Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 158 (2019) 590–601

Procedia Computer Science

www.elsevier.com/locate/procedia

3rd World Conference on Technology, Innovation and Entrepreneurship (WOCTINE)

Industry 4.0 in Terms of Industrial Relations and Its Impacts on Labour Life

Resul KURT[1] *

[1] *Istinye University, Faculty of Economics, Administrative and Social Sciences, Istanbul 34010, Turkey*

Abstract

In the 18th century, when industrial production began, the use of steam and mechanized production caused serious changes in the economy. As a result, production costs have decreased alongside increase in product quantity and product quality. In this period, production has undergone a revolutionary transformation from manual labour to mechanization.
In the following decades, the mass production with the help of electricity have resulted with the Industry 2.0 Era, and then, the emergence of digital revolution, the use of electronics and the use of information technologies in the production processes has triggered the Industry 3.0 Era.
Today, the internet of objects, the industrial networks, the cyber-physical systems and the incorporation of robotic technologies into the production has brought the Industry 4.0 Age into the stage. Industry 4.0 has created a new production model where robots are effectively used in production, this new production model has begun to change the daily life, production and working relations as deeply as the first industrial revolution.
However, the potential impacts of Industry 4.0 over the labour markets still remains as an understudied scholarly area. It is being evaluated that Industry 4.0 will lead to technological unemployment via changing the structure of employment and bring new structural problems in terms of unemployment and labour relations. Likewise, it is expected that automation and robotic production will deeply affect the unskilled labour force, and will cause a critical decrease in the workforce of vulnerable sections of society, i.e., women, migrants, youth and elderly.
This study evaluates the probable effects of the 4th Industrial Revolution over the labour markets. Via the literature review and analysis of the emerging trends with Industry 4.0, the risks, opportunities and challenges of the process is being investigated within a comparative perspective.

Peer-review under responsibility of the scientific committee of the 3rd World Conference on Technology, Innovation and Entrepreneurship

Keywords: Industry 4.0; Labour markets; employment; technological unemployment; entrepreneurship.

* Corresponding author. Resul Kurt Tel.: +90532 465 45 92
E-mail address: info@resulkurt.com

1877-0509
Peer-review under responsibility of the scientific committee of the 3rd World Conference on Technology, Innovation and Entrepreneurship
10.1016/j.procs.2019.09.093

1. Introduction

In the 18th century, the use of steam power in the industry and the initiation of mechanization resulted with the transition from the man power to the power of the machine, and consequently the production costs decreased, and the standardized and qualified products were sold to a wider audience as an inevitable result of mechanization.

Towards the end of the 19th century, the second industrial revolution based on the division of labour started to arise with the help of the use of electrical energy, and with the discovery of the telegraph and telephone, communication technologies began to spread. In the second industrial revolution, unlike the first example, the importance of scientific knowledge has emerged. [1] The adaptation of electricity and information technologies to production was named Industry 2.0 and 3.0, consequently. Finally, with the inclusion of Internet of Things and Cyber-Physical Systems, Industry 4.0 is beginning to affect every aspect of societies in today's world.[2]

The term 'Industry 4.0' was first used in 2011 at the Hannover Fair. In October 2012, Robert Bosch GmbH and Kagermann have created a working group and presented the fourth industrial revolution proposal file to the German Federal Government. On April 8, 2013, the working group presented The Final Report on the Industry 4.0 at the Hannover Fair. [3]

Industry 4.0 generally presents itself with the applications of employment of robots in industry and production, production with three-dimensional printers, development of artificial intelligence and big data studies. These changes, which also known as the Internet of Things, the Internet of Everything or the Industrial Internet, are being characterised with four distinguishing features from the previous industrial revolutions: Cyber-Physical systems (CPS), Big Data and Digital Information Exchange, Smart Robots and Digital Industrialisation. Accordingly, smart factories will automatically adapt production conditions to current conditions and organize production plans according to order demands. Robot technologies are promising to increase the impact of the Fourth Industrial Revolution, Industry 4.0.[4] In this regard, artificial intelligence, which is a key for this transformation, is the ability of a computer or a computer-controlled machine to perform various activities by analysing human thinking methods and techniques. [5]

The difference of the Industry 4.0 revolution, which will bring many changes from production relations to social relations, from cultural structures to political movements, is the fact that it is promising to evolve to a coordinated structure by triggering the developments in technology one after another, and that it is being expected to show its effects in every field of scientific progress.[6] In this context, there will be transformations in the employment and employment models with the emergence of Industry 4.0. Some occupations are being expected to emerge while some others begin to disappear and will decrease considerably.

In this study, while the historical development process and conceptual framework of Industry 4.0 are examined, the effects of Industry 4.0 over the labour relations is being examined by investigating into the views of employees and managers.

The study consists of three parts. In the first and the second section, the historical development process of Industry 4.0 and the conceptual framework and characteristics of Industry 4.0 are discussed consequently. In the third section, the possible effects of Industry 4.0 over the labour life is being evaluated.

2. Historical Development

In terms of social evolutions, five different societies are mentioned within the history of mankind. These are respectively; the hunting society, the agricultural society, the industrial society, the information society and the super-smart society (Society 5.0) which is emerging with Industry 4.0. [7]

The first development that can be defined as the breaking point in human history; is the transition to the position of the producer by taking care of the land with the settling of the nomadic societies who were engaged hunting and gathering. [8] In order to make their production more productive, societies started to change their lifestyle as to domesticate animals, cultivate crops and establishing several social organisations alongside these. [9]

The First Industrial Revolution was first introduced in 1712 by a steam engine invented by Thomas Newcomen, and the steam engine developed in the 1760s began to show its effects radically by the mechanization of weaving looms in England. The construction of the railways and the contribution of the steam engines facilitated mechanical production. [10] The machines, which has shown a rapid increase in terms of quantity and quantity, have used the steam power dominantly in the first place. As it evolves, the use of coal and later on oil, instead of wood and bio-fuel has enabled the machines to become more widespread. [11]

The concept of industry is constantly changing due to the methods used in production and management of production process. This change not only affecting production processes or industry, but also the social demographic structures, cultures and economic conditions of countries, and it may even cause the countries' maps to be redrawn. [12]

