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THE UPCOMING ISSUES OF INDUSTRY 4.0 ON OCCUPATIONAL HEALTH AND SAFETY SPECIALIZED ON TURKEY EXAMPLE

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ABSTRACT

Production, which is started with the production of something in order to meet needs of people, has been gradually increased with the selling of products to others, and was aimed faster, more efficient and better quality of production. Production, started as hand looms, is now in the way of digitization and full automation, as a result of the revolutions throughout history. At this last stage of production method, human is only in the role of desire and design, producers are intelligent machines with many functions. This new industrial revolution, called Industry 4.0, will bring about many changes in human life as well as human needs. People will be able to design products that they need, in a way that is cheaper, better quality and the most importantly faster. Smart factories established with Industry 4.0 will be beneficial to the environment as well as many other benefits such as energy saves and raw material saving. Production in intelligent factories will be based on obtaining the necessary information for production through data mining in the cloud system, and realizing the physical production process with data taken from communication and synchronization of intelligent machines with each other via wired or wireless networks. This revolution in the industry comes up with many questions such as how the transition period will be, trainings of workers, provision of qualified workforce, unemployment problem, cyber security. In our work we will try to explain the questions in the field of occupational health and safety brought by the fourth industrial revolution. That is why Industry 4.0 and the components that make this revolution possible will be described. We will make contact between Industry 4.0 and occupational health and safety and a number of potential problems in this area will be evaluated in continuation.

Keywords: Industry 4.0, Production, Quality, Occupational Health and Safety

INTRODUCTION

I. Historical Development Of Industry

The Industrial Revolution in different stages is seen as the basis of many innovations, modernity and transformation in the world. This economic transformation, which first began to take place in England in the 1760s, spread to other European countries after England1.

1 EBSO Araştırma Müdürlüğü, Sanayi 4.0, October 2015, p. 4.

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Prior to the beginning of the industry, the economic aspects of the countries were mostly dependent on agriculture and livestock, and non-agricultural production such as weaving, carpentry and ironworking also took place in handcrafted benches by artisans and craftsmen. Starting with the invention of the steam engine, industry has provided a transition to a new and different economic structure shaped by economy, mechanization and mass production based on land, agriculture and human power.

The amount of production has increased with the industry-based, machine-based production. Factory production took the place of craftsmen 's simple manufacturing forms. While the machines, which exceed the human power, allow the power to produce large quantities of raw materials, to deliver large quantities of goods, it has enabled the development of commerce focused on the sale of these goods, and the proliferation of consumers and sellers. After the Industrial Revolution, large corporations were born that had capital in their possession, so that they could buy more machines and manufacture more people.

The Industrial Revolution led to the accumulation of large population in cities, changing the scattered settlement structure based on agriculture and livestock in the entire country. Economic growth has accelerated as the population growth in the cities means that both working and consuming people are proliferating, living standards had begun to improve and lifestyles had changed.

The Industrial Revolution, which led to socioeconomic and cultural changes in human life, took place over a long period of time. From this point of view, it is possible to talk about three different industrial revolutions which have quite different structures and effects.

1-) First Industry Revolution

The First Industrial Revolution, which influenced the period between 1760 and 1830, began to show its influence through the mechanization of weaving looms in England. In this context, the use of mines and steam instead of wood resulted in increased motive power, mechanization and transport of products to the factory2. Old-style family businesses and small manufacturing facilities have left their place at the big factory.

[2] Sabancı University European Business Network, "Akıllı" Yeni Dünya: Dördüncü Sanayi Devrimi, EKOIQ Magazine Special Volume, December 2014, p. 4.

[3] Sabancı University European Business Network, p.5.

[4] TOBB, Akıllı Fabrikalar Geliyor, Ekonomik Forum Dergisi, June 2011, p.17; EBSO Araştırma Müdürlüğü, p. 5; TÜSİAD/The Boston Consulting Group, Türkiye'nin Küresel Rekabetçiliği İçin Bir Gereklilik Olarak Sanayi 4.0 Gelişmekte Olan Ekonomi Perspektifi, Publication No: TÜSİAD-T/2016-03/576, March 2016, p. 19.

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2-) Second Industry Revolution

The introduction of steam, coal and iron, as well as steel, electricity, petroleum and chemicals into production, was led to changes in the basic raw materials and energy sources used in the industry, which brought about the second industrial revolution3.

The development of electrical technology and its use in production lines resulted in this new and superior technology, which is far more powerful than steam power, to further develop the machines and increase production in large quantities. In addition, petroleum also was used as an energy source, and the petroleum-based internal combustion engines also placed itself in the industry. In this respect, serial production was passed on to the factories. One of the most recognizable and striking examples of mass production in this period was Henry Ford, Ford Motor Company. Henry Ford's automotive mass production system quickly developed industrialization4.

3-) Third Industrial Revolution

From the 1970s to the present, the Third Industrial Revolution became dominant. After the Second World War, automation of production was provided with the development of electronics, information and communication technologies. As a result of the development of programmable logic controllers (PLCs), automation in production has begun to move forward.

