MARMARA UNIVERSITY
INSTITUTE FOR GRADUATE STUDIES
IN PURE AND APPLIED SCIENCES

CHALLENGES AND READINESS OF TURKEY FOR INDUSTRY 4.0: AN EMPRICAL STUDY

EZGİ CİHAN

MASTER THESIS
Department of Industrial Engineering

Thesis Supervisor
Prof. Dr. Seniye Ümit OKTAY FIRAT

ISTANBUL, 2019

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Ezgi CİHAN, a Master of Science student of Marmara University Institute for Graduate Studies in Pure and Applied Sciences, defended her thesis entitled "**Challenges and Readiness of Turkey for Industry 4.0 : An Emprical Study**", on Sep 17, 2019 and has been found to be satisfactory by the jury members.

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APPROVAL

Marmara University Institute for Graduate Studies in Pure and Applied Sciences Executive Committee approves that Ezgi CİHAN be granted the degree of Master of Science in Department of Engineering, Industrial Engineering Program on ..... (Resolution no: 2019/22-03 30.10.2019

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SANAYİ 4.0 GEÇİŞİNDE TÜRKİYE KOŞULLARININ BELİRLENMESİ VE KARŞILABİLECEK ZORLUKLAR : AMPİRİK BİR ÇALIŞMA

Endüstri 4.0, son dönemde ülke gündemimizi sıklıkla işgal eden konuların başındadır. Konsept 2011'de düzenlenen Almanya 'daki Hannover Fuarı'nda ilk olarak kullanılmıştır. Bu süreç, müşterilerin taleplerine uygun olarak üretimi şekillendirmek ve esnek olmak için dönüşümleri içermektedir. Küresel rekabetin arttığı dünyayaa uyum sağlayabilmek için müşteri taleplerini zamanında, düşük maliyet ve yüksek kalite ile karşılaşmak gerekmektedir. Bunun için, üretim süreçlerinin otomasyonunu sağlamak ve bu otomasyon sırasında çeşitli birimlerin birbirleriyle iletişim kurması sağlanmalıdır. Böylece, insanlara olan bağlılık azaltılacak ve insan kaynaklı hatalar minimize edilecektir. Bu şekilde, kalite ve kusursuz üretim ön plana çıkana kadar maliyetleri azaltılacak. Tüm bu gereklilikler incelendiğinde, Türkiye 'de Endüstri 4.0 geçişi, zamana bağlı olarak nispeten yavaştır. Türkiye'nin bu yükselen trendi yakalaması ve rekabet gücünü arttırabilmesi için öncelikle farkındalığını arttırarak geçiş çalışmalarına hız vermesi gerekmektedir. Bu çalışmada, öncelikle Türkiye'de bulunan Endüstri 4.0 farkındalığı için model oluşturularak anket methodu yardımıyla belirlenmeye çalışılmış olup sonrasında temel olarak Endüstri 4.0 'ın Türkiye'deki geçiş zorluklarına değinilmiştir.

Anketin oluşturulması için yapılmış olan literatür çalışmasının sonuçları baz alınarak model geliştirilmiştir ve anket soruları model bileşenlerine göre gruplandırılmıştır. Anket uygulaması sonrasında çoktan seçmeli sorulardan elde edilen verilere R ve SPSS programlarından yararlanılarak faktör analizi, korelasyon, kikare ve t testleri uygulanmıştır. Anket içerisinde yer alan açık uçlu sorulara verilen yanıtlar belirlenen anahtar kelimeler yardımıyla analiz edilmiştir. Analizlerden elde edilen sonuçlara göre Türkiye'de Endüstri 4.0 kavramına ait yüksek bir farkındalığın ve ilginin olduğu ancak yeterli bilgi olmadığı tespit edilmiştir. Endüstri 4.0 geçişi için duyulan kaygıların eğitim, devlet desteği gibi temel konulardaki geliştirmeler ile aşılabileceğinin düşünüldüğü ortaya koyulmuştur

ABSTRACT

CHALLENGES AND READINESS OF TURKEY FOR INDUSTRY 4.0 :AN EMPRICAL STUDY

The industry has been at the beginning of the issues that frequently occupy our country agenda in the last period of 4.0. The concept was first used at the Hannover Fair in Germany, which was held in 2011 years. This process has raised the way that it is desirable to shape and flex the production in line with demands from customers. To be able to remove the increasing competition in the economically globalized world and to make the customer's demands must be answered in time. For this, it is included in this process (Industry 4.0) to provide automation of production processes and to enable various units to communicate with each other during this automation. Thus, the commitment to human beings will be reduced and people-borne errors will be minimized. In this way, the costs will be reduced while the quality and flawless production will come to the fore. Therefore, thanks to the innovations that will take place in this context, the transition to industry 4.0 in Turkey is relatively slow depending on time. This issue is addressed with the idea of providing the appropriate environment within the years in Turkey and talking about the difficulties encountered and addressing these problems and difficulties. In order to Turkey capture this rising trend and increase its competitiveness, it is necessary to accelerate its transition efforts by increasing its awareness first. In this study, firstly, the model for the awareness of Industry 4.0 in Turkey has been tried to be determined with the help of questionnaire method and then the basic transition difficulties of industry 4.0 are mentioned in Turkey.

Based on the results of the literature study for the creation of the questionnaire, the model was developed and the survey questions were grouped according to the model components. Factor analysis, correlation, square and t tests were applied using R and SPSS programs to the data obtained from multiple choice questions after the survey application. The answers to the open-ended questions in the questionnaire were analyzed with the help of specified keywords. According to the results obtained from the analysis, it was determined that there was a high awareness and interest in the concept of Industry 4.0 in Turkey, but not enough information. It has been found that

the concerns for the transition to Industry 4.0 can be overcome with improvements in key issues such as education and government support.

LIST OF SYMBOLS

$\propto$: significance level

LIST OF ABBREVIATIONS

ERP	: Enterprise Resource Planning
PCA	: Principle Component Analysis
R&D	: Research and Development
CPS	: Cyber Physical System
RFID	: Radio Frequency Identification
SMED	: Single Minute Exchange of Dies
3D	: 3 Dimensions
BPM	: Business Process Management
Cont	: Continue
KMO	: Kaiser-Meyer-Olkin
TPM	: Total Productive Maintenance/Management
ARDL	: Auto Regressive Distrubuted Lag Models
MES	: Manufacturing Execution System
SME	: Small and Medium Enterprises

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1. CHAPTER 1: INTRODUCTION

Industry 4.0 is a revolution to become production more flexible and smart. It was presented at Hannover Fair 2011 first time. It purposes shorter innovation cycles for more complex production, maximum automation, individualized production, energy saving, energy efficiency for used energy, more flexibility and full integrated processes. For these aims, companies must produce their products with low cost, less energy, smaller batches with huge amount, more flexibility. This reform has eight titles that are cyber physical systems, vertical – horizontal integration, internet of things, autonomous robots, big data and analytics, cloud systems, augmented reality and cyber security. (This paper will present a review for vertical – horizontal integration.)

Industry 4.0 is a synonym for the transformation of today's factories into smart factories, which are intended to address and overcome the current challenges of shorter product lifecycles, highly customized products and stiff global competition (Alçın, 2016) Industry 4.0 approach was generated because first reason is that technology is been improving day by day. Secondly, costs must be decreased because of dog eat dog world. Whatsmore, energy saving is one of the most important issue all around the world at last a few decades since energy resources are not unlimited and will end someday. For these reasons, Industry 4.0 aims for optimization of value chains by implementing an autonomously controlled and dynamic production (Schwab,2017)

Industrial revolutions are the general name given to the processes that occur due to the development requirements of the tools that carry out production operations with the increase in the production needs of mankind. These generally affect people socio-economically, and with every industrial revolution that takes place, humanity has gone a step further. The first industrial revolution in the world is simply the transition from the production method based on human and animal power to machines dominated by the machine. The revolution, which started first in England, was especially realized in the weaving industry. Then it was spread to other sectors. With the transition to the machine, the shape and quantity of production has also increased.

Industrial revolutions in general to increase the welfare and life qualities of communities realised. From societies where the right of ownership is limited, the

boundaries are not more than the increase in the ownership processes brought together by the production increase. It is expected to have an increase in quality. This increase is completely relative to the person change in production cycles as an inevitable result.

The first industrial revolution started with the increase in the level of consciousness in the society by using the steam machines used in cotton production especially for the printing of books and other production areas. In particular, with the increase in production, classes and social differences have increased with continuously increasing profits and everlasting towards this abdominal investment.

The changes and transformations in the society, which is called creative destruction according to Acemoğlu and Robinson (2017), which are the development of the property rights in Britain, have often provided advancement of technology. Britain's biggest rival in these years is France, and in this period, it has remained in serious terms, and it has pushed the remaining French people into a revolution. Meanwhile, the use of railways has been broadened to reach places where these productions will be consumed. Compared to other industrial revolutions in the first industrial Revolution, the spread of other countries has been slower; because in this industrial revolution, the things necessary for the dissemination of knowledge are limited. While the energy sources used in the world before the first industrial revolution were more human and animal muscle strength, the use of coal with this revolution has increased enormously. According to Warde (2007) estimates, the utilization rate of coal was increased to 91.4% in 1850 years.

The second Industrial revolution started with the construction of mass automobile production (Fordist), which would later take its name in the automobile factory established by Henry Ford. Ford's manufacturing innovation has reduced production costs and increased economic efficiency. With the second Industrial Revolution, access to raw materials has been facilitated by the faster and easier transportation. While accessing raw materials, different markets have been found and the products are easily reached to new markets. However, the proliferation of the car has led to widespread use of fossil fuel oil. In this period, radio and radio broadcasts have also increased and its use has become widespread. After the second industrial revolution, there has been an incredible increase in the number of large corporations, however the capital class has

been strengthened and its effects have increased both socially and economically. After the Second Industrial Revolution, scientific studies have increased and technological developments have begun to gain more space in our daily lives.

