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# SYSTEMATIC REVIEW OF BIG DATA, DIGITAL TRANSFORMATION AREAS AND INDUSTRY 4.0 TRENDS IN 2021

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## ABSTRACT

Industrial development has been going on for several hundred years. In the XX century, three great industrial revolutions occurred in human life. Today we can discuss the fourth industrial revolution, called Industry 4.0. Industry 4.0 takes overproduction with robots that can communicate, detect the environment with sensors and realize the needs by analyzing data. This industry aims to produce better quality, cheaper, faster, and less wasteful. In addition, Industry 4.0 allows objects to communicate with each other and with people by monitoring cyber-physical systems and physical processes in modular smart factories, enabling decentralized collaborative decisions. Applying Industry 4.0 to protect and sustain their existence is inevitable in a competitive environment for businesses and organizations. It is necessary to know the industry 4.0 concept and its fundamental paradigms. Therefore, in this paper, we explained Industry 4.0 and studied his applications areas in 2021. Our study shows that Industry 4.0 is not present, and the technologies are much less current in industrial production in North Macedonia. The key term of the Fourth Industrial Revolution is poorly understood; the presence of Industry 4.0 in the media is deficient.

**Keywords:** Industry 4.0, automation, robotics, manufacturing, and interconnection.

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## Introduction

The first manufacturers began to form from the pre-industrial era. Pre-industrialization was important not only because of production but also because it strengthened many economic, social, and demographic relations that provided a reasonable basis for production progress. In terms of the economy, the concept of supply and demand advanced, and people had to go to cities to sell or buy resources, which strengthened the trade network. In social terms, many people went to the cities, thus establishing work discipline. Demographic, economic, and social outlook have stimulated population growth due to a simple calculation says more people can produce more products and result in higher earnings ( Gelderblom & Trivellato, 2019).

The industrial revolution is a process that started with the introduction of new technologies and sources in the second half of the 18th century to increase production speed and reduce the cost of the finished product. Emphasis was placed on transferring manual labor to an industrial model with designing the new machines. The first industrial revolution begins with the invention of the steam engine. The second was the discovery of electricity and oil, and the third was the invention of transistors and the discovery of atomic energy. The fourth industrial revolution or Industry 4.0 refers to the emergence of robotics, the application of digital transformation, and the creation of the so-called intelligent factories.

Industry 4.0 is the name of a project proposed by the German government that promoted the digitalization of production (Skender and Ali, 2019). Germany raised the digital transformation of production, and this project gained significant interest and interest in Europe. Germany wanted to become a leading country that would put new production ideas on the market and find their advanced solutions, not planning that this project would stimulate thinking about a fourth industrial revolution. All leading countries of the European Union have accepted the assignment, adopted its concepts, and encouraged EU members to adopt the project in the mid-10s of the 21st century (Zervoudi, 2020).

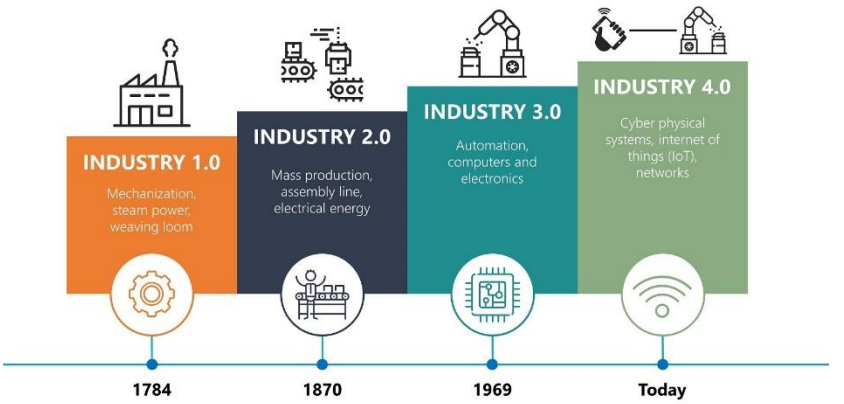



**Figure 1.** Historical development of Industry (Source: https://www.presentationpoint.com/blog/data-signals-triggers-industry-4-0/)