The Second Industrial Revolution refers to economic, commercial and social changes in the period 1870-1914. The decisive factors of the Second Industrial Revolution are the development of railways due to the technological transformation created by steel production, facilitated transportation, communication and distribution methods; acceleration of trade with new transportation opportunities; the contribution of oil and its derivatives in the economy; electrical, oil-based internal combustion engines and the development of the automotive industry. In this process, the stock markets are being formed with the opportunities provided by transatlantic telegraph and radio connections. This change also triggered new developments in the labour life, the increase in the rate of white-collar employees in employment resulted with the acceptance of trade unions, which has changed the industrial relations dramatically. Alongside these revolutionary transformations, radio, gramophone, photography, cinema and new forms of consumption, concepts and arts have emerged. [13]

At the beginning of the twentieth century, when Henry Ford began to produce the car serially, many of the oldest production-intensive traditions were terminated. The price of a car went dramatically down and the number of people who acquired it increased exponentially. In 1914, a record is being broken by assembling the T model's chassis at the factory in the US within 93 minutes from the beginning of the production to the other end. [14] The central element of the Fordist economic structure is the mass production that is articulated with mass consumption (connected with the welfare state conception) based on the principles of "8-hour work day, $ 5 wage and flowing production line". [15]

As a result of the first phase of the industrial revolution, the transportation, which has developed with railways and thus the rapid growth and acceleration in trade, led to the demand of the railways to the production of durable steel, and this has plated a role of driving force for the new stage of the industrial revolution. The decisive factors of the Second Industrial Revolution were the importance of petroleum and similar raw materials in the economy, the introduction of electricity, the operation of oil-fired internal combustion engines and the development of the automotive sector. Moreover, stock exchange are further developed and new opportunities created by the development of telegraph and radio connections. [16]

Towards the end of the 1900s, the development of electricity, electronics and computer systems was called the informatics revolution and opened the doors of the Third Industrial Revolution. [17] Programmable machines which are being developed in 1968 with the more active use of scientific knowledge, has eventually led to the beginning of the third industrial revolution. With the beginning of this period, the Fordist production method has left its place to Post-Fordism. [18]

Water and steam power of the First Industrial Revolution has left it place to oil and electricity in the Second Industrial Revolution and to the solar energy and wind power, which are renewable, in the Third Industrial Revolution.

The basis for the development and prosperity throughout these stages is capital accumulation; the allocation of capital through inclusive institutions. From this perspective, Industry 4.0 will be affecting societies by three innovation areas. These innovations are strengthening innovations, sustainable innovations and efficiency innovations. Strengthening innovations are the accumulated effects of a series of innovations that are complementary and that can be collectively organised. First of all, the strengthening innovations that are being applied in the product and production methods have tremendous effects. The term sustainable innovations refers to the innovations which are enabling today's products as to consolidate the place of the innovations of the past. Sustainable innovations are based on product differentiation; differentiation is one of the important competition tools of the industrial economy period. [19] Efficiency innovations on the other hand refers to the productions which are taking serious impacts in every stage of production of goods and services. As the large and well-established innovations reduce the cost of product development, production methods, activate processes, storage and distribution, they trigger the release of a significant amount of resources in the final analysis even if the labour is the main factor in the initial step. [20]

In the 21st century, with the combination of communication, computer and internet technologies, Industry 4.0, also known as the 4th Industrial Revolution, took its place in the society. In this period, the need for arm and muscle power, which are the traditional labour factors, almost disappeared and the machines started to manage both themselves and the production processes on their own. [21]

3. Conceptual framework and properties of industry 4.0

3.1. Conceptual framework

The Fourth Industrial Revolution began with this century and is rising over the promises of digital revolution. It is being characterised with faster, cheaper and more common mobile internet, cheaper, smaller and more powerful sensors, the artificial intelligence leading learning machines. [22]

Beyond speed and breadth, the fourth Industrial Revolution is unique because of the increasing harmonization and integration of many different disciplines and innovations. [23]

In this stage, the new technologies and developments integrated into our lives, i.e., 3D printers, qualified robots with artificial intelligence, biotechnology, Internet of things, unshielded screens, artificial fields, driverless vehicles, digital integration and data-driven services with basic data, Hyperloop, Cyber-Physical Systems, Virtual reality. All of these are affecting our daily lives critically. We will see the technological developments that we can discuss under Industry 4.0 in the near future. The technology that comes with the Industry 4.0 is also very important in terms of a breakthrough in production. Today, it is seen that the basic condition of development is to follow the innovations of Industry 4.0 and to produce and adopt to this technology. [24]

From enterprises managed with a single brain or brain teams until the revolution of Industry 4.0; we are transforming into enterprises which are being managed by all employees, partners, dealers and especially customers of the enterprise. In Industry 4.0, we will produce together with the personalized producers and we will consume together. [25]

Industry 4.0 is a collective whole of the concepts of technologies and value chain organizations. It is based on the concept of cyber-physical systems, internet of things and the internet of services. This structure makes a great contribution to the formation of intelligent factories vision. Industry 4.0 generally consists of the following 3 structures:

- Internet of Things,
- Internet of Services,
- Cyber-Physical Systems. [26]

All these developments led to the beginning of the 4th Industrial Revolution, with the effect of factors such as cyber-physical systems and the communication of objects (Internet of Things) as well as the possibility of innovations that were not possible before. [27]

The Fourth Industrial Revolution is not just about intelligent and connected machines and systems, its scope is much broader. From gene sequencing to nanotechnologies, from artificial intelligence to the internet of objects, from renewable energies to quantum computing, a series of simultaneous waves of progress are taking place. What differentiates the Fourth Industrial revolution from the earlier revolutions is the intermingling of these technologies and the interaction in physical, digital and biological fields. [28]

With Industry 4.0, there will be a new production model where automation systems, data exchanges, 3-D printers and robots are used effectively within an environment of smart factories.

