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- Araştırma Makalesi -

[H] INTERACTION OF ROBOT ECONOMY AND INDUSTRY 4.0 IN WORLD ECONOMY AND TURKIYE[*]

(DÜNYA EKONOMİSİNDE VE TÜRKİYE'DE ROBOT EKONOMİSİ VE ENDÜSTRİ 4.0 ETKİLEŞİMİ)

Doç. Dr./*Assoc. Prof. Dr.* Ali O.BALKANLI[**]

ABSTRACT

As we enter the 2000s, major changes have came about in production processes in the world economy. During these years, instead of machines that previously operated with simple human intervention in production, robots that can make relative decisions and perform operations have begun to emerge. These developments in technology have brought about changes in production in terms of quantity and quality. In the impact of the changing economic structure in these years, Industry 4.0 structuring was emerged in 2011. In this article, in order to analyze this changing in the production structure of the world economy, the development and interaction of the robot economy and Industry 4.0 structuring investigated in the context of the world economy and the Turkish economy. It can be seen from study that the robot economy has a great determining role in the existence of the Industry 4.0 structuring, together with Internet of Things. The increasing importance of robots in the In-

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dustry 4.0 structure has transformed phenomen of Internet of Things (ıoT), to Internet of Internet of Robots (IoTR).

Keywords: Robot, Robot Economy, Productivity, Industrial Revolution, Industry 4.0

ÖZ

2000'li yıllara girilirken dünya ekonomisinde üretim süreçlerinde büyük değişimler yaşanmıştır. Bu yıllarda üretimde daha önce basit insan müdahalesiyle çalışan makineler yerine, göreceli kararlar alabilen ve operasyonları gerçekleştirebilen robotlar ortaya çıkmaya başlamıştır. Üretimdeki bu gelişmeler, üretimde nicelik ve nitelik açısından değişiklikleri beraberinde getirmiştir. Bu yıllarda değişen ekonomik yapının etkisiyle 2011 yılında Endüstri 4.0 yapılanması ortaya çıkmıştır. Bu makalede dünya ekonomisinin üretim yapısındaki bu değişimi analiz etmek amacıyla robot ekonomisi ve Endüstri 4.0 yapılanmasının gelişimi ve etkileşimi dünya ekonomisi ve Türkiye ekonomisi bağlamında incelenmiştir. Çalışmadan görüleceği üzere robot ekonomisi, Nesnelerin İnterneti ile birlikte Endüstri 4.0 yapılanmasının varlığında büyük belirleyici bir role sahiptir. Endüstri 4.0 yapısında robotların artan önemi, Nesnelerin İnterneti (IoT) olgusunu Robotların İnterneti (IoTR) olgusuna dönüştürmüştür.

Anahtar Kelimeler: *Robot, Robot Ekonomisi, Verimlilik, Sanayi Devrimi, Endüstri 4.0*

***

1. Introduction

When it look at the development process of humanity, we see that for many centuries, humanity existed as a hunter-gatherer society and moved to a new structure with small by small changes. Considered from this perspective, the discovery of wheat and the production of bread and similar foodstuffs from it meant a great change for humanity. Especially the fact that wheat seeds can be collected and stored provided the world's humanity with significant comfort and the opportunity to move when it comes to unworrying about the future. Because human societies, like

other living creatures, are creatures that give their main priority to food supply.

As they were able to accumulate future food stocks over time, they were able to focus on thinking in other areas other than food supply, with the confidence that came from this.

The historical process has shown that, with the change that came step by step, hunting and gathering societies moved to the next stage, the agricultural society. When societies turned into agricultural societies, they gained more ability to accumulate and store. These acquired capabilities have been their most important supporters in moving to a more advanced social structure. When we look at the historical change processes of societies in this dimension, we see that these processes involve very long periods of time and that the development is actually step by step and cumulative.

The time period of humanity until the 1600s represented a period in which, on the one hand, they experienced the conditions of an agricultural society, and on the other hand, they sought to seize each other's assets.

The Renaissance movement, which started in Italy in the mid-1400s, meant "bringing the mind to the fore in world affairs" and, one step later, this movement supported "the phenomenon of transforming matter with mind". The most important stage of this change manifested itself (first) with the phenomenon of industrialization that emerged in England. It can say that the first starting point in perceiving the existence conditions of the robot economy, which has begun to join our lives very rapidly today, is the situation of "putting the use of reason first in world affairs", which gained strength with the Renaissance. In a sense, with the Renaissance, humanity prioritized the mind in world affairs and turned to changing matter and making new devices from it with "mind calculations". In fact, this logic is behind today's developments at the through of new technologies. It is clear that, as during the Renaissance period, people made their lives easier by adding their own intelligence and intelligence to life more effectively than before and moved to a different structure, today's humanity has also (to put it simply) uploaded/taught its own intelligence and intelligence to machines.

From this perspective, the industrialization that came after the Renaissance, the effective use of human mind and intelligence in life and in the world of materials, by transforming the substances outside the hu-

man being (such as turning metal into a cauldron, etc.) It tells how to transform it into tools. Thus, together with industrialization, humanity around the world began to mold materials and make items for production and consumption from them. Of course, the world's humanity was capable of doing somethings similar prior to the industrial revolution. However, in the industrial revolution that came with the Renaissance, this phenomenon meant being different from the past cycle, as it meant "being dominant/getting ahead and standardizing" for the social and economic structure, and it described a transformation in the social-economic structure (and outlook on life).

2. Conceptual Framework-Research Material and Method

Mainly the question sought to be answered in this study is what kind of an implementation process Industry 4.0 is at the point of industrialization and what is the place of the robot economy in this process. Here, another question is how and what degree developing Industry 4.0 and Robot economy in world economy and in Turkiye. In this context, studying area divided 3 sections. In the first section of article, investgated developments in world economy conditions and development process of electro-mechanic before 2000s to understand point to emerging of Industry 4.0 and robotics. In the second chapter of article, it focused on Industry 4.0 and robot technologies. Here, firstly, it analyzed systematic of Indusrtry 4.0 and later researched development of robot technologies. In the third section of article it focused on Industry 4.0 and robot economy developments in world economy and Turkish economy.

In study, the statistical data took mainly from International Federation of Robotics (www.ifr.org) and Turkish Statistical Institute (Turkstat), Dünya Bankası (worldbank.org) and also www.cognitivemarketresearch.com, www.marketresearchfuture.com and www.robotpark.com.tr databases. Method of research is time-data comparison-crosschecking analysis according to years, products and countries.

3. The Phases and Evolution of Industrialization in the World Economy

Industrialization, firstly which manifested itself in England in the 1600s, exhibited a process of spread and change, gradually spreading to a significant part of the world (first England, then Germany, etc.) until the mid-1900s. It can be said here that the great transformation for the

world's humanity is industrialization. Because the industrialization is way, instead of the "cycle of war supported by the quest to seize other countries and the wealth of other countries". (War and invading cycle doesn't finished but it's proirity has been decreased). Because during this time period, the world's humanity has experienced significant developments in their quest to increase production with these tools and equipment, after a step in the industrialization process, which is called the cycle of transforming materials and making tools and equipment from them. There were big transformations in industrialization from 1600 to 1900s. The quest to increase this production has also brought about production structuring trends such as Taylorism and Fordism, as production system inside of time-process[1].

With the industrial revolution that emerged in England towards the end of the 17th century, the first machine that could operate using steam power was invented, and the mechanization process that started afterwards brought about the invention of electricity and mass production capacities, and new searches continued in this process, and the dreams of automatic working machines that emerged afterwards, one step later, led to the invention of computers and advances in information-electronic technologies[2].

