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FOURTH WAVE TECHNOLOGIES IN CONSTRUCTION AND ARCHITECTURE: FROM IDEA TO REALIZATION (PART 1: BASIC UNDERSTANDING, DEFINITION AND HISTORICAL EVENTS)

ТЕХНОЛОГИИ ЧЕТВЕРТОЙ ВОЛНЫ
В СТРОИТЕЛЬСТВЕ И АРХИТЕКТУРЕ: ОТ ИДЕИ ДО РЕАЛИЗАЦИИ
(ЧАСТЬ 1: ОСНОВНОЕ ПОНИМАНИЕ, ОПРЕДЕЛЕНИЕ И ИСТОРИЧЕСКИЕ СОБЫТИЯ)

The Industrial Revolution is the restructuring of society under the influence of innovations in technology and technique, which is accompanied by a jump in productivity. Today, the 4th revolution is taking place, which is rapidly changing the landscape of various areas of life, including architecture and the construction industry. The Industry 4.0 revolution connects technologies used in organizations and people's daily lives. It combines physical and digital technologies. But it doesn't develop as a daily simple life in architecture and construction industry like many other industries like as automotive, aircraft, electronic etc. ***The relevance of the study*** *is to study and analyze the stage of the historical event on the industrial revolutions (specially fourth industrial revolution) and his realization in today's construction and architecture industry.* ***Purpose of study:*** *a comprehensive review of contemporary and historical literature related to fourth industrial revolution, and his realization level in the industry with specific focus on construction and architecture industry. Thus,* ***the main tasks of the study*** *can be distinguished as follows: review of historical literature and basic understanding of the industrial revolutions; understanding of Industry 4.0 and its principles and benefits; reveal and introduce Industry 4.0 in construction and architecture industry; some samples about using Industry 4.0 in construction and architecture industry.The first part of the study is devoted to the basic concept, definition, and historical events of the fourth wave technology. In conclusion, the advantages and main problems of this technology are described. The research used the method of analysis of scientific and historical literature and documents related to the Industrial Revolution (specially fourth industrial revolution) and his achievement in the construction and architecture industry to achieve and formulate conclusions.* ***The conclusion of study*** *is about today's stage of realization of fourth industrial revolution in the construction and architecture industry and his point of view to next industrial revolution which start from 2017. The author believes that the development of the construction and architecture industry now and in the future depends on the attention and use of new industries and professionals in this industry specially IT specialists and technology.*

Промышленная революция – это перестройка общества под влиянием инноваций в технологиях и технике, которая сопровождается скачком производительности труда. Сегодня происходит четвертая революция, которая стремительно меняет ландшафт различных сфер жизни, в том числе архитектуры и строительной отрасли. Революция «Индустрия 4.0» объединяет технологии, используемые на производстве и в повседневной жизни людей. Она сочетает в себе физические и цифровые технологии. Но в архитектуре и строительстве она не развивается так, как во многих других отраслях, таких как автомобильная, авиационная, электронная и др. ***Актуальность исследования*** *заключается в изучении и анализе этапа исторического события, связанного с промышленными революциями (в частности, с четвертой промышленной революцией), и его реализации в современной строительно-архитектурной отрасли.* ***Цель исследования*** *это всесторонний обзор современной и исторической литературы, связанной с четвертой промышленной революцией и уровнем ее реализации в отрасли, с особым акцентом на строительстве и архитектуре. Таким образом, основными* ***задачами исследования*** *являются следующие: обзор исторической литературы и базовое понимание промышленных революций; понимание Индустрии 4.0, ее принципов и преимуществ; выявление и внедрение Индустрии 4.0 в сферу строительства и архитектуры; несколько примеров использования Индустрии 4.0 в строительной и архитектурной отраслях. Первая часть исследования посвящена основному понятию, определению, историческим событиям технологии четвертой волны. В завершении описываются преимущества и основные проблемы данной технологии. В* ***исследовании использован метод анализа*** *научно-исторической литературы и документов, связанных с промышленной революцией (особенно с четвертой промышленной революцией), и ее успехи в строительной*

The conclusion of the first part of the study outlines the advantages and problems associated with fourth wave technologies. ***The scientific novelty of the study*** *is to study, analysis, identify main factors of Industry 4.0, and collection of some samples of realization of this technology (fourth wave technologies) in construction and architecture industry.*