The Mechanism of the First Industrial Revolution was defined as the serialization of the Second Industrial Revolution, while the Third Industrial Revolution was defined as the automation and digitization of the production. As an energy source; Coal, water and steam power in the first industrial revolution; In the Second Industrial Revolution, oil and electricity were at the forefront, while in the Third Industrial Revolution, renewable energy sources such as the sun and the wind became more important with the irreproducible sources and environmental concerns. Companies and countries that have emerged in this period have been able to demonstrate the flexibility to respond to diverse consumer preferences. Developments in communication and transportation, trade and industry globalized5.

[5] Siemens San. ve Tic. AŞ., Endüstri 4.0 Yolunda, p.

[6] (http://siemens.edergi.com/pubs/Endustri40/Endustri40/Default.html#p=4). 6 EBSO Araştırma Müdürlüğü, p. 7.

[7] http://www.plattform-i40.de/I40/Navigation/EN/Industrie40/WhatIsIndustrie40/what-is-industrie40.html Access Date:

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II. Industry 4.0 Description And Components 1-) Industry 4.0 Description

The Fourth Industrial Revolution, in industry, generally requires the machines so they started to manage themselves and their production processes without ever leaving. These high-level and current structures of the machines; cyber-physical systems arising from the blending of computer, communication and internet technologies, obsessed with mixed technology like the internet of things.

As a result of the adoption of this revolution and its acceptance by mankind, the level envisaged for the future of the industry is the self-governance of factories that realize production. It is aimed to provide full automation of the period from the customer's order receipt to the delivery of the product to the customer. Again, when the machines fail, they are able to repair themselves, not through a technician. For the foreseeable future, dark factories, where there are no lighting and heating systems to increase efficiency and savings, will be able to bring about this revolution.

As a new concept, Industry 4.0, was first presented at the Hannover Industrial Fair in 2011, then supported by the German government. Compared to the previous three industrial revolutions, the fourth industrial revolution aims smart production, based on the CPS (cyber-physical system) and "Internet of Things" principles. Industry 4.0 aims to keep objects in contact with each other and with people, and to make decentralized decisions, by monitoring physical processes with cyber-physical systems in modular smart factories6.

Industry 4.0, which will bring a whole new dimension to the production processes, before being announced at the Fair, the German Ministry of Education and Research (BMBF) has carried out some studies to strengthen the development of the country in the current conjuncture and foreseeable future and announced 10 major projects in 2011. These projects, known as the "Future Project", were published under the title "High-Technology Strategy 2020's Future Projects". One of the projects was named "Industrie 4.0" and was first expressed at the 2011 Hannover7.

[8] After the 2011 Hannover Industry Fair, a working group on Industry 4.0 was set up and the working group presented their proposals, one year later, on the strategic implementation of Industry 4.0, both at the 2013 Hannover Fair and to the German Government. This working group was headed by Siegfried Dias, managing director of Bosch, and Hennig Kagermann, senior manager of SAP AG (EBSO Araştırma Müdürlüğü, p. 7.)

[9] TÜBİTAK Bilim Teknoloji ve Yenilik Politikaları Daire Başkanlığı, Yeni Sanayi Devrimi Akıllı Üretim Sistemleri Teknoloji Yol Haritası, January 2017, p. 2.

[10] WILBERS Karl, Industrie 4.0 Herausforderungen für die kaufmännische Bildung, Friedrich-Alexander Universität Erlangen- Nünberg, Band 19, ISBN 978-3-7450-0595-0, Berlin 2017, p.20.

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The German government subsequently invested 200 million euros in this project. Several well-known German companies have taken steps to pass this system. Siemens and Bosch are companies that we can call the pioneer of this revolution in order not to lag behind in the competitive race and take a step8.

On this development in Germany, many countries have developed their strategies and roadmaps for the new industrial revolution in terms of their competence and originality. United States, Intelligent Manufacturing Coalition, Intelligent Manufacturing Open Platform; European Union, Public-Private Sector Partnerships, Future Plants, Resource and Energy Efficiency and Sustainable Process Industries; Germany, Industry 4.0 and Digital Economy, Industry 4.0 Vision 2025, Industry 4.0 Implementation Strategy; Japan, Society 5.0, Intelligent Manufacturing Systems, New Manufacturing Systems; United Kingdom, Value Added Manufacturing Initiative, Seven Specialized Headquarters; France put the strategies of the Future Industry Initiative into action so as not to fall behind the revolution9.

The most comprehensive definition for Industry 4.0 Platform "Industry 4.0 defines the Fourth Industry Revolution, a new level of the organization and management of the entire value chain in the life cycle of products and production systems, which is constantly focused on individual customer needs from the product development and production order to the entire chain, including a product end-user distribution and recycling."

In industry 4.0, while devices communicate and synchronize with each other through networks, the information required for production is obtained through data mining in the cloud system, enabling intelligent consumers and plants at the application level10.
With Industry 4.0, it will also be possible to openly innovate product and service development processes, instant customer special product development and customer involvement in the product development process. With the industry 4.0, production processes will have modular and flexible production capabilities that can make instant decisions on their own but can integrate with other production areas.

