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INDUSTRY 4.0 AND ACCOUNTING: DIRECTIONS, CHALLENGES, OPPORTUNITIES

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ABSTRACT

The purpose of the study was to reveal the directions, challenges and opportunities that arise in the accounting system in the conditions of Industry 4.0, when innovative solutions based on the capabilities of new digital technologies become the management of in-demand enterprises. The role of Industry 4.0 is shown, the features of modern Industry 4 technologies are revealed, the main technologies and production processes are demonstrated, interconnected using industrial protocols to create intelligent data. The rating of digital competitiveness and their readiness to implement Industry 4.0 technologies for 64 countries of the world is given and analyzed. These factors hinder the process of digitalization in countries with a low rating. The influence of Industry 4.0 on the accounting system is determined and the technologies affected by the fourth industrial revolution in terms of accounting (Big Data or Data Analytics, Cloud Computing, AI, Blockchain, Internet of Things (IoT), Robotic Process Automation) and changes waiting for the profession of accountant. The coordination of efforts of business, *education and the state in the context of the development of Industry 4.0 technologies was noted.*

Keywords: *Industry 4.0; accounting; innovative technologies; accounting information*

1. INTRODUCTION

The development of information and communication technologies and their entry into our daily lives in recent years is a sure sign that the world is on the threshold of the fourth industrial revolution. Industry 4.0 has been identified as a major contribution to the digital age. Its consequences affect society, creation, information, and including accounting. These changes are obvious. The question is how quickly a business adapts to a new business environment and how it adapts to new realities. Industry 4.0 creates the latest business models.

To manage them, businesses need innovative solutions based on the capabilities of new digital technologies. Some of these solutions are related to improving accounting. Incorrect information from one of the business departments affects the entire system. Especially in accounting, which records the financial movements of the business and reports on the results of them, the information from which is effective in making decisions that affect the whole business. Based on these results, the use of intelligent systems helps to reduce human errors and the system begins to operate faster.

The dynamics of processes in modern society and the role of business accounting are increasingly paying attention to innovations in accounting. The limited use of new technologies in accounting practice is a major limitation in assessing their effectiveness and usefulness. Digitization creates the latest capabilities for accounting. Among them: Big Data or Data Analytics, Cloud Computing, AI, Blockchain, the Internet of Things (IoT), Robotic Process Automation. Following the logical course of development of industrial relations, their impact on accounting, and the evolution of accounting, the current development reveals its essence, as well as draws attention to some new trends in accounting.

2. LITERATURE REVIEW

For centuries, technological progress has been the most important generator of changes observed in the economies of different countries (Kasych et al., 2019; Onyshchenko et al., 2020, Pochtovyuk, et al., 2021).

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It determines not only the internal development processes of countries, but also their internationalization, which affects the globalization of the world economy, especially in the context of catching up economies (Paliokaite, A., 2019).

Modern technologies and breakthrough inventions or innovations have influenced many areas of the modern world. Thus, it forms strategic options for managers in all sectors of national economies (Majerova, 2019; Pini, 2019). Their implementation, which is now unfolding, involving the convergence of the physical, digital and biological spheres, is called the Fourth Industrial Revolution. Its main tools include the Internet of Things (IoT), artificial intelligence (AI), cyber-physical devices, 3D printing, blockchain, big data, cloud computing, nanomaterials, and synthetic biology (Sieja & Wach, 2019).

These principles and theories about the four industrial revolutions (Industry 4.0) should be highly discussed in the literature (Maciejewski & Glodowska, 2020; Rymarczyk, 2020; Liu, 2017; Pisar & Bilkova, 2019).

Along with global social, economic and environmental challenges, the world is facing challenges associated with dramatic technological changes in promotion, digitalization and automation. In response to these challenges, Industry 4.0, an information-driven production system technology (Lasi et al., 2014), affects the organizational components of the economy such as productivity, efficiency and competitiveness, as well as social and environmental constraints on sustainability (Bonilla et al., 2018).

The term "Industry 4.0", also known as the fourth industrial revolution, was introduced by the German researchers Kagerman et al. (2011) to help shape the future of the German economy to automate, share data and optimize the manufacturing process in real-time. It is based on the idea that physical processes can be monitored, managed and controlled in real-time by cyber-physical systems. The idea develops into an integral concept of digitalization of the economy. Industry 4.0 uses fundamental technologies such as cyber-physical systems (CPS) and the Internet of Things (IoT) to connect people, machines and other resources, as well as products and services in the real world.

Industry 4.0 is a virtual platform where participants in business processes communicate and interact directly. According to a study by Hermann, Pentek and Otto, the platform operates on the basis of four key components: cyber-physical systems; the Internet of Things (IoT); smart factory; the Internet of Services (IoS) (Hermann et al., 2015).

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According to Anderl (2014), there are four main conceptual approaches to Industry 4.0 from a technological point of view: cyber-physical systems (CPS); Internet technologies; components as information carriers and holistic security, including the protection of personal data and knowledge (security and holistic security, including confidentiality and knowledge protection).

There are six main principles necessary to implement the Industry 4.0 platform in the practice of enterprises (Hermann et al., 2015; Petrova, 2018):

- interaction (communication), which is achieved through communication via the Internet;
- virtualization - the creation of a parallel environment in the virtual space;
- decentralization (autonomy) - the ability to work independently;
- work in real-time - the ability to collect, process and analyze data in real-time for decision-making;
- customer orientation (including technical assistance) - production should be oriented in accordance with the demand for services from customers, and it should change in accordance with their requirements, including the services offered will be available to all participants;
- modularity - the construction of a modular system that provides a quick and smooth adaptation to changes and market trends.

The impact of Industry 4.0 will undoubtedly be large, given the development of the global economy. The advent of Industry 4.0 has a significant impact on the global economy and affects international business, which is changing consumer benefits, improving asset quality by increasing data output, re-establishing relationships as learning the value of new ways of collaborating, digitally transforming existing models into new business models, especially open web platforms create new opportunities and increase competition (Di Vaio & Varriale, 2019).

Sustainability is also considered a major driver of Industry 4.0 (Beier et al., 2017). Industry 4.0 technologies can be integrated into chains that are valuable by collecting and actively sharing data to provide real-time information on the flows of machines, production, operations and components; it helps managers to monitor, control and ensure the sustainability

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of the decision to restore products when needed. These renewal-based approaches replace the traditional linear approach, the philosophy of creation, use and disposal with a circular approach that benefits the organization and supply chains socially, economically and environmentally (Geissdoerfer et al., 2017).

