the structure of the program documents of the Operational Program for the Informatization of Society (Architectural Framework) and e-Government. eHealth's main objective is to create a National Health Portal, launch a pilot application of the Citizen's Electronic Health Book, ePrescription, eAllocation, and to create the basic structures for the integration of information systems with the national e-Health system. The Electronic Health Service - Extension of Functionality and Scope of Services (EES-RFaRS) aims to consolidate information on the drug and knowledge database, to ensure security mechanisms, especially with regard to the protection of personal data, and to provide new functionalities for electronic services. A particular advantage of the system is the fact that, following the introduction of e-Health innovations, insurers can quickly access patient data as well as reliable service providers (Durdisová, 2005; E-zdravotnictvo, 2020).

According to Holčík (2010), the function of *Comprehensive Hospital Information Systems (CHIS)* is to ensure the processing of patient data as well as its processing and storage. The CHIS is designed to be able to track specific activities of several components at the same time (doctor, nurse, laboratory, pharmacy), but at the same time to protect this data and make it accessible only to authorized persons. Thus, its components are outpatient clinics, inpatient wards, laboratories, pharmacies, operations, as well as administrative and managerial or director's offices. These workplaces are also linked to higher systems such as the Ministry of Health. The CHIS is based on modules that communicate and operate together. These models or subsystems can be divided into two categories, those that are directly related to health care and those that create structures in the administration. Firstly, healthcare: central patient reception, clinical information system (CIS) - for the various types of hospital wards (inpatient ward module, outpatient department module, operating theatre module, etc.), and, secondly, for the various types of hospital wards (inpatient ward module, outpatient department module, operating theatre module, etc.), which can be set up in the same way, laboratory information systems (LIS) - for different types of laboratories, nursing process, radiology information system (RIS), pharmacy information system (LeIS), modules of specialized instrument systems, examinations and monitoring of patient's condition, module of health care reporting for health insurance companies, module of statistics reporting for the National Centre of Health Information (NCZI), module of catering service for patients (patient meals), patient ordering system (also on-line: MY SOLP). The second component consists of administration (administration, management): accounting module, invoicing module, personnel and payroll module, asset registration module, catering module for employees (employee meals), inventory module, building maintenance module, maintenance of equipment and devices module, energy management module, reporting module for insurance companies (Stanek, 2005; European Comission. 2023).

An *Electronic Health Record (EHR)* is a collection of electronically stored health information in digital form. This information and recordings can be shared with other systems through a network connection. Thus, the EHR contains data such as medical history, diagnoses, results, medications, as well as personal information about a particular patient such as his or her geographic location, height, weight age or general health. The EHR is supposed to increase the productivity of eHealth professionals and reduce the administrative burden or the cost of manpower and performance of the function, it has to support research and clinical systems, it has to be capable of developing future technologies in healthcare and it has to increase the level of security and protection of eHealth data. The EHR is supposed to be an information channel for the connection between patients, institutions, insurers, healthcare providers in general. *OpenEHR* was created as a result of the development of an open, interoperable software platform for healthcare, of which electronic health records are a core component. OpenEHR thus integrates the requirements of healthcare institutions and clinical research. OpenEHR has mainly applications in information and communication systems in healthcare as such. The main focus of the OpenEHR project is on the computerization of healthcare based on electronic health records and EHR systems. The main priority is the possibility of storing information, i.e., all medical histories, diagnoses, results or services that are provided (NHIC, 2019; WHO, 2023).

The main objective of *ePrescribing, eMedication and eDispensing* is to provide healthcare professionals with an efficient mechanism for prescribing medicines. Thus, the physician receives comprehensive information about possible contradictions, diseases, predispositions or drug allergies. In this way, the number of documents issued by the doctor should be reduced. The paper prescription will thus be replaced by an electronic version and the patient will not receive paper documents in his or her hands, thus preventing their misuse or damage. This ensures a more efficient and at any time verifiable communication between patient, doctor, and pharmacist. ePrescription is thus in short, an application by which medicines are transcribed on an electronic basis, which means that the instructions for the medicine, its dosage, information on the use of the medicine are written down and the patient can collect them in another country participating in the eHealth project. With the help of the information system, which is part of the National Health Information System, it is possible to look into the patient's records, namely his electronic health book, and check the medicines he is using, find possible contraindications and thus determine more effective treatment. Doctor enters the details of the new diagnosis as well as the recommended medicines in a card that can be retrieved at any time, thus simplifying the patient's path to the information. The patient who requests the medication recommended by the doctor at the pharmacy does not go with a prescription; the pharmacist will view his report through the information system. If the medicine is not available, the pharmacist can replace it with another medicine, just from a different manufacturer. Thus, the doctor is informed about the change of the medicine and the information is stored in the database (MHSR, 2017; E-zdravotnictvo, 2020).