[11] Lee, J., Bagheri, B., & Kao, H. A. (2015). A cyber-physical systems architecture for industry 4.0-based manufacturing systems. Manufacturing Letters, 3, 18-23 (Provided from; DAVUTOĞLU Naci Atalay/AKGÜL Birol/YILDIZ Erşan İşletme Yönetiminde Sanayi 4.0 Kavramı ile Farkındalık Oluşturarak Etkin Bir Şekilde Değişimi Sağlamak, Akademik Sosyal Araştırmalar Dergisi, N. 52, September 2017, p. 548,549).

[12] BRADLEY, J. M. ve ATKINS, E. M., 2015, Optimization and Control of Cyber-Physical Vehicle Systems, Sensors, N. 15, p.23023 (Provided from; ALÇIN Sinan, Üretim İçin Yeni Bir İzlek: Sanayi 4.0, Journal of Life Economics, N.8, 2016, p.23).

[13] EBSO Araştırma Müdürlüğü, p. 18.,[14] Siemens San. ve Tic. AŞ., p. 10.,[15] Siemens San. ve Tic. AŞ., p. 10.

16 EBSO Araştırma Müdürlüğü, p. 21., [17] Siemens San. ve Tic. AŞ., p. 10.

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With Industry 4.0, production and productivity will be directly proportional to the innovation capacity of companies, not the past thinking with the muscular power. For this reason, the greatest difficulty of Industry 4.0 is primarily human resources.

The fact that companies compete with each other in the process of adapting to Industry 4.0 is clear that companies with strong financial means are ahead in this race. However, companies with financial means,

• The difficulty of the aggregation of all stakeholders in the common pension and the inability to enter into economic risk,

• The transition to Industry 4.0 is costly,

• They are hesitant to move to Industry 4.0 for reasons such as the time it takes to find solutions to problems, such as ensuring the continuity of education.

2-) Components Of Industry 4.0

Industry 4.0 is a collective body of today's technology and production chain organizations. Industry 4.0 is generally made up of constructs such as the Internet of Objects and Services, and

Cyber-Physical Systems. That is to say, with the concept of Industry 4.0, modular intelligent factories, physical processes, monitoring with cyber-physical systems, creating a virtual copy of the physical world, and making decentralized decisions11.

In order to understand Industry 4.0 as a collective whole, it is useful to know the concepts that are often used in terminology. Many of these concepts have been passed on to life today, but they give important clues as to what might be in the future, as well as showing them as the first signs of Industry 4.0.

[18] Siemens San. ve Tic. AŞ., p. 10.

[19] Siemens San. ve Tic. AŞ., p. 10.

[20] WANG, L., TÖRNGREN, M. ve ONORI, M., 2015, Current Status and Advancement of Cyber-Physical Systems in Manufacturing. Journal of Manufacturing Systems, N. 37, p. 521 (Provided from; ALÇIN, p.26).

[21] EBSO Araştırma Müdürlüğü, p. 19.

[22] Siemens San. ve Tic. AŞ., p. 11.

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A-) Cyber-Physical Systems

The physical system is a system that people can understand with their five sensory organs. From cyber system it should be understood that like cybernetics that is a scientific discipline that researches the communication and control of living things and machines from the cyber system, the control process based on information technologies, computers, and internet12. The systems connecting the physical world and cyber world with the internet are called cyber-physical systems.

The National Science Foundation describes cyber-physical systems as:

"The system is governed by a hybrid technology consisting of basic principles of production processes such as observation, coordination and control, computation and communication, which makes the physical machines smarter by integrating with cyber technology, so the process is expressed as a whole as cyber-physical systems"13.

The Cyber-Physical Systems, which create a wide communication network with the Internet of things and thus move to remove the boundaries between real and virtual worlds, constitute one of the forces underlying Industry 4.014.

Industry-based production processes are based on systems connecting to different networks over different interfaces and communicating with different services. Just as we have access to a variety of content through the Internet connection on smartphones, and we communicate with other smartphones around the world on different platforms, Industry 4.0 reflects the communication between Cyber-Physical Worlds on machines15.

B-) Horizontal and Vertical Integration

System Integration allows multiple systems to work together as a single system16. In terms of production with Industry 4.0, continuous flow provided by interconnected structures has a critical prescription. In order to keep this continuous flow and so that; to be able to respond quickly to changes in the production processes and problems, to provide the customer customized production, to increase resource efficiency, to achieve optimization in global supply chain, to have a more flexible production structure, in industry 4.0, horizontal and vertical integration needs to be achieved at every point. System integration in terms of functionality of Industry 4.0 is important. 17.

[23] EBSO Araştırma Müdürlüğü, p. 13-15.

[24] EBSO Araştırma Müdürlüğü, p. 20.,[25] TÜSİAD/The Boston Consulting Group, p. 26,27.

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Horizontal Integration means that there is a seamless flow of steps between in the production and planning process in-between and the production and planning processes of different businesses. This integration contains everything from raw material procurement to design, production, marketing, referral. Horizontal Integration between different businesses also allows for the development of new business models. In short, Horizontal Integration creates integrated and end-to- end systems18.