Some authors have envisioned circular economy (CE) business models as the most competitive operational tools for developing SBM in Industry 4.0 environments (Bressanelli et al., 2018; Nascimento et al., 2019). Overall, Industry 4.0-based businesses rely on IoT connectivity, whereby “company” products and processes are interconnected and integrated to achieve greater value for both customers and internal company processes” (Frank et al., 2019). While many industries have long been stuck in unsustainable but financially viable business models (Boons & Lüdeke-Freund, 2013), Industry 4.0 offers businesses sustainable longevity, efficiency and recovery while contributing to their social, economic and environmental costs (Strandhagen, 2017; Strandhagen et al., 2017). More precisely, for SMEs, Industry 4.0-based business models can contribute if organizations focus on their ability to absorb new technological innovations and their respective innovation strategies (Müller et al., 2020).

In manufacturing, Industry 4.0 has introduced new technologies that provide maximum results using efficient use of resources (Kamble et al., 2018). Cyber-Physical Systems (CPS), the Internet of Things (IoT) and other emerging technologies are opening the way for industrial development to improve productivity and efficiency across organizations.

3. DATA AND METHODOLOGY

As the main research method, we use critical analysis and comparison of analytical reports, IMD World Digital Competitiveness Ranking 2021 report, PricewaterhouseCoopers report, Fortune Business Insights report and Industry 4.0 - Global Market Trajectory & Annual report on Industry 4.0, academic publications, CFA Institute and Focus Group Discussion surveys, research proposals for literature review and desk research of current business press reports, professional reports, Industry 4.0 technology company web pages, and modern accounting technologies

Concerning the scientific approach, this article uses a qualitative research design, the method of indirect observation, causal analysis and predictive synthesis, induction and description. To achieve the goals set, the following general scientific and specialized methods were used:

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- theoretical generalization, comparison and systematization - to study the essence and features of modern Industry 4.0 technologies in accounting;
- system analysis - to determine the state and level of development of digital competitiveness of different countries of the world and their readiness to implement Industry 4.0 technologies;
- abstract-logical - for theoretical generalization and conclusion;
- graphical method - for visualization of modern technologies Industry 4.0 and visualization of digital competitiveness ranking 2019, 2020 and 2021.

4. RESULTS AND DISCUSSIONS

The fourth industrial revolution is a fundamental change in our world, way of life, work. This is a new chapter in the development of humanity, thanks to an achievement commensurate with the achievements of the first, second and third industrial revolutions - the unification of the physical, digital and biological worlds and the connection of technologies in a way that creates both opportunities and challenges.

Industry 4.0 defines a new era of smart factories and smart manufacturing processes, first developed and implemented in Germany, involving the integration of automation methods and related facilities to revolutionize manufacturing. Industry 4.0 functions as a subset of the Internet of Things (IoT) and covers all aspects of industrial development. Thus, the potential of Industry 4.0 is remarkable for achieving sustainable industrial value creation in social, economic and environmental aspects by improving the efficiency of resource use (Sharma et al., 2020).

In an Industry 4.0-enabled manufacturing environment, different manufacturing processes are interconnected via industrial protocols to generate intelligent data (Fig.1). The dynamic engineering and business processes of such a production environment allow the end process of production to change, thus responding flexibly.

Industry 4.0 is a concept in which production facilities are equipped with modern sensors and wireless technologies that visualize and reflect the entire production process. These sensors and wireless technologies are integrated with various technics, including artificial intelligence (AI), IoT, machine learning and cloud computing. The integrated use of these technologies in an Industry 4.0-enabled manufacturing environment allows manufacturers to

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make informed business decisions and improve production efficiency. By optimizing technology and material usage as well as asset performance, an Industry 4.0-enabled manufacturing environment improves business profitability.

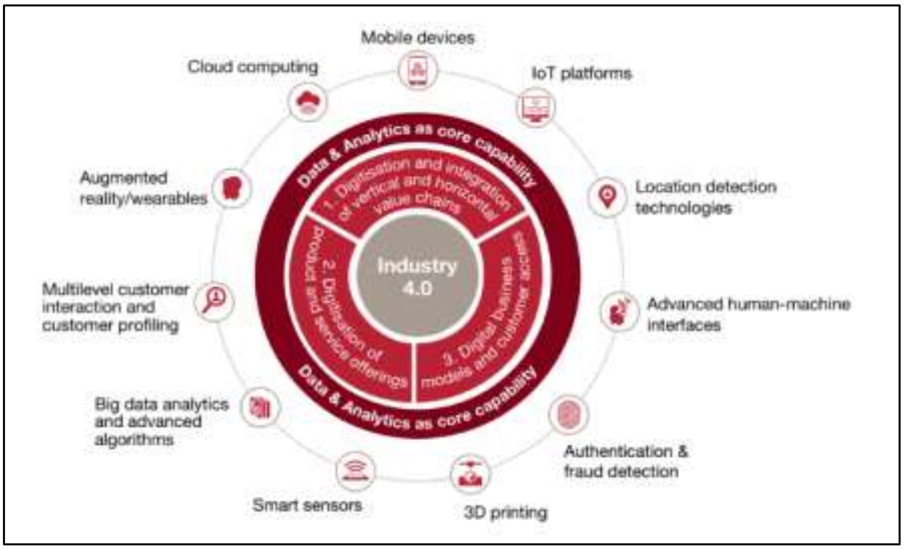

Figure 1: Industry 4.0 framework and contributing digital technologies
Source: Industry 4.0: Building the digital enterprise, available at: https://pwc.to/3sniQUQ (2016).

But is the world ready to accept modern technologies? Digital transformation takes place primarily at the level of enterprises (private or public), but it also occurs at the levels of government and society. The IMD World Digital Competitiveness Ranking 2021 presents the overall ranking calculated in 2021 for 64 economies of the world. The rating is calculated based on 52 criteria and determines the digital competitiveness of countries entrenched in three main factors: knowledge, technology and future readiness. Countries are ranked from the largest to the least digital competition (Fig.2).