и архитектурной отраслях для достижения и формулировки выводов. ***Вывод исследования*** *заключается в сегодняшнем этапе реализации четвертой промышленной революции в строительной и архитектурной отраслях и ее точки зрения на следующую промышленную революцию, которая началась с 2017 года. Автор считает, что развитие строительства и архитектуры сейчас и в будущем зависит от внимания и использования новых отраслей и профессионалов в этой сфере, особенно IT-специалистов и технологий. В выводе первой части исследования сформулированы преимущества и проблемы, связанные с технологиями четвёртой волны.* ***Научная новизна*** *исследования заключается в изучении, анализе, выявлении основных факторов Индустрии 4.0 и подборке образцов реализации этой технологии (технологии четвертой волны) в строительстве и архитектуре.*

Keywords: *construction, fourth wave technology, 4IR, Industry 4.0, construction robot, artificial intelligence, augmented reality (AR), virtual reality (VR), extended reality (XR)*

Ключевые слова: *строительство, технология четвертой волны, 4ИР, индустрии 4.0, строительный робот, искусственный интеллект, дополненная реальность (AR), виртуальная реальность (VR), расширенная реальность (XR)*

Introduction

The relevance of the study. The Industrial Revolution is the process of transition from an agrarian economy characterized by manual labor and handicraft production to an industrial society dominated by machine production. The history of human activity related to the invention, design and manufacture of technical products and devices. It is a story of evolution from the handicraft production of single objects to the assembly industrial production of series products [1, 2, 3]. The development of mankind is inextricably linked with the progress of science and technology, which is confirmed by several industrial revolutions. Construction and architecture which appeared in ancient times and as an industry that creates complex technical devices, such as buildings and structures − is also evolving in this direction and went through several stages of evolution.

There are many reasons why construction has not yet evolved into precision housing. Many of these reasons lie in the realm of finance and marketing rather than engineering and technology [4, 5]. Where modern products of the automotive, aircraft, electronic and other industries of mechanical engineering have been phenomenal in reducing product costs through mass production and in increasing sales through clever marketing and distribution, the construction industry has choked. In light of the development of the concept of "Industry 4.0", the term "Construction 4.0" appeared but this term didn't develop in real life of humans like another industries!

Thus, the *research objectives* are as follows:

- *basic understanding of the industrial revolutions;*
- *review and analysis of literature about the industrial revolutions specially about Industry 4.0; its principles; main challenges and benefits;*
- *reveal and introduce Industry 4.0 in construction and architecture industry;*
- *search and find some samples about using Industry 4.0 in construction and architecture industry.*

Research methodology would be used literature review, pattern recognition, identification and conceptualization method for contribute the results of study. For this occasion, main stages and methodology of this research are like as follows:

- Literature review and analysis method: latest scientific literature, interdisciplinary text and documents with a suitable thematic analysis related to industrial revolutions, Industry 4.0, construction and architecture;
- Pattern recognition is the ability to see patterns in seemingly random information. The goal is to note the main patterns and concepts in the results of the first step. The second step looks for similarities or patterns in the sample and codes the results by concept;
- Identification method: to recognize specific, problems and characteristic of Industry 4.0 and its relation to modern construction and architecture (results of part one and two);

▪ Conceptualization method: in order to find a suitable theoretical connection between the identified concept and its relation to Industry 4.0, urban development, modern construction and architecture.

Main part

The Industrial Revolution is a period of global changes related to industrial production processes, machines and technologies that took place in Europe in the 18th and 19th centuries. This historical period led to tremendous economic, social and technological progress and was one of the most significant in world history. The technological changes that were taking place at that time gave impetus to innovation not only in industry, but also in many other areas of life. The process of industrialization began with the transformation of agriculture, the mining industry and the textile industry, which improved the lives of millions of people. One of the main industries which effected by industrial revolutions are architecture and construction industry.

Thus, the purpose of this article is to study the history and causes of the industrial revolution, as well as its consequences and effect on the latest industrial technology (4th industrial technology) in construction and architecture. We will review the key facts and events associated with this area, as well as discuss all the changes that it made to the development of mankind especially associated with architecture and construction industry.

I. Basic understanding and historical events of the industrial revolutions

The industrial revolution was actually huge and extensive transformations in industry and agriculture, factories and industries that took place in the period from 1760 to 1840. This revolution first started in England and continued in America. In fact, the industrial revolution occurred simultaneously with the industrialization of factories and industries and the use of machines instead of human power. England was very apt to start this revolution. The reasons are: the experience of several centuries of internal political transformation, the development of foreign colonialism, the expansion of the naval fleet, the growth of the country's middle class, the improvement of military affairs, the improvement of administrative affairs, and having resources such as land, labor, and capital.