Another one of the innovations that the second Industrial Revolution brings to social life is association. In this way, workers ' demands were reported to the employer in a more tidy and different forms of management began to take place on the world. These management approaches, which are formed in the later times, after World War II, a concept like Cold War will lead to the world. Another change in conjunction with the second Industrial revolution is that the United States makes the industrial share of the world more than the countries around the world. Almost 1/3 of the world's production took place in the United States. This is explained as the main reason for immigration to America. Unlike the first in the Second Industrial Revolution, steam-based energy generation has become more widespread than fossil fuels (www.mahfiegilmez.com, 2017)

The third Industry revolution was raised after the Second World War. The foundations that this revolution relies on are the widespread use of programmable devices. Meanwhile, the transition to lean applications was made in production. In this revolution, because of the general transport and Internet connection, the boundaries of people were virtually destroyed and humanity had an incredibly intense relationship with each other. Even if the use of energy started with fossil fuels, the use of natural gas emerged in this period and became widespread. In the illustrations below, you see the rates of coal-sourced and natural gas-sourced electricity from Germany, England and the United States. This was realized by the proliferation of natural Gas (Qui et al, 2016).

As far as we can see, the problems in the world have often been gathered in this region because of the vast majority of oil and gas reserves in the Middle East and North African countries. This has also led to the fact that countries such as the United States, especially those that are doomed to these types of energy, are attempting to drag and control the countries in this region.

As written above, the first industrial revolution has realized the mechanization of production processes, the Second Industrial Revolution mass production, and the third industrial revolution is the automation of production and more digitization.

One of the natural consequences of the third industrial revolution is the rapid depletion of our resources and the use of these resources as a rough. In parallel, the concept of sustainability in production has been raised.

The third industrial revolution has been highlighted by the fourth industry of the airline transport the revolution, namely Industry 4.0, will leave its place in the space transport. It will be here in conjunction with the developments, human relations will be defined differently and the management will change this way.

The fourth era of industrial revolution, namely the known and widely used name in the concept of Industry 4.0, innovation and the human factor as far as possible, and to the minimum level of in a simple sense as a revolution in which the production was perfected by minimizing their faults but this is not exactly the expression of Industry 4.0.

However, we can describe industry 4.0 as follows in digital manufacturing, cyber physical systems, integrated communication networks, smart factories and data analysis, making meaningful information on the basis of undertakes. One of the main factors of this industrial revolution is the in a competitive position of western society and the production industry with cheap labour.

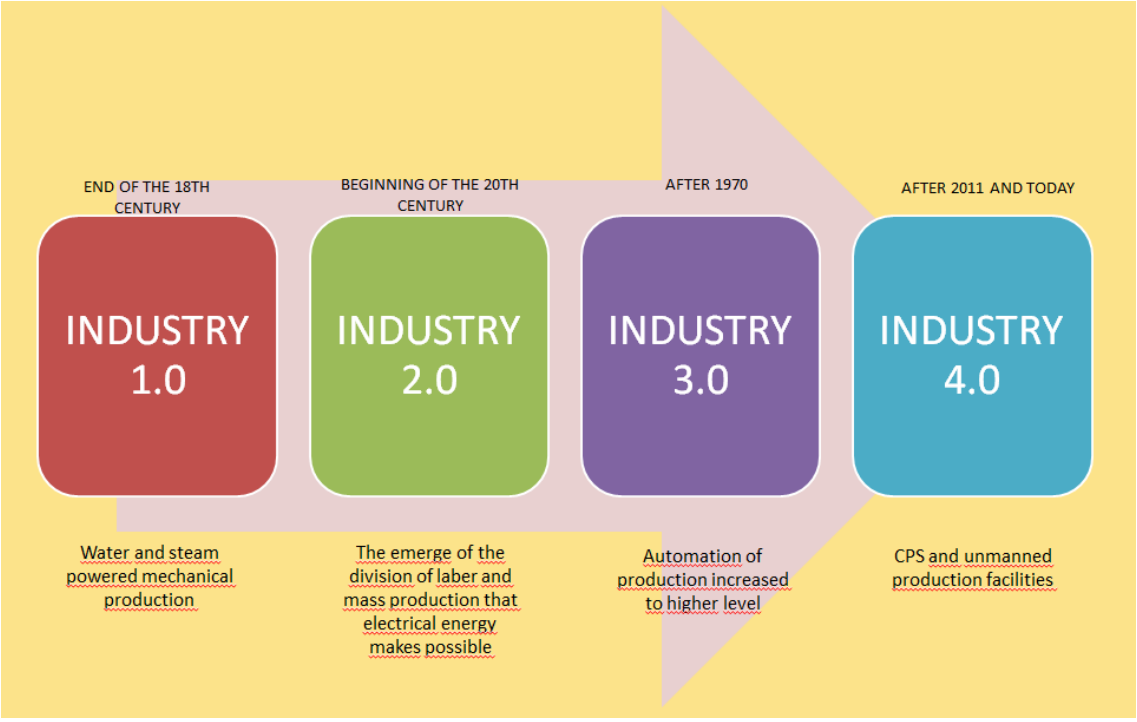

Figure 1.1 Stages of Industry reproduced from (TUSIAD,2016)

As an overview of industrial development Figure 1.1 shows all industry revolutions as a stage and explains their contributions to industry concept.

This study covers the description of Industry 4.0, key components of Industry 4.0 as the scope in Figure 1.2. In order to understand if Turkey has enough awareness and knowledge also is ready about this technological transformation.

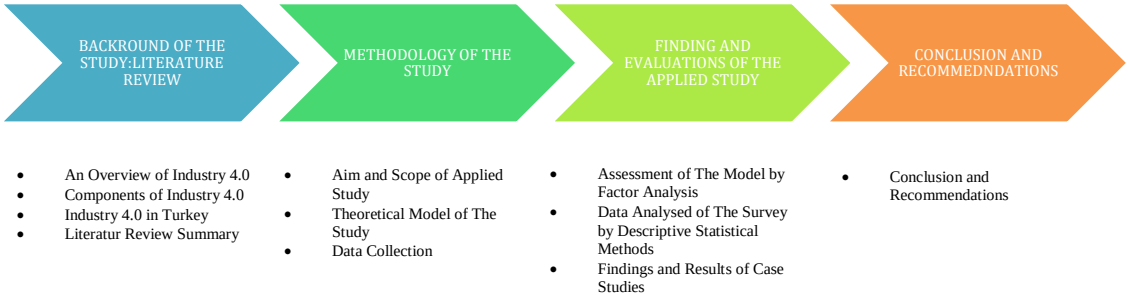

Figure 1.2 Scope of The Study

In Chapter 2, the definition of Industry 4.0 and its components. Additionally, this chapter includes literature view of Industry 4.0 in the world and Turkey researches.

Chapter 3 explains methodology of this study to understand the questionnaire model and what analysis applied.

In Chapter 4, the relationship between questions of questionnaire and check suitability of questions for the study aim. In analysis, factor analyse, correlations analysis, chi-squares and t tests are applied.

Finally, the findings are provided in the Chapter 5 and the conclusion is achieved according to these results. It can be said that last chapter is the summary of the study and the general remarks are given. Moreover, this chapter helps to understand how ready Turkey is for Industry 4.0 transformation, what challenges can be faced during the transformation, what level Turkey has knowledge about Industry 4.0.

2. CHAPTER 2: BACKROUND OF THE STUDY:LITERATURE REVIEW

The Industry 4.0 concept was first in 2011 in Germany's Hannover the exhibition is held in the city. While the concept of Industry 4.0 was introduced by Germany, it was aimed to solve the problems that the production processes brought from the heavily developed countries to the undeveloped countries.

In this chapter, Industry 4.0 will be introduced what the main purpose of Industry 4.0 is that it is a concept of production using cyber physical machines for faster and more accurate production of the the effect of this process on the philosophy of production can be personalized and to be more flexible. In doing so, the ability to handle large data is to provide. The biggest advantage we have here is the spread of the internet and we have the Internet in almost every map and the data received from it can be processed significantly. In this way, it gives us speed and flexibility.

This chapter has four parts. The parts are shown in Figure 2.1.

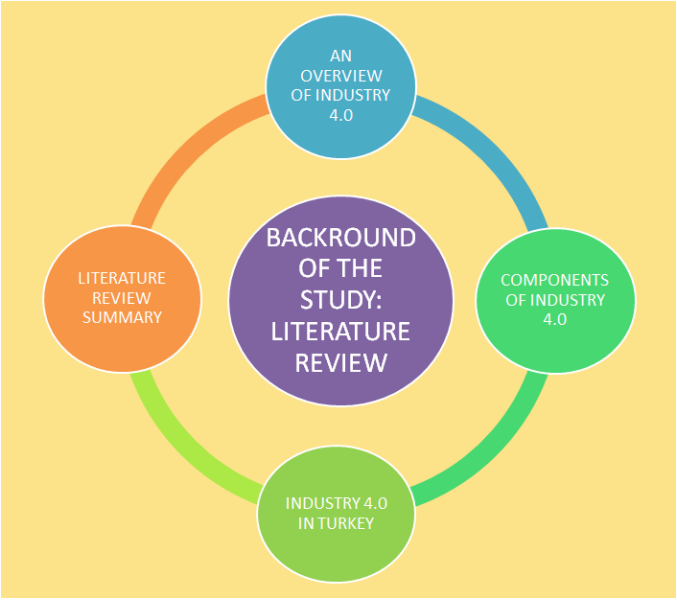

Figure 2.1 Backround of The Study: Literature Review

2.1. An Overview of Industry 4.0

Industrial revolutions until the Industry 4.0, respectively, coal, oil, natural gas was widely used as energy sources. Industrial 4.0 is also renewable energy resources will be

widespread and the use of these energy sources is will be increased on the basis of both the world and our country (Schwab, 2017). Regarding Rıfkın (2014); new Industrial Revolution in the world with the emerging energy regime with the Internet defines. According to this, the renewable energy that people produce in their own places and they will not only meet their consumption, but also with the transfer of the income.

Both the interest and contribution of both the academic circles and the business world have expanded as the process of propagation has accelerated. This transformation has already become one of the important agenda items of countries that plan for their countries. Legal figures are also being monitored to prepare the ground for more effective opportunities on the products and processes of this transformation process.