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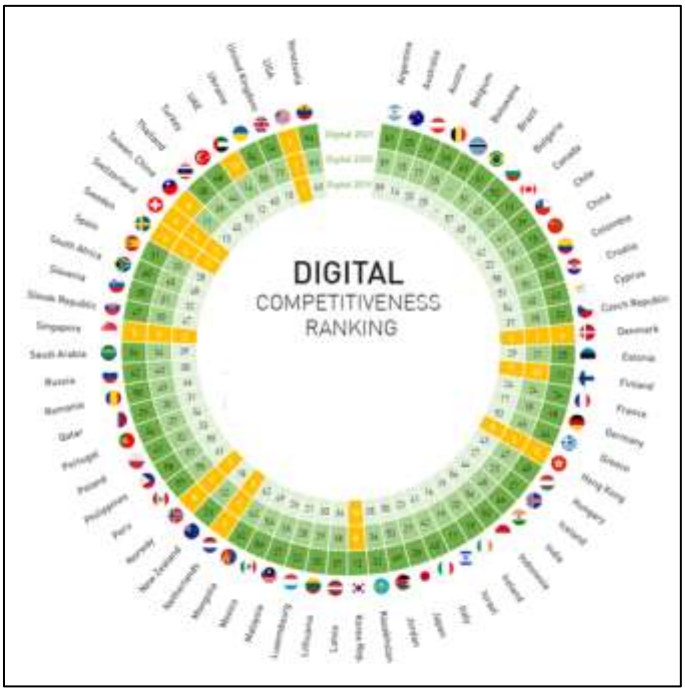

Figure 2: Digital competitiveness ranking 2019, 2020 and 2021
Source: The IMD World Competitiveness Center «IMD World Digital Competitiveness Ranking 2021» (2021).

The Global Digital Competitiveness Ranking analyzes and evaluates the extent to which countries adopt and explore digital technologies leading to transformation in government practices, business models and society at large.

Among the countries that are among the top 10 digital competitiveness leaders in 2019, 2020, 2021 are the USA, Singapore, Hong Kong, Sweden, Denmark, Switzerland, the Netherlands, Norway, the Republic of Korea, Finland, Taiwan, China, UAE.

According to the Fortune Business Insights report, the market is geographically segmented into five major regions, namely North America, Europe, Asia Pacific, Middle East and Africa, and Latin America.

Europe has achieved the highest Industry 4.0 market share in 2020. European industry has made significant investments in technology and skills to maintain its position in the global market. Communication setup, network objects, real-time data processing and ubiquitous information are changing paradigms in industries. Tech giants including Siemens, Honeywell and General Electric are among the early adopters of the software and far ahead of its adoption.

As North American companies increasingly embrace the concept of smart manufacturing, the region is expected to dominate the market. Most of the factories operating in the market are now equipped with new machinery and smart manufacturing technologies,

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enabling other businesses to move from conventional production methods to smart manufacturing. Government initiatives and increased funding for research and development have become vital factors in making North America a dynamic region for market development.

Japan, China and South Korea are leading the market growth due to their comprehensive measures to introduce industrial automation and introduce disruptive technologies in the value chain of their production system in the region of Asia-Pacific. In 2015, the Chinese government launched a ten-year scheme called "Made in China" that would run until 2025. The plan covers the top ten industries, including semiconductors, advanced robotics, electric vehicles and artificial intelligence.

This state industrial policy aims to make China dominant in the world's high-tech manufacturing and draws its inspiration from the German government's Fourth Industrial Revolution development plan. Japan launched the Society 5.0 program aimed at solving economic, social and industrial problems.

In September 2020, Siemens AG launched an Advanced Manufacturing Transformation Center (AMTC) in Southeast Asia to support the fourth industrial revolution. This factor will provide training, support and guidance to companies in Southeast Asia.

In Latin America, the Middle East and Africa, the fourth industrial revolution is supported by government initiatives and awareness of the importance of introducing digital technologies to support the global market. For example, in September 2017, the UAE government launched the Industry 4.0 strategy for the country during its annual meetings. The strategy is designed to strengthen its position as a global center and increase support for the national economy. In addition, in Brazil, the leading players have come together to stimulate the introduction of technology assets in order to accelerate the adoption of advanced technologies.

Among the factors hindering the process of digitalization in other countries are:

- lack of built infrastructure to ensure the implementation of the concept of Industry 4.0;
- level of bureaucratization;
- lack of a clear understanding by the local performers of the ways to implement the concept of Industry 4.0;

- insufficient funding, which does not allow the implementation of innovative smart projects;
- the global pandemic caused by COVID-19;
- lack of state incentives for entrepreneurs to change business processes, move on to building a smart-factory;
- the outflow of highly qualified specialists to more developed countries (in particular, IT specialists);
- weak interaction between the state, entrepreneurs, scientists and society;
- low innovative activity of small and medium-sized companies;
- the presence of obsolete equipment at enterprises and the lack of free funds for re-equipment;
- the complexity of making decisions about the implementation of configurations.

By not paying due attention to the implementation of Industry 4.0 technologies, countries are losing a lot. According to "Industry 4.0 – Global Market Trajectory & Analytics" amid the COVID-19 crisis, the global Industry 4.0 market valued at $90.6 billion in 2020 is projected to reach a revised size of $219.8 billion by 2026, increasing by 16.5% over the period of analysis. The Internet of Things, one of the segments analyzed in the report, is projected to achieve a 17.3% CAGR and reach $68.2 billion by the end of the analysis period. After a thorough analysis of the impact of the pandemic and the resulting economic crisis on business, the growth of the industrial robotics segment has been revised to 18.7% CAGR over the next 7-year period.

The Industry 4.0 market in the US is valued at $25.5 billion in 2021. China, the world's second largest economy, is predicted to reach a projected market size of US$40.9 billion by 2026, lagging CAGR by 20.7% over the entire period. Other geographic markets that are projected to grow include Japan and Canada, each projecting growth of 13.7% and 14.9%, respectively. In Europe, Germany is forecast to grow at around 15.3% CAGR.

The growth of the market is being driven by the growing awareness of companies about the benefits that these technologies offer. Other factors driving the predicted growth in the global Industry 4.0 technology market include the increasing adoption of the Industrial Internet of Things (IIoT); growing demand for efficient and cost-effective manufacturing processes across a wide range of industries; and significant growth in demand for automation systems to improve the quality of finished products Additional factors driving market growth include innovation and technological advances in additive printing technology; and advances in intelligent sensing technology and controls.

In addition, the growing trend towards factory automation, together with the growing demand for energy-efficient equipment and processes, as well as integrated IoT-enabled sensor computing capabilities, is also predicted to drive the growth of the global Industry 4.0 technology market. In addition, IoT sensors, smart devices, and data acquisition are being used by Industry 4.0-based systems to improve work efficiency, which is also expected to provide significant growth opportunities for the global Industry 4.0 market.

Industry 4.0 – Global Market Trajectory & Analytics specialists predict that in the next 10 years, enterprises will create global networks, including their production facilities, equipment and warehouse systems as cyber-physical systems. Such systems in a production environment consist of storage systems, production rooms and machines that can autonomously exchange information and independently control each other. These configurations provide great opportunities for optimizing manufacturing and production activities.