It can be said that while the 1th industrial revolution (Industry 1.0) described mechanical production systems using water-based power and steam-based power, the 2th industrial revolution (Industry 2.0) described mass production with the support of electrical power. The 3rd industrial revolution (Industry 3.0) describes the process of automating production with the digital revolution, the use of electronics and the development of IT (Information Technologies). The fourth industrial revolution (Industry 4.0) is a collective and interactive system that includes many con-

[1] M. Aiman,K. Bahrin,N.H.N.Azli and M.F. Talib,'Industry 4.0: A Review on Industrial Automation and Robotic' (2016) Jurnal Teknologi 78 <https://journals.utm.my/jurnalteknologi/article/view/9285/5537> 138 Access:15 April 2024

[2] E. Öztemel, 'Yapay Zekâ ve İnsanlığın Geleceği' (TUBA, 2020, Bilişim Teknolojileri ve İletişim: Birey ve Toplum Güvenliği) <https://tuba.gov.tr/files/ yayinlar/bilim-ve-dusun/TUBA-978-605-2249-48-2_Ch9.pdf> 101 Erişim Tarihi: 23.07.2024; C.Dirican, 'Teknolojik Gelişmelerin Ve Yapay Zeka Çalışmalarının Pazarlama Bilimine Etkileri' (2015) 2 (3) Journal of Management, Marketing and Logistics 565; H.Y. Taş, 'Dördüncü Sanayi Devrimi'nin (Endüstri 4.0) Çalışma Hayatına ve İstihdama Muhtemel Etkileri', (2018) OPUS, <International Journal of Society Researches,Yıl:8,Vol:9/16> 1830

temporary automation systems, data transfers and production systems. Industry 4.0 means the presence of the internet of things in process of production. Industry 4.0 plays a major role in the creation of a smart factory system where robots are used in production[3].

The smart factory system and cyber physical systems that came with the Industry 4 structuring have actually become functional with the internet/intranet of things. It must say that these systems and objects interact and communicate with sensors and the information they receive from sensors[4]. In result, it must say that at the backside of the robot technology, there are firstly industrial revolution (mechanical power), secondly digital revolution (computer power)[5].

Immediately after the World War II, humanity began to seek to manage these tools and equipment, which it discovered with the industrialization revolution, with elements that can also be called simple mental calculations, instead of motivating them entirely with human power. The first step in this search is transistors. In 1947, the solid-starte transistor was invented in the USA. In 1948, W. Shockley developed the BJT (bipolar junction) transistor. Here, it must say that theoretical development of quantum mechanics in the 1920s, has critical role in the development of solid-state-electronics in England. There is a direct connection between quantum mechanics and solids[6]. Transistors began to be introduced to the market in the 1950s. Later, using these transistors, new "human-activated semi-intelligent devices, being pre-robot" was began to be produced. The operating logic of transistors is a 0-1 on-off logic, by creating a series of transistors, different commands were derived from these, and devices, the first interaction of which was initiated by humans, began to be produced.

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[3] U.İ.B.,Yapay Zeka Ve Yeni Teknolojiler (2017) <https://uib.org.tr/tr/kbfile/yapay-zeka-ve-yeni-teknolojiler> 2

[4] T.Özçelik and F.S. Onursal, 'Endüstri 4.0'ın İş Hayatı ve Sendikalaşma Üzerine Etkisi' (2020) BMIJ 8(1) < http://dx.doi.org/10.15295/bmij.v8i1.1399> 991 Access:10 June 2024

[5] S.Makridakis,'The forthcoming Artificial Intelligence (AI) revolution: Its impact on society and firms Futures'(2017) V 90 <https://www.sciencedirect.com/science/article/pii/S0016328717300046> Access:10 June 2024 Access: 06 April 2024

[6] W.F.Brinkman, D.E. Haggan, and W.W.Troutman, 'A History of the Invention of theTransistor and Where It Will Lead Us' (1998) Journal Of Solid-State Circuits < https://www.researchgate.net/publication/2977642> Access: 28 April 2024

This development in industrialization has opened the door to a new beginning in the world society and economy. In order to understand today's robot technology and economy phenomenon and the foundations of other developments and to analyze the development differences of economies in the world economy on the basis of knowledge and technology, it is need to consider everytime the invention of the transistor. Because the essence of this economic change occurring in developed economies who create to robot economy and Industry 4.0 system, there is concentration and transition to micro-electronics in electronics.

This transfer/impact from electronics and electro-mechanics to economy is not incomprehensible. Because in today's world economy, this change in electronics and electro-mechanic has effects on every product subject to production and consumption. That's why it can be said that this new structure formed in the electronics world after 1947 forms the beginning of the change of today's world economy and is the starting point of current trends, including robot technology and industry. It can be said that the year 1948 and its aftermath was the first transformation period in the world economy in which electronics found a place in economic life and came to the fore[7]. This period describes a period in which information beyond mechanical production knowledge and devices that process information were invented and began to take the lead in production. These developments determined the direction of economic development and international trade in the world economy until the 1980s[8]. After invention of transistor, "chip" invented at the second phase.

The new product, called chip/IC, has been essentially a "transistor network" consisting of multiple transistors. After the invention of the integrated circuit, the computer processor was invented. Integrated Circuit (IC) is network of transistors. Processors are a transistor network combination that contains many more transistors than the integrated circuit. This first processor was produced by Intel in the USA in 1965. After the first processor it produced in 1965, the company doubled the transistors in the chip/integrated/processor 1.5 years later[9]. The development has occurred very rapidly. So much so that, while in 2007, Intel

[7] A.O.Balkanlı, 'Ekonomik Gelişme ve Uluslararası Ticarette Nanoelektronik, Eğitim ve İnsan Sermayesinin Etkenliğinin Değişimi ve Endüstri 4.0 Devrimi' (2019) 9 (1) Journal of Current Researches on Business and Economics 109

[8] Balkanlı, (n 7) 109-111

[9] ibid

produced processors working with 820 million transistors, by 2012 this number increased to 1.7 billion transistors (in the 4-core i7 processor). Today's (2024 year's) processor, the Intel Core i7-10700K processor (and i-9 Processors), has approximately 10 billion transistors. However, if we compare the transistors in processors to neurons in the human brain, it should be noted that processors in their current state are still very weak compared to the human brain and it is necessary to consider how much they can develop.

Considering that there are more than 100 billion neurons (nerve cells) in the human brain[10], it should be said that it will not be easy for the number of transistors in current computer processors to reach the number of neurons in the human brain. (For processors to come close to the human brain, an increase of approximately 10 times in processor capability is required). However, this is also a fact: Even in its current state (when we think of past periods), the developments in computer processors in the 2000s largely explain the electronic dimension of today's robot technology phenomenon and the corresponding development of the world economy in the 2000s. Because this increase in transistors in processors has become an important electronic factor that has brought about a change in the world economy.

In the change of the world economy in the 2000s, this change in electronics is almost the main determinant. The developments in electronics are not limited to the processor electronics industry alone (and its impact on production). The revolutionary changes that started after 1950s greatly changed not only production but also the content and dimensions of international trade. So, in order to understand the change in the world economy and international trade in the 2000s and the reasons for this, it is necessary to take into account the changes in the 1950s and 1970s.