After-sales services are increasing customer satisfaction with the methods that can follow the products, archiving problems for the manufacturer and providing the necessary data to prevent duplication by itself. The industry 4.0 provides the ability to achieve real-time data that allows you to measure, assess, quickly intervene and develop main titles such as efficiency increase, resource utilization efficiencies. In this sense, the competitive environments are hardening nowadays, with the advantages it captures in the production process, it increases the mobility in the market. If Industry 4.0 integration into general processes is defined as horizontal and vertical integration, it is not only at designated points, but at all points of view, to ensure sustainability in the continuous flow principle, which is a critical point in production need to provide horizontal and vertical integration (Tobb,2016)

Offering the opportunity to serve as a comprehensive service provider in different areas to maintain the activities of enterprises, cloud computing, hardware service, Iaas (Infrastructure as a Service), is concerned with changing and evolving processes has provided a service network with three models, such as PaaS (Platform as a Service), which provides an environment where improvements can be made, and SaaS (software as a Service), which offers instant use of software services by servers.

Information and Communication Technologies (LICE) constitute the backbone of this revolution. Countries the future of enterprises and individuals, the degree to adopt digital technologies is more than ever will be more connected. Regarding World Economic Forum's Global Information Technology (2016), the benefits of emerging

technologies and the opportunities offered by the digital revolution and beyond is a study that evaluates how ready it is to exploit. 2016 report on four important posts and is expressed as follows:

- First, innovation is increasingly based on digital technologies and business models and in a smart way, economic and social gains can be obtained from LICE.
- Secondly, enterprises adapting application formats, for them to develop as a key to their use. Therefore, the digital to fully embrace the power of the technologies, the government's priority.
- Third, to direct the social impacts of both the private sector and governments should increase their efforts to invest in innovative digital solutions.
- Finally, a sustainable digital economy is the development of communities' emerging to predict, shape and respond quickly to changing conditions. Governance frameworks that allow them to develop rapidly is reported (WEF, 2016)

Industry 4.0, a technology for enterprises is not as a cultural exchange. It should be seen as a business strategy. Therefore, organizational and cultural structure of the business of Industry 4.0 are organized to place and accept the importance of the business within the enterprise. For example, organisational the units and positions related to industrial 4.0 in the structure must be created. Also innovativeness for employees supporting team work that will reveal a free working environment is also required (Lichtblau et al., 2015). Regarding Geissbauer et al, in the research on the Industrial 4.0 digital Industry 4.0 transition processes in the absence of culture and education the most important shortness faced by the enterprises Industry 4.0 innovation-oriented processes and technologies must have a structure that is used. (Geissbauer et al, 2016) In this sense after the transition to Industry 4.0, there is a sustainable organizational structure of the enterprise for the application. Research development, innovation and technology management and to invest in areas such as information management required.

1, 2 and 3. Industrial Revolutions; it is a process that is realized by investing and supporting countries to increase their market share and give importance to their industry with the desire to lead position. However, last parts of the 3rd Industrial Revolution, the

gap between the world's economic dimension, market shares and sectoral distribution has become increasingly unavoidable developments in the world of informatics. At a time when the consumption was so dense, production shifted to China in a large proportion due to the cheap workforce.

Considering all these situations and the negativity that these situations may bring, economists, academicians and industrialists in Germany used the term Industry 4.0 for the first time. Fewer people and therefore less human power are needed to perform, track, and direct business processes. The reduction in cost share in the system, which turns into a smarter structure, brings back the calculations within parameters such as profit and economic increase. Nowadays the world; Technology, industry, economics and many other areas have not been so integrated and intensely communicating. Increased digital communication and applicability of this communication to integrated systems lead to an unimaginable potential. The most basic feature of the machine age is that it is possible to integrate an automation-based system into the host control of machines controlled by computers. All this coverage; all machines, processes and all the integrated systems connected to the production are described as 'rationing'. Using the innovations brought by Industry 4.0, it plans to increase economic objectives by combining it technology with every area of production.

Industry 4.0, the concepts of technologies and value chain organisations are a collective set of. This structure contributes greatly to the creation of smart factories vision Industry 4.0. It cannot occur without the information infrastructure. It will take place in intelligent production with information infrastructure; it will strengthen the process with legal infrastructure It will continue to develop with new business models. (Schwab et al, 2016).

Industrial 4.0; information-communication technologies and machines and all the chains in the production process are integrated with each other and called a production model vision. The first industrial revolution worldwide has been experienced in the field of steam engines. The second industrial revolution took place in the field of mechanizing and electricity with mass production or other expression. The third industrial revolution is experienced in the field of electronic and digital technologies, which can also be defined as part of mass production optimization. Today, the world is talking about the

4.0 industrial Revolution; is the heartbeat of machines with the other phrase that communication with each other is heard from each stage of production. Industry 4.0 is defined as the footprints of the technological developments that go towards the days when the robots and smart machines are dealt with radio waves of robots and the administration (Schwab, 2017). It can be defined as a reshaping of the industry existing manufacturing concept with developing technology. It is not possible to disclose the revolution within the scope of a new production model or attitude, which is only relevant to the technology itself. Regarding The Turkish Perspective, 2017, ' The computer revolution is the most audible revolution in the history of the world, the funny thing is that we still underestimate its effects. ' Also the digital and intelligent technologies provided by the Industry 4.0 revolution help people with disabilities overcome traditional barriers to communication, interaction and access to information (Fırat and Cihan, 2019) .

The efficiency of the firms is of great importance in order to ensure that the international competition is increasing, the market needs are changed by increasing every day, and the demand for the correct proportional quality can be responded to the global market understanding. One of the business production functions is to provide and stabilize the efficiency directly affecting profitability, which is the main purpose of the business without compromising quality. The efficiency parameter seems to be among the most important facts that measure the overall functioning and degree of success for enterprises. For this reason, productivity can be thought of as an audit tool that is used as a criterion for the future of the business.

In other words, efficiency; is defined as output/input for product production. Industry 4.0 based on the efficiency parameter of the reduction of actual production costs through adaptive and automation-based production technologies, which can be used at every stage of production, in the form of capacity increase due to flexible production (Gorçün, 2016). The one of the most important key points of the Industrial 4.0 revolution is the mechanization and the adaptation of the serial and flexible production that will arise accordingly. The industrial 4.0, which will minimize the human power, is aimed at large economic shares thanks to the automation-based serial production system, which is connected to the mechanisation. In this context, one of the leading and promising exemplary technologies in Industry 4.0 is the three-dimensional printers. The

system is designed as a virtual and 3d product in a computer environment is defined as a kind of modern CNC machines. However, with innovation and promising direction, the place in industry 4.0 is already predictable. With three-dimensional printers, even the production of complex products with long processes and in all areas of production will be carried out in a serial manner and with zero fault tolerance. In addition, in this context, the production of products that were not previously possible in the complex and structurally impossible will be made possible in three-dimensional printers through the virtual environment. With these printers capable of making products from the smallest to the largest size, the production spectrum will expand in the sector. Nowadays, three-dimensional printers are used in a wide range of areas such as healthcare, automotive, aviation, defence, architecture and construction. (Gorçün, 2016)

World-wide change and development depends on production and manufacturing is based on innovative technologies. Technological innovations have been the most driving force of economic change and development. Innovative technology requires such qualities as innovative thinking and problem solving. In our country, some of the R&D works are carried out by the private sector, part of the university and some of the public institutions. In addition, there are many legal arrangements that encourage R&D work in our country. These regulations include:

- Incentives and arrangements that support the budgetary and university industry cooperation devoted to university R&D studies.
- Encouraging and supporting R&D works that are made by public institutions established with the aim of supervising.
- Tax incentives.
- Techno park support

If R&D is to be addressed worldwide, it is evident that the development countries and the share of the R&D of these countries are proportionally proportional. The importance of creating a stable layout with intelligent robots, machines, R&D and Automation-based systems that will work in the production site for all companies that want to be present in the future of global competition is very important. (http://www.endustri40.com)

Success factors in Industrial 4.0 processes due to a lack of literature on the described factors were created in the literature. Studies, published reports and various institutions the maturity models are taken into consideration. Strategic vision Industry 4.0 is a technology based on the improvement of production capabilities in business processes a change in paradigm (Erol,Schumacher and Sihn, 2016). Therefore, the Industry 4.0 is not as a technology investment, but the entire business and bringing new business models to the long-term should be seen as a business strategy. In this sense business strategies and an integrated Industry 4.0 vision and strategy should be implemented. This strategy is short in the process of transition to Industry 4.0, a digital roadmap covering the mid-and long-term must be created. However, the strategy created and monitoring the performance criteria of the roadmap is another important issue. The strategic roadmap to be created must have three basic qualities (Erol, Schumacher and Sihn, 2016):

- For new transformation with technology support to provide a continuous planning and analysis infrastructure,
- Vision, strategy and projects related to industrial 4.0 to ensure the functioning of a holistic structure,
- All activities in the Industry 4.0 transition process guidance for monitoring and management.

2.2. Components of Industry 4.0

The components/building blocks of Industry 4.0 are generally: Internet of things, cyber physical systems/simulation, cloud Information, augmented reality, autonomous robots-smart machines, layered production-3D printers, cyber security, big data and analytics (big data), vertical and horizontal system integration as shown in Figure 2.