One of the consequences of the industrial revolution was the expansion of European colonialism in Asian and African countries, which they exploited as workers. Other important consequences are: using devices to replace traditional and manual production methods, making new chemical materials and formulas, making new iron production methods, using water and steam power, the emergence of mechanized production factories, making machine tools, etc.

The industrial revolution had a great impact on the lives of some people and increased the variety and amount of products production and food. However, its negative impact on the lives of the working class and poor people was so great that many villagers migrated from rural areas to urban areas due to the high unemployment rate. All this fueled the expansion of industry in the city. The innovations and inventions of the industrial revolutions have created changes in trade, agriculture, the way people work, and the shape of societies. The effects of these revolutions have not stopped and continue to affect us and the world we live in. Each of the industrial revolutions that history has gone through is known by a name and a set of inventions and developments.

▪ ***The first industrial revolution (era of machine production; 1784-1870)***

The main characteristic of the first industrial revolution is the change of manual production to machine production with the benefit of steam and water machines (1760-1840). This method became very prosperous especially in weaving. Among the other changes of this period was the production of locomotives with steam engines, which, although it happened 100 years later, was due to the use of this method. We can trace these changes in other industries such as mining and agriculture.

It was the steam engine that became the symbol of the first industrial revolution. The use of steam power for industrial purposes was a great advancement for mankind. With the invention of the steam engine, instead of using his muscles, mankind used steam power to move businesses and industries. In fact, steam power was able to provide the necessary energy to move various factories and industries, and establish our dependence on various machines. The construction and development of the steam engine later led to the construction of locomotives and railway lines. As a result of this invention, Britain's road network, which was relatively rudimentary before industrialization, made a major improvement. In addition, steam-powered boats and ships became widespread, moving goods along Britain's rivers and canals, as well as across the Atlantic (fig. 1).

▪ ***The second industrial revolution (age of science and mass production; 1870-1969)***

With the introduction of steel and the use of electricity in factories in the early 20th century, the second industrial revolution began. Distribution of electricity in factories increased production speed, efficiency and productivity and helped the mobility

Fig. 1. Factory in the first industrial revolution

of machines in factories. The second industrial revolution was transferred to car production to the point where car parts were also produced together with cars. The result of the Second Industrial Revolution was railroads and telegraph networks, which enabled the faster exchange of people and ideas. The invention of electricity during this period allowed factories to develop modern production lines. During this period, the economy grew rapidly and productivity increased. The second industrial revolution also caused problems for the society, such as the increase in unemployment due to the mechanization of most of the work in factories.

It was at this time that Henry Ford drastically changed the process and production line of the car and moved towards mass production. During this time, cities grew; factories dispersed and people's lives were regulated by the clock instead of the sun. Although the working conditions in the factories were difficult, unskilled workers were cheap and plentiful. Therefore, people and even children were forced to work long hours in unsafe conditions that continued into the 20th century.

▪ ***The third industrial revolution (digital revolution; 1969▪ early 2000)***

After the changes caused by steam power and science in the first two industrial revolutions; this time, it was the turn of technology to change the course of the world once again. The third industrial revolution, also known as the digital revolution, occurred after the end of World War II as a result of increased technological advancements and industrialization. With manufacturers using electronic technology and eventually computers in the late 1950s, the third industrial revolution slowly emerged. During this period, automation software and digital technology were emphasized more. The use of a designed automation based on programmable computers with memory in a way that makes the entire production process automatic and without human intervention became popular. The next major breakthrough came with the advent of supercomputers that facilitated communication in the manufacturing process.

The third industrial revolution introduced large computers and the Internet into our lives; for this reason, this revolution is also known as the digital revolution. The advent of the Internet and computers changed not only countries but the whole world and brought countries one step closer to each other regardless of their borders and physical distance.

▪ ***The fourth industrial revolution (cyber physical system; 2000-Now)***

The fourth industrial revolution or "Industry 4.0" or "4IR", which we are currently implementing in the world. The characteristic of the fourth industrial revolution is the application of information and communication technology in industry. Systems and computers with third revolution technology expanded with network connectivity. This extension provided the possibility of communication with other input and output devices. The fourth industrial revolution increases a more comprehensive, broader approach and comprehensively concerned in the field of production and gives business owners the opportunity to control various aspects of production and to improve productivity, production and increase the rate of growth. This is made possible by better communication with the digital world (fig. 2).