In the global 3D printing segment, the US, Canada, Japan, China and Europe will account for the 16.3% CAGR estimated for this segment. These regional markets, with a total market size of US$11.5 billion in 2020, will reach a projected size of US$33 billion by 2026. Led by countries such as Australia, India and South Korea, the Asia Pacific market is forecast to reach US$3.4 billion by 2026.

According to a Fortune Business Insights report, the global Industry 4.0 market was worth $101.69 billion in 2020. The global impact of COVID-19 has been unprecedented and overwhelming, with industry decisions showing a positive demand shock in all regions amid the pandemic. According to their analysis, the global market showed a significant growth of 14.5% in 2020 compared to the annual growth in 2017-2019. The market is forecast to grow from $116.14 billion in 2021 to $337.10 billion in 2028 at a CAGR of 16.4% over the period 2021-2028. The sustained growth of CAGR is due to the growth of this market and the return of demand to the level of the pandemic after the end of the pandemic.

One of the concepts mentioned in the Industry 4.0 concept is "Digitalization" or "Digital Transformation". Digitalization is defined as changing business models to use digital technologies and create opportunities to provide new sources of income or value creation (Dengiz, 2017).

Industry 4.0 plays the role of digital transformation. Vertical networks, horizontal integration, end-to-end engineering across the entire value chain, and exponential technologies are the characteristics of Industry 4.0 that have changed the power of industry and manufacturing (Deloitte, 2015).

The growth of Internet penetration and the trend towards digitalization due to the increasing volume of the global Industry 4.0 market in 2020 amounted to 101.69 billion US dollars. The impact of COVID-19 has been significant, but the past positions are slowly recovering. According to a report from Fortune Business Insights, the global market posted a significant 14.5% growth in 2020 compared to 2017-2019 year-on-year growth. The market is forecast to grow from $116.14 billion in 2021 to $337.10 billion in 2028 at a CAGR of 16.4% over the period 2021-2028. The sustained growth of CAGR is due to the growth of this market and the return of demand to the level of the pandemic after the end of the pandemic.

In turn, the expansion of technology market product offerings, the focus of various industries on efficiency and cost-effective performance increase the opportunities for market growth. Recent advances in digital technology and industrial automation have begun to expand the possibilities of disrupting the industrial value chain. With the advent of Industry 4.0, companies are witnessing efficiency gains, lower costs, increased production, customized offerings, and the development of new revenues and business models.

For example, in May 2021, Robert Bosch Engineering and Business Solutions Private Limited launched Phantom Edge to display electrical parameters, instrument level information, power consumption and operational usage in real-time. The Phantom Edge combines artificial intelligence and the Internet of Things (IoT) and can be used in a variety of sectors including retail, manufacturing, healthcare, agriculture and mobility.

Digital technologies such as artificial intelligence, the Internet of Things (IoT), augmented and virtual reality, 3D printing and blockchain disrupt all elements of the value chain including product design, supply chain, manufacturing process and customer experience. In addition, global manufacturing giants such as Germany, the US, France and Japan have been

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supported by strategic government initiatives to digitize their manufacturing processes across industries.

Given the global market environment devastated by the COVID-19 pandemic, digitalization in industries is also rapidly accelerating. This factor has made it possible for digital leaders to develop and make creative decisions to accelerate digital transformation at all levels of the company.

According to a study published by IBM in 2018, the X Force Threat Intelligence Index indicates that the manufacturing sector is the second industry targeted by data breaches and cyber-attacks. Industry 4.0 systems cannot prevent hackers from accessing manufacturer data and collecting all sensitive data due to their attack proneness. As a consequence, there is a need to raise awareness of such threats and awareness of the need for cybersecurity across all organizational networks. Cybersecurity is a defining moment in Industry 4.0 due to the increase in the number of interconnected devices. Industry 4.0 requires unified communication standards and protocols and uses many devices ranging from machine controllers, sensors, production lines and other industrial systems, so cybersecurity threats will increase dramatically (RÜßMANN et al, 2015). Some vital information will not be protected by traditional methods, which will lead to major developments in cybersecurity (BENEŠOVÁ and TUPA, 2017).

Of course, the development of all industries will inevitably have an impact on accounting rules and the accounting profession. Since digitalization plays an important role in business, the accounting will deal with a large number of intangible assets, human resources and technologies that can accelerate and change the concept of traditional accounting, functionally move to strategic management accounting. The organization of accounting for innovative digital technologies will be special. As a product of intellectual labor, they will certainly be classified as intangible assets. The lack of proper regulation and practice can create certain difficulties in writing an accounting policy for recognition, measurement and disclosure of information about them in financial statements.

This is evidenced by the experience of Industry 3.0, which also brought changes to accounting. Enterprises began to carry out accounting using computer technology and the Internet, introduced the use of electronic signatures, electronic invoices, electronic declarations. Invoices and accounting data began to be stored in an electronic environment. In this way, businesses have been able to develop the applications they use with Industry 3.0. In

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order to achieve a situation where enterprises can keep records of activities without requiring human resources, enterprises need to adapt their technological infrastructure to Industry 4.0 and make significant investments to make their factories smart.

The influence of Industry 4.0 on the accounting system has indirectly transformed the role of accounting into a more advanced digital system. As a result, the accounting will gradually evolve from a traditional to a technological system (Damayanti, 2019).

One of the processes that information systems can help improve the accuracy of the information and improve the organization's decision-making activities is accounting. An accounting information system is defined as the collection, recording, storage and processing of accounting records to provide information to decision-makers.

An accounting information system is the combination of people and technology in an organization that collects, records, stores, and processes data to provide the information needed to make informed decisions (Marshall & Paul, 2021).

According to Weygandt et al. (2019) an accounting information system is a system that collects and processes transaction data and provides financial information to internal and external parties.

Fontinelle notes that an accounting information system is a computerized way of tracking accounting activities using IT resources.

According to Hall (2010), an information system is a set of formal procedures by which data is collected, processed into information and distributed to users. It consists of three main subsystems: transaction processing system; general ledger system and financial reporting system; management reporting system.

Belfo and Trigo (2013) emphasize that an accounting information system focuses on five cycles such as income, expenses, human resources, production and finance.

According to CPA Australia, accounting is the process of recording, processing, analyzing and summarizing the transactions of a business and communicating this information for decision-making. Financial statements traditionally present information based on historical data useful for decision-making by stakeholders such as potential investors, lenders, suppliers and customers (Belfo et al., 2015).

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As a business enters a new economy, information based on historical data may receive less attention. The business community in the new era of real-time enterprise demands more up-to-date information covering a complex set of enterprise software products and services. They require a new business accounting called Real-time Accounting (Vasarhelyi & Alles, 2008).