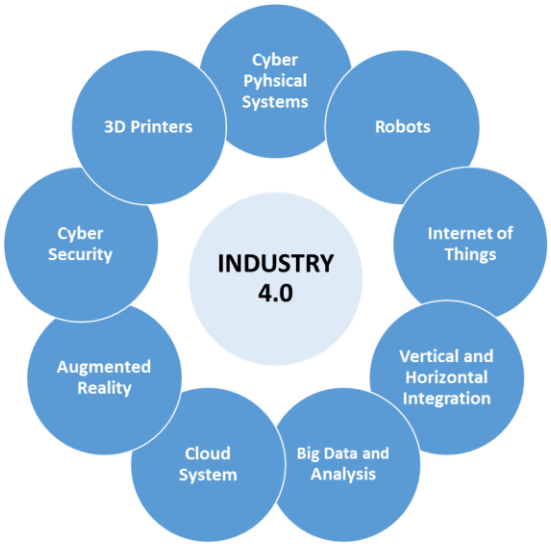

Figure 2.2 Components of Industry 4.0

2.2.1. Internet of things

The physical world objects, the sensors found next to them, the cloud services Connected via wireless internet. This link new applications and business models are emerging. The communication tools of the objects and sensors are for Wi-Fi, Bluetooth and Local wireless network connections such as GSM, GPRS, 4G, 5G etc. With hardware and artificial-moron software on a network built-in intelligent systems, understanding data and transferring to other systems functions such as track your daily activity with a wristbands that show how much calories you spend on your ECG, smart sports products, augmented reality applications, entertainment, smart watches, location and tracking tools from the IoT products and systems.(Banger, 2017).

One of the key elements that power industry 4.0 is that it enables the "Internet of objects" function, which allows the emergence of a wide network as possible, to reduce the boundaries between the virtual environment and the physical world, or even destroy it. Industrial 4.0 based manufacturing steps are aimed at communicating with other steps or phases by connecting to changing networks with the interfaces for the system's needs. If a cause-and-effect relationship is mentioned, "smart factories" can be regarded as one of the consequences of this relationship. (Gorçün, 2016)

2.2.2. Cyber physical systems

Cyber Physical systems (CPS) are communication in the cyber world, information exchange, physical process to manage, track and monitor processes, information such as computers, networks and software technologies. Most striking applications of Industry 4.0 is the cyber physical system, which is expressed as an embedded system. Examples include physical sensors, smart grids, medical monitoring, autonomous vehicle systems, industrial process control systems, robotic devices and automatic control electronics. First Iitelligent and communicating machines (bench, devices, and so on) are the connected, large physical system they create. Secondly, the physical system is working in a real environment a virtual copy of the process in the information environment simulation (Banger, 2017).

In this type of factories, automation networks that allow machines, devices and equipment to communicate and regulate manufacturing processes by communicating between them make the factories smarter. If there is a problem in one of the manufacturing phases, the relevant order information needed is automatically passed to the relevant section. The problems that arise are immediately determined on the spot and the necessary correction can be made. In this way, each level of the production is able to perform its task without having a capacity problem.

It is not only a factor that concerns the manufacturing processes of cyber-physical systems, but also extends the use of day-to-day usage in units such as R&D, marketing and design, and increases usage intensity. Nowadays, a production facility can be simulated before the investment process reaches the physical stage, the feasibility of the main elements in the calculation of investment cost may be revealed through this simulation. (Gorçün, 2016)

Smart factory is generated through connecting all systems. Within smart factories, real-time internet-based advanced data usage information and communication technologies and intelligent products and machines with self-governing systems. By ensuring communication between machines in smart factories, is one of the most important process for the machines integration with other systems. Also in smart factories, digital and holistic production control systems in a sub-structure, corporate resource planning, product life management, product data management, machine data collection, computer aided systems, such as design.

2.2.3. Cloud computing/cloud technology

As cloud technology the term "cloud computing" is the first time that networks in communication and information systems used for the display. Until 1994, the cloud symbol symbolize the internet ssed. Servers are not in the company, they are used for external service. It contains information technologies such as servers, storage, networks, software. (Zhang, Luo, Tao and Liu, 2012). This technology is a combination of the internet of Informas, Google, BM. It is a new model in the investments of technology giants such as Microsoft and resources, software, data, and services to the user's expectation. Computer derivative can be accessed and shared via other devices. (Sami and Üner, 2013). More broadly, cloud computing aims to make information technology resources useful by granting access to specific people. (Mell and Grance, 2011).

2.2.4. Augmented reality

From education to medicine; game in many areas ranging from industry to sports, the augmented reality is a shape, the information, the content, the photo, and the user's 3D in augmented reality, unlike virtual reality connection with the world in the user's environment disappear. Connecting with the real world, data and images real world images, and virtual, real objects are in the environment (Sincere and Honey, 2017). Virtual reality is called the media they create by simulating the computer (Banger, 2017). At the beginning of areas where augmented reality is widely used for sports applications such as football, cricket, baseball, tennis, etc. more known augmented reality application, the ball used in games The Hawk-Eye, which was developed to follow the road (Sincere and Honey, 2017).

2.2.5. Autonomous robots - smart machines

Autonomous robot, artificial intelligence due to embedded hardware and software on-site alternative options/decisions, which can be used in the appropriate other intelligent and connected, which can mobilize, collect data from the environment, can be defined as robotic systems that can communicate with objects (Banger, 2017). In a more concise sense, smart robot teams/smart coordinated execution of machinery manufacturing systems facilities.

With the emergence of the concept of Industry 4.0, it is thought that significant improvements will be made in the field of occupational health and safety by reducing work accidents by integrating robots that are components of them. Especially in the production areas, the idea was that many accidents in major and minor would be prevented by positioning robots at points where the risk of accidents was high.

In addition to all the advantages of robots, ideas have been formed suggesting that they will negatively affect the power of employment. However, not to reduce the desired employment under Industry 4.0, but to reduce costs by providing human robot cooperation, increased resource utilization efficiency, energy efficiency, increased production productivity, improvements in the working environment, occupational health and to achieve positive results in reducing risks in security issues (Cihan and Fırat, 2019). For this purpose, discussions and investigations are under way about which types of jobs robots can replace humans or in which situations they will be working together (Fırat and Fırat, 2017; WEF, 2016; IFR, 2017a; Friis, 2016).

2.2.6. Layered production-3D printers (additive manufacturing)

Layered Instead of printing papers with printers, the three-dimensional geometric Layers of materials used in the data are continuously interconnected to each other In the 1970s, this technique is a manufacturing technique that expresses intended to produce samples of designs with rapid prototypes. Common use of articled manufacturing (3D printing) technique is one of the main components of Industry 4.0. (Ozsoy and Duman, 2017). Using this technology solves the need to store and assembly complex parts together made possible by single operation (Banger, 2017).

2.2.7. Cyber security

Business/companies are connected with each other with security systems. Cyber security provides information security by protecting them from cyber-attacks (TUSIAD, 2016). To secure their data against these cyber-attacks and to prevent disruptions in applications, cybersecurity has begun to pay more attention. Thus, much so that in the future, it is inevitable that there will be a significant increase in the number of companies that want to work with cybersecurity experts with their level of competence in order to ensure this security. (Akben, 2018)

2.2.8. Big data and analysis

Big data for the first time used genetic and in astronomy fields then become used for the internet. Big data concept is been developing blogs, photos, social media from other sources, such as shares, videos, and network logs, and the need for mixed storage, processing and used to express data stacks that can be meaningful (EBSO, 2015). Data stacks can be analysed, extracted, and analytics, which are proprietary software for the processing of to improve the quality of production and to conserve energy (Banger, 2017).

The development area of big data reveals itself as the improvement of service processes and the need for production to be met by revealing more successful and effective predictions for the customer (Lee et al., 2014).

Big data and data analytics technological communication, data arising during process monitoring and management, both the volumetric sizes need to be processed and data analytics applications, such as new needs to be analysed brought. According to the research conducted by Cisco in 2013, "The Internet of Everything" means that over 20 billion electronic devices, with 2016 years of data to be traded in the system, in zettabytes (1 zeta byte = 1 billion terabytes). It will be valuable in industrial terms to be kept and analysed in secure systems and converting to meaningful information. So that there are solutions on early diagnosis for foreseeable problems and errors, the potential opportunities to emerge can be predicted by early reaction plus benefits. Service and maintenance interventions can be simplified and reduced manufacturing costs(Gorçün, 2016).

With Industry 4.0, the utilization rate in production will increase the increased big data production quality while contributing to energy efficiency, facilitating autonomous and scheduled maintenance and reducing costs (Noble, 2018). For example, the company "Infineon Technologies", which produces semiconductor materials, has reduced product errors by correlating data from a single chip with process data obtained in the previous stages of the process during the testing phase at the end of the production process, and in this way, the company has improved the quality of production by identifying the structures that enable the extraction of faulty chips in the production process (BCG, 2015).

The Internet of Things (Hermann, Pentek and Otto, 2015), which are other components of Industry 4.0, and robots, horizontal-vertical integration studies play a major role in the rate of increase in large data. At this point, in addition to the data mining developed for analysing and interpreting large data, the process mining that has been heard in recent times and the analysis software that comes with it emerges. It offers to the enterprises the possibility of instantaneous monitoring of not only the data generated by horizontal integration with process mining, but also the data formed by vertical integration and communication of objects formed on production lines.

Although business process management systems (BPM) and enterprise resource planning software (ERP) are used in many enterprises today, it is very difficult to determine whether processes flow in the layout of the model they should have. At this point, the need to analyse the data obtained from the processes was born. Together with the developing technology, this need has brought about the concept of process mining, which works in conjunction with the discipline of data mining.

Process mining was developed by computer scientists and is used in many fields, especially engineering and management. (Schimm, 2003; van der Aalst and Weijters, 2004; Rozinat et al., 2007; Lijie et al., 2009; van der Aalst, 2010a).

2.2.9. Horizontal and vertical system integration

In business functions and resources is called vertical integration; harmonized with non-operating stakeholders is called horizontal integration. This component of Industry 4.0 is a supplier of business suppliers and connects them to end-to-end. Universal data across the enterprise as connection networks, in-business departments and competencies will become more harmonious (TUSIAD, 2016).

2.2.9.1. Horizontal integration

Creating customer satisfaction is a flexible and fast to create a structure for the life of the products in order to the management of the entire value chain in a common structure is important is a point. At the angle of Industry 4.0's effective functioning In the process of transition to Industry 4.0, the customer requests and needs with subsystems. Suppliers and the cyber physical systems work together in the integration (Oesterreich and Teuteberg, 2016). In this sense Industry 4.0 in transition processes with the internal

processes of the enterprise external processes should come together on a common platform. Horizontal integration, logistics, inbound and outbound business suppliers with internal processes such as production and marketing other businesses and customers in the value chain, such as information, material and energy flows. Information technologies for the provision of horizontal integration in cyber physical systems both supplier and customer side provides a digital structure (Kagermann, Wahlster and Helbig, 2013). Horizontal integration the main objective is to optimise the flow of goods and information within the value chain (Wolter et al. ,2015).

