



# Scanning the Industry 4.0 Ecosystem in Turkey: Digitization and Innovation Studies

Muhammet Arucu<sup>1\*</sup>

<sup>1</sup> Bandirma Onyedü Eylül University, Department of Computer Technology, Bandirma, Turkey (ORCID: 0000-0001-7620-9044), marucu@bandirma.edu.tr

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## Abstract

Recent technological developments and innovations across the world has led to significant increases in industrial productivity since the beginning of the industrial revolutions. Steam-powered factories in the 19th century started mass production in the early twentieth century, and in the 1970s the industry became automated. In the following years, the industrial sector has further developed, with advances of industrial technology, particularly information technology, mobile communications and e-commerce. By the end of the Industry 3.0 revolution, which was the period of electronics and informatics (1970-2000), digital technologies, intelligent robots, large database, internet of objects, cloud system composed the industrial revolution of today (industry 4.0 or digital transformation). In this way, it is ensured that the value chains are integrated to each other in production and as a result, high efficiency is achieved with low production costs and increased production. Therefore, countries have been able to gain global competitive advantage by increasing their growth rate with increasing investment. In our country's industry, it is aimed to provide that production, quality and efficiency are increased by cyber physical systems developed with industry 4.0, creating common data, design and production bases. In order to ensure positive results from these studies, relevant ministries have prepared industry strategy documents. In this study, industrial and technological activities carried out in the digital transformation process in Turkey were examined.

**Keywords:** Industry 4.0 implementations, Digital transformation, Smart production, Industrial strategy

## Türkiye'de Endüstri 4.0 Ekosisteminin Taranması: Dijitalleşme ve Inovasyon Çalışmaları

### Öz

Dünya genelinde teknolojiye son gelişmeler ve yenilikler endüstriyel devrimlerin başlamasından bu yana endüstriyel üretkenlikte önemli artışlara yol açmıştır. 19. yüzyılda buharla çalışan fabrikaların 20. yüzyılın başlarında seri üretime başlamasıyla 1970' lerde endüstri otomatik işlevsellik kazanmıştır. Takip eden yıllarda, sanayinin sektörünün gelişimi özellikle bilgi teknolojisi, mobil iletişim ve e-ticaret olmak üzere endüstriyel alanlarda kullanılan teknolojilerin daha ileri bir noktaya gelmesiyle artmıştır. 1970-2000 yılları arasında etkin olan elektronik ve bilişim dönemi olarak bilinene Endüstri 3.0 devriminin sonlanmasıyla, dijital teknolojiler, akıllı robotlar, büyük veri tabanı, nesnelerin interneti, bulut sistemi günümüzün endüstriyel devrimini yani endüstri 4.0 çağını başlatmıştır. Bu şekilde değer zincirlerinin üretimde birbirleriyle bütünleşmesi sağlanarak düşük üretim maliyetleri ve artan üretim ile yüksek verimlilik elde edilir. Bunun doğal bir sonucu olarak dünya genelindeki ülkeler, artan yatırımlarla büyüme oranlarını artırarak küresel rekabet avantajına sahip olmuşlardır. Türkiye endüstrisinde, endüstri 4.0 ile geliştirilen siber fiziksel sistemler ile üretim, kalite ve verimliliğin artırılmasıyla ortak veri, tasarım ve üretim üsleri oluşturulması ana hedef noktası olmuştur. Bu çalışmalardan pozitif sonuçlar elde etmek için ilgili bakanlıklar endüstri stratejisi belgeleri oluşturmuşlardır. Bu çalışmanın en temel amacı ülkemizde dijital dönüşüm sürecinde gerçekleştirilen endüstriyel ve teknolojik faaliyetleri incelemektir.