Technologies influenced by the fourth industrial revolution in terms of accounting will be the following: Big Data or Data Analytics, Cloud Computing, AI, Blockchain, the Internet of Things (IoT), Robotic Process Automation. Let's consider them in more detail.

4.1. Big data

The biggest impact on Industry 4.0 accounting will be Data Analytics or Big Data – data analytics associated with relational databases in an accounting information system. Big Data identification allows accounting and finance to take on a more strategic role and help shape the future.

Big Data is a generic term for any collection of datasets so large and complex that it is difficult to process or can only be handled by conventional database management or traditional data application processing. This data is usually not structured.

According to (Gandomi & Haider, 2015), big data are information assets of great volume, speed and variety, requiring cost-effective, innovative forms of information processing for better understanding and decision-making.

The existence of big data during Industry 4.0 is undeniable. They change the information life cycle from traditional to modern by removing multiple processes such as acquiring, classifying, transforming, indexing, and searching, and adding multiple processes such as collecting, sieving, synchronizing, preprocessing, and monitoring (Coyne et al., 2018).

The existence of extensive data significantly changes the accounting process. Since big data is primarily composed of unstructured data generated from audio, video, and images, traditional accounting software and database system cannot properly analyze the generated financial statements (Warren et al., 2015). Big data is changing the perspective of accounting

Big data is changing the perspective of accounting, providing real-time accounting and leaving a periodic basis (AL-Htaybat et al., 2017). It is likely that in future accounting, the data will not be stored, but will be implemented in a system that needs to be accounted for in the organization's accounting information system. Big data requires accounting practitioners to adjust their system to capture a huge set of data and unstructured events and report on financial statements that will benefit investors and all stakeholders.

Big Data will reduce the time that accountants spend on collecting, checking and processing data and increase the time for analysis, provide business insight. This will change the role of accountants in the company (Stanciua & Gheorghe, 2017; Ucar et al., 2018).

The development of real-time accounting, which must face the presence of big data and the new dimension of intellectual capital (IC), requires an accountant who is not only an expert in the field of accounting, but also has experience as a business professional. The accountant must possess the skills of defenders of the design and maintenance of information systems for decision makers.

At the same time, accountants must be able to distinguish critical data and ideas from what is obtained from the data. Accountants do not need to fully understand the structure of a database or perform their own analysis of the data. The results of data analysis must be understandable to accountants, and accountants must be able to determine how these results can add value to the business (Gamage, 2016).

In the realm of auditing with Big Data, auditors can perform data analysis to change the audit process at any time at the transaction and general ledger level, with new data mining and visualization tools so they can produce even better analyses. Data analytics, if applied properly, can enable continuous auditing and help reduce operational costs, risks, and improve efficiency and effectiveness.

In addition, the results of data analysis can even enrich their work by providing advice that can help customers improve their competitiveness. Another area where Big Data can be used is forensic accounting services. This service requires investigative knowledge and experience in collecting, analyzing and evaluating evidence to interpret and report results. When extracting big data, the results are expected to be better using forensic data analysis tools (Gamage, 2016).

4.2. Cloud Computing

Another major influence of Industry 4.0 on the role of accounting is cloud computing.

The evolution of accounting is changing the expectations of clients and accountants are forced to adjust the way they do it to meet the requirements. People are willing to do less paperwork as they need to focus on what they are passionate about in the things they want to do. This means that people will have to depend on technologies to help them work in a more integrated way. One of the current technological trends is the rapid development of cloud technologies (Khanom, 2017).

Cloud accounting is one of the advanced forms of digital accounting (Tugui, 2015). Its emergence is the result of personal platforms created over the past 6-7 years (so-called clouds or cloud spaces) on the Internet, which makes it easier to access boring data anywhere, anytime and from any type of device that supports the Internet.

Dimitriu and Matei (2015) consider cloud accounting as a service in the business model. Cloud accounting is a transformation of accounting applications and a solution for a modernized business environment.

According to Sobhan (2019), a cloud system or cloud computing is an on-demand delivery of computing services that does not require active management by service users. It offers services consisting of hardware and software via the Internet. In the cloud system, services such as data and software can be accessed from anywhere and anytime via the Internet through a cloud application service provider.

Cloud accounting is a combination of cloud computing and accounting using a web server to create a virtual accounting information system. Cloud accounting services consist of three models: Infrastructure as a Service (IAAS), Platform as a Service (PAAS), and Software as a Service (SAAS) (Mohammadi and Mohammadi, 2014).

When switching to cloud accounting, accountants being not adapted to technologies, will face more difficulty in their roles than accountants aware of the transition through the era of globalization and digitalization (Tarmidi et al., 2014). To be able to analyze a lot of data, accountants must be equipped with analytical skills such as SQL Query, Tableau, Power BI (Salem et al., 2021).

The cloud accounting system has brought advantages such as data accuracy, faster data entry and update, integrated and centralized system, easy access to mobile devices, human resource efficiency and cost savings. However, it experiences security issues such as account hijacking, broken APIs and interfaces, broken authentication, broken credentials, and data breaches including a stable internet connection.

An interview with the Focus Group Discussion (Krueger & Casey, 2000; Wilkinson, 2004) showed that the accounting information system has evolved into a digital system that has influenced Industry 4.0, and accountants will not double-entry manually in line with technological developments. Traditional accounting will be gradually replaced by an automated accounting system supported by technology in the digital age.

According to questionnaires, 90% of respondents agreed that cloud accounting is the digital transformation of accounting from a traditional to a more offline accounting information system that has influenced Industry 4.0 in the direction of business and the role of accounting (Özcan & Akkaya, 2020).

Statistics show that for 2020, 25 percent of surveyed organizations worldwide reported large-scale adoption of distributed cloud technologies, and 29 percent use distributed cloud solutions on a small scale (IMPLEMENTATION OF EMERGING TECHNOLOGIES IN COMPANIES WORLDWIDE 20).

Cloud computing offers customers access to a wide range of technologies while lowering costs and reducing the need for technical expertise. The cloud services market is divided into three main service models covering infrastructure, platforms and software. Customers can choose between private, public, or hybrid cloud deployments based on their business needs and security concerns.

In line with the growing popularity of cloud computing companies, the global revenue generated from these technologies has grown rapidly in recent years. Software as a Service (SaaS) is the largest segment of the global cloud computing market with over $100 billion in revenue as of 2019. It is the most widespread cloud technology and is now used by most organizations around the world. Popular SaaS programs include customer relationship management and enterprise resource planning software.