4.4 Aspects for using AI in Healthcare

According to Szabo et al. (2020) and Rozsa, et al. (2022), artificial intelligence (AI) is a subfield of computer science that deals with the development of machines that exhibit human-like intelligence. This intelligence can be achieved using a method called machine learning. It is immediately apparent that the method in question has great applications in healthcare, specifically in diagnostics. Judging whether something is pathological requires an expert trained over the years, and even that expert will often seek the opinion of a colleague. Already today, artificial intelligence is beating experienced doctors in making a diagnosis. Artificial intelligence, specifically its subfield of natural language processing (NLP), is already assisting doctors in studying vast medical materials, identifying correlations, and recommending the most appropriate treatment. While a human can read a single page in a few minutes, artificial intelligence can absorb knowledge from an entire library in that time. In the future, it will be common for a doctor to consult his or her treatment procedure online with artificial intelligence. Artificial intelligence can help doctors or healthcare professionals wherever their decision-making is contingent: for example, with expertly correct diagnosis in the light of the latest medical knowledge and based on the correct, complete, and timely evaluation of large amounts of data and information. Large volumes of this data can be converted into so-called structured data that AI can read and predict possible courses of action (using neural network technologies, machine learning, expert systems, as well as genetic algorithms). Examples of the use of artificial intelligence for medical purposes are as follows. Automated systems for reading and recognizing outputs from modalities such as MRI, CT, or ECG with similar or better accuracy than doctors. In the use of natural language processing technologies - to assist software in analyzing a patient's condition based on their speech, particularly in the field of psychological and psychiatric examinations (e.g., better recognition of depression - a diagnosis that now threatens an increasing number of mentally active people). Sequencing the human genome, i.e., 'reading' genes, the cost of which is falling at an enormous rate every year. Based on gene data, it is possible to predict a patient's disease or to specify cancer treatment more precisely (WEF, 2019).

Examples of the AI usage for administrative purposes in healthcare sector include applying machine learning to the pre-packaging of medicines or medical devices, which can improve their availability in more remote parts of the country. Identifying anomalies in prescribing medicines using data from health insurance companies. At the hospital level, better use of data will be able to contribute to better shift planning, space, or bed utilization. The benefits of applying AI in healthcare, taking into account more data than any individual physician can collect and process, will enable more effective disease prevention, personalized treatment for the patient, less healthcare waste, less congestion for healthcare staff, and accessibility to healthcare (Designworldc, 2021).

5 Discussion

Based on the displayed results, the impact of the changes brought about by the implementation of Industry 4.0 elements in the healthcare sector will impact healthcare, and the future of healthcare is impacted by a number of aspects. The integration of healthcare and social services is seen by many as a key solution to relieve the burden on it - this effort has a rational justification. With around one third of the elderly population in Europe suffering from chronic health conditions, any solution to reduce fragmentation of services, reduce duplication and rationally allocate diminishing resources in a more efficient way can only be seen as a positive one. Hospitals that are able to cooperate with social care institutions gain a more comprehensive view of the patient, not to mention time and administrative savings. For patients, the seamless contact between health and social care means that their situation is understood, and their needs are met. Most importantly, however, thanks to the effective exchange of information between the two sectors, healthcare can finally be transformed from corrective to preventive and meet the challenges of the 21st century.