**Anahtar Kelimeler:** Endüstri 4.0 uygulamaları, Dijital dönüşüm, Akıllı üretim, Endüstriyel strateji

\* Corresponding Author: marucu@bandirma.edu.tr

## 1. Introduction

Industry 4.0 constitutes the most current of industrial revolutions; machines in production systems are connected to each other thanks to sensor technology, data exchange takes place and, in this way, the factories of the future are built with the conversion of software and algorithms in a whole system into instant reports. Developing technologies, varying customer expectations and competitive conditions have forced product and service providers to explore various solutions for design and processing of products in manufacturing systems [1-3]. It is of great importance for countries to provide innovation, localization and transfer of technology in the industry, to increase the dynamism of the domestic market and foreign trade, to create new markets in the international arena for the domestic industry, to increase the quality of employment and labor force, to reduce the current deficit by increasing foreign exchange inputs. Within this framework, it is possible to take positive steps in the industry with the development of key technologies by analyzing product and technology needs through the most up-to-date solution of basic components of industry 4.0 [4]. In today's world, changing consumer and customer behaviors, technology progression and increasing digitalization, as well as business models, products and services, the experience how customers do business are questioning. In this interaction, they change to become the company that decides or establishes the rules of the game and impacts on the ecosystem in which they live. Footsteps of digital conversion without sector discrimination are currently gaining important part [5-8] in Figure 1.

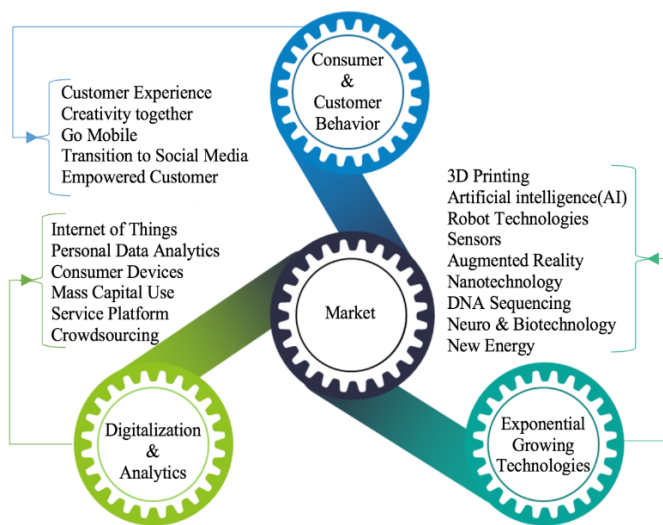


Figure 1: The Factors triggering digital conversion for industrial companies [6].

### 1.1. Industry 4.0 Ecosystem

Equipping the production lines with IoT-supported sensors in mechanization includes a wide range of areas, from automatically reporting the status of the system to notification/elimination of failures in the production line and from reducing production costs to improving digital marketing activities. Modern factories, which can be easily customized according to demand in the Industry 4.0, use artificial intelligence software that manages intelligent machines and robots equipped with sensors, cyber-physical systems monitoring physical processes and intelligent production lines for virtual copies of the physical world. As smart software

develops, it becomes easier to solve the problems on the production line immediately and on time. Thus, industry 4.0 establishes semi-centralized (distributed) structures in production, management and governance processes. This provides organizations with flexible manner in different areas, from competitiveness to production optimization and crisis management [9-10].

In future digital Technologies, Big Data, Internet of Things (IoT), Artificial Intelligence (AI) .etc will represent heart of the full industrial sector of production in Figure 2. For the industry 4.0 ecosystem, it is required to become supportive, common sense, collaborative, sensitive businesses. Industry 4.0 should not be an idea to be passed, it will actually constitute the entire infrastructure for the next generations. We need to build, support, experiment and invest in this ecosystem. Entrepreneurship should not be considered only in incubation centers, but also in the core of the company or in a room of house and in the drawings of notebooks [11-14].