Industry 4.0 is in many ways different from its predecessors and is about to open the door to a whole new era. The progressive promises of the Industry 4.0, will enable both new technologies to trigger each other, and will lead to immediate developments in industry and other areas of science and technology. Thus, its effects will not be just linear but vertical as well. In the 21st century where individuality is becoming more and more important, industrial production will also be made tailor-made. Therefore, the production and even economics as a whole will face new questions and new problems. [29]

Industry 4.0 is a process that brings with it challenges and opportunities. New products and services that are increasing the efficiency of personal life, reduced transport and communication costs, easier logistics and global supply chains are some of these opportunities. [30]

From this point of view, while Industry 4.0 forces labour markets and production methods to transform, it would be impossible for classical production methods and industrial relations to oppose this transformation. Together with Industry 4.0, it is expected that changes and transformations in the production methods of goods and services will trigger changes in the industrial relations first and in the socio-economic and cultural structures eventually.

It is expected that efficiency of production systems will be ensured by saving resources. In addition, it is expected that this savings will be sustainable and the productivity will increase while costs are decreasing. Production systems are transforming into a more complex structure every day. Thus, with the transition to automation/control systems, a decrease in the number of active human personnel and an increase in the level of education of the personnel using the

production equipment are expected to outcome. It is planned to make data processing easier with supercomputers and smart systems, and even to develop computers which have the processing power of the human brain in a decade or so. In the process of value creation, the use of three-dimensional printer systems in the production process has shortened the production processes. With the increase in the value chain, customer satisfaction will be provided at maximum level and industrial internet will allow new business models to emerge. [31]

Today in Turkey, if these targets are not reached any delays will increase the social costs. In Turkey, within the scope of the Industry 4.0, the priority is to create new technological infrastructures and expert staff who can work with these infrastructures. In order to be able to compete in global markets, it is vital to absorb the benefits of this new industrial era. Because non-innovative organizations will be deleted from the market in the short term as the Industry 4.0 emerges. Gaining momentum in the realization of the Industry 4.0 revolution depends on organizations completing their digital transformations. It is impossible for enterprises that have not taken this transformation within both the infrastructure and organizational culture contexts to catch the new age.

2016 dated "Digital Revolution in Turkey, the CEO's Perspective Report" is being written as a result of face-to-face interviews executed with 58 senior executives of Turkish companies. The research has been carried out with companies operating in important sectors such as Banking, Holding, Retail, FMCG and Telecommunications. According to these senior executives in Turkey, the understanding capacity rate among the employees regarding the digital strategy of the company is 66% and the C-level managers who are giving direction to the application also rose to 38%. When the digital competence level of their companies is being asked to the senior executives; 7% have said that they have a digital structure with an elementary level, 59% have said they have a digital structure with an intermediate level and only 34% have confirmed that they have an advanced digital structure. In addition, one of the most critical questions of the research is how much companies invest in digital development. The average rate for this question's answers is 27%, which is promising. [32]

3.2. Properties of industry 4.0

Industry 4.0 is the revolution in which jobs requiring unskilled labour is being executed by the robots and value-added skilled labour is specialising for creating more productivity. [33]In this respect, Industry 4.0 deeply influences both the qualifications of the work, the identity of the worker and the worker-employer relations.

The Fourth Industrial Revolution, or the so-called Industry 4.0, was first used at the Hannover Fair held in Germany in 2011, and was announced to the world in 2013 by the German National Academy of Science and Engineering (Acatech) in the 'Industry 4.0 Manifesto'. Industry 4.0 focuses on end-to-end digitization of all physical assets and integration into horizontal and vertical value chains with digital ecosystems. In other words, ICT, which aims to bring information technologies and operational technologies together, is a situation that affects and intensifies the production processes. [34]

Digital transformation affects every part of society in different ways. This digital transformation is interpreted and named differently according to the needs and priorities of each country. As a two remarkable example, it is being named as the Internet of Things, mostly in the United States, however as Society 5.0 in Japan and as Industry 4.0 in Germany and Turkey. [35]

Although digital transformation primarily manifests itself as mechanization in production, it also affects social life, human systems and demographic structure. In addition, getting the connection and getting the highest efficiency in the production systems where the human-machine interaction is carried out intensively, necessarily will bring social changes. [36]

Many global companies are researching and developing on the application possibilities of the Internet of Objects in order to ensure global competitive advantage. When completing the development of the Internet of Things, not only objects but also people's participation in this large network will be of greater benefit. Therefore, the concept of Internet of Things is expected to evolve as the Internet of All Things in the future. [37]

When we think that technological and innovative products that we could not have imagined years ago are now in each and every moment of our daily lives, we can better understand what innovations Industry 4.0 could bring in the forthcoming years.

Another very important reason for the emergence and implementation of Industry 4.0 is the change in consumer demands. In today's world, consumers have begun to feel the need to reach new products quickly because of the globalized world and the amount and variety of products produced have increased. In addition, the need to meet individualized customer demands is considered to be one of the factors triggering the last industrial revolution. [38]

Moreover, personalized manufacturers are also needed in order to produce customized products prepared according to the demands of customers in Industry 4.0.

With Industry 4.0, it is possible to produce more and better-quality products at lower costs, and to bring them to the customers more quickly with new transportation technologies such as drone and unmanned vehicles from the enterprises based on robotics and automation.

4. Industry and industrial relationships: the reflections of technological developments over the employment and the labour force

Industry 4.0 is a transformation based on cost minimization and productivity increase in the production line. The fact that conventional milling is replaced by intelligent factories makes the perception that the structural characteristics of the labour market is set to change. [39]

Industry 4.0 is creating the factories of the future where the production lines are to be connected with each other via sensor systems, instant data exchange takes place and thus software and algorithms in an entire system can be converted into instant reports. The business world has to adapt quickly to the new way of producing and doing business. It is no longer possible for businesses to remain outside the electronic information networks linking institutions and organizations. Intelligent factories, dark factories and internet of things will be operated with the remote management approach where human is involved at least over the internet and in which high efficiency will be provided. [40 This directly affects the critical position of the labour force, which is the power of production in today's production model, and transforms the labour relations way far from the classical industrial relations formula.