2.2.9.2. Vertical integration

One of the main conditions for rapid response to the market in industrial 4.0 processes is that the business processes the realization of a digital structure. In this sense, all business subsystems are connected to each other. Therefore, Industry 4.0 transition processes from production to distribution can provide mutual cooperation in all processes. Physical structures are required (Erol, Schumacher and Sihn, 2016). Vertical integration gathers internal processes of the business material, product and data in the enterprise. To optimize the flow of sales, engineering, diverse hierarchical levels such as production planning and control and other planning levels of the business Integration with information technologies can be expressed (Kagermann, Wahlster and Helbig, 2013, Wolter et al., 2015).

2.3. Industry 4.0 in Turkey

The effects of industrial revaluations in Turkey are not in the form of a harmony with the technological developments of social transformation, but technological developments have been experienced as a force of social transformation. The capital stock deemed necessary for industrial revolutions to be experienced was not formed in Turkey. In particular, the lack of improvement in the agricultural area and the steps that should be taken in the industry have not been taken for a long time, and eventually the state was tried to create capital with the inclusion of the process itself. Although the first development on the rights of the property was revealed with the tanzimat decree, which was described in 1839, the first serious modern legal order could be revealed with the republic. The absence of a healthy statistics on the date of the republic of 1923, or the lack of access to the data stored in the performance indicators due to the inability to

create the information set within the scope of the thesis examinations began in the year 1923.

For the Turkish community, the republic has also been a period of industrialization, but the industrialization steps that have been thrown to reach contemporary civilization have been much faster and more sudden than industrialised societies. For example, canalization process in Britain in the 18th century could be considered to be a similar one of Turkey's infrastructure investments today. Turkey is an important country for other developing countries that have to experience the process of parts industry revolutions.

Another similarity is that the first industrial revolution of the social transformation created by the people living in villages in the village of 1980 after the rapid settlement of the cities in the middle of the Second Industrial Revolution, the villages in Europe quickly as a flow to cities.

Countries that are experiencing or have not experienced industrial revolutions are experiencing similar problems. The harmonious transformation of industrial revolutions together with the technological and economic developments in the community is seen only in countries that have removed industrial revolutions from their own bodies. As the developing or undeveloped countries stay away from the level of civilization, they enter into the process of alienation with civilization, faced with the situation of losing more chances of presenting solutions to the problems of civilization. However, the countries that enter this race are able to manage the progress of civilization to the extent that they have the chance to bring suggestions to the solution of the problems and allow their communities to live harmoniously.

However, as in Turkey, the chances of developing countries are still in a world of Industry 4.0's preparedness. Developing countries should strive to be involved in this process within a moment of insight. Otherwise, the inter-communal prosperity gap will reach unstoppable dimensions.

There are a lot of researches about Industry 4.0 in Turkey. Besides academicians ,non-governmental organizations work on Industry 4.0 as well. In this study, these researches are examined in two categories called ‘Approaches of Non-governmental organizations’ and ‘Academic Approaches’.

This chapter three main parts as approaches of non- governmental organizations, academic approaches and special cases of Industry 4.0 in Turkey. Three cases are examined in special cases. Figure 2.3 shows these parts and their relationships.

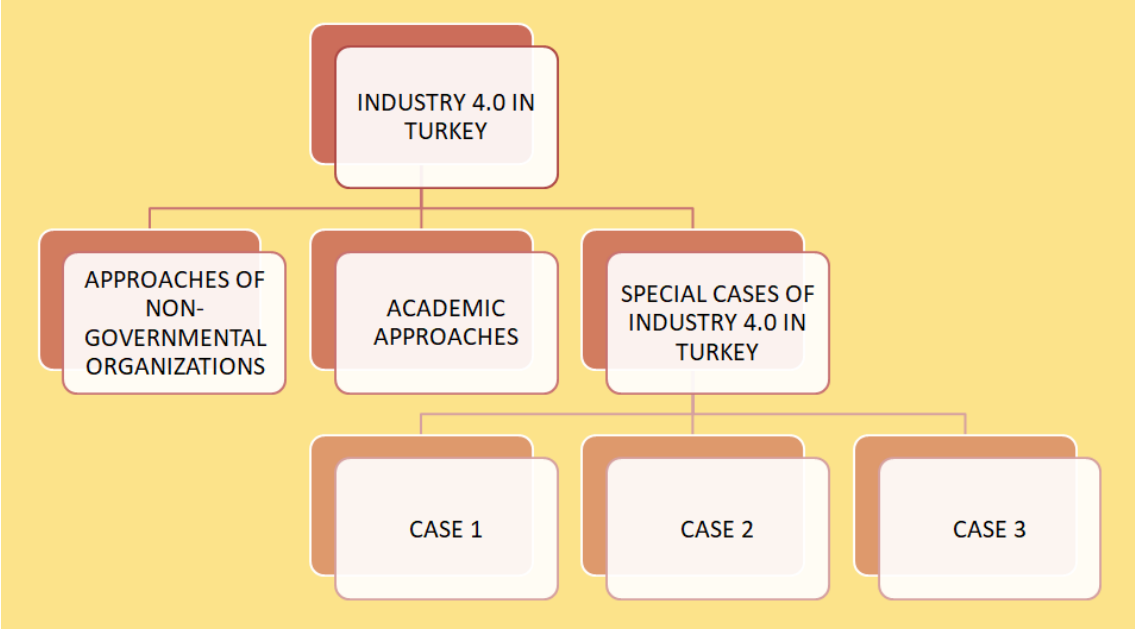

Figure 2.3 Industry 4.0 in Turkey

2.3.1. Approaches of Non-governmental Organizations

Turkey is currently on the road in terms of indicators of Industry 4.0. Industry 4. 0 Turkey has a long way to take on this issue despite its potential to provide significant opportunities for increasing productivity in production and increased development speed in Turkey. TUSIAD etc. organizations do many studies to increase the sensitivity and awareness of various segments in the society (Milliyet Teknoloji, 2018). According to the Slope (2017), Turkey must purchase the robots made by industry 4.0 because it will have a high cost of not catching this revolution, developing and developing the production with these robots and selling the products it differentiates. Bending (2007) has made some recommendations for the adoption and dissemination of Industry 4.0:

- High-quality employee-raising science high schools must be established.
- Students must be trained in these high schools to adapt to this new industry and to use the programmes it requires.
- Return to the branches of science in universities.

- Quotas should be reduced rapidly in the faculties of economic Administrative Sciences.
- In the new order, many professions such as accounting, human resources expertise and management will be greatly reduced to human needs because of their computer programs.
- Change of education for the Future society.
- Agriculture and livestock policies should be developed in order to reduce unemployment, which will arise with the transition to Industry 4.0.

When the keys of the Industry 4.0 transformation have evolved over time is inevitable if the countries are not affected by the innovations and changes it brings. The correct perceptions of the requirements of this new era of businesses in countries and countries, their agenda, and they must have a roadmap available today and new businesses are in line with the transformation elements of Industry 4.0 The philosophical direction, strategies, and especially business processes of the enterprise orientation. Accordingly, the changing conditions of countries and enterprises by accurately analysing resources and skills to become a necessity to reviews means. Union of Chambers and Commodity exchanges of Turkey (TOBB), Turkish Exporters' Assembly (TIM), Turkish Industrialists' and Businessmen's Association (TÜSIAD), Independent Industrialists and Businessmen Association (MÜSIAD), International Investors Association (YASED) and Turkey technology some public and private sector organizations, such as the Development Foundation (TTGV), Industry 4.0 road maps prepared by the platforms.

TUSIAD (2016)'s report, "Industry 4.0 as a necessity for Turkey's global competitiveness", is expected to develop in four major categories in Turkey regarding Industry 4.0:

- Efficiency: Industry 4.0 is a successful The efficiency of the application to the manufacturing industry is expected to increase between 4% and 7%.
- Growth: It is estimated that Turkey will achieve significant economic competitive advantages with this revolution and a 3% increase in production.
- Investment: an annual investment of 10-15 billion TL must be made to meet expectations.

- Employment: The industrial 4.0 will increase the need for skilled labour force. Because it is imperative to have certain competencies in order to use the technologies brought by this revolution. In addition, the need for unqualified labour force is expected to decrease.

According to TUSIAD (2017), there is some changes in Turkey regarding TUSIAD (2016) report. They are:

- Industry 4.0 knowledge level was %77 in 2016. This level is increased to %90 in 2017.
- Interest of digital transformation level is %95.
- %61 of participants think that their company is ready for the transformation.
- %99 of participants think that all these technologies which are used in transformation process will raise Turkey's global competitiveness.
- Companies in Turkey believe that produce the highest benefit of digital transformation in industry and resource efficiency and improvements in product quality. That result shows mean that companies do not have enough information about operational quality and non-operational opportunities offered by digital transformation in the industry, despite they specify that they have knowledge about the Industry 4.0
- Almost all companies use ERP system and production management system. That result means that these systems are already being used is a hint of significant potential when considering the need to build the applications of technologies such as Big Data Analysis, Horizontal/Vertical Integration and Cloud on automation systems gives.
- 41% of large companies (companies with annual turnover greater than TL 250 million) this rate is 18% in small companies while having full and semi-automatic storage operations.
- The utilization rate of RFID technology is quite low; this technology is used by 9% of large companies and only 3% of small companies.
- Using the lean production principles of companies ensure that the levels of excellence in production are measured. Companies with lean production principles have the understanding of continuously improving their production

processes. Regarding additional research that was done to measure companies lean production level, pull principle, SMED and autonomous maintenance need to be improved.