The fourth industrial revolution is a worthy revolution that has been able to lead to the

improvement of processes and products [6, 7]. This smart factory collects data with smart and advanced sensors, software and robotics and makes faster decisions by analyzing the received data. As expected, those who switch to Industry 4.0 realize significant savings and increase the efficiency of their desired process. But if they don't give in to the fourth industrial revolution, they will face big obstacles, including the exorbitant costs of the processes. In a competition between a traditional process and an industrialized process with Industry 4.0, the latter will definitely win because it produces a better product in less time and with higher quality. Therefore, industrial automation is one of the important things that should be considered by industry leaders (fig. 3).

Some people think the fifth industrial revolution (2017 – Now) are exists and it will be the next breakthrough technological revolution, it will be faster and more scalable. The concept of "Industry 5.0" was presented in Germany at CeBIT 2017 in Hannover. At this event, Japan presented its vision for the future of industrial automation, robotics and smart manufacturing. The Japanese invention, called "Society 5.0", gave rise to the concept of "Industry 5.0" as the development of the original idea with the strengthening of the role of human. Industry 5.0 is the future of work, with people using robots and intelligent machines to increase productivity and economic growth. Workers will benefit from the help of robots and advanced technologies such as the Internet of Things (IoT) and big data, making work easier and prioritizing safety and collaboration. The 5th Industrial Revolution will empower workers and maximize efficiency. This industrial revolution