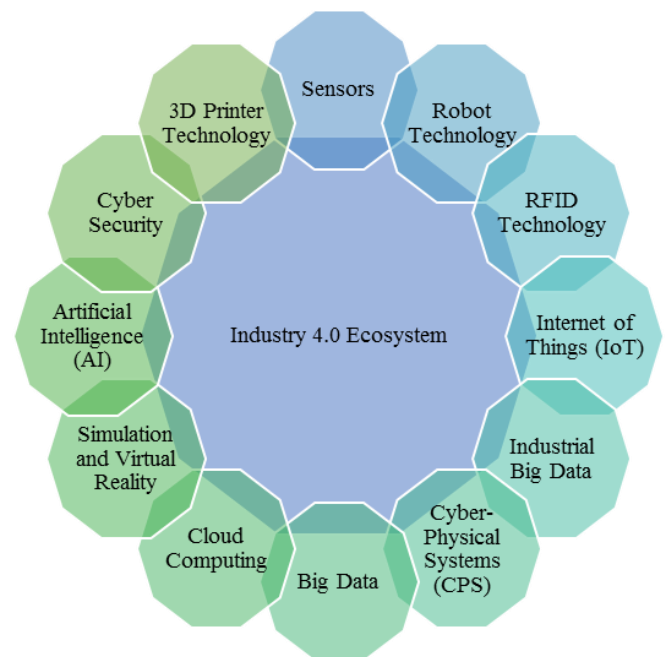


Figure 2: The key components of industry 4.0 digital manufacturing process

### 1.2. Sustainable Opportunities in Industry 4.0

In recent years, developing countries, which rely mostly on imports in their production, have also started to follow with this development. These countries need to further professionalize their industrial production to increase productivity, efficiency, quality and digitalization. The addition of digital technologies in production processes also fastens and grows production power. The growth of the economies, the change in the import-export balance, the formation of different business areas caused significant changes in the current system of life. Intelligent production processes, smart products and remotely intervenable systems will provide a high level of flexibility in production processes. Simultaneously, it will allow customers to be integrated into the system and pave the way for the production of products that can be customized at low costs in line with customer requests [15].

Offering advanced technology, virtual processes and high optimization, industry 4.0 has the potential to provide maximum

productivity at all stages, from product design to service ensuring economic growth, employment, social stability, lasting value, job security and greater productivity, and therefore high living standards. In addition, industry 4.0-based virtual 3D development, digital planning and monitoring, systematic identification of customer needs through virtually error-free production processes and the creation of new business processes makes production processes more efficient [15-16].

Globally, national economies are investing in large-scale initiatives to strengthen their manufacturing industries. Upon manufacturing technologies, emerging digital information processing paves new opportunities for industrial enterprises to be compatible with the future [17]. So that, it is comfortable that the concept of industry 4.0 is rapidly realizing itself. In the past years, the industries concentrating heavily on imports in their production have gathered around this concept and started to adapt to the processes step by step, facing the most significant problem as professionalization. As mentioned above, technological developments particularly focusing on digital computing increases the production speed of the industry continuously [18].

## **2. Methodology Mechanism**

### **2.1. Industry 4.0 Studies in Turkey**

The integration of production, design and administrative processes in the manufacturing sector with software, machines and robots is defined as industry 4.0. Industry 4.0 uses cyber-physical systems, sensors, artificial intelligence, analysis algorithms, IoT, cloud computing and cognitive analysis software. This section will present Turkey Current Status of Digital Conversion, needs, capabilities and industry 4.0 applications. It is seen that the western countries leading the digital transformation race in industry have made a significant progress in this area. Although it is thought that production will shift to western countries with digital transformation, China has become one of the countries that led the digital transformation by acting with foresight. Considering the ratio of Turkey's high-tech product exports and R & D investments to gross domestic product (GDP), it is seen that there is a long way to go in order to reach the leading countries in the digital transformation race in the industry [19-20].

Companies across the world are noticeably understanding that sustainable success is related to the adoption of new digital technologies within the scope of digital transformation in industry. In order to measure how quickly industrial companies in highly competitive economies can adapt to these new technologies, Boston Consulting Group (BCG) conducted a survey involving senior executives from some companies in Germany, USA, China, France and the UK [21].

Digital technologies to ensure the technological transformation that will enable production of higher value-added production and ecosystems as well as to integrate the entire value chain to produce these technologies are of great importance in Turkey. For this reason, technology producers and users in Turkey for measuring the competence level of the company and shortcomings of these companies is of great importance in the context of analysis of the current situation. In order to contribute to this purpose, extensive research has been conducted with technology users and suppliers within the framework of this study [22-23].