Generally speaking, the use of technology and improved information management is also important in this process. For example, electronic prescribing reduces errors by up to 50 per cent compared to manual prescribing. If we have complete electronic documentation and other patient information, we can immediately electronically check a patient's prescription for the amount of medication ordered, its contraindications with other medications or allergies, and the patient's clinical condition. By and large, pressure is also increasing to standardize roles and job tasks to streamline services to patients and to share the work to reduce spending and forced redundancies of medical staff. While these challenges increase the efficiency of healthcare delivery, personalization of patients and services needs to be integrated to achieve the full potential of industrialization. These areas are, of course, interlinked by information. On top of that, more and more information is being collected about patients in hospitals, and sophisticated technologies are beginning to be used not only in major, but also in smaller and local healthcare facilities. It can be assumed that sharing information over the internet in the form of documents, images and medical reports is becoming more and more common (NCZI, 2018). Another factor to consider is that tracking systems and software reduce waiting times and allow the doctor to know the exact location of the patient at any time. Some hospitals use portable wireless tablets to track patients, while others use tracking systems after leaving the hospital to help patients with follow-up treatment. Some patients are starting to track and record their medical history to get a clear picture of their healthcare. At the same time, data sharing and shared workflow systems give patients an increased level of control, for example, in obtaining an alternative solution from another provider if they are not satisfied with the proposed treatment.

When it comes to industrial robots and automation, they are moving beyond the factory floor and into healthcare and science. We can think of innovation in healthcare as anything that can be delivered to a patient in medicine at the level of available science, and we can see the result as a change in quality of life for the better. In the world today, there are robots that can assist with interventions, administer medication to patients, help patients with rehabilitation, provide information based on shared files. Another fundamental change is online services. People no longer must go to a medical facility when they want to prescribe medication. They owe this to electronic prescribing of medicines (Tupá, 2020; Svec, Mura, 2020). We consider these electronic services to be very efficient, as people do not have to waste time in waiting rooms and do not have to expose themselves to possible infection by sick patients. As a consequence, these applications have a significant impact on reducing the number of errors and problems with prescriptions, eliminating duplication, which has a positive impact on time preservation. Among other things, communication will be unified between several entities, including health insurance companies, which can check back on services and devices or medicines that have been provided. This will make it possible to produce statistical studies on diseases and the use of over-the-counter medicines (for example, the amount of antibiotics used over a certain period of time).

Another point worth noting, harnessing the power of the Internet to integrate medical devices, medical data and IT systems gives physicians powerful tools to improve patient outcomes and reduce their hospital stays. The essence of SMART medical devices is adding intelligence to the traditional medical device system, encompassing all sources and locations of patient information. It is about leveraging dynamic and engaging facilities to serve personalized patient needs and identifying opportunities for staff and facility administrators that differentiate treatment options as well as where care is delivered (Zajac, Pazitny, Marcincin, 2004; Grmanova, Ivanova, 2021). It is important to recognize that the healthcare sector is part of the digital revolution. This is why the term 'Health Care 4.0' is beginning to appear more and more frequently. In addition, the changes and trends coming for those working in the healthcare sector, such as doctors or nursing staff, are becoming more and more evident and noticeable. Today, the healthcare sector is already using advanced digital devices to accelerate the progress and development of medicine while ensuring economic efficiency.

6 Conclusion

On the whole, the results and findings suggest that the impact of the Fourth Industrial Revolution on health and healthcare sector is crucial. It can be concluded that Industry 4.0 is affecting all areas of the economy to a large extent. In case of healthcare, the revolution has brought significant changes in terms of robotics, digitization, the Internet of Things, artificial intelligence, and big data. The fundamental change is made by digitization that brought in healthcare sector the possibility of greater and more transparent data connectivity so that systems can communicate to each other, saving not only time and money, but also providing better healthcare, as many diseases are diagnosed and treated early.

The paper dealt with the issue of changes in healthcare sector under the influence of Industry 4.0. Taking everything into account, the implementation of new technologies and technological knowledge into healthcare sector is very important for humanity. The rapid transformation of an ageing population and society over the next few decades will require the deployment of better tools and technologies that will enable us to lead longer, healthier and more productive lives while achieving better access to care for the population. As a conclusion we can say that the healthcare sector should take its lead from the industrial sector, where digital technologies are arriving precisely within the concept of Industry 4.0. Digital technology is indeed ahead of the curve, but in different intensities in terms of personal and commercial areas. All things considered; the healthcare sector has long been using the latest digital devices that are designed to accelerate healthcare services and medical advances on one hand and ensure economic efficiency and cost pressure on the other hand.

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Primary Paper Section: A

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