Vertical Integration means that seamless communication and flow can be maintained between technological infrastructures used in all processes, not between processes. For example; The integration of units such as sensors, actuators, valves, motors, control panels, production management systems, enterprise resource planning software, business intelligence applications in the field of production is covered in this scope19.

C-) Big Data and Data Analysis

Big data, based on the analysis of large datasets is one of the most popular concepts of this age. Advances in information and storage systems have made it possible to virtually aggregate and store data in unprecedented quantities. Cyber-physical systems (CPS) and the Internet of things (IoT) make it possible to transfer these data that reach enormous dimensions to physical systems20.

The definition of big data is; "the transformed form of meaningful and manipulable form of all of the recovered data from various sources, such as social media sharing, network blogs, blogs, photos, videos, log files etc." Large data is consist of information from web servers, internet statistics, social media broadcasts, blogs, microblogs, sensors, search records from GSM operators, etc.21.

When we look at the context of Industry 4.0, companies will start to obtain valuable information thanks to such a large quantities of data, that being held on secure systems and being extensively evaluated and transformed into meaningful information, about production systems, enterprise and customer-based management systems. When possible malfunctions can be anticipated and precautions can be taken, the opportunities will be noticed beforehand and can be actuated quickly, too. The production costs can be reduced while service-maintenance processes are facilitated. To sum up, analysis and forecasting are facilitated in every aspect from customer expectations to market movements, improving decision-making processes and value chains. It is also possible to make real-time decision-making.

[27] DAVUTOĞLU/AKGÜL/YILDIZ, p. 554.[28] EBSO Araştırma Müdürlüğü, p. 22.,

[29] http://www.sanayidegelecek.com/sanayi-4-0/kavramlar/ Access Date: 22/10/2017.

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D-) Internet of Things

Today, the Internet, which we generally know, provides an environment that connects people all over the world and each other, while the Internet of Things connects devices by providing them to communicate with other devices via wired or wireless means. This can be summarized as "Things, (i.e. devices) physically connected to each other and functionally connected to the internet". For example; smart house technologies are based on the solution of the Internet of Things. Also, it is possible for a refrigerator to identify the wanting food or vegetables and send messages to the mobile phone through the Internet of Things22

Internet of things provides the following advantages when used in an active and detailed way in a factory:

• Management and production process in the factory can be managed by smart robots, in the case of an adverse event, the processes will be automatically stopped by the smart robots,

• Sensors and intelligent tags placed on the products will enable products to self-manage throughout the supply chain and the supply chain will become smarter,

• Intelligent measuring instruments and sensors that will be placed on the machines will determine the optimum energy level by measuring how much energy is to be used where and so, energy and infrastructure costs will be reduced to prevent unnecessary energy use,

• Smart robots in smart factories will manage every process of production, so fewer human resources will be needed,

• Increase in revenue and profits after reduction in costs and expenses23.

E-) Smart Robots

A robot, which is thinkable first when it comes to automation, become increasingly autonomous, flexible and cooperative, and also cost less. Thus, by analyzing events and situations in an objective way, robots, which are expected to reduce human based errors the least, result in increasingly widespread use in the production process.

[31] BANGER Gürcan, Endüstri 4.0 Ekstra, Dorlion Yayınları, 2017, p.139. ,[32] Siemens San. ve Tic. AŞ., p. 14.

[33] TÜSİAD/The Boston Consulting Group, p. 28. [34] At the rest of the article, it will be referred as "İSGK".

[35] Resmi Gazete Date: 29.12.2012 Resmi Gazete Number: 28512, at the rest of the article, it will be referred as "İSGKY".,[36] SAKA Gizem Cem, Örgütlerin İş Sağlığı ve Güvenliği Uygulamalarının Eşbiçimliliği Üzerine Bir araştırma, Master Thesis, February 2017, p. 27.,[37] SAKA, p.28.

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So that, robotics will also be used in factories where Industry 4.0 is used effectively. For example, in smart factories, robots will be able to manage production process by communicating and recognizing each other, doing work sharing automatically, analyzing the things and adapting more quickly to changes.

F-) Virtual Reality

Virtual reality can be defined as; “Imitation of a real-world process or system in a technical sense over time24". Currently, three-dimensional simulation of products, materials, and production processes is utilized during the design phase, but on the way to Industry 4.0, virtual reality will become even more prevalent in factory operations. Therefore, Virtual Reality is considered as one of the main features of Industry 4.0. For example, there is no need to wait for the factory to be physically constructed to see how efficiently a fabrication works. In the framework of Industry 4.0, the factory is constructed, operated and analyzed in a virtual environment. Not only factory in general, all individual production processes or machines can be examined and elaborated. For example, personnel responsible for servicing and maintenance of machines can get practical training on the virtual reality, even unreachable parts of the machine can be observed and error probabilities can be predicted on the virtual reality. Operators will also be able to shorten the machine setup time and improve quality by finding opportunities to test on the virtual reality before actually setting machine parameters for the product in the production line25.