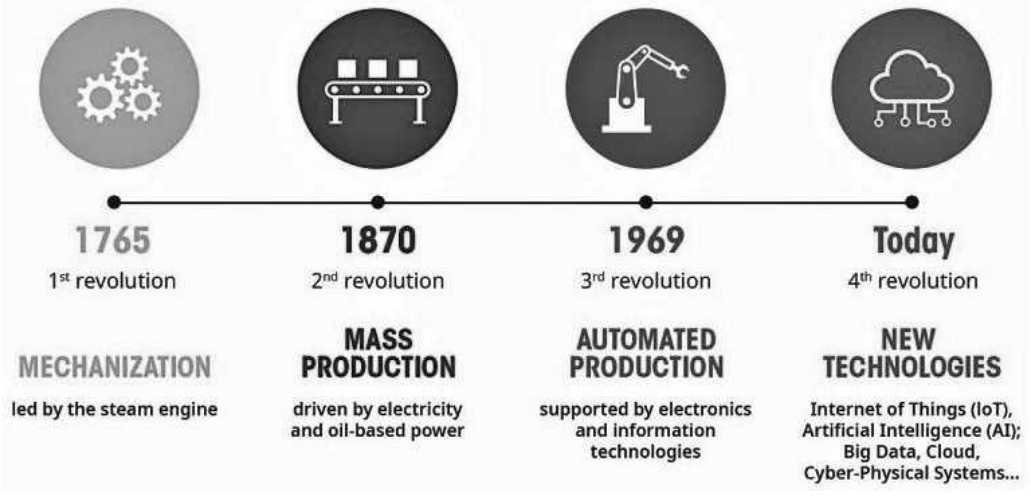

Fig. 2. Industrial revolutions timetable

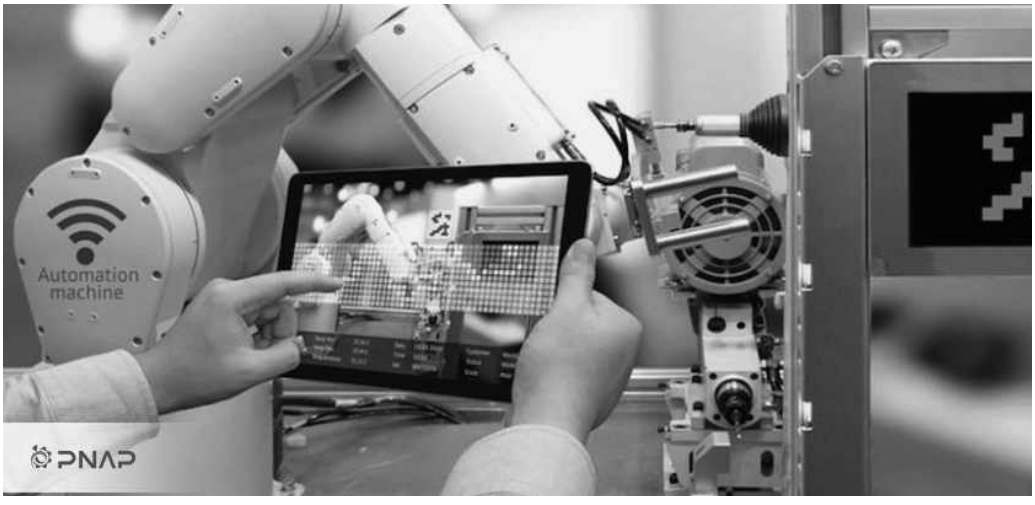

Fig. 3. The fourth wave technology concept

defenders tries to develop this idea yet and tries to set exact definition for it. For this occasion, this research tries to explore and concretize fourth industrial revolution in construction and architecture because these industries didn't develop sufficient during fourth industrial revolution yet.

II. What is fourth wave technology (or Industry 4.0)

For the first time, the name "Industry 4.0" was used to describe fourth wave technology among the strategy documents presented by the German government with the aim of "production computerization". Germany, as one of the most innovative countries in the industry field, is seriously trying to optimize its production and industry, and intelligentization is one of the most important methods in this country to reduce costs and at the same time maximize productivity in the field of industry.

The fourth wave technology seeks to increase productivity in the industry by using Internet and cyber capabilities and information exchange in general. The foundations of this technology can be considered as "cyber-physical dual systems", "Internet of Things (IoT)" and "Cloud Processing". At the same time as people's homes are becoming "smart homes" by Internet of Things technologies, the fourth wave technology is trying to make factories and industries smarter as well. In industries which equipped with fourth wave technology, a combination of cyber and physical systems will monitor physical processes within factories and industries, effectively creating a copy of the physical factory and allowing these hybrid systems to intelligently (and only, if necessary, with human intervention), for example, to make decisions about the production line of a factory. This method of managing a factory is also called "Internet of Services" (IoS). In describing the phenomenon of fourth wave technology, it should be noted that some of the names chosen for this new phenomenon (which is not exclusive to Germany) lack sufficient accuracy. For example, everyone agrees that the first industrial revolution refers to the mechanization of industry using steam power, the second industrial revolution refers to the phenomenon of mass production using electric power, and the third industrial revolution refers to the phenomenon of automation in factories using digital technologies. On the other hand, many believe that the term "Fourth Industrial Revolution" has been used many times during the past decades, and therefore, this term may not be considered exclusive to the phenomenon of industrialization and fourth wave technology. In addition, the issue of fourth wave technology only affects a part of the industry including manufacturing and construction, and is not yet generalized enough to be considered a revolution in the wider field of "industry".

▪ ***The four principles of fourth wave technology***

Experts believe that the fourth wave technology is based on at least 4 principles:

1. *Collaborative performance:* In the form of fourth wave technology, machines, devices, sensors and people are connected and communicating with each other through the "Internet of Things (IoT)" and the "Internet of People (IoP)" in order to achieve a final goal such as managing a production line.

2. *Information transparency:* The requirement of using the fourth wave technology is the ability of information systems to create a virtual copy of a part of the physical world (for example, a factory) using industrial designs with the aim of complementing the digital data of the sensors, and the requirement of this work is to collect the raw data of the sensors and convert them into information is more valuable and meaningful.

3. *Technical assistance:* Fourth wave technology provides technical assistance to the people using the technology in at least two ways: decision-making assistance and physical assistance. Therefore, physical-cyber auxiliary systems in industries equipped with fourth wave technology, firstly, by collecting and visualizing information in a way that is understandable to humans, provide the context for informed decision-making and immediate problem solving by human agents in the shortest time, and secondly, by performing a wide range of tasks that are inconvenient, tedious, or unsafe for the "human partners" of these systems are physically assisted by humans.

4. *Decentralized decision making:* Physical-cyber systems, in addition to the ability to help decision-making by human agents, can independently and automatically make decisions and perform their tasks. In this way, only in exceptional cases (for example, when there is interference or conflict in the work of two systems), the performance of a task is assigned to higher levels, i.e. human factors.