Production processes based on the latest technology and covered by devices for mutual autonomous communication best describe what Industry 4.0 is. "Smart" production has become an inevitable norm in a world where machines controlled by artificial intelligence that can independently exchange information are used. The production goal did not change during all the industrial revolutions (Ortiz et al., 2020). The purpose of Industry 4.0 is to increase productivity by as much as 50% more than it is now and to reduce the resources needed for production (financial and physical). The main features of Industry 4.0, according to (European Parliament, 2016), are:

· **Interoperability and interconnection:** Interoperability connects cybernetic and physical production systems that consist of work surfaces, assembly sites, and production itself. They allow people and smart factories to connect and communicate with each other.

· **Information transparency and virtualization:** A virtual copy of a smart factory was created by connecting sensory data with a virtual factory model and simulation models.

· **Decentralization and autonomous decision:** This feature involves the ability of the cyber-physical system to make independent decisions and for local production, thanks to technologies such as 3D modeling and printing.

· **Real-time capabilities:** This involves collecting and analyzing data and simultaneously gaining insight into the process.

· **Technical assistance and service orientation:** Services that are enabled by automated propulsion and reach users efficiently.

· **Modularity:** Includes flexible adaptation of smart factories to demanding changes through expansion or replacement of individual modules.

The future provided by Industry 4.0 is getting closer. Namely, the opportunities provided by Industry 4.0 by improving production processes and introducing robotics in the processes prompted us to think about how all this will affect the situation outside the smart factories themselves. Industry 4.0 has ten major global trends, most of which are existing but improved in terms of the features it has introduced the same (Efthymiou & Ponis, 2021).

With the development of technology and improved production processes, a new terminology has emerged to describe it much better Industry 4.0. In Figure 2 are some of the introduced new terms that make it easier for the community to understand things around it.


**Figure 2. Terms Related to Industry 4.0** (Source: https://industry40marketresearch.com/blog/industry_4-0_technologies/)

**Digital Transformation**

Adaptation refers to the rapid shift of all areas to technological channels and the continuation of activities in the digital field. The digital transformation uses information technologies in many occupations due to quick access to information to save excess cost and time. Many works done in the physical environment are now completed in seconds on the digital environment. It is possible to see this in many daily activities, especially in the business world (https://www.oracle.com).

Technology, period and human (employed) are three essential elements for businesses experiencing a digital transformation (Mergel et al., 2019). Transformation does not belong to a specific period; it requires continuity. According to (Yang & Gu, 2021), an interdisciplinary approach is also essential to Industry 4.0 development. It will be in the best interest to constantly take forward-looking action by following technological developments and integrating them into business. When all the features participate in the change process, a much more productive result emerges. Digital transformation provides excellent benefits both in individual and social areas, especially in education and business (Selimi et al., 2020). The benefits of digital transformation we can list as:

**Time:** The contribution of digital transformation to the business world is undeniable. Many corporate businesses must use different evaluation systems. A prepared file prepared can be sent to more than one other department. Each department compiles the information of its personnel and transmits it to the human resources department. This data flow is only possible with technological systems in an enterprise with many personnel. Preparing all these data on paper and getting feedback causes a significant loss of time. The flow provided with the crafted Excel file or the existing software allows you to complete the work process in a much shorter time.

**Productivity:** With the technological tools required by digital transformation, the workflow is completed much shorter, and productivity increases. The use of electronic channels leads to an uninterrupted business process. Productivity makes topping the to-do list much more accessible (Velkoska et al., 2018c). Continuous flow in the business process increases productivity.

**Reduction of expenses:** Operational costs can be reduced with high efficiency, resulting from digital automation (Velkoska

et al. 2018d ). Digital transformation brings advantages that will increase operational profitability, thanks to the "more work needs less workforce" situation.

**Reduction of errors caused by employed personnel:** With the software and robotic automation brought by the digital transformation process, the programmed works can be completed without human touch and error-free. Thus, the possibility of human-induced problems is eliminated.

**Sustainability:** The integration of robotic automation systems and advanced software support to businesses brings the opportunity to work uninterruptedly. The mechanical automation systems ensure the business process's continuity by preventing interruptions that may arise from personnel.