On the automotive sector, which is one of the sectors that will benefit most from Industry 4.0, it may be possible to use virtual reality in the sales phase. Potential customers will be able to choose the colors or accessories of the vehicle according to their preferences and they will be able to test their personalized vehicle before production and make changes26.

Through the use of virtual reality, it will be easy to access data about the real world 27.

G-) Cloud Computing

Cloud computing or as a functional meaning, online information distribution; is the common name given to services that provide common information sharing among computing devices. When a comprehensive description is made "All the applications, programs and data stored in a virtual server (in the cloud) and while being connected to the internet can be easily accessed through the devices through the devices"28.

[38] SASSENBERG Thomas/FABER Tobias, Rechtshandbuch Industrie 4.0 und Internet of Things, C.H.Beck&Vahlen, 2017, p. 232.

[39] SASSENBERG/FABER, p. 233.

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Thanks to Cloud Computing, users can use applications and information, required for the business, on the Internet via computers at the service provider instead of keeping the applications and information on the on-premises computers or data centers. Thus, more economical, flexible and agile data management is achieved.

In terms of industry 4.0; machines can find the information necessary for production from cloud computing through data mining. The information that the machine can obtain is not only a field, it can also be in different areas. By engaging communication between smart devices, Big Data, Internet of Things and Cloud Computing work together to form the foundation of Industry 4.0.

H-) Smart Factories

Smart factories come to life advanced programming integrated to machines via computer.

Smart factories are considered as one of the most concrete evidence of Industry 4.0. Some of their features are listed above:

• Smart factories can overcome problems and difficulties which occur during the complex manufacturing process with haste and trouble-free.

• Products, created from smart factories have a longer lifespan and less defect.

• Machines, staff and manufacturing resources are in synchronous and share a deep connection29.

Automation process in Smart factories is happening via an inter-connection between machines and devices. For example; if a resource shortage problem happens during the manufacturing process, the resource is ordered automatically without human need and the malfunctions can be spotted instantaneously only to repair by itself. Those features help the Smart factory to operate at its maximum capacity without any serious problem.

I-) Cyber Security

Security is the very first question when it comes to Data Volume and Intensity30. This situation has more importance on systems, which aims to connect systems which were unconnectable before; such as Industry 4.0. Industry 4.0 will increase the number of interconnections and smart-devices in factories. Cloud connection and the connection between other machines create the intranet of the factory. Besides of intranet, there exists an external link to communicate between customers and factory in order to smooth out the process of order and delivery. Cybersecurity is essential for all those procedures to operate without any problem. However it is essential to

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notice that, cyber security should not interrupt or slow down the manufacturing process while defending the factory to outer-treats31.

When we point out to the facts of Cyber Security such as; increasing security and the parts of advanced security developments; we clearly see that a factory that has the advanced features of should only be accessible to authorized and educated personnel. This is important for data verification and intensity of data. For instance; in a manufacturing facility critical data should only viable to authorized personnel. In order to verify inputs to the system; sources should be secure and verifiable32. In order to strengthen their up cyber market; industrial hardware companies buyout or merge with smaller cyber-security companies33.

MATERIALS AND METHODS

I-) Impacts of Industry 4.0 to Occupational Health and Safety

In order to frame occupational health and safety issues for Industry 4.0; Turkish law and regulations are referenced.

Occupational health doesn't be defined in İş Sağlığı ve Güvenliği Kanunu34(Occupational Health and Safety Act, number: 6331) and İş Sağlığı ve Güvenliği Hizmetleri Yönetmeliği35(Occupational Health and Safety Services Regulation).

[40] At the rest of the article, it will be referred as "SSGSSK".

[41] EREN Fikret, Borçlar Hukuku ve İş Hukuku Açısından İşverenin İş Kazası ve Meslek Hastalığından Doğan Sorumluluğu, Ankara 1974, p. 28; ULUSAN İlhan, Özellikle Borçlar Hukuku ve İş Hukuku Açısından İşverenin İşçiyi Gözetme Borcu – Bundan Doğan Hukuki Sorumluluğu, İstanbul 1990, p. 82; GÜZEL Ali/OKUR Ali Rıza/CANİKLİOĞLU Nurşen, Sosyal Güvenlik Hukuku, Edition 13, İstanbul 2010, p. 419; TUNCAY Can/EKMEKÇİ Ömer, Sosyal Güvenlik Hukuku Dersleri, Edition 16, İstanbul 2013, p. 351; SÖZER Ali Nazım, "İşgöremezlik, Meslekte Kazanma Gücünün Kaybı Kavramları Ve Sakatlık Kavramı İle İlişkileri" Adalet Dergisi, N. 1, January-February 1984, p. 315.

[42] EREN, p. 28; GÜZEL/OKUR/CANİKLİOĞLU, p. 419.

[43] Labor Force and Occupational Loss and Loss Ratio Determination Procedures Regulation has been come into force by publication in Resmi Gazete dated 11.10.2008 and numbered 27021. tarihli ve 27021 sayılı Resmi Gazetede yayımlanarak yürürlüğe girmiştir.