4. Industry 4.0-Robot Economy Relationship

4.1. Development of Industry-4.0 Structure

The Industry-4.0 concept was discussed for the firstly at the Hannover Trade Fair in Germany on April 1, 2011. Industry 4.0 meant the 4th industrial revolution. The 1st industrial revolution referred to the

[10] N.E.Süslü 'Büyük Mucize Beyin Ve Öğrenme' (2015) Hacettepe University, Helath Sciencess Journal <https://dergipark.org.tr/tr/download/article-file/88896> 630 Access: 06 July 2024

period between 1760 and 1830. The industrialization period of Britain expressed this period of industrial development. II. industrial revolution emerged in the early 20th century. While production was reshaped after the 1929 World Depression, industrialization moved to a different dimension than previous processes. In production lines, Taylorism was replaced by the Fordist mode of production and later by the Post-Fordist mode of production. With the 1970s, III. The industrial revolution began and lasted until the early 2000s. In 2011, the definition of "Industry 4" was introduced in Germany and it considered the beginning of the 4th industrial revolution.

The simplest answer to the question of why Industry 4 emerged in Germany is the quest to eliminate and bring forward Germany's lagging behind in world industrial product production. At this point, the main point of action for Germany in this initiative has been to regain the industrial production power it lost against countries such as China, where labor wages are very low, and to surpass its rivals, China and the USA, in the production of new technology products. Following the announcement of the Industry 4 program in 2011, Germany established the Industry 4.0 Platform in 2013. This platform consisted of companies, ministries and unions. On the website established within the context of this platform, the aims of the platform were listed as follows: To make Germany the world's largest producer of production tools and to transform the country into the production center of almost every sector in a situation[11].

Essentially, after the 1990s, when the world economy transformed into a global economy, Germany, which shouldered the European Union, could not achieve much success in the global economy as of these years. Because the German economy was in trouble during these years. At the behind the economic acceleration experienced by China there were with the support of US capital and enterprise (starting from the 1980s) and the support of China's cheap labor force and raw material advantages. At this point, the concept of "Industry 4" put forward in Germany also expressed the desire for Germany to participate in world competition and industrialization processes as an actor as before.

[11] L. Özyıldırım and Ö. Özbay, 'Sanayi 4.0: Bildiğimiz Kapitalizmin Sonu mu?' (2019) <https://www. enternas yonalsosyalizm.org/sanayi-4-0-bildigimiz-kapitalizmin-sonu-mu.html> Access: 30 July 2024

The objectives of Industry 4.0 may sbe classified as follows:[12] (i) Flexibility, (ii) Personalized Solutions, (iii) Fast, high-quality, cheap production, (iv) Energy saving, (v) Reducing waste, (vi) Using production areas more efficiently (vii) Increasing working speed and reliability, (viii) Providing sustainable competitive advantage. With the Industry 4.0 structuring, it is envisaged that all monads in the production is able to communicate and interact with each other, access big data, and thus obtain products-outputs that is best meet expectations In the background of the Industry 4.0 structuring, the most basic elements among the dynamics that reveal this structure are the huge developments in the digital world and the cyber-physical systems, called the internet of things that can communicate with each other. And to these factors, it must add that big data processing capability[13].

According to the observations made in the production facilities during the Industry 4 implementation process, there are the four factors that seperate Industry 4.0 from other 3 industrial revolutions and these are (i) sensors (which are the sensors required for machines to collect data), (ii) richness of data (to store what is received from the sensors and make them ready for processing), (iii)knowledge (As artificial intelligence's activity, to make them ready for processing), (iv)process efficiency (which means getting the machine to do that type of work after the decision has been made). By combining these four elements, automation in production comes to the fore and unskilled workforce's employment decrease in production process. Instead of unskilled labor, processes that have a very low error rate and provide stability are obtained[14].

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[12] Ö.Y.Saatçioğlu, G.T. Kök and N.Özispa, 'Endüstri 4.0 Ve Lojistik Sektörüne Yansımalarının Örnek Olay Kapsamında Değerlendirilmesi', (2018) Vol.23 Suleyman Demirel University The Journal of Faculty of Economics and Administrative Sciences Special Issue on Industry 4.0 and Organizational Change 1679

[13] A.Soylu, 'Endüstri 4.0 ve Girişimcilikte Yeni Yaklaşımlar' (2018) Sayı 32 Pamukkale University Journal of Social Sciences Institute, Pamukkale Üniversitesi Sosyal Bilimler Enstitüsü Dergisi <, https://dergipark.org.tr/tr/download/article-file/474447> 44 Access:13 July 2024 ; Taş, (n 2) 1823-1824; TUSİAD,'Türkiye'nin Küresel Rekabetçiliği İçin Bir Gereklilik Olarak Sanayi 4.0 Gelişmekte Olan Ekonomi Perspektifi' (2016) Yayın no; TÜSİAD-T/2016-03/576 27

[14] S.Şener and B.Elevli, 'Endüstri 4.0'da Yeni İş Kolları ve Yüksek Öğrenim' (2017) Vol.1 (2) Journal Of Engıneer Brains <https://dergipark.org.tr/tr/download/article-file/310191> 26-27 Access:13 July 2024

The Industry 4.0 revolution is a structure that prioritizes digitalization, information, computer technologies and robot production technology in industrialization. In a sense, with the Industry 4.0 application, it was desired and achieved to realize production on a large scale with robot technology and computer technology in production facilities. However, it is clear that at the advanced level the world economy reached in the 2000s, the production structure called "Industry 4.0" has become a current structure in the world's leading developed economies as noname.

With other words, “dark factory” meant to Industy 4.0, describes a production structure in which humans are less labor force and robot machines are more effective in producing more, which brings competition. And this structure is a situation where implementation is sought in many developed countries at the level that computer systems and artificial intelligence effectiveness have reached (as of that period) after the 1990s. When we look at the Industry 4 structure, it can be said that it is a structure where automation supported by computer and artificial intelligence applications is at the forefront in production and its infrastructure is fed by the Post-Fordist mode of production. While Industry 4 structuring brings automation to the production cycle to a great extent, it meant the smart factory structuring that minimizes human activity in production and provides the opportunity to be competitive, with the support of efficient business models created. Because the robots and automation systems that came with Industry 4.0 did of great value in the competitiveness of industries in the world economy. Inside of this structure, more intensive use of robots, assembly, robot systems and industrial image processing systems reduced production costs and achieved high quality standards[15].

Behind the Industry 4.0 production structuring, defined as the dark factory or smart factory there are (i) Internet of things (with the support of sensors), (ii) Autonomous Robotics technology, (iii) Horizontal and Vertical integration in Production, (iv) Remote management and Control access and Cyber Security phenomenon (Cloud administration, supervisoring and computing via by support of cloud), (v) Big data collection and analysis, (vi) Augmented reality and additive production phenomenon, (vii) 3D printers[16]. Internet of things came to the fore in 1991 and

[15] UIB, (n 3)3

[16] Soylu, (n 13) 47/52;TUSİAD, (n 13) 27

describes the ability of electronic devices to interact with each other and transfer data to each other. In this way, management and interaction between devices in production depending on the data command set has become possible[17]. 3D printers are machines that transform data into real things that can be, and many mechanical parts can be printed/produced with these printers[18].