**Consistency:** Software-assisted business models always deliver a more consistent business process. Minimal exposure to any errors, problems, or interruptions that may arise ensures a constant business process.

**Automation:** It provides advantages with reporting, reminders, and business process management, which are provided to perform more productive work by putting their effort into it.

**Instant analysis:** Thanks to digitalization, you can quickly get information about your business processes and analyze your business.

**Effective management process:** Effective management relies on measurable, tangible data. You can easily access the data and evaluate it periodically, thanks to digital tools.

**Business intelligence powered by artificial intelligence:** Thanks to AI (Artificial Intelligence), you can apply data analysis techniques to make predictions and decide on the new business case if you have enough data.

**Application of digital transformation in business:** The business's applications for its operations are a tangible indicator of digital transformation. It is much faster and easier to process the data you provide in the digital environment. Ensure that the applications and software you use while transferring them to the digital medium are reliable. By choosing secure software, you will not risk your corporate information.

**Top 10 Industry 4.0 Trends in 2021**

**Cyber Security, Transparency and Privacy**

As production practices become more personal and adaptable, in-store data management practices will significantly affect a company's attractiveness. The flow of information due to connectivity in Industry 4.0

raises concerns about security, transparency, and privacy. The transmission and processing of sensitive industrial data should be done securely to avoid cyber-attacks on critical industrial facilities (https://www.startus-insights.com). Digital ethics and privacy, privacy enhancement technologies, self-adaptive security, zero-trust security, end-to-end security, DevSecOps, and blockchain are new developments. They should balance the focus of cyber security with transparency and privacy (Saračević et al., 2018).

**Edge, Fog & Cloud Computing**

The extensive data generated by the Industrial Internet of Things (IIoT) encourages the adoption of the capabilities for computing work, fog, and cloud in Industry 4.0. Custom hardware and software solutions, such as cloud connectivity, cloud distribution, distributed computing and storage, hybrid computing, low-code development platforms, microservices, mobile computing, and multi-computing, are increasingly shaping this trend in Industry 4.0. The new overview of IIoT applications and their enabling technologies is given in the work (Basir et al., 2019).

**Artificial Intelligence**

AI and machine learning are driven by innovation across industries and functional areas. Factories are beginning to integrate artificial intelligence into their production systems and processes. Artificial intelligence-specific hardware and new algorithms are being developed to optimize existing systems and address the unique challenges facing manufacturing (Haefner et al., 2019). Advanced Artificial Intelligence enables predictable maintenance, cognitive computing, swarm intelligence, context-aware computing, intelligent machines, hardware accelerators, and generative design. All these technologies move the production capacities towards complete production without lights.

**Human Enlargement and Augmented Reality (XR)**

People's physical and cognitive growth is another major trend in Industry 4.0. Limitations on people are being increased with the help of technologies such as carrying devices and exoskeletons. Furthermore, industrial mobile devices, natural and intuitive interfaces, and portable machine control screens improve the ease of use of such technology. XR technologies such as mixed reality (MR), augmented reality (AR), and virtual reality (VR) is already used in Industry 4.0 from research and development (R&D) to complete production and post-production processes (Lacks & Choi, 2020). The nature of human-machine

interaction is increasingly aligned with machine workers. This paradigm with more experience changes the way industrial production systems function.

**Networking and Connectivity**

Networking and connectivity are among the main driving forces for enabling Industry 4.0. Networking and connectivity have a wide range of technological advances. Cloud-to-cloud, gigabit Ethernet time-sensitive networks, low-power wide-area networks (LPWAN), 5G, machine-to-machine communication (M2M), real-time deterministic Ethernet, time-sensitive Networking (TSN), ubiquitous radio access are some of the advances. Also, a unified IoT (Internet of Things) framework and zero-touch networks encourage factories to implement IIoT to transform into Industry 4.0 capability. These technologies are constantly improving machine-machine and human-machine communication and data transmission (Saračević et al., 2019). The innovations in this area increase speed, improve security and efficiency, and reduce network connectivity costs.