It should be noted that the German government, in addition to the above four principles, which is based on the principle of "extensive personalization of products in the conditions of [mass] production and at the same time very flexible" (in other words, the use of mass production line but with the aim of designing a unique product for each customer); also emphasized on "creating methods for self-optimization, self-adjustment and self-troubleshooting of intelligent systems along with the understanding and information support of these systems from human factors". In the fourth wave technology, a virtual plan of the factory or production line is provided to human agents for control and decision making (fig. 4).

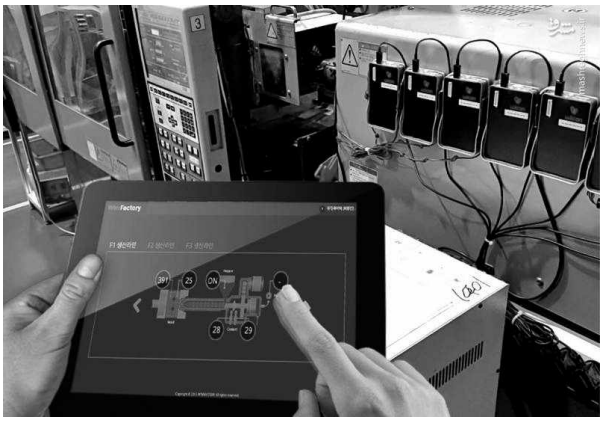

Fig. 4. The fourth wave technology in industry

▪ ***Benefits of fourth wave technology***

It may be that at first glance, the fourth wave technology is very similar to the third wave technology (digitalization of factories), but actually these two have fundamental differences from each other. For a third wave factory to be equipped with fourth wave technology, it is not enough to simply apply some "changes" in its production line or industrial devices, but the infrastructure of that factory must be transformed.

"Klaus Schwab", the German economist and founder and chairman of the board of directors of the World Economic Forum, in one of his books entitled "Fourth Industrial Revolution", specifies the fundamental differences between the fourth wave technology and the previous waves [1]. Schwab has written two books about the fourth industrial revolution. His first book titled "The Fourth Industrial Revolution" was published in 2016, which has been translated into 30 languages and has sold more than one million copies worldwide. His second book titled "Shaping the Future of the Fourth Industrial Revolution" was published in 2018. In this book, Schwab has briefly reviewed the past three industrial revolutions. Then he explained in detail about the fourth industrial revolution, its technologies, opportunities and threats and its 12 important categories of technologies. Finally, the book ends by explaining the role of humans in guiding the effects of this revolution. According to Schwab, fourth-wave technology is a range of new technologies merges the physical, digital, and biological worlds, affects all scientific, economic, and industrial domains, and even our ideas about what it means to be "human" are undergoing change and transformation.

But the main question is: why should the fourth wave technology replace the previous technologies? Experts have listed countless benefits for moving towards fourth wave technology, some of which (along with indirect benefits such as helping to preserve the environment) are as follows [8]:

▪ *Increase competition:* The development of fourth wave technology will create competition not only between different companies and factories, but also between different countries. For example, China, as a country that is still not considered an "industrial" country despite its giant economy [9], is now trying to become a leading country in this new field of technology by investing heavily in fourth wave technology. This way will take a big step towards industrialization.

▪ *Increase productivity:* Fourth wave technology increases productivity in various industries in various ways, one of which is increasing efficiency. The use of smart devices that can work more accurately and with less energy consumption will definitely increase productivity in the production sector. As some surveys in Germany show, the productivity in the production sector will increase by more than 60 % as a whole with the spread of the fourth wave technology. For example, it is estimated that by equipping the automotive industry with fourth wave technology, productivity in this industry will increase between 10 and 20 percent.

▪ *Increase employment:* Although a number of job opportunities may be lost with the intelligentization of devices, the use of fourth wave technology will eventually lead to increased employment among the educated and specialized class, and the same issue in improving the quality of human resources, especially in the fields of engineering and mechanics will be impressive. It goes without saying that employment in the field of information and communication technology, infrastructure and cyber security, and other fields related to the intelligentization of industries will also increase significantly.

▪ *Increase income:* Fourth wave technology is considered one of the main drivers of income growth in the production sector of countries. Although equipping industries with this technology requires significant investments by companies, cost-benefit estimates show that these investments will be compensated quickly and in the best way by increasing income.