In general, there is a negative corealation thinking in societies between Industry 4.0 and employment. But it cannot be said that employment will be completely negatively affected by the Industry 4 structuring. And on the contrary, with the spread of Industry 4, new job areas were expected to be created in 7 areas in the economies. And also significant portion of these business areas are active now and take employment. These are[19]: 1. Software Programmers, 2. Information Techologies and Internet of Things Solution Producer (IT/IoT Lösungsarchitekt), 3. Industrial Data Analyst (Industrieller Datenanalyst), 4. Robot Coordinator, Programmer, Repairer (Roboterkoordinator, Roboterprogrammierer), 5. Production Technologies Expert (Produktionstechnologe), 6. Smart Cities Planners. Smart City Planners (Smart City Planner), 7. Product Designer and Manufacturers. It should be noted here that the Internet of Things/Robots (IoT/R) combined with smart robot applications has come into being with Industry 4.0, which also means smart production system[20].

4.2. Robot Technology and Automation in Economy Logic

The term of robot was first used by the Czech philosopher Karel Capek in his fiction "Rossum's Universal Robot (R.U.R.)" in 1922. In Czech, robot means "worker" or "slave". After Karel Capek, Isaac Asimov wrote science fiction novels about robots in 1939. Conceptually, the robot as a machine is similar to a human operating at a very high capaci-

[17] Soylu ibid 45-47/52;TUSİAD, ibid

[18] S.A. Göv and D. Erdoğan, 'Dördüncü Endüstri Devriminin (Endüstri 4.0) Neresindeyiz?' (2020) 7(2) İstanbul Gelişim Üniversitesi Sosyal Bilimler Dergisi 302-303

[19] Şener and Alevli, (n 14) 29-32

[20] Aiman and Bahrin,(n 1) 137-138; B.Akyılmaz,'Robot Üretim Sistemleri Ve Nesnelerin İnterneti',(2021) <https://www. researchgate.net/profile/burhan-akyilmaz-2/publication/351748032_ikinci_bolum_ robot_uretim_ sistemleri_ ve_nesnelerin_ interneti/ links/60a78768299bf1031fba33bc/ikinci-boeluem-robot-ueretim-sistemleri-ve-nesnelerin-interneti.pdf> 22 Access: 25 June 2024

ty, but this machine is intended to be completely free of human-specific shortcomings[21]. The use of robots in economic functioning has meant that they enable production at lower costs, primarily for entrepreneurs in businesses, instead of humans as labor in production processes. Therefore, robotic technologies, which positively affect profitability, have led entrepreneurs to employ robotic machines in production. In the Industry 4 structuring, where technology is the determining factor, it should be considered that the increased use of robots in production will, on the one hand, positively affect business profitability, while on the other hand, it will increase human labor unemployment[22].

However, the use of robots in factories and other areas of the economy is not only for the profitability of entrepreneurs. Robots also protect people from work accidents and problems they may encounter through the activities they carry out in areas where there are human occupational risks in economic processes (risk of work accidents, risk of disease, etc.)[23]. Therefore, when talking about the participation of robots in economic life, we should not think only in terms of profitability. It should also be noted here that robot technology supports the perfection of the product within the targeted/planned framework by decreasing the error rate in production and the product produced, and this positively affects consumer satisfaction.

It can say that main factors related to Industry 4.0 are Robots, Horizontal and Vertical System Integration, The Internet of Things, Cybersecurity, The Cloud, Big Data Analytics, Simulation, Additive Manufacturing (3 D Printing), Augmented reality[24]. Robotic technologies are nourished by many branches of science and are thus an interdisciplinary field. Mechanical, electronics and computer engineering contribute the most to the development of robotic technologies[25]. While the combined use of Robotics, Artificial Intelligence and Automation (R(obotics)+AI (Artificial Intelligence)+AI(utomation)=RAIA) in production processes increases, a new economic structure that can be called the robot economy has emerged. RAIA creates major changes in production and there-

[21] A.Varol, 'Robotik' < https://www.asafvarol.com/dnotlar/robotik/robotik_kitabi.pdf, M.E.B. Yayınları> 56-57 Access: 14 July 2024

[22] Özçelik and Onursal, (n 4) 982

[23] ibid

[24] Aiman; et al., Jurnal Teknologi 78,(2016) 3

[25] UIB, (n 3) 3

fore consumption and provide great advantages to producers and consumers. For this reason, thanks to these advantages, robots used for both special purposes and industrial production are increasing[26]. It should be noted here that different sciences such as Autonomous Mobile Robots (AMR), Internet of Things (IoT), Big Data, Augmented Reality, are of great importance in the realization of Industry 4.0. Here, "Autonomous Robots" may be called as robots that have certain intelligence and can make and implement decisions based on the data they collect, rather than robots with automatic work ability[27].

It should be noted here that the phenomenon of human-machine collaboration is at the foreground of Industry 4.0 system and in the Industry 4.0 system, smart robotic systems have an important place in realizing human-machine cooperation[28]. Industry 4.0 allows to use more Autonomus Mobil Robots (AMRs) not only on production lines but also on assembly lines. AMRs have a different structure than standard autonomous guided robots. AMRs, unlike standard vehicles, they do not necessery an external system to localize. They are equipped with cameras and sensors to directe their environment and carry out their work themselves[29].

Robots are divided into 5 types according to their application areas: industrial robots, service robots, medical robots, military robots and amusement robots[30]. Robots may undertake different tasks thanks to their features. In this surround, robots play an important role in production process. Because they will success their tasks perfectly, intelligent-

[26] D.Kurt and Ü. Bozoklu, 'Robot Ekonomisinin Yükselişi, Sosyal Bilimler Metinleri' (2019) Sayı 01 < https://dergipark. org.tr/tr/download/article-file/712252> 25-26 Access: 03 May 2024

[27] A.Yazıcı, 'Endüstri 4.0 Ve Otonom Robotlar' (2019) Elektrik Mühendisliği Dergisi < https://www. emo.org.tr/ ekler/91f2bb2a057879e_ek.pdf?dergi=1069> 39 Access:14 July 2024

[28] M.Soori, R.Dastres and B.Arezoo,B.Jough, 'Intelligent robotic systems in Industry 4.0: A review' (2024) 4(3) Journal of Advanced Manufacturing Science and Technology <https://hal.science/hal-04439263v1/file/ Intelligent%20robotic%20systems. pdf> 3 Access: 24 March 2024

[29] M.Javaid, A.Haleem, R.P.Singh and R.Suman, 'Substantial capabilities of robotics in enhancing industry 4.0 implementation', (2021) Volume 1, Cognitive Robotics 59 Access: 13 May 2024

[30] <https://www.robotpark.com.tr>(2024) Access: 20 July 2024

ly, safety, flexibility and collaboratively[31]. Collaborative robots are cobots that can interact with humans. These devices aim to increase human capacity in a healthy way. Robots that do not involve human-robot cooperation generally operate independently[32]. In the 4th Industrial revolution, by the use of digital technology, automation, and data sharing in production processes to improve productivity, adaptability, and flexibility in industrial environments, intelligent robotic systems are developed. Therefore, the integration of intelligent robotic systems within the context of Industry 4.0, while it transforming traditional production processes, it has started new peirod of smart manufacturing[33].

Robots can automatically and continuously perceive their environment (sense), transform what they perceive into processes through data analysis (think), and perform physical functions such as movement or non-physical functions such as warnings and suggestions (act)[34]. With the increasing use of robots in industry, there has been a dramatically reducing in the number of non-qualitive workers employed. Because robots are more advantageous than human labor because they can carry out the tasks assigned to them without interruption. And robots do not exhibit major malfunctions, except for rare malfunctions, and can work with the same efficiency 24 hours inside of a day[35].