[44] GÜZEL/OKUR/CANİKLİOĞLU, p. 420; TUNCAY/EKMEKÇİ, p. 351ff.

[45] A camera company went bankrupt because it could not adapt to the digital machine in time. A company with a mobile phone market leader has lost its superior position in the transition to smartphones and has fallen far behind. We will encounter this type of story more often as a result of the transition to Industry 4.0 in the coming periods. For example, there will be radical changes in computer technology and architecture. Companies that can't adapt to this and similar

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Occupational health exist because there is a need for workers health condition is required to be protected, therefore some conditions are required to met36.

Occupational safety is not defined in İSGK and İSGKY.

Occupational safety exists for workers to be able to perform their responsibilities properly37.

According to İSGK Article 4, employers are responsible for their worker's safety. According to this, some of the responsibilities that are related to avoiding work accidents are which given in specifications are not restrictive but they are examples.

Work accidents are defined in İSGK Art. 3/1-g.

According to İSGK Art.3/1 g, "Events that are ending with death, psychological disorders or harming the integrity of workers body while working or in a workplace" are considered as work accidents. Work accidents are not restricted by the only workplace. If the employee has an accident while conducting a work-related task outside of the workplace perimeter, it is also considered as a work accident.

According to ISGK Art.3/1-h, “Organization, with the purpose of supply or service, regardless of aim to profit, where employees organize and where employer is responsible for the quality and quantity of the products that are produced or the service that is given and has the resting, breastfeeding, eating, sleeping, showering, examining, spiritual and physical training grounds under the roof of same administration” is defined as workplace.

Supervising employer’s safety and health responsibility are given to the Employer by law. According to ISGK Art.3/1-b, an employer is “Regardless of their private rules and regulations, a person who hires”. A person who qualifies to get the gains and debt is the real person. In Industry 4.0 workplace safety and health requirements are valid for few number of people because of the digitalization and automation. There are no specifications are foreseen for the smart robots in our current law. Therefore the work accidents which only harm smart robots are not considered as work accidents.

processes won't be able to take part in the world of tomorrow no matter how big they are today. Many companies will be on the verge of bankruptcy.

As one of the purposes of Industry 4.0, It can be shown that, developed countries such as Germany are now trying to bring back the production that shifted to developing countries such as China, Brazil and Argentina due to cheap labor, cost reductions and tax reductions to their own countries in order to ensure global competition. In this context, as Industry

4.0 becomes widespread, it can be seen that factories located in developing countries are shut down and moved to the countries of origin due to wide possibilities in the field of information and technology.

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Beside of ISGK Art. 4, employers are required to;

• The obligations on ISGK Art.6 (about occupational health and safety services),

• The obligations on ISGK Art.10 (about risk assessment, control, measurement and research),

• The obligations on ISGK Art.12 (about evacuation),

• The obligations on ISGK Art.13/1 (about right to avoid work),

• The obligations on ISGK Art.14/1 (about registration and notification of work accidents and occupational diseases),

• The obligations on ISGK Art.16 (about informing employees),

• The obligations on ISGK Art.17/1 (about education employees)

Follow all those rules also on Industry 4.0. These obligations are special obligations.

An employer has to obey those rules when he/she decides to integrate to Smart Factory model in Industry 4.0.

The qualified workforce will be required more than the unqualified workforce as smart factories and Industry 4.0 becomes more dominant in the industry. As the process continues, operations and demography of the factories will be altered. This change will result in a shift in health and security precautions.

In another aspect, advanced automation will change workplace to more ergonomic environments in order to create stress-free and more comfortable places for employees. However, working in an Industry 4.0 environment causes another set of problems because of the time and spatial flexibility. Psychological threats to the employee will be more become more of an issue than physical threats and disorders because of the diminishing need of muscle force. Moreover, accessibility of machines at all times requires more workforce38.

[46] AKIN, Levent; İşverenin İşçiyi Gözetme Borcundan Doğan Hukuki Sorumluluğunda Uygun Nedensellik Bağı, Çimento İşveren Dergisi, V. 25, March 2011, p. 26,27. ,[47] AKIN, Levent; İş Kazasından Doğan Tazminat Davalarında İşveren Kusurunun Belirlenmesinde Ölçüt, Çimento İşveren Dergisi, V. 27, N. 6, November 2013, p.

[48] AKIN, Levent; İşveren ve Vekillerinin Hukuki, İdari ve Cezai Sorumlulukları, Çimento Sektöründe İş Sağlığı ve Güvenliği Sempozyumu Tebliğleri Kitabı, 2008, p. 53.

[49] AKIN, Levent; İşverenin İş Kazasından Doğan Sorumluluğu Kusur Esasına Dayanır (Karar İncelemesi), Çimento İşverenDergisi, V. 28, N. 3, May 2014, p. 40,41; AKIN, İşveren ve Vekillerinin Hukuki, İdari ve Cezai Sorumlulukları, p. 52.