Cloud technologies have four types of cloud deployment models (Sobhan, 2019). Deployment models vary by deployment type, hosting type, and authorized access such as public cloud, private cloud, hybrid cloud, and community cloud. The main benefits that are attracting more and more consumers to turn to this type of innovative form of accounting are:

- accessibility - round-the-clock access to all data from anywhere, the only condition is the presence of the Internet;
- security - access to the cloud space is personally authorized with a password and username. For contractors, this is also a deadline, a circumstance that guarantees a high degree of protection;
- - reducing costs compared to traditional accounting software products, on the one hand, and reducing the cost of ongoing maintenance, on the other hand;
- - allowing large amounts of data to be transferred.

The following advantages of cloud accounting can be added: it adapts to the needs of financial information, creates information in real-time, financial and accounting information is updated, archived and restored automatically; the software does not require periodic updates (Petrova, 2018). It is suitable for low-budget companies; for companies whose employees work remotely, as well as those who cannot afford adequate protection. Conversely, for companies that need strict control over accounting data and have concerns about wireless network security; companies wishing to control access to accounting information from third parties, as well as for companies with an uncertain future, cloud accounting is not a suitable solution. The main advantage of cloud accounting is access to real-time accounting information around the clock and seven days a week.

Among the main obstacles are: lack of awareness among managers and entrepreneurs; conservatism of managers and entrepreneurs; lack of desire for radical change; insufficient motivation; lack of staff; distrust of data security, lack of readiness for system integration, etc. The threat of cyber piracy is also relevant.

4.3. Artificial Intelligence (AI).

Artificial intelligence is the science of designing, creating and constructing a machine (computer) or computer program that would have an intelligence similar to that of a person. Intelligence in this case is the ability to act or solve problems in the way that people use their intelligence. The scope of intelligence covers many aspects of the abilities of the human intellect, such as reflection, knowledge, planning, learning, natural language processing, and the ability to manipulate objects. With artificial intelligence, the machine is expected to have general intelligence, just like humans.

Various trends that could change the role of accountants in management accounting through the use of Artificial Intelligence (Al) based technology include: enterprise performance management (EPM), including business intelligence; predictive accounting; improvement of management accounting methods; IT management and shared business services; better skills and competencies in behavioral cost management and strategic planning (Meskovic et al., 2018).

4.4. BlockChain

Blockchain is a digital data storage system consisting of many servers (multiserver). In blockchain technology, data created by one server can be replicated and verified by another server, which is why blockchain is often compared to a bank's cash book containing all customer transaction data. However, this general ledger is available to all blockchain users and is not limited to authorized bank employees. With blockchain, a transaction no longer has to depend on a single server, because the transaction will be replicated throughout the network.

The nature of the network is peer-to-peer, blockchain users can also avoid a variety of frauds that can occur due to data modification or hacking. On the blockchain, each block (a special area that contains all the changes in a transaction) consists of a hash, which is an identifier of digital data. Now each block contains the hash of the previous block. Each block in this system is interconnected and if there is an attempt to change the data in one block, then it must change the data in another block. Each block, protected by cryptography, is connected to create a network. Through the blockchain, intermediate transactions will be much more efficient than regular transactions, which still require the existence of intermediaries.

4.5. Robotic Process Automation

One of the main technologies as a sub-technology of the Industry 4.0 model is Robotic Process Automation (RPA).

Robotic Process Automation is the application of technology that allows employees to configure computer software or "robots" to capture and interpret existing applications for transaction processing, data manipulation, response initiation and communication with other digital systems (IRPA & AI, 2017) .

Robotic process automation is a combination of related technologies such as stand-alone systems, machine learning, AI and robotics. These latest technologies have shaped the structure of RPA solutions and become the basis for RPA. It works by clearly replicating the actions of today's employees, using existing core programs, accessing websites, and manipulating spreadsheets, documents, and e-mail to complete tasks (Lamberton et al., 2017).

Although the term RPA means seeing physical robots roaming the offices performing human tasks, the term means automating work tasks that people used to do. For business processes, the term RPA most often refers to configuring the software to perform pre-human work, such as transferring data from multiple input sources, such as e-mail and spreadsheets, to recording systems such as ERP and customer relationship management systems (CRM) (Lacity et al., 2015) and also benefit (KPMG, 2017).

The functions of finance and accounting are always under pressure in terms of improvement and new technologies. RPA technology will undoubtedly affect accounting and finance.

The automated workplace of accounting will significantly change the role of the accountant. Much time-consuming, manual work will be replaced by technology, so accountants will be able to focus on strategies and analysis. RPA and automation will destructively change accounting processes and operations. RPA will be particularly inefficient, and accounting professionals will focus more on strategic operations in the context of strategic accounting management. RPA will also provide automated internal control / audit and automated critical financial reporting.

According to Axson (2015), transaction tasks will move to integrated solutions for business services that use robotics, and this will automate or eliminate up to 40% of transaction accounting work by 2020. As a result, staff can spend more time supporting decision-making, forecasting, and performance management.

This technology not only improves the efficiency of accountants, but also creates access to financial data in real-time, so that reporting and analysis can be performed simultaneously and continuously. RPA does not replace accountants; it develops their work in a progressive and positive way and allows them to focus on the greatest value they can give to their organization (Spanicciati, 2016).

Under the RPA, fundamental changes await cost management practices. As direct labor will begin to gradually decrease, the formation of the cost of production will be excluded from

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the definition of conditional cost. With the development of Industry 4.0, the remaining workforce - if any - will need to improve their technical skills. This new understanding of work practice will be dominated by cross-functionality. As direct labor of a variable nature will be based on the equation of cost calculations, the amount of intangible assets will increase, and depreciation as a fixed cost will become a material part of the cost of production. In addition, such a system will need continuous improvement (Reinnarth et al., 2018).

In terms of strategic forecasting, firms will have to allocate significant funds for both improvements to become better / modify RPA systems; and for maintenance and support that fall under the jurisdiction of operating costs. However, it is clear that traditional and outdated cost management systems will fail if firms do not take precautionary measures to change their strategies so that they fit into this new way of thinking. While these improvements, the financial accounting function will also receive its share of restructuring (Cline et al., 2016).

Critical roles such as receivables and payables will be compromised as the RPA automatically enters data and some accountants will still be involved in monitoring documents. Because RPA can be used at every stage of accounting, operational work will be able to track and progress. Account reconciliation can be efficiently performed with the help of automation. Accounts payable and receivable will be reconciled with both unilateral and bilateral transactions with customers and suppliers (Cigen, 2017).

All distributions and adjustments can be made by RPA in general accounting. After bank reconciliation, credit cards, credit records, etc., as well as intercompany transactions, robotic programs can perform closing and consolidation operations.