The increase in robots in production has brought the concept of robot economy. There are continiously developments in robot technology. And these advances in robotic technology made robotic activities's diversifications and more reliable. At result of this diversification in robots, today, according to another definition, robots may be subdivided into autonomous robots, cobots, interactive autonomous smart robots,

[31] R.Goel and P.Gupta, 'Robotics and Industry 4.0', (In) (Ed.Nayyar,A. And Kummar,A.) A Roadmap to Industry 4.0. Erei-Springer (2020) < https://doi.org/10.1007/978-3-030-14544-6> 158 Access:13 July 2024 ; Aiman and Bahrin (n 1)139

[32] Javaid, Haleem, Singh and Suman, (n 29) 64

[33] Soori,Dastres,Arezoo and Jough,(n 28) 2

[34] I.Wildhaber, 'Die Roboter kommen-Konsequenzen für Arbeit und Arbeitsrecht. Zeitschrift für Schweizerisches Recht', (2016) Band 135, I, Heft 4 <https://www.alexandria.unisg.ch/server/api/core/bitstreams/0151e75f-7bfb-427d-89aa-174c76c8d608/content> 316 Access:13 July 2024

[35] Varol, (n 21) 77

humanoids, mobile robots, cloud robots, pick and place robots and robot swarms[36].

The Third industrial revolution refered to the transition from analog and mechanical devices to digital devices[37]. In this period, transistors, microchips, computers and the internet emerged/invented. Industry 4.0 constructed on these devices/developments. In this point, Industry 4.0 refers to the era of "smart factory" and "smart objects" in which physical, digital and biological systems in the production area interact and are aware of each other and can work in harmony with each other. In this Industry 4.0 period, emerged, robotics technology, the internet of things which describes the interaction of the internet and network connections, the participation of co-bots in business life, which allow humans and machines to work together, the participation of nanotechnology in the production processes. And in this period, such as 3D printers emerged and also additive manufacturing. While digitalization grow in this process and big data has emerged. These big data started to analysed with the support of computers and information processing devices and cloud computing[38].

Table 1: Industrial Robots' Installations (Annual, 1.000 ')

Regions/ Years	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Asia/Australia	85	99	134	161	200	280	284	255	274	385	405
Europe	41	43	46	50	56	67	76	74	66	82	84
The Americas	28	30	33	38	41	46	55	47	39	52	56

Source: IFR, <https://ifr.org/img/worldrobotics/2023_WR_ extended_version.pdf> (2023) 10

[36] Javaid,Haleem,Singh and Suman (n 29) 68

[37] Z.Tekin and F.Uslu, 'İşletmelerde Zaman Yönetimi:Endüstri 4 ile Ölü Zamanı Sıfırlamak' (2018) Uluslararası 4. Çin'den Adriyatik'e Sosyal Bilimler Kongresi 138

[38] Özyıldırım and Özbay, (n 11);TUSİAD,(n 13) 25

Table 2: According to Customer industries, Robot Installations, World, (Annual, 1.000')

Sectors /Years	Electrical& Electronics	Automotive	Metal& Machinery	Plastic& Chemical	Food	All Others	Unspecified
2020	112	83	41	19	12	37	85
2021	143	117	68	25	15	55	102
2022	157	136	66	24	15	61	94

Source: IFR, <https://ifr.org/img/worldrobotics/2023_WR_extended_version.pdf> (2023) 12

Industry 4.0 is system which interact with each other through a connected network of computers and equipment. In this system, the robots' activities were connected to programmable logic controller. So, works were organized and automated more easily and more[39]. In this process, inside of time, impact of developed technology, robots, sensitive and able to think and act (sense, think, act), have become more important factor in production[40]. While the first and limited robots produced in 1959 were aimed at lifting/motivating certain objects in industry now, there are currently an estimated 650 thousand industrial robots working in the world[41].

In the development of robot technology, the traveling robot named "Shakey", which was developed in 1966 and perceives its surroundings. In 1980, the 3rd generation robots were developed, and these robots, as the pioneers of autonomous robots, were robots that perceive their environment, produce a plan/decision with their perceptions, and act accordingly. Until the 1990s, industrial robots had a dominant share in robot production sector[42].

There are also significant developments in the material basis of the development of robot technology since 20-30 years. The increasing demand for industrial robots has been particularly determinative here. Es-

[39] Javaid,Haleem,Singh and Suman,(n 29) 62

[40] Wildhaber, (n 34) 317

[41] Varol,(n 21) 75-76

[42] Yazıcı, (n 27) 39

pecially since 2017, the stock of industrial robots has increased annually average of 13%. China played a major role in this increase in demand. So much so that China's operational industrial robot stock has grown by an average of 25% every year since 2017. While the number of robots in China was one million in 2021, it exceeded 1.5 million in 2022. This amount represented 38% of the global stock. It should be noted here that the largest industrial robot market in the world is in Asia, at the effect of China. Because Asia's largest market is China as it seen from data. (If it say for compare, In the US, installations are 56,053 units in 2022 (55,212 robots in 2018)). From 2017 to 2022, annual robot installations in China was grew annually average of 8%. When it look in world economy, 79% of global robot installations occurred in five countries. They are China, Japan, USA, Republic of Korea and Germany. As of 2022, 156,936 robots have been installed in the sectors of home apparatuses, electrical machines, semiconductors, solar panels, computers, telecommunication apparatuses and video and other electronic amusement products[43].

It is clear that which factors are effective that make it attractive for businesses to replace human labor instead of robots. The main advantages of replacing the workforce with robots are decreasing costs, increasing production, developing of product quality, increasing of precision in the process, reducing production costs, reducing error margins and risks to people. However, it should be noted that robots have disadvantages. For example, the disadvantages of replacing the workforce with robots include increased unemployment rate, decreased tax collection, lack of empathy and the danger of hacking, here[44].

Today, robots are used in industry, medical sector, war equipment/defense sector, film industry, space industry, housework, agriculture and animal husbandry, and sports[45]. In 2012, 60,141 robots were installed in general industries (38% of the total robots), while in the same year, 66,508 robots (42%) were installed in the automotive indus-

[43] IFR, <http://www.ifr.org> (2023) 12-13 Access:15 June 2024; www.marketresearchfuture.com, (2024) Access:09 June 2024

[44] E.Carrera, F.M.Lorena,L. Zambrano, H.Yandry,V. Rade and L.Yasmina, L, 'Replacement of human personnel by artificial intelligence: advantages and disadvantages' (2022) 25 15, n. Investigación y Negocios,ol. <http://www.scielo.org.bo/ pdf/riyn/ v15n25/ v15n25_a04.pdf> 35 Access:11 March 2024

[45] Varol, (n 21) 78-83

try and 32,697 robots (20%) were installed in the electrical and electronics sector. By 2022, robot installation in general industries increased to 259,986 (47% of the total robot installation), 156,936 in the Electrical-Electronics sector (28% of the total robot installation), and 136,130 in the Automotive sector (25% of the total robot installation). While 14% of industrial robots were installed in China in 2012, this rate increased to 52% (290,258 units) in 2022. While the robot installation of countries other than China in 2012 was 86% with 136,359 units, in 2022 this share decreased to 48%, with 262,794 units[46]. It is very clearly that in the process, the share of robot usage in Chinese economy greatly increased.

Industrial robotics market size reached to 18.6 billion USD in 2023. The Industrial robotics market's value is presciented to grow from USD 20.68 billion in 2024 to USD 43.6 billion by 2032 (compound annual growth rate (CAGR) of 9.77% (2024 – 2032)). Here, automotive industry are the main market factor increasing the market growth[47].