In the 10th development plan covering the years 2014-2018, it is stated that the importance of information increases gradually, especially in the countries such as India and China. The studies on technology export have increased and therefore the studies regarding technological development should be supported by the public without waiting for the private sector. In this regard, work has been started with technology centers [24].

In the latest development plan, it is stated that digital communication, nanotechnology, surface technologies, material sciences, metering devices, biotechnology and environmental technologies have been released especially in information technologies, automation and advanced production techniques and health technologies. In particular in these sectors, it is aimed to increase technological products as to improve productivity in all sectors. In order for this target, it is aimed to increase the production of technological products with technology incubation centers and techno parks. Additionally, strengthening the internet infrastructure of the country and increasing the number of people accessing the internet are among the targets. Developing technologies that increase productivity in production processes and support sustainable production, increasing the share of high technology sectors in manufacturing industry production and export, and increasing university industry cooperation are important for the transition to industry 4.0 [25].

### **2.2. Turkey Industrial Strategy Document and New Opportunities**

Based on the analysis of economic developments in Turkey with a participative approach, Turkey Industrial Strategy Paper was prepared between 2015-2018. In this context; "Medium-high and high-tech products in Afro-Eurasia to the design and production base" as the overall objective of Turkey's Industrial Strategy, with its vision of "increasing the competitiveness of Turkish industry and productivity, higher share in world exports, mainly high value-added and accelerate the transformation of high-tech products into an industrial structure with a qualified workforce and at the same time sensitive to the environment and society. For the general purpose mentioned, three main strategic objectives have been determined in order to realize structural transformation in industry under the focus of industrial strategy [26-27].

Turkey to pioneer high-tech and value-added produce digitalized world, with the support of stakeholders has been prepared by the Ministry of Industry and Technology of 2023. Industry and Technology Strategy. This document Turkey's "National Technology and Strong Industry" for the vision of "High Technology and Innovation", "Digital Transformation and Industry Move" and "Entrepreneurship", "Human Capital" and "Infrastructure" including consists of five main components and twenty-three smart product goals in Figure 3 [27].