We can designate the four most important elements that distinguish Industry 4.0 from other industrial revolutions as Sensors, Data, Information and Operations. By combining these four, unskilled labour forces are eliminated. [41] With the acquisition of robots and machines which will replace the unqualified workforce, character and qualifications of labour force as well as the number of the workers in a given industry set to change dramatically.

The mechanization of production processes will inevitably draw the working class from the labour market, and consequently an increase in the army of the unemployed. [42] In fact, the possibilities produced by Industry 4.0 is realising Marx's foresight.

When it is called robot, humanoid structures, artificial intelligence, machines that act with the algorithm and the robot arms in factories are coming into the mind.

As can be seen in the second and third industrial revolutions, it is a necessity for the exchange and transformation of skills in every industrial revolution. Today, we are facing a similar situation in Industry 4.0. [43]

The fourth industrial revolution is based on a background based on information and communication technology. Training the young population on these foundations and providing the necessary qualified workforce [44] beginning from primary education, vocational high schools and universities, and giving education on coding, software, robotic technology will ensure the evolution of the workplace.

In this sense, with the new industrial revolution, some professions will come to an end, and new and high professions that require high knowledge and technology will emerge. On the one hand, while unemployment is expected to increase, on the other hand, employment will be increased in the new jobs and occupations that will arise. In this new era, the first countries that can be able to develop and use technology are expected to decrease rather than the increase in unemployment, whereas on the other hand, it is estimated that the countries that cannot be able to adopt themselves to the technology and who are latecomers in this field may experience unemployment problems. [45]

Since the first industrial revolution, the need for more qualified labour force has always been raised in different periods. In the fourth industrial revolution, it is inevitable that some professions end and some professions change. The professions that will shine the star can be enlisted as technical professions, professionals in the field of information technologies, internal audit expertise, digital human resources expertise, digital marketing expertise, interface design, data analyst, big data management etc. [46] When we look at the historical process, it is seen that every innovation and change leads to the emergence of new professions while causing some professions to be lost or lost. For example, the professions such as Copperworking, Tinnedness, Blacksmith, Saddle-producing, Stone Carving, Wooden Spooning, Straw Grinding, Basket Weaving, Willow-producing, Pottery and Gramophone Repair stand out as lost professions. Similarly, within a period of time less than two decades, we will witness that the most popular professions of today such as SEO specialist, Edge Computing Expert, 3-D Printer Engineering, Data Security Engineer, Machine Learning Engineer, IT/IoT Solution Architecture, Cloud Computing Specialist, Wearable Technology Design and Data Security Expert-ship will be absent or unknown.

It is expected that in many areas change the characteristics of the workforce, the disappearance of many professions, the emergence of new professions, in other words, evolution of the workplace. What is important at this point is to achieve compliance with the process and to identify opportunities and threats correctly. Although the concerns are not different from the 18th century, there will of course be different in terms of what will be experience. The Fourth Industrial Revolution has many opportunities and threats. The idea that the revolution will only affect the production process remains simple. As in the other three revolutions, the transformation in the production stage in the Industry 4.0 process will seriously affect the labour relations and hence the social, economic and legal structure. [47] In the fourth industrial revolution, new professions, new job descriptions, new sectors, new initiatives and new business opportunities will emerge. [48]

One of the most important concerns about employment is the concern that in the future robots can replace the human workers and that unemployment may increase. However, rather than saying the producing robots will result with unemployment, the labour force needs to align itself as to fit the need of the new era and to canalize its potential into areas such as robotics and automation on the one hand and into areas as social sciences, anthropology, services sector, natural life expert-ship, organic products, education, agriculture, livestock business and technology business. New professions, new products, new processes, new production methods and new technologies are to be produced by the humans. The transformation of a production process into a digitalization process does not mean that all employment will be adversely affected. On the contrary, people should respond to this process with more than one transformation strategy and with innovative changes. As Turkey is in a threat zone in terms of the high possibility of faster-than-expected unemployment rise, evaluating the threats and opportunities of the new era consists a more imminent responsibility for emerging countries such as Turkey. [49]

As far as technological trends are concerned, companies can be expected to turn to the joint work of human and machine, simplified applications and light robots in the future. Two-arm robots, mobile solutions and the integration of robots into existing environments can be added to this. There will be an increasing focus on modular robots and marketable robotic systems at extremely attractive prices. Demand among customers for industrial robots is also due to various factors. This includes addressing new materials, energy efficiency, more advanced automation concepts, and linking the real-world factory and the virtual world according to the definition of Industry 4.0 and the Industrial Internet of Business. [50]

With the widespread use of robots in many sectors, especially in production and industry, the effects of this over the labour force is being defined as ‘technological unemployment’ in the literature.

The factories, which are using robots most commonly, should prepare themselves more efficiently. Because as a requirement of the industry 4.0, the robots in the factories are becoming active members of employees and working teams, rather than upholding the sole purpose of helping people. For this, it is very important to ensure that people and robots work together in the most proactive manner. [51]

For the future professions, the institutions and organizations related to employment, especially public agencies such as the Turkish Labour and Employment Agency, have been working on developing vocational technical skills by raising their awareness levels. The workforce of the future will consist of the Generation-Z, and the work habits and performances of this generation are not well researched yet. Therefore, it is not known to the extent of the negative scenarios proposed in real economic and social life. The important point is that, Turkey's having a significant potential for the future of this country with its young population and is doing its utmost potential for use in the most efficient manner. With the new regulations to be made in the curriculum and applying success criteria in the field of middle and higher education, it may not be difficult for the young population to reach the desired level in Turkey. [52]

One of the consequences of globalization is that international capital is directed towards countries where labour is cheap, and that the labour force in the origin country faces unemployment. It is being complaint on that, the industrial investments facing towards the underdeveloped and developing countries from the developed countries is resulting with unemployment in the origin countries. Countries facing with unemployment rates which are reaching two-digit numbers, in particular the EU-member countries, are seeking new recipe for the solution of this new problem. In this sense, the multinational corporations are requiring democracy and transparency. [53]

Due to the low labour costs in labour-intensive sectors, the investments directed to the underdeveloped countries will be brought back to the developed countries together with Industry 4.0. Nevertheless, underdeveloped countries will enter a new era of unemployment and unemployment will be higher in unskilled labour.