In world economy, service robots for professional use in Transportation and logistic sector increased from 60.000 to 86.000 from 2021 to 2022. In hospitality sector service robots for professional use increased from 11.000 to 25.000 from 2021 to 2022. In Medical robotics area service robots for professional use was 9.000 in 2021. (in 2022, it was 9.000.) In Agriculture sector service robots for professional use increased from 7.000 to 8.000 from 2021 to 2022. In professonal cleaning sector, service robots for professional use is increased from 6.000 to 7.000 from 2021 to 2022. In 2022, while USA ranked first place in among the service robot manufacturers with 204.000 devices, China ranked second with the production of 99,000 devices, Germany ranked third with 74,000 devices, Japan ranked fourth with 67,000 devices, France ranked fifth with 48,000 devices, and South Korea ranked sixth with 50,000 devices[48].

Essentially, robots consist from drivers, robotic manipulators, sensors, end effectors and controllers. Most of these devices are using in automomotive industry. So, it can say that the industrial robotics industry is feeded by the growth of automotive industries. While industrial robot sector grows, this development increased the integration of AI

[46] IFR, (n 43)

[47] <www.market researchfuture.com> (n 43)

[48] IFR, op.cit

robots, IoT, and other digital technologies. In the impact of development of robot industry, robots are started to use, not only in the automotive industry, but also in food and beverage, healthcare and pharmaceuticals, aerospace and defense, metals and mining and other industries, more than ever before[49]

When robot sector's sells analized, it seen that the electrical/electronics sector is seeing the main demander of industrial robots in 2020-2021-2022. In 2022 alone, 156,936 robots were installed in the production sector of electrical machines, semiconductors, solar panels, computers, telecommunications devices, household appliances, and video and electronic entertainment products. Robot demand in the electrical and electronics industry increased by an average of 5% annually since 2017. The average robot density in the manufacturing sector in 2022 was 151 robots per 10,000 employeesWhen this number looked at especially for Asia, it is seen that the number of robots per capita is higher. For example, Asia's average robot density in 2022 was 168 units per 10,000 employees. In the same period, Europe's robot density was 136 units per 10,000 employees. In America, this rate was 120 robots per 10,000 employees[50]. (In Turkiye, 32 robots were used per 10.000 employess in 2020[51].

Under the influence of the widespread of Industry 4.0, the tendency towards robotics and smart production in the industrial field is increasing. The growing industry directs companies to advanced technologies. For example, in the automotive industry, the increasing interest in electric cars brings lively demand in the robot market, considering the cost-benefits[52]. According to end use, the industrial robot market is basically divided into two. The primary market is include to Automotive, Electrical and Electronics, Chemical Rubber and Plastics, Manufacturing, Food and Beverage industries. The second market is others. "Other industries". The essence of this distinction is that the main demanding industries in the robot market are the primary market industries. When it

[49] <www.marketresearchfuture.com> ibid

[50] IFR, (n 43) 15

[51] <https://www.stendustri.com.tr/turkiyede-robot-kurulumlari-yuzde-11-artti> (2022) Access:05 July 2024

[52] <www.marketresearchfuture.com> ibid

look to detail, in 2022, more than 25% of the industrial robot market consisted of the electrical/electronic end-use segment[53].

In nowadays, there is a rapid increase in the production and sales of industrial robots in the world economy. So, while the robot installation of the Asia/Australia region (especially in China) was 85,000 in 2012, this number is 405,000 in 2022. Robot installation increased dramatically in this region in 10 years. This value is extraordinarily high compared to other regions. At the robot installation data of other regions are quite low. For example, robot installation in Europe increased from 41,000 units in 2012 to 84,000 units in 2022. Robot installation in the Americas increased from 28,000 in 2012 to 56,000 robots in 2022.

For todays, modern trends and contents in the development process of robot technology are as follows: Cloud system and 5G telecom networks, digitalized production process, machine control and vision, programming, detection of shapes and smarter, faster, more efficient and more accessible automation, and nearshoring of production, democratizing of robot using[54].

When it analyzed developments, it can be said that robots can offer better product quality than human labor. Because robots programmed in automatized works are reliable, safety and they supplies high-quality product quality. Robots give to firms, 24/7 operation efficiency[55]. As of 2024, in Robot market The US, Canada, German, France, UK, Italy, Spain, China, Japan, India, Australia, South Korea, and Brazil are active. And key companies in the Industrial Robotics market are Abb, Fanuc Corporation, Yaskawa Electric Corporation, Mrk-Systeme GmbH, Epson, Mitsubishi Electric Corporation, Comau SpA, Daihen, Denso Corporation, Finsar, Aurotek, Apex Automotion and Robotic, Adept Technology, Kawasaki Heavy Industries, Ltd., Omron Corporation, Kuka AG, Hirata Corporation, Toshiba Machine Co.Ltd.[56].

[53] <www.cognitivemarketresearch.com> (2024) Access: 16 May 2024

[54] IFR, (n 43) 34-35

[55] <https://go4robotics.com> (2024) Access: 08 April 2024

[56] <www.marketresearchfuture.com> (n 43):https://www.cognitivemarket research.com (2024) Access: 23 July 2024

5. Robotics and Industry 4.0 Developments in Turkiye

The first study on robotic technologies in Turkiye was carried out in 1987 with the support of TUBITAK Engineering Research Group and ITU. This work started with the establishment of the "Robot Technology Research Unit (ROBOTEK)" and Turkiye's participation in the European Regional Project on "Industrial Robotic Applications" organized by the United Nations UNDP/UNIDO organization in 1988. The "National Focal Point (NFP) ROBOTECH unit" of the study organized by UNIDO was determined as ITU[57].

It can be said that enterprises with capital adequacy in Turkiye have increasingly participated in industry 4 structuring and the use of robots over the years. So much so that, as of 2022, the robot installation level in Turkiye ranked 13th among the world countries with 3,700 units. In list of World Robotics Organisation, after Turkiye, in ranking, Thailand installed 3.300 robots and then Canada installed 3.200 robots. Before Turkiye (in ranking), the country that installed the most robots was China (290.300 robots), followed it by Japan (50.400 robots), the USA (39.600 robots), South Korea (31.700 robots), Germany (25.600 robots), Italy (11.500 robots), Taiwan (7.800 robots), France (7.400 robots), Mexico (6.000 robots), Singapore (5.900 robots) and Spain (3.800 robots)[58]. After Turkiye, Thailand ranked 14th and Canada ranked 15th in robot installation. In Turkiye, from 2015 to 2020, annual robot installations grew by an average of 3 percent. The operational stock is 16,464 units (+%10). From 2015 to 2020, the robot stock increased by 16 percent CAGR (compound annual growth rate)[59].

In the coming years, the industrial robotics market in Turkiye is expected to experience rapid growth, with an estimated compound annual growth rate of approximately 5.5 percent. With this rate of increase, the market volume of the industrial robot market in Turkiye may increase to 43.3 billion US dollars in 2027[60]. There are many reasons for this progress. Among these, increased productivity and cost savings have big importance. For these reasons, it seems that the use of robots will

[57] Varol, (n 21) 78

[58] IFR, (2023) 17

[59] <www. stendustri.com.tr> (n 51)

[60] Reportlinker.com, 'Turkey, robotics, Market Overview 2024-2028' (2024) <https://www.reportlinker.com/ market-report/Robotics/492848> 5 Access:17 June 2024

increase due to the increase in automation in many sectors, especially the automotive, electronics and metal industries[61].