- More than %50 of companies that are included the research use sensors and cyber security Technologies. However, the opposite result was observed about Additive Production, Augmented Reality, Artificial Intelligence and Intelligent Systems.
- Only 2% of companies reported that artificial intelligence and intelligent system were successfully implemented their companies
- Regarding all those results, Turkey' companies are still at the pilot project level in terms of applications and Turkey's level about industrial revolutions is between Industry 2.0 and Industry 3.0.

TUSIAD suggestions about completing digital transformation and Industry 4.0 journey (TUSIAD, 2017) are below:

- Companies must identify their digital strategies and map the roadmap for digital transformation in the industry should shape it accordingly and direct their investments to the goal that is about completing digital transformation and Industry 4.0 principles.
- Companies should prioritize their investments to are easily accessible, fast-moving and the highest impact on them.
- By directing the additional profit generated into financing new investments, the companies create a "cycle of innovation" and ensure the continuity of investments.
- Companies should prepare for the transformation of existing human resources and work expertly force to be withdrawn to Turkey and the protection of the existing expert workforce.
- Companies should have a strategy of data collection and evaluation and network infrastructure, connection standards and data security systems should invest in such issues today.
- By investing in the right technologies, the supplier should develop the ecosystem.

- Companies should be supported for their transformation journey by a transformation guide.
- Companies should focus on vertical/horizontal integration, big data and industrial internet.
- The government needs companies to undergo digital transformation as a priority provide the guidance and counselling.
- The government make companies' digital transformation investments attractive through public institutions, tax regulations and incentive mechanisms.
- The government generated human resources policies to provide qualified workforce that will be needed in transformation processes.
- The government should be identified the problems that will be faced in following years and make legal arrangements and investments to support companies to overcome them.
- A high-tech institute which can serve as a bridge between industry and academia should be established.
- R&D and innovation to be established by companies in cooperation with the academy center should be encouraged by the government.
- The relationship between universities and industry should be increased to protect and develop the existing workforce cooperation.
- Supplier ecosystem must be supported to protect the value created.

Besides TUSIAD, another non-governmental organization called EBSO works on Turkey's Industry 4.0 journey and prepare a report in 2015. EBSO (2015) report, a survey applied and they made some suggestions below:

- Standardization between companies should be provided.
- Management principles should manage complex systems.
- Companies must create advanced digital structure.
- Companies must use or create a strong cyber security system.
- Companies should recreate their business organizations and designs that include robots and human interaction.
- Trainings should be one of the most important issues at companies' priority lists.

- Legal arrangements should be made to support the transformation.
- Resources efficiency should be provided to manage regarding smart technologies.

Industry 4.0 offers great opportunities for Turkey to maintain its competitiveness and to be among the developed countries. Turkey's geographical position and low-cost workforce provide a competitive advantage. However, Turkey also encounters some difficulties that complicates competitiveness (dependence on imports, limitations of labour competence, high labour turnover, etc.). Overcoming these challenges will be facilitable with the transition to industry 4.0 and Turkey's competitiveness will increase. Industry 4.0 is generally thought to provide the following advantages to Turkey:

- Increase in labour and ecosystem quality,
- New employment opportunities, reduction of the need for unqualified labour force,
- Protecting and enhancing competitiveness,
- High value-added production.

However, these studies to be a reference resource for Industry 4.0, the public, private sector and university business quickly and efficiently, and joint studies are required. In Turkey, the state of Industry 4.0 does not remain as a fashion or temporary whim, private sector, good exemplary practitioners are important tasks in this regard. Industry 4.0 The focus of this study and discourse in order to avoid being left behind in Turkey is a holistic From perspective, to adopt industry 4.0, to raise awareness in social consciousness, to regulation of international standards/laws and the necessary arrangements in higher education.

The scale frame in which countries are assessed is located under the four main categories (lower indices), The area consists of 10 subcategories and 53 separate shows scattered across different subcategories. This countries according to a composite score calculated from the scale. The Global information Technology report 2016 in Turkey on the basis of all sub indices and components in 139 Rankings in the country and the points received in table 2. is shown. Turkey's overall ranking and score is not changed by last year, but with 4.4 points (full score = 7) (Fırat, 2017)

In the comments for each country in the report, it is sorted by last year for Turkey. The lower indices and indicators have strong contradictions in the level. More by improving the digital skills of the community with cheap mobile and fixed internet and the emphasis is further expanded. Nevertheless, these positive movements, regulations and business Deterioration of the environment and the importance of LICE in the government's vision because it is being neutralized. When viewed as a whole, negative effects are compared to positive economic impacts, and especially the social consequences. However, in terms of the business and innovation environment, Turkey is in the top-three and that means it is a good basis for accelerating and jumping forward.

Industry 4.0 has many modern automation systems, data exchanges and production a collective term that includes technologies. Industry 4.0 distinguishing the most important. Elements can be grouped under three headings (EBSO,2015)

- Speed: Industrial developments in the new era are developing at a great pace. Every day, a new technological development is witnessed, new technological developments.

- Width and Depth: Developments in the new period on the digital revolution evolving. But this rapid development is not only the production structure, but in the business world, leading to profound changes in the living conditions of the society and the individual.

- System effect: New term, companies, sectors, but also change the structure (systems) of the countries and to transform the holistic Includes.

These three distinguishing elements will be very decisive in the coming period and companies and countries that cannot provide a major loss. Developments the fourth stage of industrialization is only intelligent and connected machine not limited to systems, but also from Gene science to nanotechnology, edible from energy to different branches of health and social sciences, there will be a breakthrough in all areas (Banger, 2016).

In published study about application of Industry 4.0 at SME's, maturity scale is applied. The aim of the study is that provide a new maturity scale for SMEs. In order to realise the new maturity scale, firstly this paper carries out a review of the main Industry 4.0 maturity models available in the literature. As a conclusion, the study help add a new model to the literature (Trotta and Garengo,2019)

In a study for automotive industry, the aim is develop an Industry 4.0-based smart manufacturing system in a sunroof ambient light production system. The benefit of the study is that the recent advancements in the areas of Cyber-Physical Systems (CPS) and Internet of Things (IoT) as key enablers of Industry 4.0 to increase the productivity of the production system and eliminate the most wasteful activities to enhance the competitive edges of the manufacturer company to face the challenges in the global markets.(Ramadan,2019)

A study about relationship between lean manufacturing and Industry 4.0, literature review is examined in Industry 4.0 (Industrie 4.0) initiative and sets out to identify the highly cited papers examples. As a conclusion, there are much potential for Industry 4.0 environment to further improve the effectiveness of Lean Manufacturing initiatives to drive efficiency and productivity better(Lai et al., 2019)

2.3.2. Academic Approaches

After Industry 4.0 was presented to whole world, academicians started to work on it. Researches generally involve effects of Industry 4.0 in Turkey, effects of Industry 4.0 in special departments in Turkey and awareness of Turkey. In this study, some of researches are examined with awareness and effects sides.

Tutar et al, 2018 make a research to compare Turkey's Vision 2023 strategy with Germany's 2025 strategy through indicators of Industry 4.0. In that empirical study, secondary data sources are used. The results are:

- There are a lot of differences between Turkey's strategy and Germany's strategy.
- Turkey's strategy is not enough to complete Industry 4.0 transformation journey, so Turkey needs to improve it.

- Turkey plans to gain competencies on artificial intelligence, sensors, robots, big data, internet of things, cyber security, cloud system. However, very few of these targets appear to be compatible with Industry 4.0 indicators.
- On the other hand, Germany's 2025 strategy is compatible and consistent with the indicators.

Ona of the Industry 4.0 studies, reseacrhers compare Turkey and European countries compared to Industry 4.0 indicators. In this study, they examined 10 Industry 4.0 indicators for 28 European countries and Turkey using factor and cluster analysis. Ward method is chosen for the study and conclude that Germany performed best on the basis of these methods, while Turkey was in the same cluster as Hungary, Latvia and Poland(Unlu and Atik, 2018).

A researcher examined R&D data that belongs to years 1981-2015 via ARDL method to find relationship between technological progress and employment structure in Turkey. The result of this analysis is that employment structure has been changed by Industry 4.0 transformation(Aydin,2018)

In a master thesis, in an organized industrial zone ceramic production facility by evaluating the differences between manual glazing systems and robotic glazing systems by simulation, robotic automation glazing systems evaluated for industry 4.0. As a result of the study, it is stated that the number of production is 60 times more than manual system in the robotic production system and an increase of around 8% in terms of efficiency is achieved. Although the manual production system is superior to the robotized production system in terms of investment and maintenance costs, it is stated that the use of the robot system in terms of occupational health and safety would be much more appropriate. In order to adapt to the increasing competitive environment in the world, it has been suggested that the ceramics industry be sensitive to the transition of Industry 4.0(Berksun, 2018).

In another study , researched Turkey's potential to adapt to Industry 4.0, following the example of Germany, the country that introduced Industry 4.0. During his research, the private sector has been considered and focused on its attitudes towards developments and how state policies should undergo a change. In the study, he mentioned an uncertainty that could arise from government changes, and given past experience unless

there are science and technology policies, and reminded that there is the possibility that Industry 4.0 may pose a threat to Turkey rather than an opportunity(Soyak, 2017)

In a study examining the Industry 4.0 approach of the furniture industry, suggestions were presented stating that some of the problems of the sector could be solved with the developments of Industry 4.0. It has been concluded that Industry 4.0 should be closely monitored and transformations should be initiated quickly in order to provide a competitive environment in the furniture industry, which is an industry where customer demand changes frequently (Ozturk and Koc, 2017).

An article published in 2018 titled 'The effects of the fourth industrial-industrial revolution in terms of international political economy and Turkey', the reseacrhe examined how Industry 4.0 will affect Turkey under global economic conditions. Establishing education policies for the creation of qualified workforce by indicating that the advantages of cheap labour in developing countries, including Turkey, are in danger of disappearing, and increasing R&D activities importance of the need for it(Ozkan et al,2018)

In 2017, in an article examining the effects of Industry 4.0 on the automotive industry along with the trigger causes, industry 4.0's prosperity because it allows the production of innovative and more value-added products it has been stated that it creates the opportunity to increase the level. In this context, the automotive industry, one of the sectors acting as a locomotive in Turkey, plays an important role in the transformation of Industry 4.0, in this context, for industry 4.0 transformation in sector education and R&D activities, strategies for eliminating negative scenarios development must be made and increased (Gabacli and Uzunoz,2017).