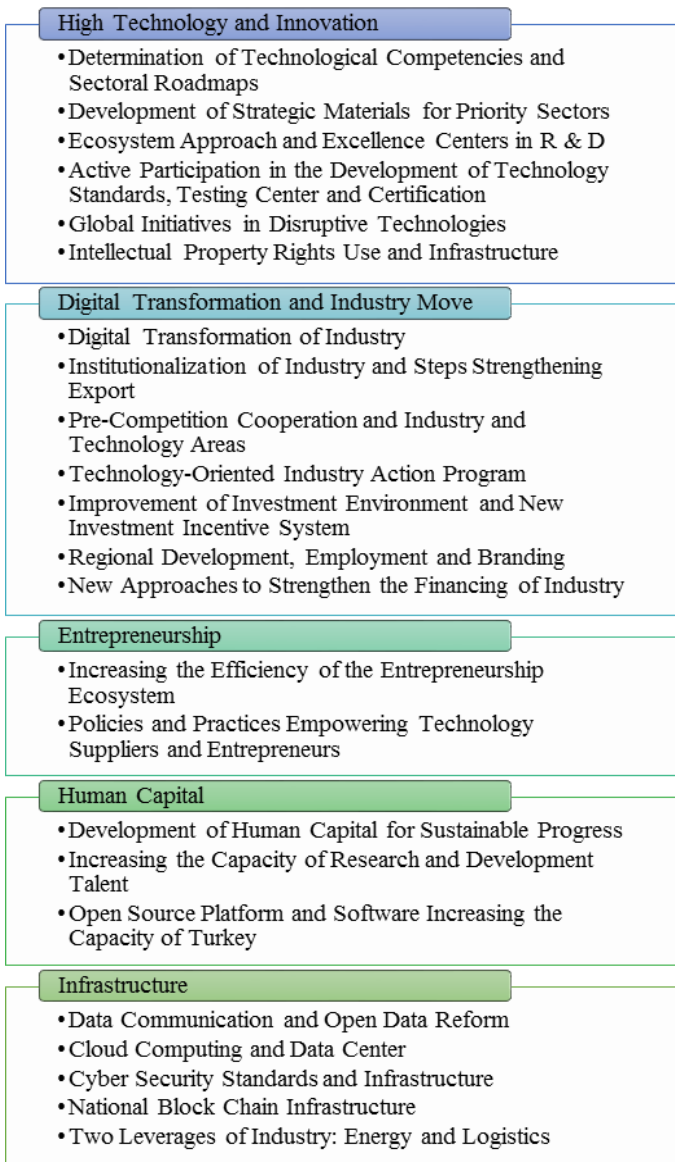


Figure 3: Industry and technology strategy for Turkey's 2023 targets for digital transformation in industry [27].

According to the report entitled "Turkey's Digital Transformation Capabilities in Industry", 61% of the company's employees in Turkey indicate that time is ready for digital conversion [21]. In the same report, the problems faced in the realization of digital transformation are high investment costs, uncertainty of return on investment, low demand for digital technologies of users. At the top of the difficulties encountered by technology user companies is the low level of awareness and the lack of qualified labor.

In this study, the awareness and investment plans of companies about digital transformation of manufacturing industry were investigated. While the firms are aware of the digital transformation in the field of additive manufacturing, it is found that the magnitude of awareness in the internet of things and big data areas is low and relatively less important for the future. In the methods of handling the financing demands of suppliers in digital transformation, equity is the first criteria while government supports are the second. In addition to benefiting mostly from government subsidies, financing deficiencies are defined as one of the main problems and expectations are determined to increase government policies.

Like in other countries, there are many effects of the fourth industrial revolution in Turkey. The industry sector, which aims to handle the sectoral requirements with a fast, reliable and innovative manner, is entering a new industrial reform period, industry 4.0, thanks to rapidly developing technology opportunities. In Turkey, due to the rapid industry currently in the automotive, industry 4.0 concept reduces the time to market by a considerable rate. Turkey due to its geopolitical position is expected to quickly complete the revolution transition [28-29]. Companies becoming a global brand leader (Siemens, Bosch, Festo, Mitsubishi etc.) in this revolution give importance to research and development (R & D) work in the factories located in Turkey.

With the growing economies and the parallel import-export balance, it is unlikely that many of the current business lines will continue in the coming period. The reason behind this is that rapidly developing advanced technological opportunities create new business lines. The most important difference between business lines is the adaptation of intelligent production processes to these systems. Together with intelligent production processes and the concepts of lower cost and more productivity, which can be considered as the essence of engineering, may also change equally. Industry 4.0 applications in Turkey focused on the automotive industry which is the fastest growing and emerging industry. Indeed, time taken to market the products in the automotive industry is significantly reduced because of usage of industry 4.0. With Turkey's emerging industrial facilities, it is necessary that Turkey must have a growth rate of 8.5% in economy to take part in the top 10 economies worldwide [27, 29]. This growth can be achieved by intelligent production processes and embedded system applications of advanced technological facilities, digital data processing capacity, the strongest communication between human to machine and the efficiency of the results obtained based on this communication. More flexible and efficient production, shortening time-to-market in Turkey which will gain Turkey to have a say in the use of advanced technology in the international arena but it will require effective and efficient use of technology.

### 3. Findings and Discussion

During the digitalization roadmap of Turkey's ministry of industry and technology in the industry, competence, research, infrastructure was extensively observed. These systems enable to test and optimize machine settings for the next product in the physical world, thus reducing machine installation times and improving quality. Industry 4.0 sensors are not just the Internet of Things and robots. The new generation of IoT-oriented industrial era concept, including the emergence of layered production (3D printing), robotics, enriched reality, artificial intelligence, has included exponential technologies that will reshape industries. Effective use of information can affect key business objectives such as your company's growth and business operations, enabling transformation across the value chain and its various stakeholders. The path to realizing industry 4.0 is clearly understood through how the physical can inform the digital or how the digital can inform the physical.