According to the evaluations of Frey and Osborne from Oxford University; soon, 47% of the current jobs in the United States are in danger of being replaced by computer technologies. A similar study conducted for Germany indicates that as a result of the digital revolution, 59% of the jobs are at risk. This ratio is 57% for the Organisation for Economic Cooperation and Development (OECD) member-countries. Deeper analysis suggests that the likelihood

of replacing work done by computer technologies varies considerably between different working groups. [54] Another study examining the labour market concluded that more than 50% of current jobs in Sweden can be replaced by computers and robots over the next 20 years. It is clear that this process of change will not affect the labour market equally. At this point, it is foreseen that the labour market will be divided into segments such as low skilled/low wage earners and high skilled/high wage earners. [55]

It is seen that two-thirds of people in the US believe that most of the work that people do is done by robots, but 80% of these people have a foresight that their work will not be affected by this process. [56] It is stated that the first impact of Industry 4.0 in the labour markets is primarily technological unemployment, as in other industrial revolutions. [57]

Industry 4.0, however, will leave skilled professionals unemployed primarily and professions which have the change to work on their own account with unskilled labour. [58] Sooner or later, the work of many different professions, such as jurists, financial analysts, doctors, journalists, accountants, insurers, and librarians, will be partially or fully automated before most people envisioned. [59]

It can be foreseen that Industry 4.0 will be in a tendency to increase the supply of skilled labour in the areas of software, coding and robot veterinary in the labour market. The fact that qualification could be realized in a short term in the Fordist production model has resulted little impact over the characteristics of labour markets. In the process of Industry 4.0, the acquisition of skills by the vocational and technical education of labour force is an unpredictable compensation policy in the short term. In this case, short-term unemployment in the labour market could concentrate more on unskilled labour workers and the skilled workforce will not be able to respond to the increase in supply during this short-term. This would result with a labour market on the one hand increasing wages of a small amount of skilled labour, on the other hand decreasing trend in the wages of the unskilled labour force. [60]

According to the 2015 Global Gender Gap Report of the World Economic Forum (10th Edition), occupations in which both men and women work intensively are at risk from automation. Unemployment will be higher as a result of automation in sectors dominated by men such as manufacturing, construction and installation. However, the increasing capabilities of artificial intelligence and the ability to digitize the tasks in the service sector are the result of the automation and this would also supress the labour demand in the occupations such as call centres and retail sector in which women are traditionally occupying a larger ground. [61] In other words, because of the automation of many jobs it is being expected that the female labour force will face the most job loss. It is suggested that creating new jobs instead of lost jobs will not be as much proportional as the works created in previous revolutions. [62]

It is understood that the blue-collar workers of the past industrial revolutions are no longer needed and white-collar workers will only be employed on the areas that cannot be filled by automation and robotics. Yet, grey-collar skilled labour force and gold-collar workers have the opportunity to work in-line with their capacity to benefit from their knowledge, skills and experience. [63]

New technologies show their presence in the production structure in the first stage. But the transformation in the manufacturing industry can affect the direction of supply and demand in labour markets and consumer behaviour in the second stage. Efficiency of companies to save workforce, provide stock management, ensure effective process management, apply quality management, and to control the processes of sales and after-sales services are offering a wide range of opportunities in terms of efficiency. [64]

The displacement of the workforce by machines may cause a reduction in employment rates, as well as minimizing the failure rates in production. Critical factor for humans to participate in production is the ability factor. This can deepen the low skill/low wage, high skill/high wage gap. [65]

According to the World Economic Forum's 'The Future of Jobs' report, 65% of primary school students' future professions will be in the in yet-unknown professions and these professions will require a high level of creativity, problem-solving, logical and mathematical reasoning, and visual ability. [66]

Additionally, it is being predicted in the same report that [67] data analysts will be more demanded in all sectors in the future. Computer programmers, software developers and information security analysts will be ranked second in the field of computer and mathematics. Architecture and engineering, specialized sales-people, senior executives, product designers, human resources and organizational development experts and state relations experts are also added as the second. Almost every sector, every business area will be digitalized as mentioned here, and each will become a separate line of business. [68]

Increased demand for expert technical skills may increase gender inequalities and the divergence between male roles and female roles, as the weight of men in computer science, mathematics and engineering professions persists. However, demand for roles based on human characteristics and abilities, such as empathy and sensitivity, can grow,

which machines cannot fill. Females, overwhelmingly occupy the occupations such as psychologists, therapists, coaches, activity planners, physiotherapists, nurses and other health care professions. [69]

Industry 4.0 and its infrastructure will transform developed economies and the global economy will be fully affected. For example, automation works will return to the EU and the US. By 2020, 30 billion intelligent objects will be used around the globe and 47 percent of today's businesses will be able to automate. In today' world, some production costs are less than in China and India in Northern Europe and North America. In 2020, 30% of US imports from China are planned to be produced in the US. World giants (GE, Otis, HP, Apple, Caterpillar, Ford, etc.). In other words, this would be the beginning of a shift from the Far East to the US and Northern Europe. [70]

Industrial production 4.0 first brought the robotic technology and employment problems to mind in Turkey. In fact, the days in which people work with more information, decision and direction, management and continuous application development rather than the crude muscle force do not seem so far.

People working in production in the fourth industrial revolution will not lose their jobs to a large extent, but their job descriptions and professions will change. Today, blue collar employees will be transformed into knowledge workers simultaneously with various trainings in industry 4.0. The next generation will be eligible for the new period starting with primary school, with Industry 4.0 and technology training. Industry 4.0 will cause changes in many areas such as industry, technology, community welfare, technical infrastructure, education, production and consumption. [71]

According to the 2017 Labour Market Survey report conducted by Turkish Labour and Employment Agency (İŞKUR) for the Information and Communication sector, it has been determined that 170.347 people are employed in the establishments included in the research and 65.9 percent of the employees are male and 34.1 percent are female. 60.6 percent of those employed in the sector, such as a large proportion, is located in Istanbul region. It is determined that 63.7 percent of the employees in the Information and Communication sector work in the establishments which are employing 20+ employees. [72]

It is expected that the Fourth Industrial Revolution will facilitate a lot of work in the production and service sector with the use of high technology.