But it should say that the manufacturing industry in Turkiye, which is among the high-middle income economies, is concentrated in the low and medium-low technology group[62]. For this reason, it can forecast that the use of Industry 4.0 and robot technology is not high in Turkiye, except for companies with high capital. This situation can understand from the low level of high-tech products in exports and the high level of high-tech products in imports[63]. In Turkiye, some large companies operating in the automotive sector and white goods manufacturers are closer to Industry 4.0 and robot technology[64]. (for example, Ford Otosan, Toyota Türkiye). In addition, large white goods manufacturers and electronics companies (Karel[65], Mitsubishi-Turkiye[66] and etc are work in the Industry 4.0 system[67]. Apart from these, it can be said that companies in the pharmaceutical and chemical sectors are work in the Industry 4.0 system.

It can give another company's examples to transfer to Industry 4.0 in Turkiye. Example, Koç Holding companies and Sabancı Holding companies and another big holding companies transfered to Industy 4.0 system. Example, as an Electronic company Vestel (Zorlu Holding's Company) also transformed to Industry 4.0 system. Not only Vestel Company, but also Zorlu Energy, Zorlu Textile, and Zorlu Real Estate Companies, which are other companies within Zorlu Holding, have real-

[61] Reportlinker, (n 60) 5

[62] EBSO, 'Sanayi 4.0' (2015) EBSO Yayınları 45

[63] <www.tuik.gov.tr (2024)> Access:30 July 2024

[64] A.Sarıkan, 'Endüstri 4.0 Nedir? Türkiye'de Endüstri 4.0 Uygulamaları Nelerdir?'(2024) <https://www.karel.com.tr/bilgi/endustri-40-nedir-turkiyede-endustri-40-uygulamalari-nelerdir-alper-sarikan-roportaji> ; E. Kasnak and B.Özkara, 'Türkiye'deki İmalat Şirketlerinin Endüstri 4.0 Olgunluk Düzeyinin Belirlenmesi' (2022) July 3 Journal of Productivity 377 Access:17 July 2024

[65] <www.cybermagonline.com> (2024) Access: 26 July 2024

[66] <https://tr.mitsubishielectric. Com> (2024) Access:26 July 2024

[67] EBSO, (n 62)31-36; H.Kahraman, 'Dördüncü Sanayi Devrimine Öncülük Eden 5 Şirket' (2024) <https://www. endustri40.com/dorduncu-sanayi-devrimine-onculuk-eden-5-sirket> Access:18 July 2024 ; <www.businessturkiye. com> (2024) Access:18 July 2024

ized their structuring within the scope of Industry 4.0[68]. Examples can be increased. Another example is Hema Industry Inc., serving in many areas from the defense industry to the automotive industry, from construction equipment to the aviation sector. As another example, Koç System (Koc Holding company) system founded in the logic of Internet of Thing (IoT), base stations, electricity meters, and production equipment as "platform 360", and this platform covered not only the production process but also the logistics and marketing processes[69].

On the subject of digital change, which is at the basis of Industry 4.0 in Turkiye, a research was conducted under the name "CEO Perspective on Digital Change" in cooperation with TUSIAD, Samsung, Deloitte and GFK organizations. Within the scope of this research, between 29 September 2015 and 15 January 2016, face-to-face interviews were held with the senior managers of 58 companies, including 11 were from the banking sector, 11 from the holding sector, 6 from the retail sector. According to this research, it has been observed that there is a significant correlation between digital maturity and digital strategy in institutions. So much so that the participants of the research saw "the clarity of the strategy" as the most fundamental factor in the success of corporate digital change and stated that the most important obstacle to digital maturity was "lack of strategy". However, as stated by the participants of the research, digital change is not yet perceived holistically in Turkiye. According to senior managers participating in the research, companies are making operational investments in individual technologies, not comprehensively[70]. In this research, first activity point was customer behaviours and after digitalization and analyze process. According to research's logic, these behaviours and digitalization process are effect to markets and also these market developments impact to technological growing in production sectors[71].

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[68] N.A.Davutoğlu, 'Sanayi 4.0 uygulamalarının dünyadaki ve Türkiye'deki sektörler açısından detaylı analizi' (2021) 8/67 Journal of Social and Humanities Sciences Research < http://dx.doi.org/10.26450/jshsr.2368> 805 Access: 20 July 2024

[69] Davutoğlu,(n 68) 805; <www.kocsistem.com.tr> (2024) Access: 26 July 2024

[70] TUSIAD, Samsung, Deloitte, GFK, 'Türkiye'de Dijital Değişime CEO Bakışı' (2016) <https://www2.deloitte. com/ content/dam/Deloitte/tr/ Documents/ technology-media-telecommunications/turkiyedeki-dijital-degisime-CEO-bakisi.pdf> 4 Access: 21 July 2024

[71] TUSIAD, Samsung, Deloitte, GFK, ibid

There are also efforts to direct the industry towards Industry 4.0 structuring in Turkiye. For example, in a report published by TUBİTAK in the 9th month of 2023 (as an evaluation of the years 2019-2020), prioritization was made in the fields of robotics and automation. Within the scope of this study, according to Tübitak's Private Sector Machinery Manufacturing plan for 2020, robotics and mechatronic system technologies (Intelligent Robotic Systems, Advanced Control Technologies, Servo Actuators, Soft Robots, Robotics and Automation system components, Collaborative Systems) and Factory Automation systems (Collaborative Robots and Autonomous robots) have described to priority[72]. In Turkiye, large companies are turning to Industry 4.0 applications.

According to Tusiad, for Industry 4.0 structuring 6 sectors (Total of these sectors have share %60 in Gross Production) are more forefront in ranking in Turkiye. These sectors are Automative and automotive Sub-industry (Share in Gross Production share %6), Machine Industry (Share in Gross Production share %4), White Goods Industry (Share in Gross Production share %5), Food and Beverage Industry (Share in Gross Production share %18), Textile (Share in Gross Production share %15) and Chemical Industries (Share in Gross Production share %12)[73].

In Turkiye, it is seen that Telecom companies provide application support to companies in terms of the Internet of Things in the Industry 4.0 application[74]. Moreover, at the point of supporting to Industry 4.0 system, there are activities in Turkiye. Among these supports (apart from the works of TUBITAK and other state organizations) there is also the studies of TUSIAD Turkish Industrian and Businessman Assocation)[75].

In Turkiye, there are companies that import robots as well as companies that produce locally. It is observed that there is a specialization in the production of AMR, FMR, LMR, CMR, CTU type robots, especially in the production of robots for the automotive, chemical, shipping, food, iron and steel, cable, and pharmaceutical industries. As of 2024, the main demander sectors in the robot production/trade area are Durable Consumer Goods, Electronics and IoT, Energy, Aviation and Space,

[72] <https://tubitak.gov.tr> (2023) Access: 18 July 2024

[73] TUSIAD, (n 70) 42/44

[74] <www.turkcell.com.tr> (2024) Access:26 July 2024, <www.vodafone.com.tr> (2024) Access: 26 July 2024, <www. turktelekom.com.tr> (2024) Access: 26 July 2024

[75] <www.tusiad.org> (2024) Access: 20 July 2024

Machinery Manufacturing, Medical and Dental, Engineering, Automotive, Robotics and Automation, Defense sectors[76].