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In order to protect the health of the employees, regulations that give responsibilities to employers are standardized by ISGK and alike regulations. However, those regulations have to change in order to keep up with the improving world conditions. Employers have the responsibility of assessing workplace safety and health issues in order to train his/her employers regarding this issue. However, it is fairly unclear to point out those responsibilities. In case of any problem or questions, employer's responsibilities are hard to identify. That's the real reason why Industry 4.0 will bring some complications in the process of the change39.

II-) Assessment of Industry 4.0 to Possible Health and Safety Facts

1-) Professional Disease That Can Reveal on Workers of Closed Companies on Transition to Industry 4.0

Definition of Occupational Disease according to Sosyal Sigortalar ve Genel Sağlık Sigortası Kanunu40 (Social Insurance and General Health Insurance Act) Art.14 is; "Occupational disease is temporary or permanent illness, physical or mental disability that the insured has undergone for a reason repeatedly due to the nature of the work it is doing or doing, or due to the circumstances of the work."

As it is understood from the above, it is clear that the necessity of finding a causal link between work and the disease has been established41. In order to be able to speak about occupational illness, it is emphasized that there is a need for the existence of an illness bond between work and illness, but that it does not require great difficulty to prove the existence of the illness bond42.

Which diseases or disabilities that make the insured disabled are to be considered as occupational diseases is issued by "Çalışma Gücü ve Meslekte Kazanma Gücü Kaybı Oranı Tespit İşlemleri Yönetmeliği" (Decree of the Determination Procedure of Working Force and Proficiency Loss and Loss Ratio) that is based on SSGSSK Art.1443. This regulation describes the method of determining occupational diseases and also includes a list of occupational diseases. According to Art.17 of the Regulation, according to the list of Occupational Diseases (Annex-2), which diseases will be considered as occupational diseases and the diseases will be accepted as the latest in the occupation of the insured. Therefore, in order for a disease to be regarded as an occupational disease, as a rule, the name of the addendum to the Regulation must be found and must have appeared in the period specified in this list44.

In the SSGSSK Art. 14/3, the period of notification of the occupational disease (also the employer's obligation period) is exempted. According to this paragraph; "Even if the duration of the obligation in the list of occupational diseases is exceeded, if the clinical and laboratory

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findings of any occupational disease are determined and the cause of the occupational disease is determined at the end of the examination of the workplace, occupational disease may be considered with the approval of the Social Insurance Higher Health Board." This provision clearly expands the period of responsibility for the occupational disease of the end-user from clinical and laboratory investigations and examination of the workplace.

There is a group that will be unemployed due to the adoption of Industry 4.0 by employers45. Occupational health and safety problems may create a situation; what is the applicability of the worker in the later emerging occupational disease. If the employer is bankrupt, there is an employer for whom the employee can still file and report the occupational disease for the duration. Also SSGSSK Art. 14/3 (an exceptional ruling) can be used in that situation. However, if the employer moves the workplace to a different country, it will be followed by a costly proceeding or will not be used because the worker will be out of the country of responsibility for the employee. Again, when the lawsuit is filed, the award of the compensation awarded in the case of the employer will be extended and the enforcement process will be further extended, but if the compensation is not paid, the enforcement power will not be forcibly enforced because the law enters into the sovereign territories of the countries. In addition, in case the occupational disease occurs after the time that regulation stated, there is no factory to be investigated. So that, there will be no application to SSGSSK Art.14/3 which makes an exceptional ruling on behalf of the employee.

This situation can cause workers to suffer significant loss of rights in our country which is developing and provides relatively cheap labor to European countries

2-) Importance of Occupational Health and Safety Training in Sense of Industry 4.0

According to ISGK Art.4/1-a, the employer is obliged to ensure the health and safety of the employees in relation to the work and to take all kinds of precautions including training and informing the employees. This obligation is among the general obligations of the employer. The elaboration of this article was also made in Article 17 entitled "Training of Employees" in the same Act. According to that Art., "The employer shall ensure that employees receive training in occupational health and safety, especially before starting work, in the case of change of workplace or work, in the case of change of work equipment or in the application of new technology. Educations are renewed in accordance with the changing and emerging risks, if necessary and repeated at regular intervals."

Also Regulation on the Procedures and Principles of Occupational Health and Safety Training of Employees issued on the basis of ISGK Art.30/6-e shall also regulate the procedures and

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principles of occupational health and safety training to be provided to employees by the employer.

Occupational health and safety training needs to be specialized for Industry 4.0 because it is provided by the employer for a small number of qualified personnel. First of all, it is necessary to determine the hazard class of the workplace because it will change the quality of the education to be given. It is obvious that today's hazard class criteria will not be valid and inadequate in smart factories. For this reason, the legislation on which the criteria for the determination of the hazard class should be revised and adapted to the requirements of Industry 4.0 in smart factories that have adapted to Industry 4.0.

Experts who will train employees on work, health and safety, work equipment, new technologies, new risks must also be knowledgeable and able to provide training in the field of Industry 4.0. Finding someone to train in this area with lack of qualified staff could be a problem for the employer.