**Advanced Robotics**

Advances in robotics make Industry 4.0 faster, more efficient, and more secure. Robots offer greater precision and agility while improving the ability to develop adaptive robots quickly. Robots also free up time for the workforce of humans to focus on non-repetitive or high-value tasks. The most prominent robotic technologies that affect production include autonomous robots, collaborative autonomous mobile robots, humanoid, mobile robots, collaborative robots (cobots), cloud robotics, APIs, selection and placement robots, and swarm robots. For collaborator robot works, readers can find examples in the research (Schranz et al., 2020).

**Internet of Everything**

The machine-to-machine, man-to-machine, and real-time human-machine connections make up the Internet of Things in production. Includes IIoT, Internet of Things, Internet Services, Internet Systems, and IoT Store. The Internet combines real-time data, machine intelligence, and human skills, resulting in faster, more efficient, and cost-effective production processes. Interoperability and a unified framework for the Internet of Things are critical to the smooth implementation of capacity in Industry 4.0. The security and vulnerability in the Internet of Things are given in the work (Shancang, 2017).

**Digital Twin**

Digital twin technology creates virtual models of industrial assets by combining dynamic sensor data and real-time visualization. Future digital

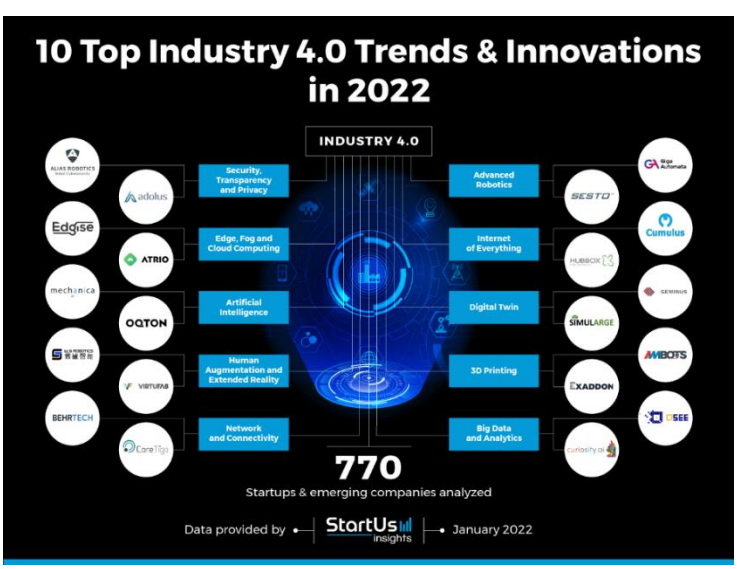
twins' future uses include model-driven design, virtual prototypes, virtual system validation, bandwidth optimization, and evolutionary design.

**Additive Manufacturing**

Advances in material science and techniques such as stereolithography and metal 3D printing make complex structures and components easier. Manufacturers constantly look the new technologies to cover all aspects of growing market demand (Velkoska et al., 2018b). The production of additives, which began as a prototype technique, revolutionized and decentralized production. Hybrid production aims to integrate both displays with additives and production with subtraction. The output of additives makes highly adaptable and sustainable cloud-based production a reality.

**Big Data and Analytics**

Big data is complex and valuable only when captured, stored, and analyzed quickly and economically (https://hexaingenieros.com). Advances in utilizing data to gain valuable insights into production systems and the availability of immediate and real-time data open up opportunities for proper, predictable, and enhanced analytics at various levels of a company's production capacity. The industrial data collection scale eventually allows factories to transition to industrial facilities 4.0.




**Source: https://www.startus-insights.com/innovators-guide/top-10-industry-4-0-trends-innovations-in-2021/#trend-five**

**Discussion**

Big data and data analysis caused significant changes in many areas of industry 4.0, such as transportation, electricity, health, aviation, agriculture, finance, and retail. Today, companies, banks, and public institutions can efficiently process many data from various sources: finance, mobile, health, transaction, customer research, and social media data in databases. The developments in information and cloud technologies and the instant access to online data sources have led to a new generation of powerfuĬ tools (Legriel and Maler, 2011). Combining this power with analytical tools has given academics, and business operators access to and use large previously inaccessible datasets. Businesses and governments can make better and faster decisions using text analysis, machine learning, predictive analysis, data mining, statistics, natural language processing, and visualization. Then, available information about the commonly used visualization techniques explains the importance of visualization for organizations.