Effective usage of information determines critical business goals such as effective growth, and various stakeholders provide digital transformation in the value chain. On the road to realizing Industry 4.0, the process of conversion from physical to digital or digital to physical is well-understood. With the recent

improvements in the integration of information and operation technology, it is evaluated not only where the manufacturers are but also where they want to be in future. The digitalization of the sector will influence the growth of the production, thereby contributing to the growth of the company. Sectors with high-technology capabilities are most positively affected by digitalization. For this reason, it is absolutely necessary to digitize the sector in order to increase high technology productions and exports. Technologies, such as information and communication technology, to protect the security of basic resources (food, water and energy), new health technologies, new production and automation technologies will shape the digital transformation of the future.

Generally speaking, in the framework of industrial transformation in Turkey, the main focus should be particularly placed on high-tech and innovative technologies to robotics and automation, big data and analysis, artificial intelligence and intelligent systems topics. In this context, it is required to determine the digital transformation roadmap to point out the role of companies. In addition to the whole process, companies prone to some technological transformations are capable of making the necessary conversions within their own structure. There are important applications particularly in data security, robotics and IoT. These developments are not sufficient and companies need to take more steps to make efficient production using Industry 4.0 components.

Integration, one of the vital requirements of Industry 4.0, exports its products to many developed countries. Therefore, companies follow new road maps and workforce planning strategies in the digitization process. As digital and advanced production technologies have the potential to restore many jobs and professions, labor markets will also be affected by the Industry 4.0. The most important capital of the new age will be educated and qualified human resources. Therefore, the creation of a qualified workforce currently with the necessary skills to create a competitive workforce, Turkey aims to design and manage their own systems. The biggest challenge faced by technology manufacturers in Turkey, low awareness of the digital transformation of the sector, lack of funding, qualified manpower, are seen as major obstacles to digital conversion. In recent years, to overcome the obstacles with great emphasis on the IT sector in Turkey, programmers are trained and digitization work is accelerated for more research.

## 4. Conclusions

Turkey in 2023, country's industry towards industry 4.0 that aims to be a pioneer, as companies that want to offer a holistic approach for industry 4.0 services jointly aim to provide a common platform for the services. In addition to the prosperity gained in developed societies integrated into industry 4.0, the demographic structure of the world has changed as a result of the increase in unemployment, hunger and poverty in societies where common knowledge is not shared. There has been an increasing trend in the production processes and supply chains of companies that will increment the penetration of industry 4.0 concepts. The flow of information, advanced technologies and materials unlike IoT words of industry 4.0, it makes possible to produce completely new things in new ways and to revolutionize supply chains, production and business models. Business leaders should not think of one application without the other, and they must truly integrate and work together to inform each other in order to realize

all the benefits of industry 4.0. Effective use of information can affect key business objectives, such as business growth and business operations, and transformation between the value chain and its various stakeholders may be possible. The way to implement industry 4.0 requires a clear understanding of how physics can inform digital and vice versa.

Industry 4.0 taking into account the perspectives and awareness of the adaptation process improves the economic structure and strategic documents of Turkey to produce digital conversion systems, added value, facilitating the transition to high production and the competitiveness of the country. At the same time, developing Turkey's share in the global market will decline rapidly and producers will start to struggle in the domestic market. Integration products, one of the vital requirements of Industry 4.0, are high value added in smart production systems that facilitates the transition to production and sustainably increase the competitiveness of the country. As a result, this work examines industry leading companies with 4.0 adaptation process and sustainable industrial strategy document recognizes in Turkey.

In the digital age, industry 4.0 strategy and practices provide solutions to many different problems, and the results show that different types of problems can be found in this area. Industry 4.0 activities of Turkey in case of integration of strategic application is sufficient to make focus of the global market in the foreseeable future. The factories provided by the Internet of Things in Industry 4.0 and the completely unmanned production system, where the human element is scarce and integrated into all production processes, is to make the world more livable, to use all solutions developed for human life and to shape the society with this awareness. Companies should have a more competent workforce to effectively manage new production systems around digital technologies. Therefore, it is very important to create long-term training programs to gain additional qualifications that create value for the current workforce. With the transformation, increasing demand for specialized workforce in different disciplines will create new employment opportunities for qualified workforce.

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