Yuksel and Sener conducted surveys with 13 participants working in different departments of companies with the help of 5 open-ended questions. In this study, it was concluded that although the Industrial 4.0 transformation was not completed in Turkey, there was awareness of the concept (Yuksel and Sener, 2017).

Survey results in the TUSIAD (2017) and TUBITAK (2016) reports on the impact of Industry 4.0 transformation on the manufacturing and foreign trade balance in the 2018 article titled ‘Industry 4.0 As An Opportunıty Wındow For Turkey’s Foreign Trade' examined. As a result of the study, it was stated that there was a chance that the foreign

trade deficit would be closed if Turkey completed the Industrial 4.0 transformation, but if it was too late for the start of the work, this transformation would pose a threat, not an opportunity (Nuroglu and Nuroglu, 2018).

Another study published in 2017 examined the contributions of Industry 4.0 to the business and production processes. During the review, targets of Industry 4.0 were selected according to the primary sectors that can be implemented in Turkey. Sixteen countries, including Turkey, were included in the study. As a result of the study, a business model has emerged that collects, observes and analyses every data in production if Industry 4.0 is implemented. At least twice as much productivity increase, minimum energy use, increased reliability, lower heat emission as a contribution to the environment by enabling higher quality, larger quantities, more cost-effective production after the transformation (Ozturk, 2017).

Another study conducted in 2019 examined the effects of Industry 4.0 on human resources. As a result of the study, production in cooperation with human robots will significantly affect human resources planning, measures should be taken to minimize the impact of the existing workforce and the number of existing manpower (Yılmaz and Erkollar, 2019).

In the article 'Industry 4.0: Understand The New Production Style', the preparatory process and impacts that companies and countries must follow to protect against the threats that Industry 4.0 may create while taking advantage of the opportunities it will create. As a result of the study, it was demonstrated that Turkey should make long-term investment plans, pay attention to education and complete automation and information processes quickly in order to complete the Industry 4.0 transformation (Bagci, 2018).

Erturan and Ergin, 2018's study examined the effects of Industry 4.0 on the profession of accounting. In the article, the accounting profession will be significantly affected by intelligent systems and automation systems, vocational training as well as the use of technology, data analysis should be trained in the industry 4.0 process should be equipped consequently (Erturan and Ergin, 2018).

‘With Respect to Industry 4.0 an Analysis on Turkey’s Current and Future State' is an article to obtain answers by interviewing the senior managers of 6 companies among the leading companies in the field of Industry 4.0 in the research words have been created.

As a result of analysing and interpreting the answers, it was determined that Industry 4.0 awareness was formed in Turkey, roadmaps were prepared for transformation and studies were started (Yulsekbilgili and Cevik, 2018).

In another study on effects of Industry 4.0 on human resources, the benefits of transformation such as savings, security, etc. cannot be achieved when manpower is ignored and specified that human resources are encountered as an important part of this transformation (Filizoz and Orhan, 2018).

In another study, 321 undergraduate and graduate students at a university were surveyed with questions to determine individual innovation and industry 4.0 knowledge levels. The data obtained from the survey were analysed by the SPSS analysis program. As a result of his study, it was determined that there was no correlation between individual innovation status and gender, whether they had heard of Industry 4.0 before and education levels (Kaygısız and Sipahi, 2019).

Another study examined the effects of Industry 4.0 on the medical sector. As a result of the study, rapid adaptation to technology in dynamic issues such as education and research, advanced medical technologies that are generated by transformation, cyber security, additive production, internet of things, big data and analysis should be focused on (Sayılgan and İşler, 2017).

Another published work of Industry 4.0 transformation is aimed to determine the effects on employment decisions. Taking into account the digital transformation process and the issue or relationship of human capital, turkey's current labour profile and other economic conditions are not in line with expectations, meeting expectations in the labour market in the short and long term, it has been concluded that it depends on the development of labour capabilities and that it is possible to consider this transformation as an opportunity for Turkey through the necessary policies and studies (Dogru and Mecik, 2018).

In a study about relationship between sustainability and Industry 4.0, the relationship is examined regarding different indexes. Indexes based on indicators published in indices the findings of the study show that which resulted in descriptive research within the framework of Industry 4.0 technology and components are related with economic, social and environmental sustainability (Dogruel Anuslu and Fırat, 2019)

2.3.3. Special Cases of Industry 4.0 in Turkey

After the introduction of Industry 4.0 to the world, companies in turkey started to work to achieve digital transformation in order to maintain their competitive claims. Inthis study, on the way to Industry 4.0, three of the companies that are about to complete the transformation and which have decided to start the transformation have been interviewed and compiled from published sources. Their names are not specified due to company confidentiality. Improvements of companies is mentioned in this section. However, findings will be mentioned in chapter 4.

2.3.3.1. Case 1 : A Food Company

The company, which is one of the pioneers of food industry, established its first factory in Gaziantep in 1989. In 1991, the exports to the Turkic republics consisted of a considerable portion of the production. Until 1994, the company continues its production activities in Gaziantep in the same year by opening the Istanbul office and taking an important step, the company's growth targets shifted from the Turkic republics to Europe. By the year 2001, the number of country of exports was 66. In 2005, he continued to increase the growth and product diversity by establishing the second production facility in Gaziantep. In 2009, they established Europe's most modern production facility in Silivri and stepped into a new section in the field of food activities. In addition to modernizing production facilities, the management methodology has been adapted to the requirements of the day and has two high-level management mechanisms as a management and executive Board that has changed its management structure in 2010. As a natural consequence of growth and modernization, it has placed an important line in a prestigious list covering the world's leading confectionery producers.

During the production and managerial developments, the company has reached an advanced level in the implementation of quality certifications and turquality programs in the 2000 years. In this process, in 2009, in the course of an unusually fast, ERP and management systems in the software by commissioning live systems, has come to the important ways of automation. Adopting the TPM as a manufacturing philosophy, the company has developed itself in the implementation of the philosophy of production by taking a know-how and consultancy service from a company operating in Japan, which

is the birthplace of the TPM. Today, the company continues to end the TPM activities as well as the Industry's 4.0 journey.

In 2014, with the concept of Industry 4.0 in the world and the rapid, decisive stance on moderation of the administration, the transition has begun to work quickly. First, R&D facility has been established for both product and technological developments within the GAZIANTEP production plant and has received the title of R&D Center. In 2017, Silivri plant was also awarded the title of R&D center by showing the same developments. Thus, the companies operating in Turkey have the title of being the only company that has two R&D centers.

The company is fully controlled by robots, sensors and intelligent software in the scope of Industry 4.0. The best example is the use of 18-spoke smart robots that are used to package a product produced by the company. Each of these robotic arms carries 80 products per minute and is capable of working 22 hours a day. Thanks to this performance, the single arm packaging approximately 100,000 products a day. In a single packaging line, 2 million products are processed annually, considering the year. In consideration of all product varieties, the product packaging can be made up to 7 times the population of Turkey. The number of movements carried out by all robot arms in the production line is 3 times more than 11,400 per minute.

In this process, both visual and intelligent software and samples are taken at a certain intervals by using the SPC method is carried out. Thanks to the increase in performance and capacity of the robots, the quantity produced in advance 40 even now can be produced even at 10. In this way, while labor time falls, quality has been greatly increased in hygiene and capacity, which is one of the indispensable conditions for food.

Mixing raw materials into production is also provided with intelligent software (smart prescription software) and robots, as in other production lines. The incoming raw material is passed through quality control processes and barcode and Advanced Level intelligent warehouse is stored in the barcoding system.

The Smart Warehouse is designed as a facility with a height of 36 meters, a width of 53 meters, a depth of 135 meters. The warehouse has 55 thousand pallets and has the capacity to store 2 million raw materials and products. The warehouse is divided into

three sections and the products and raw materials are stored in the section held at 18 degrees with intelligent air sampling system in order to prevent work accidents such as temperature and fire. With all these production and storage systems, 30% energy saving is ensured. This high energy efficiency, as well as low gas emission rates, has been established and an environmentally conscious system that contributes to both its own and country and world climate.

They have begun to manufacture their own machinery in the company with the support of incentives and advisers from state institutions along with technological developments while supplying the machines they use in production facilities in an outward-dependent manner. After having the titles of the R & D center, they continue to manufacture machinery with the help of consultancy services and incentives from abroad. In this way, they had the chance to have special machines belonging to their own product structure.

These developments in the field of production are used within the company ERP, management Systems software, robots and data from the machines in the lines of the intelligent software that collects the need to work with each other by talking to the integrated way . Therefore, all hardware and software systems are integrated. The best example is the collaboration of ERP, Smart Warehouse, production and centralized intelligent distribution systems. In this way, shipments can be made with minimum deviation/error in accordance with the quantity and order.

Transmitted customer complaints are taken from the sites through management systems software to the customer as soon as the solution oriented with the principle of return is managed.

Currently, the company has reached 4.0 level in 5 years. This transition has been invested approximately 600 million TL. The transition cost problems encountered in the first stages of the migration, the firm's own resources and capital without the encouragement of the management through the determination of the administration has been overcome. With the development of the R & D center, they take advantage of incentives and carry out cost fulfillment.

The energy cost provided by automation of everything was folded at first, but with the profitability of investments brought after the systems, both these energy costs were balanced and the systems provided energy efficiency.

The price of the transition has been influenced by the amount of products offered to the market on the basis of the produced product. The average kilogram price in Turkey is 2.21 USD, while the average kilogram price of the company is 3.71 USD. However, this increase is visible and the measure of concern is not reflected in the company's export and sales rates as negative.