There may be some disadvantages of new technologies as well as many other benefits. In the beginning of these, human health will be protected in some sectors which are very dangerous and harmful for human health (chemical, paint, yarn, mine and construction) by employing robots instead of workers. In this way, those who are wasted in the work accidents can be transferred to other areas by educating their employees, others can be allocated to retirement or job-loss compensations. [73]

Nowadays, human and machine are working hand in hand together with human robot cooperation in many new applications besides unmanned-dark intelligent factories. While doing human production control and follow-up, robots are physically exhausting and doing wrist-based work. Thus, they both contribute in accordance with their attributes and special abilities (TMMOB Makine Mühendisleri Odasi İstanbul Branch, no-date).

The innovations introduced by Industry 4.0 are not only in terms of professions. Worker and employer will also change their relationship. The tasks and projects that are divided over human cloud platforms are carried out by the workers who are more independent rather than the dependent traditional employees. Some of the workforce will be able to work as semi-independent such as a UBER driver, an Instacart shopper, an Airbnb roomer or a Taskrabbit installer. In this process, they will not be subject to obligations such as minimum wage, employment tax and social insurance for those who are categorized as self-employed. [74]

Another area which would be tremendously effect from the change of industry will be trade unions. The power of workers' unions against employers will decrease with the replacement of robots in enterprises instead of manpower and the spread of free work with human-cloud platforms. [75]

The expected changes in working life can be listed as follows:

- The need for unskilled labour will be reduced,
- The need for skilled workforce and digital skills will increase,
- New professions and jobs will be created instead of lost professions, and many new job opportunities will emerge,
- The importance of flexible structures with the capacity to respond quickly to changes in working conditions will increase,
- There will be transformation in social structure,
- Occupational health and safety will be supported by robots and more stringent measures can be taken against the risks.
- In the face of cyber security risks, the concepts of vocational education and lifelong learning will gain more importance.

- Man and machine will work together in human robot cooperation,
- Trade unions will lose their importance and power,
- Working times will be reduced by improving work conditions and work-life balance,
- Freelancers will increase through human-cloud platforms,
- Unqualified worker wages will fall,
- Wages of qualified workers will increase.

It is thought that especially dangerous works will be done by robots, and the loss of life will be reduced due to work accidents.

In terms of business relations, Industry 4.0 will cause serious changes. However, these breakdowns not only will occur in countries that have completed their industrial infrastructure, but also in developing and industrializing countries. In fact, Industry 4.0 is expected to have more impact in developing countries as mentioned in the previous sections.

As the emerging countries which have not yet completed their industrialization could not transform the education system into high quality labour force, they could not be establishing and transforming their economic systems towards on high value-added products rapidly. The common characteristics of such underdeveloped countries are low labour costs and low production costs due to the inadequate and unskilled manual labour force and the lack of legislative infrastructure.

Less developed or developing countries will face with waves of mass unemployment as Industry 4.0 will transform the production more and more and as the global employment will begin to shift back to the industrialised world. Therefore, in order to compete with the industrialized countries, increasing their capacity to make high-quality, low-cost and personalized products is a more important task for underdeveloped and developing countries in the Industry 4.0 Era. These countries require to perceive the transformation of the labour markets correctly and take measures accordingly. Otherwise, their low cost labour-based industrialization model will lose its comparative advantage due to the necessities of Industry 4.0. In addition to the large waves of unemployment that will occur in these countries due to the lack of crude arm power in the Industry 4.0 Era, their lack of necessary preparation will have devastating effects over the industry and labour markets of such countries.

Thus, research on the probable impacts of Industry 4.0 over the underdeveloped and developing countries within different dimensions is a necessity, which is a gap in the literature yet. These countries require to adjust their economic development models so as to comply with the needs and necessities of 4th Industrial Revolution within the evidences to be found on this research area. In addition, these countries also need to adjust their legislative framework (especially labour law and social security law) which is generally based on the rigid formations of the precursors of the 3rd Industrial Revolution. However, as these country's are generally not aware of the devastating and shocking results of the Industry 4.0 and not prepared for the forthcoming transformation, they are inadequate in terms of preparation for the impact.

5. CONCLUSIONS

In this study the historical development and conceptual framework of the Industry 4.0 is being examined in the first stage and in the second stage a quantitative research is being executed regarding the preparedness and awareness of employees and managers in Turkey towards the transformations that will occur with the Industry 4.0.

In the last decade, starting from smart and connected machines and systems, from gene sequencing to nanotechnologies, from quantitative energies to quantum computing, a process that involves simultaneous development in a number of fields is being labelled as the Industry 4.0. This process, also called the Fourth Industrial Revolution, is still developing and represents an industrial production model where technologies intertwine and interact in physical, digital and biological fields.

As in many other areas, Industry 4.0 has opened the door to radical changes in social and economic fields. It is inevitable that the Industry 4.0 revolution, which will bring many changes from production relations to social relations, from cultural structures to political movements, will also trigger social transformations.

Industry 4.0 will lead to critical transformations in labour relations not only in industrialized countries but also in industrialized countries. In fact, Industry 4.0 is expected to have more critical and shocking effects in developing countries. These countries are countries that have not yet completed their industrial transformations, have not transformed the education system in a way to produce high-quality workforce, and are unable to establish an economic system based on high value-added products. For this reason, it is a more urgent and critical responsibility for

developing countries to correctly perceive the transformation of the Industry 4.0 and to align their labour markets as to face the shock.