It should be noted that; with the use of virtual reality in everyday life, workers can be given training with this technology, possible job accidents can be shown virtually. Except for occupational health and safety training, which will be provided without starting work according to the last paragraph of Article 12 of the Regulation, the general issues mentioned in Annex-1 of the Regulation may be provided by distance education to workers.

3-) Employers Responsibilities on Occupational Working Accidents Regarding Cyber-Attacks

In industry 4.0, cyber security is the basic element as described above. Providing cyber safety in the plant is necessary for the preservation of business secrets from the commercial side, but it is also imperative that the ISGK fulfils the obligations imposed by the employer. The employer is obliged to follow the developments in this area and to acquire these improvements, always keeping the cyber security at the highest level according to the nature of the operator. When smart robot systems are observed to be capable of hacking, it is likely that more serious work accidents will occur than today's work accidents.

When it comes to the responsibility of the employer from the cyber-attack done by a third person;

The employer must be flawed in order to be able to take legal responsibility for the work accidents at work. For this reason, legal liability in work accidents is a responsibility based on the bounty. Because, as long as there is no special exception in the Turkish legal system, legal

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liability is a responsibility based on a claim. There are no special exception clauses in work accidents for the acceptance of flawless responsibility46.

According to Akın, Yargıtay (the Court of Appeals) accepts responsibility based on the nuisance in the workplace accidents in its views which are the principles of its final decisions47.

The worker is obliged to prove that the employer does not fulfill his obligations when he/she wants compensation due to the work accident. The employer is obliged to prove that he fulfills his obligations arising from contract and law in order to be able to get rid of his responsibility due to work accidents48.

In determining the responsibility of the employer, ISGK Art.4 and 5 and the relevant provisions of the Occupational Safety Regulations must be observed.

The employer's failure to comply with its obligations under the law is a measure of acceptance of the existence of faulty behavior. However, the employer's obligation should not be limited to the obligation specified in the law alone. Not being written in the law, failure to take the measures required by technological developments constitutes faulty behavior49.

In this context, for the responsibility of the employer, responsibility for general fault shall be taken which is not exceptional in our law. Even the Social Security Institution (SGK), which is responsible for in case of a work accident according to SSGSSK, is able to sue the employer according to the rate of responsibility of the employer.

The employer has followed up the current developments in the area of Industry 4.0 in terms of occupational health and safety and has followed the improvements made to the machines and equipment according to these developments without considering cost and work on the development of the software should not be responsible for the work accident considering other conditions if using current interfaces.

In addition, the hacker, who is the other defective person, may also be responsible for the work done by the system as a result of hacking.

4-) Obligation to Have All Necessary Staff in Workplace

The fact that the power of the muscles in smart factories is largely taken up by autonomous robots will reduce the number of workers in the factory but will increase the quality of the workers. The workers will be knowledgeable in their fields, will be able to use and manage the machines and intervene if necessary.

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In this new system new working classes will emerge as the work order in the factory changes. These workers have to be distributed to the organism in the factory and the division of labor must be done. This obligation belongs to the employer. While this is necessary for the operation of the factory, it is also necessary for occupational health and safety;

If a machine malfunction, a technician should be provided if the machine can't resolve its fault. If a technician is not available or if there is a technician but no action is taken, a work accident will result in the failure of the employer and, if applicable, the technician. If the machine is a machine that can handle the malfunctions and if it can't resolve the problem and it is withdrawn from production, it is expected that the employer will be able to foresee it in risk assessment and have a technician who can call it immediately.

When we look at the Turkish equation, it is necessary for the employer to employ technicians who are competent enough to meet the business conditions, and to provide necessary in-house training and occupational health and safety training, instead of a few technicians who are cheap enough.

RESULTS AND DISCUSSION

The amount of production has increased with the industry-based, machine-based production. Factory production took the place of craftsmen’s simple manufacturing forms. It enables the production of raw materials and a wide variety of products in a heavily loaded amount of machines, which have exceeded the human power, and it has enabled the development of trade focused on the sales of these products and the increase of consumers and sellers. The desire of sellers to sell more products and the increasing demand of consumers for these products forced manufacturers to go a step further. In this way, the end products of the producers' cooperation with different sciences have undergone various revolutions.

In this age, the producers entered into the end product industry 4.0, the interaction with science branches like information technology. Internet of Things, smart factories, cyber-physical systems, big data, smart robots, virtual reality, system integration, cloud computing, cybersecurity enabled that.

Industry 4.0 has brought a number of problems from its ideology to its functioning as well as the system that is changing today. First of all, in the process of transition to Industry 4.0; victims are likely to be victimized by the fact that workers who previously worked in factories that went to developed countries to get more benefit from technology, get caught up in a later occupational disease. The fact that smart factories that will be set up will have difficulties in determining hazard classes according to the current legal system and it is clear that the occupational health

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and safety obligations that employers have in accordance with current legislation will continue to fall in line with the functioning of smart factories. However, due to the heavy consequences of these obligations, it is necessary to show how it will change and be embodied. It should also be clarified that besides the employer, who will be responsible for work accidents.

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