▪ *Optimization of manufacturing processes:* There is no doubt that by using intelligent systems based on information technology and establishing close and meaningful communication between them, it is possible to make the best and maximum use of available resources (whether economic resources or resources such as water and electricity). Product production time in industries equipped with fourth wave technology will be significantly reduced due to increased

production speed. On the other hand, when the need for human intervention in a production line is minimized, sometimes restrictions (such as the number of working hours per day or night) are also practically removed from industries.

▪ *Development of ancillary (peripheral) technologies:* The fourth wave technology not only transforms various industries by itself, but also becomes the motivation and launching pad for the development of other technologies. Designers and manufacturers of production lines can use fourth wave technology as an infrastructure to create newer technologies. For example, nowadays, more and more companies are using 3D printer technology, and the fourth wave technology can help these printers advance as well [10, 11].

▪ *Improving customer service:* At present, monitoring and feedback mechanisms about a production line or factory take relatively much energy and time. Using the principles and methods of fourth wave technology, reports and statistics about a production line or factory will be collected automatically, and therefore the reaction to these reports will be accelerated. In this way, some reforms will be done intelligently in the system, and those reforms that require human decision-making will be formed much faster .

▪ ***Technologies of the fourth industrial revolution***

Technology has changed the world in many ways. Every new technology that enters human life is initially accompanied by the resistance of a group of people, but over time, it becomes an inseparable part of their lives in such a way that it will be difficult and impossible to imagine and remember life before their presence. New technologies are not completely out of control, nor can they be considered simply as a tool to be used; therefore, it is necessary to learn to interact with these technologies. The fourth industrial revolution will introduce 12 important technology categories into our lives. These technologies include: new computing technologies, block chain, Internet of Things, artificial intelligence and robotics, advanced materials, additive manufacturing and multidimensional printing, biotechnologies, neurotechnologies, augmented and virtual realities, extraction, storage and transmission of energy, climate engineering and space technologies.

▪ ***Benefits of adopting Industry 4.0***

Attractiveness for the workforce so that they can invest in new and creative technologies. The possibility of more cooperation among the members of a process and making the team stronger; because they can perform predictive analytics, process and enforcement, and allow operators to use data and information, and in this way, each person performs better in their area of responsibility [12, 13, 14]. Eliminate potential incidents before they occur; upfront analysis and Internet connectivity and automation allow for proactive troubleshooting and maintenance.

▪ ***Main challenges***

▪ The first challenge is to ensure that the benefits of the fourth industrial revolution will be fairly distributed. The wealth and prosperity resulting from previous industrial revolutions have been and continue to be unfairly distributed.

▪ The second challenge is managing the side effects of the fourth industrial revolution in terms of the risks and damages that follow. In the previous industrial revolutions, not many efforts were made to protect vulnerable populations, the environment, and future generations against the damages of unwanted consequences, change costs, secondary effects, etc.

▪ The third challenge is to ensure that the fourth industrial revolution is human-driven and human-centered. Human values should be intrinsically respected, not measured by financial criteria.

▪ It is expected that the expansion of fourth generation industry springs will decrease the level of employment with the increase of automation.

▪ The next challenge may affect personal privacy. Since this fourth revolution can monitor and control the entire process of an event, there may be legal or illegal access to personal data. Hence, data collection and processing can be used against others for personal gain or to rule over (governing) people [9].

Results and conclusion

Based on the summary of this study, we could draw the following conclusions:

▪ Basic understanding of the industrial revolutions in which describes four main industrial revolutions in the history based on literature review (starts from machine production era (1784) up to days cyber physical system);

▪ Describes the fourth wave technology (or Industry 4.0) and detection of its principles, benefits and main challenges;

▪ There is the concept of the fifth industrial revolution, but so far from its signs in construction and architecture;

▪ Using fourth wave technology has its advantages, disadvantages and risks, but do not forget that under the conditions of its refinement, the degree of human safety, accuracy and quality of work, economics and environmental aspects increases;

▪ Despite achieving good results from the use of this industry in construction and architecture, the final result of this industry construction and architecture is still far away and the concept needs to be refined in all aspects and details.

Conclusion

During the last three industrial revolutions, not only did people's personal and professional lives change over and over again, but sometimes they were even threatened. After each revolution, the world took a new direction. This time, the fourth industrial revolution will change our lives; although the speed and dimensions of this change will be very different and bigger than the changes of the past three industrial revolutions. Will the developers succeed in creating a complex developed system of using fourth wave technology in construction and architecture which everybody and construction companies using them for everyday working – we should work harder and will see in a few years.

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