REFERENCES

[1] F. Kavrakoğlu, "Sanayi Devrimleri", https://kavrakoglu.com/sanayi-devrimleri/
[2] H.Y. Taş (2018), "Dördüncü Sanayi Devrimi'nin (Endüstri 4.0) Çalışma Hayatına ve İstihdama Muhtemel Etkileri", *International Journal of Society Researches,* Vol/Cilt: 9, Issue: **16**:1817-1830; E. Ersoy, Endüstri 4.0'da İnsan, Robot ve İstihdamı, https://www.endustri40.com/endustri-4-0da-insan-robot-ve-istihdam/
[3] B.Kurtulmuş, "Endüstri 4.0 Yapay Zeka Teknolojileri", http://kergun.baun.edu.tr/20172018Guz/YZ_Sunumlar/Endustri_4_0_Belginar_Kurtulmus.pdf
[4] Z.Yüksekbilgili, G.Çevik (2018) "Endüstri 4.0 Bağlamında Türkiye'nin Yerine İlişkin Güncel ve Gelecek Eksenli Bir Analiz", *Journal of Finance Economic and Social Research (JFESR)*, Vol: 3, Issue:2, 424-425.
[5] G. Banger (2018), Endüstri 4.0 Uygulama ve Dönüşüm Rehberi, Ankara: Dorlion Yayınları, s.33.
[6] "Endüstri 4.0 Ve Yeni Teknolojinin Kavramları", https://www.mmo.org.tr/istanbul/haber/ayin-makalesi-endustri-40-ve-yeni-teknolojinin-kavramlari
[7] M.T. Kurt, "Endüstri 4.0 ve Yalin", https://lean.org.tr/endustri-4-0-yalin/
[8] T. Güran (2009). İktisat Tarihi. İstanbul : Der Yayınlar..
[9] M.Özkan, A. Al, S. Yavuz (2018), "Uluslararası Politik Ekonomi Açısından Dördüncü Sanayi Endüstri Devrimi'nin Etkileri ve Türkiye", *Marmara University Journal Of Political Sciences*, Vol: 6, Issue: 2, s.129.
[10] K. Schwab (2016), Dördüncü Sanayi Devrimi, (çev.) Zülfü Dicleli, İstanbul: Optimist Yay. s.16; Özkan, Al, Yavuz, s.130; A.G.Özüdoğru, E. Ergün, D. Ammari, A.Görener, (2018), "How Industry 4.0 Changes Business : A Commercial Perspective", *International Journal Of Commerce And Finance,* Vol. 4, Issue 1, s.84.
[11] Ege Bölgesi Sanayi Odası, http://www.ebso.org.tr/ebsomedia/documents/sanayi-40_88510761.pdf
[12] M. Castells, (2013), "Ağ Toplumunun Yükselişi - Enformasyon Çağı:Ekonomi,Toplum ve Kültür", Vol: 3, İstanbul Bilgi Üniversitesi Yayını : İstanbul, s.43 ; Özkan, Al, Yavuz, s.130; N.N. Çakır (2018), "Endüstri 4.0 ve Çalışmanın Geleceği", *Electronic Journal of Vocational Colleges*-November/Kasım 2018, s.98.
[13] F.Yılmaz, "Üretim Süreçlerinde Devrim ve Endüstri 4.0", *Dünya Gazetesi*, 22 Haziran 2016, https://www.dunya.com/gundem/uretim-sureclerinde-devrim-ve-endustri-40-haberi-320687
[14] http://ushistoryscene.com/article/second-industrial-revolution ,
[15] İlhan Dağdelen, Post-Fordizm, *Mevzuat Dergisi*, Yil: 8, Issue: 90, Haziran 2005, https://www.mevzuatdergisi.com/2005/06a/05.htm ,
[16 "Endüstri 4.0 Ve Yeni Teknolojinin Kavramları", https://www.mmo.org.tr/istanbul/haber/ayin-makalesi-endustri-40-ve-yeni-teknolojinin-kavramlari
[17] Özkan, Al, Yavuz, s.130.
[18] M. Eğilmez, (2017). "Endüstri 4.0", http://www.mahfiegilmez.com/2017/05 /endustri-40.html
[19] R.Bozkurt, "Endüstri 4.0'ın Serbestleştireceği Sermayenin Yönetimi", *Dünya Gazetesi*, 06 Mayıs 2016.
[20] R.Bozkurt, "Yenileşme etkisi ve yeni nesil OSB'ler", *Dünya Gazetesi*, 11 Ocak 2018.
[21] Keidanren (2016). "Toward realization of the new economy and society – Reform of the economy and society by the deepning of "Society 5.0" ", http://www.keidanren.or.jp/en/policy/2016/029_outline.pdf,
[22] Yüksekbilgili, Çevik, s.429.
[23] Schwab, s.17.
[24] F.Yılmaz, Üretim Süreçlerinde Devrim.
[25] Ege Bölgesi Sanayi Odası, s. 38.
[26] "B.Kesayak, "Endüstri Tarihine Kısa Bir Yolculuk", https://www.endustri40.com/endustri-tarihine-kisa-bir-yolculuk/
[27] Bauernhansl, T., Hompel M.T. and Heuser B. V. (2014). "İndustrie 4.0 in Produktion, Automatisierung und Logistik", SpringerVieweg Yay. s. 5-7.
[28] Schwab, s.17.
[29] "Endüstri 4.0 ve Yeni Teknolojinin Kavramları", https://www.mmo.org.tr/istanbul/haber/ayin-makalesi-endustri-40-ve-yeni-teknolojinin-kavramlari
[30] Schwab, s.16.
[31] PWC (2016). "Industry 4.0: Building The Digital Enterprise", https://www.pwc.com/gx/en/industries/industries-4.0/landing-page/industry-4.0-building-your-digital-enterprise-april-2016.pdf,
[32] M. H. Calp and, A. Doğan, "Endüstri 4.0, Uygulama Alanları ve Beklenen Gelişmeler", 2nd International Congress on Multidisciplinary Studies, 4 th-5 th May 2018, Adana-Turkey, Proceeding Book, Economics and Administrative Sciences Vol: 2, s.474-475. http://www.multicongress.net/2018Multicongress/IKTISADI_VE_IDARI_BILIMLER_C%C4%B0LT_II.pdf
[33] Şener, S., and Elevli, B. (2017), "Endüstri 4.0'da Yeni İş Kolları ve Yüksek Öğrenim". *Engineering Minds Journal*, 25-37.
[34] "İ. E., Erturan, E.Ergin, (2017). "Muhasebe Denetiminde Nesnelerin İnterneti: Stok Döngüsü". *The Journal Of Accountıng and Finance*, http://journal.mufad.org.tr/attachments/article/908/2.pdf , 13-30
[35] B.N. Doğru, O. Meçik, "Türkiye'de Endüstri 4.0'in İşgücü Piyasasına Etkileri: Firma Beklentileri", *SDU The Journal Of Faculty Of Economics Administrative Sciences,* Y.2018, C.23, Endüstri 4.0 ve Örgütsel Değişim Özel Sayısı,s.1582, (ss.1581-1606.)
[36] Ersoy, İnsan, Robot ve İstihdam; Ersoy, Kişiselleştirilmiş Üreticiler, https://www.endustri40.com/endustri-4-0-ve-kisisellestirilmis-ureticiler/
[37] A.Karakuş, "Bilim-Kurgu Filmleri Yavaş Yavaş Gerçek Oluyor: Yakın Gelecekte Hayatımızı Değiştirebilecek Teknolojik Gelişmeler", 09/05/2017,https://www.gzt.com/teknoloji/bilim-kurgu-filmleri-yavas-yavas-gercek-oluyor-yakin-gelecekte-hayatimizi-degistirebilecek-teknolojik-gelismeler-2655083; Ersoy, İnsan, Robot ve İstihdam; Ersoy, Kişiselleştirilmiş Üreticiler; Doğru, Meçik, 1582.
[38] "Gilchrist, 2016, BMAS-White Paper, 2017 Gilchrist, A. (2016). Industry 4.0: The Industrial Internet of Things. New York: Springer.
[39] Ege Bölgesi Sanayi Odası, s. 40.