Table 3: Gross R&D Expenditure/GDP in Turkiye

Years	R&D % Value	Years	R&D % Value
2001	0.52	2012	0.83
2002	0.51	2013	0.81
2003	0.47	2014	0.86
2004	0.50	2015	0.97
2005	0.56	2016	1.12
2006	0.55	2017	1.18
2007	0.69	2018	1.27
2008	0.69	2019	1.32
2009	0.80	2020	1.37
2010	0.79	2021	1.40
2011	0.79	2022	1.32

Source:www.tuik.gov.tr Access: 30 June 2024

A significant portion of the companies operating in the robot industry sector in Turkiye in terms of production and/or trade (according to information disclosed to the public in open access) may ranke as follows as of July 30, 2024: Altınay Robot, Akın Robotics (humanoid robot), Defense Industry Presidency, Oskon, Xometry, Robo Automation, Universal Robots, Ecomaks Automation, Gürmas Gürel Makina San. A.Ş.,Balkan Robotic, Ingtecro, rts robotics,ceylan robot, Arge robotic,Abb,Mcfly Robotics, Kuka Turkiye, Schunk Turkiye, Siff Electromechanical, Günmak A.Ş., Closs Turkiye, Manu Robotics, Reel Mechatronics, Rotsis Robot Automation, Phoenix Contact, Sintek Engineering, Murr Electronics, Dedem Automation, SYS Robotics, Askaynak, Stäubli Robotics, Behaotomasyon, Moritek, He-Pro Mechatronics,Roboder, Wetec, Aselsan, Bozkurt Machinery, Ceysan, Demir İş Machinery, FenRobotics, Gurmak, Inno Robot, Makro Robot, Mechatronics, Robotics Inc., Robaxis,Asmetal, Omron, 3drobotik. It should be said that there are other companies in the sector than the companies above. Other companies

[76] <https://xometry.com.tr> (2024) Access: 20 July 2024

may investigate from Roboder (In the robot industry sector, there is an association under the name of Roboder) database[77]. These companies operating in Turkiye can produce/provide the robot requirements of the production and service sectors in many fields, including industrial robots, service robots, agricultural production robots, medical sector robots, etc. As of May 11, 2023, more than 17,000 robots involved in production in Turkiye[78].

Although there are efforts to develop and advancements Industry 4.0 and Robot technologies in Turkiye, it is difficult to say that these are sufficient. The development of the ratio of R&D Expenditures to GDP in Turkiye is an important indicator in determining this. At this point, when we look at the ratio of R&D expenditures to GDP in Turkiye from 2011, when the Industry 4.0 structuring was announced, to 2022, it is seen that the rate, which was 0.79% in 2011, increased significantly to 1.32% in 2022. However, when this rate is compared with world examples, it should also be said that it is not a very high rate. For example, while the world average ratio of R&D expenditures to GDP was 1.99% in 2011, it was 2.62% in 2021[79]. Compared to the world average, the share allocated to R&D by Turkiye is low. At this point, as Sözen and Mescioğlu also stated, it would be more accurate to position Turkiye's industrial condition not in 4.ındustrial revolution but somewhere between the 2nd Industrial Revolution and the 3rd Industrial Revolution. The reason for this is the inadequacy of companies' R&D budgets and investment in technology[80].

6. Conclusion

The robot economy and the Industry 4.0 are two intertwined elements. 3rd Industrial Revolution meant a structural change from mechanical systems, semi-electro-mechanical systems to digital systems. Of course, while production structures are changing, consumption cycles and preferences also kept up with this change with new products. From changing production and consumption processes have also affected so-

[77] <https://uyeler.roboder.org.tr> (2024) Access: 18 July 2024

[78] M.Varış,<https://www.bloomberght.com/turk-sanayiinde-17-bini-askin-robot-uretim-yapiyor-2331255> (2023) Access:13 July 2024

[79] <www.worldbank.org> (2024) Access: 16 May 2024

[80] M.Sözen and T.Mescioğlu, 'Endüstri 4.0'ın İtici Güçlerinin Türkiye Ve Çin Üzerindeki Etkileri' (2019) VFol.12/1 International Journal of Social Inquiry 310 Access: 26 July 2024

cial structures in some way. This is not surprising. Because, in world societies, social cycles and economic cycles are intertwined at many points. For example, as industrialization increases in countries, information has come to the fore not only in production processes but also in consumption processes.

This differentiation became more evident especially in the 4th Industrial Revolution. In today's world, it seems that societies are more involved in "information and learning". As societies engage with knowledge and learning, production processes have also become more knowledge-based. Structure of changing society supported to development of production cycles. In this surround, it can say that robot economy and Industry 4.0 application describes the reshaping of production with knowledge. This is so, because behind robot technology and the 4th Industrial Revolution there are digitization of information and its application to production.

Behind the Industry 4.0 production system, defined as the smart factory, there are autonomous Robot technology, Internet of Things, Horizontal and Vertical integration in Production, Remote management and Control access and Cyber Security, 3 D printing technology, Big data collection and analysis, Augmented reality and additive manufacturing. All of these are related to development of knowledge efficiency and digitalization of knowledge.

While developed capitalist economies of world economy together with 1980s take to front knowledge in their economic and social life,when they came 2000s, they moved to 4th industry revolution and this transformation is continuing nowadays. Here, when it look transformation of Turkiye’s industrialization, it can see and say that Turkiye has positive developments in Industry 4.0 structuring. In Turkiye, although it not widespread, there is development in the field of Industry 4.0 and robotics, especially in large-capital companies and in the automotive, durable consumer goods and other electronics sectors.

In the 21st century, with the industrial 4.0 revolution in the world economy, production lines in factories of some developed countries have at the big rate transformed on a different structure than in the past. So that, production is became more sophisticated with the support of digitalization. While production lines have changed under the influence of smart production techniques in today's industrialization process, both

significant increases in production have been encountered and it has become easier to design and develop new products.

Although Turkey's industrialization emerged in the 1700s as a longing in the eyes of some managers (in Ottoman period), the dates when serious industrialization steps were taken were in period of Turkish Republic. The industrialization efforts that continued from 1923 until the 1980s can be defined as the 2nd industrial revolution in the distinction of the industrialization revolution. In 1980s, while world economy change, Turkish economy is also changed. An industrialization process emerged after the 1990s, which may name a 3rd industrial revolution, with increased use of computers in production.

However, in these years, at the impact of the hegemonic power of the liberal doctrine of world economy and at the impact of the conditions of country's economy and it is not possible to talk about the intense support of the state as in the 1960s and 1970s at industrialization. A similar situation is also the case in the 2000s. In these years, Turkiye is in global economy conditions.

In these years, the striking situation in large-scale and big capitalized companies of Turkiye is the emergence of a tendency towards the Industry 4.0 revolution in varying degrees. And again in these years, the use of robots in production and distribution lines in medium and large-scale enterprises began to increase. So that, when examined as of 2022, it is seen that the use of robots in production has increased considerably. According to the calculations of the International Robotics Organization, Turkey ranked 13th in robot installation on a world scale. As of this year, this ranking represented a degree front of Thailand and Canada.

According to data above, in today's world economy, the application of Industry 4.0 and the effectiveness of the robot economy are fastly increasing. However, in Turkiye, firstly, after 2010 (2011), It cannot be said that the Industry 4.0 aplication tendency, which emerged in areas such as automotive and electronics, has spread to the whole economy. There is a tendency, but this tendency is weak. In this area, the state's supportive policies are needed in the main route of developing Turkey's industrial production (industrialization) and foreign trade. At this point, technology policies including tax reductions and production supports can be created to encourage companies to turn to Industry 4.0 and the robot economy by public autorities.

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