As for the finance function, treasury operations can also be tracked through RPA. After the closing process, RPA can provide enhanced financial reporting for both internal and external purposes. Automated reporting will be created that will enable early warning through specially crafted ones, as well as provide users with real-time reports to help them with proper monitoring (Mcintosh-Yee, 2018).

RPA can perform planning and budgeting in a control function, and provide a range of scenarios in a short period of time, which makes the decision-making process more efficient. Both long-term and short-term plans can be properly built thanks to RPA's advanced forecasting feature.

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There are two specific aspects of RPA in the control and audit function. First, auditors will benefit from robotics through regular internal controls. For example, if required controls are missing or any action does not match the programmed rules or pattern, the robot marks the transaction and alerts the auditor to take a closer look and search. This will help audit teams save time, be proactive and focus on the more analytical side of their work, as seen in the Accounting and Finance function. RPA will also serve to manage risk and is expected to reduce the risk of fraud as well as human error (Vasarhelyi et al., 2018).

In addition, auditors will have to audit robotics. Any type of automation has certain degrees of risk. RPA has its own learned algorithm and a faulty algorithm can have a huge impact on hundreds of bots using the same faulty algorithm. Hence, without human verification, there may be some dramatic and disastrous results. The auditor should check the RPA.

Recent research is shedding light on the benefits of RPA solutions to the extent that the use of RPA in accounting operations such as reconciliation, automatic booking or manual automation, and in financial operations such as consolidation and reporting will change dramatically (Powel, 2017).

4.6. Industry 4.0 and ERP-systems

Today, many companies are already using solutions provided by IT, such as ERP (Enterprise Resources Planning) systems, to manage company processes and to integrate all the various operations in order to increase the flow of information within the company, as well as cooperation with partners, suppliers and customers. ERP systems help companies in many areas ranging from improving information sharing between departments, improving workflow, better supply chain management, integrating real-time data, processes and technologies in internal and external value chains, standardizing various business practices, improving order management and providing accurate inventory management accounting information.

An ERP (Enterprise Resource Planning) system is a business process management software that manages and organizes a company's business processes, all in a single integrated platform. Activities that can be managed with an ERP system include finance, sales, customer relations, manufacturing, inventory management, supply chain management, human resources, payroll, etc. (Trunina et al., 2018).

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Basically, an ERP system unifies the entire organization into a single package and provides all the necessary information about business activities through a common database, which is accessible to all programs in the system. Therefore, it does not require multiple systems that do not communicate with each other to manage various processes such as accounting, HR, CRM, supply chain, etc.

Today, ERP systems are seen as the most basic information systems that businesses have to support their operations. In addition, it is believed that institutional businesses will not be able to operate if there is no ERP and a customer relationship management (CRM) system. However, the existing ERP and CRM systems on the way to the future of the industry have significant obstacles (Stojkic et al, 2016).

Existing ERP systems do not quickly provide adaptation to production planning. At the same time, it is clear that traditional structural automation is not enough to meet the requirements of Industry 4.0. In addition, they are known not to have a flexible enough structure to quickly integrate with dynamic variables for factory workflows and offer the best solutions. These points can be cited as an example of an obstacle to existing ERP systems (Rojko, 2017).

Since ERP and CRM systems will continue to be the backbone of enterprises, it is necessary to provide existing ERP and CRM systems in line with Industry 4.0. From this point of view, ERP and CRM systems should be adapted to Industry 4.0 and should contain the following characteristics (Stojkic et al, 2016):

- ERP and CRM systems must function to provide users with access to the information required by mobile phones and tablets. These system enhancements will increase productivity in enterprises and allow workers to take full advantage of these systems.
- ERP systems must be adapted to automatically analyze a large amount of unstructured data collected in real-time from operational processes using embedded big data;
- Virtual applications should be introduced to allow enterprises to realize their activities in real-time through a reasonable value chain. Thus, ERP systems will be functional;
- it is necessary to integrate ERP systems with social networks, which will allow faster transfer of information to end users.

4.7. The Internet of Things (IoT)

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ERP systems equipped with Industry 4.0 technologies and using the Internet of Things are systems directly related to the creation of smart factories, requiring the installation of production equipment that can read and store received data from variables such as production, energy, time and other manufacturing processes. The goal to be achieved with the creation of smart factories is to establish a direct relationship between all systems in the enterprise, including ERP systems (Robleket et al., 2016).

Industry 4.0 contains technologies, any of which are related to ERP systems in one way or another. Starting with the Internet of Things (IoT), which is the first Industry 4.0 technology that ERP systems must support. With the support of IoT, all other Industry 4.0 technologies could be linked to ERP systems. IoT should be the point of integration between Industry 4.0 and ERP systems. The integration of this technology in Industry 4.0 is closely related to communication protocols between machines and different frameworks, which should be harmonized in the future.

Now, in most cases, data on production warehouses, production planning, quality control, processes and other sources are entered manually into ERP systems. The use of the Internet of Things would help to automatically enter data into ERP systems collected from different production sources, and this would eliminate the data entry error. Data entry using IoT equipment will also help change the approach to ERP systems (Gërvalla & Ternai, 2019).

There will be another connection between ERP and Big Data Analytics and other Industry 4.0 technologies. Using Big Data Analytics, ERP systems can allow real-time collection and evaluation of data from different sources and can help in decision-making, quality control, cost optimization and other aspects. In addition, Simulation, another Industry 4.0 technology, can be linked to ERP through the use of Big Data Analytics to predict and evaluate the performance of systems that are analytically difficult to model in order to validate and optimize resources.

4.8. Industry 4.0 and Extensible Business Reporting Language (XBRL)

It is believed that for Industry 4.0, real-time credentials will be presented to users with information faster and more efficiently. In today's system, this is visible in real-time when credentials are provided to information users via XBRL (Extensible Business Reporting Language). XBRL is a financial reporting language that is rapidly spreading around the world. XBRL is the name of a framework that allows real-time presentation of financial information on the Internet and enables electronic communication (Toraman & Abdioglu, 2008).

XBRL (eXtensible Business Reporting Language) is an international standard for providing IFRS financial statements in electronic form.

This format is widespread in the world, since it allows processing large volumes of qualitative and quantitative indicators. It is based on the metadata set out in the taxonomy and the relationships between concepts described.

The main goal in XBRL is to provide integration between data interacting with each other in the preparation of financial statements and the rapid receipt of financial statements. However, as internal reporting, XBRL is also used for information, integration, and process control. In addition to delivering significant benefits to all enterprises, the benefits gained by using XBRL in highly automated enterprises are growing. Some of these benefits are as follows (Faboyede et al., 2017):

- it allows you to analyze competitors and compare the enterprise with other enterprises in the same industry;
- it allows to develop audit processes and analyze the goals of enterprises, such as mergers and acquisitions;
- it allows enterprises that have recently joined other enterprises to integrate more quickly;
- allows communication between autonomous divisions of the enterprise, even if different accounting systems and ERP are used;
- it automatically provides data across different software and databases.