[40] G. Çakmakcı, "Endüstri 4.0 Vs Eğitim X.O Geleceğin Endüstriekosistemini Geliştirecek İnovatif Ve Girişimci Bireylere İhtiyacımız Var", *3I in Employment*, Issue 27, s.74.
[41] Çakır, s.103.
[42] D. Güvenç, "Endüstri 4.0'ın İş Gücüne Yansımaları ve Geleceğin Becerileri", *3I in Employment*, Issue 27, s. 69.
[43] Çakmakcı, s. 75
[44] Özkan, Al, Yavuz, s.153.
[45] Taş, s.1829
[46] İ. Savcı, "Endüstri 4.0 ve İşgücü Piyasasında Değişim", *3I in Employment*, Issue: 27, s. 43.
[47] Schwab, s.16-21.
[48] G.Sak (2018). "Türkiye'nin, İlgi Alanını Bir An Önce Para Politikasından Eğitim Politikasına Kaydırması Gerekiyor", The Journal of *Economics and Society*, (94): 34-39.
[49] Doğru, Meçik, s.1582.; Taş, s.1827; Ersoy, İnsan, Robot ve İstihdam
[50] O.Z.Fırat & S. Ü. Fırat, "Endüstri 4.0 Yolculuğunda Trendler ve Robotlar", Istanbul University Journal of the School of Business Vol: 46, No:2, November 2017, 211-223, s.219
[51] Sener, Elevli, s. 26
[52] A.T. Yılmaz, "Bilgi Ve İletişim Teknolojileri Sektörünün İşgücü Piyasası Açısından Değerlendirilmesi Ve İŞKUR'un Sektöre Yönelik Faaliyetleri", *3I in Employment,* Issue: 27, s.49.
[53] Ö. Gürkan (2001), "Küreselleşme Ve Yeni Uluslararası Ekonomik Düzen", *Journal of Social Sciences and Humanities Researches*, Issue 3, s.370. (SS.366-374); Savcı, s. 40.
[54] F. Blinder, "Education for the Third Industrial Revolution", S. Princeton University CEPS Working Paper No. 163 May 2008, https://www.princeton.edu/ceps/workingpapers/163blinder.pdf ACCESSED AT 11.01.2019
[55] T.Bozlar, "4. Sanayi Devrimi Ve İşgücü Piyasasina Olasi Etkileri", *3I in Employment*, Issue 27, s. 69.
[56] Gilchrist, 2016, BMAS-White Paper, 2017 Gilchrist, A. (2016). Industry 4.0: The Industrial Internet of Things. New York: Springer.
[57] Bonekamp ve Sure, 2015 Bonekamp, L ve Sure, M. (2015). "Consequences of Industry 4.0 on Human Labour and Work Organization". *Journal of Business and Media Psychology.* http:// journal-bmp.de/wp-content/ uploads/2015/12/04_ Bonekamp-Sure_final.pdf (13.08.2018)
[58] Fırat, Ümit Fırat, s.213.
[59] Schwab, s.46.
[60] Doğru, Meçik, s.1582.
[61] Schwab, s.52.
[62] Savcı, s. 43
[63] Bozlar, s. 64.
[64] Doğru, Meçik, s.1582.
[65] Schwab, s.16.
[66] WEF (2016). (Future of Jobs Report: Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution, *Global Challenge Insight Report*), http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf , ACCESSED AT 28.02.2019
[67] Doğru, Meçik, s.1582
[68] WEF (2016). (Future of Jobs Report: Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution, *Global Challenge Insight Report*), http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf , ACCESSED AT 28.02.2019
[69] Schwab, s.52-53.
[70] N. S. Pamuk, M. Soysal (2018), "Yeni Sanayi Devrimi Endüstri 4.0 Üzerine Bir İnceleme", *Productivity Journal*, Issue 1, s. 42, (ss: 41-66)
[71] Taş, s.1826;
[72] Bozlar, s. 65.
[73] Ö. Topkaya, (2016). "Dünyada Endüstriyel Robot Sektörü ve Çalışma Hayatına Etkileri", *Journal of Economics and Administrative Sciences,* Vol.30, Issue: 5: (1129-1144.).
[74] Schwab, s.56-57.
[75] B. Öztuna (2017), Endüstri 4.0 (Dördüncü Sanayi Devrimi) İle Çalışma Yaşamının Geleceği, Ankara :Gece Kitaplığı, s. 106.