Data visualization is a new and promising field in computer science (Selimi and Saracevic, 2018). It uses computer graphics effects to reveal patterns, trends, and relationships in datasets. Thanks to today's developing technology, it has easily analyzed large and complex data sets. However, the sampling method was considered natural when information was scarce and high-capacity digital technologies were not widespread. The new generation programs developed today have allowed us to use all the data and see many details that we could not see before with a limited amount of data. This way also helped us see a clearer view of the sub-categories and infrastructures that the sample could not reach. Big data continues to create significant opportunities, especially for developing countries, thanks to the technological transformations it pioneers. As can be seen in its applications in many sectors today, big data, when interpreted correctly, creates new opportunities for institutions and societies. Big data has had a facilitating effect on social life in many areas such as transportation, health, and marketing by determining the underlying causes of climate change, disease surveillance, and natural disasters.

Despite advances in technology today, the age of big data is still in its infancy. Therefore, extensive data processing methods evolve to solve big data problems, and new solutions are constantly being developed. On the other hand, the benefits of big data to society are often limited in terms of

data privacy and security. Today, scientists develop multidisciplinary methods and techniques to understand big data better, its complex structures, and the connections between them.

As a result, it will be possible to train managers who can test different scenarios in a short time, ask the right questions, quickly change direction if necessary, and integrate actions in the data mass into the company's performance. Such a development will cause a severe change in business culture both in the academic and business world. Today, when companies and CEOs are looked at from a professional perspective, it is seen that most top managers (including young people) still maintain the management approach and culture of 20 years ago. The exciting thing is that although they are well educated, this observation shows that it is difficult to move away from the conventional understanding. The solution lies in the awareness of being able to manage the information society. This new culture will become an essential competitive advantage in the long run. Organizations that do not have the necessary skills, competent and open-minded managers will lose their chances of survival and success. On the other hand, it is another fact that data scientists will have more options to manage through graduate and similar training in business and finance compared to those coming from other disciplines (Velkoska et al. 2018a).

## CONCLUSION

Today we live in times that are subject to change that is happening faster than ever before in the segment of social and economic frameworks.

They can be attributed to the processes of globalization, from which they indeed arose, but also to technological development, which, based on new scientific knowledge, experienced a real revolution, the fourth in a row. Unfortunately, only the third industrial revolution is still in full swing in our region.

In the last years, the development of IT (Information Technology) technologies has further emphasized the digital transformation of industrial production as a direction that must take. The Internet has created a pervasive network and possibilities of mutual communication to the extent that everything that surrounds it will connect people or little left that is not in the global communication chain. Terms like Cloud Computing, the Internet of Things, 3D printing, Big Data, and the like have become the foundation of today's modern and industrial world. New value chains, innovative products, the interaction of product customers

with the production process, networking of all factors of production, and data as a fundamental value are all concepts related to Industry 4.0. Due to this, we see increasing investment in research and development, protection of intellectual property, protection of information from cybercriminals, gaining new values, optimizing costs, and gaining the advantage of market concurrence.

Advancement through technology and progress through investment in new academic disciplines is something that the developed world recognizes as a natural path to a new industrial paradigm new social values. When discussing social matters, we discuss contemporary views on evaluating expertise, knowledge, experience, a new attitude towards employees, and satisfaction with the job, income, and conditions.

This research showed that Industry 4.0 is not widespread in our country, much less present in industrial production. Although it was difficult for citizens to assess whether Industry 4.0 is a threat or an opportunity, they recognize it as the future, even for our industrial production, with caution regarding its application in neighboring countries.

Future or present - depends on the position from which it views. If viewed from the part of leading economies, it is a present that is already in a profound transition towards a complete fourth industrial revolution. Still, it views with a certain distrust and misunderstanding. We hope that the development and increase of the works in Industry 4.0 will change citizens' thinking and opinions about the future, which has potential.

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