Considering the views of both investors and analysts and other users of information, significant benefits can be achieved using existing XBRL applications. Some of these advantages are as follows (IIas et al., 2014): the significant time spent on analyzing the financial statements of enterprises is reduced; provision of an easy access to financial information that needs to be obtained around the world; allowing real-time financial analysis; permitting to quickly and easily see the financial condition of enterprises; allowing to compare the financial statements of companies operating in different countries.

A 2016 CFA Institute survey to measure awareness of XBRL members shows significant results. This survey included 362 CFA members in the US, Europe, Middle East,

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Africa, and Asia-Pacific who were trying to measure their XBRL awareness. In the 2016 survey, 55% of members do not know about XBRL, 35% of them know about XBRL but do not use it in financial reporting, and 10% of members use XBRL. This finding is almost identical to the results of surveys conducted in 2007, 2009 and 2011 (CFA INSTITUTE).

Given all the benefits of XBRL in terms of financial reporting, it is understandable its great importance for all users of information. However, it is clear that the level of use of XBRL applications is not high, as shown by periodic CFA surveys. In other words, it is clear that participants did not benefit from this reporting language and there were few important benefits or beneficiaries. It is believed that the level of awareness and use of XBRL is expected to provide great benefits to users through applications developed with Industry 4.0.

Through the widespread use of XBRL, the real-time presentation of financial statements, which are the most important outputs of an accounting information system, will be more reliable, and the cost of obtaining information will be lower. In addition, it may be said that the accounting information system will have a more flexible structure, which means that the information that needs to be obtained will be received much faster.

4.9. Industry 4.0 and Intellectual Capital (IC)

Under the conditions of Industry 4.0 in the current digital ecosystem, accounting may face the problem of measuring intangible assets and Intellectual Capital (IC). After all, intangible assets will be focused on big data. As mentioned earlier, the structure of the big data set, which consists of audio, images, video, will be difficult to record in a traditional accounting system. The problem depends on how to measure intangible assets, which for the most part cannot be reflected in the financial statements.

Torre et al. (2018) note that the traditional accounting system works poorly with the digital system because the digital system requires more intangible investments than physical assets, which are potentially difficult to measure and report in financial statements. The debate over the measurement and reporting of intellectual capital requires companies to provide more information that is reliable for all investors. Some types of disclosure and lack of awareness of intangible assets force management to provide uninformed value that may differ materially from decision-making (Seetharaman et al., 2004).

One of the alternatives is compliance with IFRS (International Financial Reporting Standard). IFRS states that IC reporting in financial statements is voluntary if the company does not recognize IC as its intangible asset (LIAO et al., 2013).

Liou et al. (2013) also noted that International Accounting Standard No. 38 (IAS 38) states that intangible assets require companies to recognize intangible assets, whether acquired or created independently, if it is probable that future economic benefits associated with the item will flow to the Group relating to the asset are received by the entity and if the value can be measured reliably. The main emphasis is on the identification of research and development. Research can be classified as cost, and development can be capitalized only after establishing the technical and commercial feasibility of the asset for sale or use. Adoption of IFRS will increase the disclosure of ICs in financial reporting, especially for high-tech companies in the UK 38 (IAS 38) states that intangible assets require companies to recognize intangible assets, whether acquired or self-generated, if it is probable that the future economic benefits associated with the asset will flow to the entity; and if the value can be estimated reliably.

On the other hand, the application of IFRS may not be a solution, as the presentation of intangible assets may not help investors assess the value of intangible assets. Some experts (Liou et al., 2013) also argue that the IC measurement response does not yet have an unambiguous answer, and they are pessimistic that accounting rules will take into account the possibility of capitalizing intangible assets. IFRS allows a company to capitalize its intangible assets, which are classified as development costs if the costs are incurred after technical and commercial expediency for sale or after creation. At the same time, the provisions for the valuation of intangible assets, including IC, differ in various countries.

5. CONCLUSIONS

The world is constantly changing, technological progress is constantly spreading to more and more areas of life, production, industries and professions. Industry 4.0 technologies are already a reality today. Of course, the introduction of "smart" technologies has a direct impact on the accounting.

As has been repeatedly noted, one of the negative aspects of Industry 4.0 is the reduction of jobs and the disappearance of certain professions. There are fears that the accounting profession will become one of them. According to the calculation published in 2015 by the American media group NPR, the chance that everyone accounting tasks will be assigned to jobs exceeding 97% (Khrystova, 2017). Also of concern are the results of the 2016 Association of Professional Accountants annual report, according to which 55% of members surveyed admit that automation will replace the accounting profession in the next 10 years (Khrystova, 2017).

However, in our opinion, the role of the accountant will change. If, until decades ago, an accountant was a data recorder in accounting with the advent of automation and computer accounting systems, he had to know business and business processes well, have good analytical skills to perform functions such as planning, forecasting, cash flow management. Today it's also necessary to be able to analyze data to understand the factors driving business; realize the most customer needs and how to track them; the ability to use new forms of data and use them to make business decisions; the ability to interpret data to provide information that is more meaningful to decision-makers (Surianti, 2020).

Technology will not supplant accountants, but on the contrary, will help to enrich their knowledge, skills and abilities; set aside time for accountants to analyze and manage the company's activities; make it easier for accountants to perform routine actions and operations. The evolution of digital transformation in the accounting information system will accelerate the work of the accountant for more accurate, efficient and real-time reporting.

In the period of Industry 4.0, the human factor in enterprises will decrease significantly, but it is the human factor that will be activated at important decision-making points. Although it is known that all accounting procedures can be done by intelligent systems, it is believed that the human factor will be necessary to ensure effective control over the system being created. For this reason, accountants must have a sufficient level of knowledge in many areas, such as knowledge of robotics systems, software, development and computer science knowledge, and project management skills.

Industry 4.0 is being built around the world based on three pillars: business, education, and the state. If only business is involved in the processes, the economy is faced with a shortage of qualified personnel, if innovations are only carried out at universities, then the lack of funding becomes a problem. And, of course, if there are only state initiatives, then in the end we will get a result that is divorced from the real sector, with a lack of business tasks and expertise. Therefore, it is very important that universities should be able to work closely with industry to ensure that graduates have the necessary knowledge, including the accounting.

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Nevertheless, it is important to coordinate and combine the efforts of business, education and the state in the context of the development of Industry 4.0 technologies.

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