When it comes to industry 4.0 and robotics, the company has a visibly decreased number of employees by directing idle personnel to newly created lines or other product lines in the interest of employment reductions and personnel inference. It is possible to increase competence levels by providing training in the fields of TPM-centric visual and applied education within the company in order to adapt to the necessary vocational, technical and innovations. The use of newly acquired machines, autonomic maintenance/planned maintenance trainings have been carried out in practical and theoretical ways from suppliers in the first hand and have the most accurate and reliable knowledge.

The volume of data that grows and grows, as well as the ability to analyze both storage space and analysis, has revealed the need for staff with strong, good statistical knowledge. The infrastructure of the ERP system used to provide fast access to storage and data has been passed to the storage structure developed by this software. The needs of qualified personnel for statistics and analysis were provided to the personnel within the company by offering internal and external training opportunities.

Big Data ERP, produced due to concerns in terms of data security, is managed with the necessary security prerequisites, stored on servers as on premise in the data storage infrastructure.

Integrated intelligent software, speed of robots, capacity-quality-hygiene is important in Turkey thanks to the orders received for the holiday periods are completed in 2 months. For these periods, the response time from the customer to the orders from 8 -10 to 75%-80% was obtained from the improvement. This improvement has reduced the risks and ratios of pre-and post-production raw materials, semi-finished products and product

degradation, which have not only provided significant savings from the time most important value in today's competitive conditions.

The improvement in the rate of waste has brought a significant reduction in customer complaints. In 1989, the company, which makes 10 tons of production with 50 people, now the company has total 73 even with its 62 main production line, 11 semi-finished and packaging lines. In these lines, a total of 800,000 tons of production is performed daily. After the transition in 2017, 763 million TL turnover, 150 million USD export revenue has achieved. (www.dunya.com)

2.3.3.2. Case 2 : A White Goods Production Company

In an interview on www.endustri40.com, another company that works in white goods production sector in Turkey started its work by creating the Industry 4.0 roadmap. Information that will enable these changes by accelerating their efforts to "intelligentize" the production systems they are using, increase their level of automation and improve human-robot interaction they are engaged in large-scale projects in the development of their technology infrastructure. It allocates large budgets for the realization of these projects in all factories in Turkey and around the world. The company keep all new production facilities with intelligent factory infrastructure.

The company has shortened the cycle times of cooling systems with increased effectiveness using inserts made with metal 3D printers in plastic injection molds and provided an advantage in competition. It has begun work on the production of 3D printers and service parts and the use of real production materials and 3D parts producing printers is one of the projects we are carrying out. In the future, they aim to increase the capacity of our prototype production process with both metal and plastic 3D printers.

With RFID technology; data collection, performing improvements by analyzing data, managing automation islands and production, automatic material transportation systems are used.

To meet digital factory standards, MES (Manufacturing Execution System) software is under way to transform different software that operates in islets in the production area into integrated software.

Simulation software is used extensively in many areas from logistics to balancing assembly line. With the development of sensors and other data collection tools, the use of simulation tools to create real-time virtual copies of the production system is among the items included in the Industry 4.0 transition roadmaps.

They have a large number of horizon 2020 projects, supported by funds related to augmented reality. The innovation and R&D departments, which have been established in the fields of robots and people working together in workstations, data security and cloud systems, are continuing their studies.

The engineering team they have created works on data management, secure data transmission and the development of smart products.

2.3.3.3. Case 3 : A Wood Work, Paper and Paper Products Factory

The company called case 3 works in wood work, paper and paper products sector. It has decided to complete Industry 4.0 digital transformations. Therefore, transformation has just been started. Before the decision, TPM has been applying since 2013. With TPM applications, it has achieved many good improvements. Developments in issues important for TPM such as occupational health and safety, efficiency and autonomous maintenance are undeniable.

From the point of view of Industry 4.0, the company is working hard in the fields of robots, cyber security and system integrations. Special custom-prepared reporting and data analysis of the ERP system used in for big data. To increase big data studies, it decided to use an data collection system from the field.

Studies on cloud system, augmented reality, horizontal-vertical integration, 3D printers has not begun yet.

2.4. Literature Review Summary

There are lots of researches about Industry 4.0 in Turkey. Most of them is about awareness and effects of Industry 4.0.

Some of studies about effects of Industry 4.0 in Turkey wide are shown in Table 2.1. Education, investments and increasing researches studies are strongly recommended to achieve Industry 4.0 digital transformation.

Table 2.1 Studies of Effects of Industry 4.0 in Turkey Wide

Reference	Subject	Result
OZKAN et al, 2018	Effects of Industry 4.0 in Turkey	Priorities of education policies and R&D activities must be increased.
BAGCI, 2018	Effects of Industry 4.0 in Turkey	Turkey should make long-term investment plans, pay attention to education and complete automation and information processes quickly in order to complete the Industry 4.0 transformation.
DOGRU and MECIK, 2018	Effects of Industry 4.0 in employment decisions	Relationship of human capital, turkey's current labour profile and other economic conditions are not in line with expectations, meeting expectations in the labour market in the short and long term, it has been concluded that it depends on the development of labour capabilities and that it is possible to consider this transformation as an opportunity for Turkey through the necessary policies and studies.

Addition to Turkey wide studies, there are lots of studies about effects of Industry 4.0 regarding departments in Turkey. As shown in Table 2.2, number of studies about human resources department and automotive industry are more than other. The reasons are:

- Human resources department is one of the departments that will be most affected after production department.
- Automotive industry is one of the locomotive industries most prone to robotization.

Table 2.2 Studies of Effects of Industry 4.0 Regarding Departments in Turkey

Reference	Subject	Result
OZTURK and KOC, 2017	Effects of Industry 4.0 in furniture industry	Industry 4.0 should be closely monitored and transformations should be initiated quickly in order to provide a competitive environment in the furniture industry, which is an industry where customer demand changes frequently
GABACLI and UZUNOZ, 2017	Effects of Industry 4.0 in automotive industry	Education and R&D activities, strategies for eliminating negative scenarios development must be made and increased.
NUROGLU and NUROGLU,2018	Effects of Industry 4.0 in foreign trade	The transformation a chance that the foreign trade deficit would be closed if Turkey completed the Industrial 4.0 transformation, but if it was too late for the start of the work, this transformation would pose a threat, not an opportunity.
YILMAZ and ERKOLLAR, 2019	Effects of Industry 4.0 in human resources	Relationship human and robots will significantly affect human resources planning, measures should be taken to minimize the impact on the existing workforce.

Table 2.3 (Cont) Studies of Effects of Industry 4.0 Regarding Departments in Turkey

ERTURAN and ERGIN, 2018	Effects of Industry 4.0 in accounting	Accounting will be significantly affected by intelligent systems and automation systems, vocational training as well as the use of technology, data analysis should be trained in the industry 4.0 process should be equipped consequently.

Table 2.2(Cont.) Studies of Effects of Industry 4.0 Regarding Departments/Industries in Turkey

Reference	Subject	Result
FILIZOZ and ORHAN, 2018	Effects of Industry 4.0 in human resources	Human resources are encountered as an important part of this transformation.
SAYILGAN and ISLER, 2017	Effects of Industry 4.0 in medical devices industry	Education and research, advanced medical technologies that are generated by transformation, cyber security, additive production, internet of things, big data and analysis should be focused on.
DOGRUEL ANUSLU and FIRAT,2019	Relationship between sustainability and Industry 4.0	Findings of the study show that which resulted in descriptive research within the framework of Industry 4.0 technology and components are related with economic, social and environmental sustainability.

Table 2.4 **Studies of Awareness of Industry 4.0 in Turkey**

Reference	Subject	Result
YUKSEL and SENER, 2017	Awareness of Industry 4.0 in Turkey	Although the Industrial 4.0 transformation was not completed in Turkey, there was awareness of the concept.
YUKSEKBILGILI and CEVIK, 2018	Awareness of Industry 4.0 in Turkey	Industry 4.0 awareness is formed in Turkey, roadmaps are prepared for transformation and studies are started.
KAYGISIZ and SIPAHI, 2019	Awareness of Industry 4.0 in Turkey	There is no correlation between individual innovation status and gender, whether they had heard of Industry 4.0 before and education levels regarding attendances.

Table 2.3 shows some of studies about awareness of Industry 4.0 in Turkey. As a result, Turkey heard what Industry 4.0 is. However, preparations and transformation studies of companies have not been finished yet.

Table 2.5 Non-Governmental Organization Studies of Awareness of Industry 4.0 in Turkey

Reference	Subject	Result
TUSIAD,2016	Industry 4.0 as a necessity for Turkey's global competitiveness	Turkey must work on efficiency, growth, investment and employment
TUSIAD,2017	Competencies of Digital Transformation in Industry of Turkey	Turkey must work on investments, shaping human resources for future, create a value.
EBSO, 2015	Industry 4.0	Turkey must work on legal arrangements, support the relationship between universities and industry.

Not just universities and academicians work on progress of Industry 4.0 in Turkey, also non-governmental organization work on it. Table 2.4 show some of these organizations studies. Common ideas at all of these studies are:

- Turkey should increase investments about the transformation.
- Turkey should create a strategy about employees' education.
- The government should support the companies for R&D studies.
- Companies should be supported through legal arrangements by the Turkish government.
- Relationship between universities and companies should be increased.

As seen in literature, there is awareness of Industry 4.0 in Turkey and some of industries has started about the transformation. However, there is no idea about knowledge level of Industry 4.0 and its components. In addition, there is much study about advantages, disadvantages, challenges and their solutions, studies on companies.

3. CHAPTER 3: METHODOLOGY OF THE STUDY

Because of the results that mentioned in Chapter 2, there is lack of knowledge and background about Industry 4.0. Although there are several researches about awareness, there is almost none researches about knowledge level. Therefore, in this study besides awareness, knowledge level and background of Industry 4.0 in Turkey. For this aim, a survey applied and interviewed with some companies that started to work on Industry 4.0. While the level of individual knowledge and awareness level is measured by survey, the knowledge level of the companies that have been implemented with the help of interviews has been tried to be measured. In this study, knowledge level and awareness are focused, no research has been conducted measuring technological adequacy.

This chapter includes three parts. They are aim and scope of applied study, theoretical of the study and data collection. Figure 3.1 show the parts.

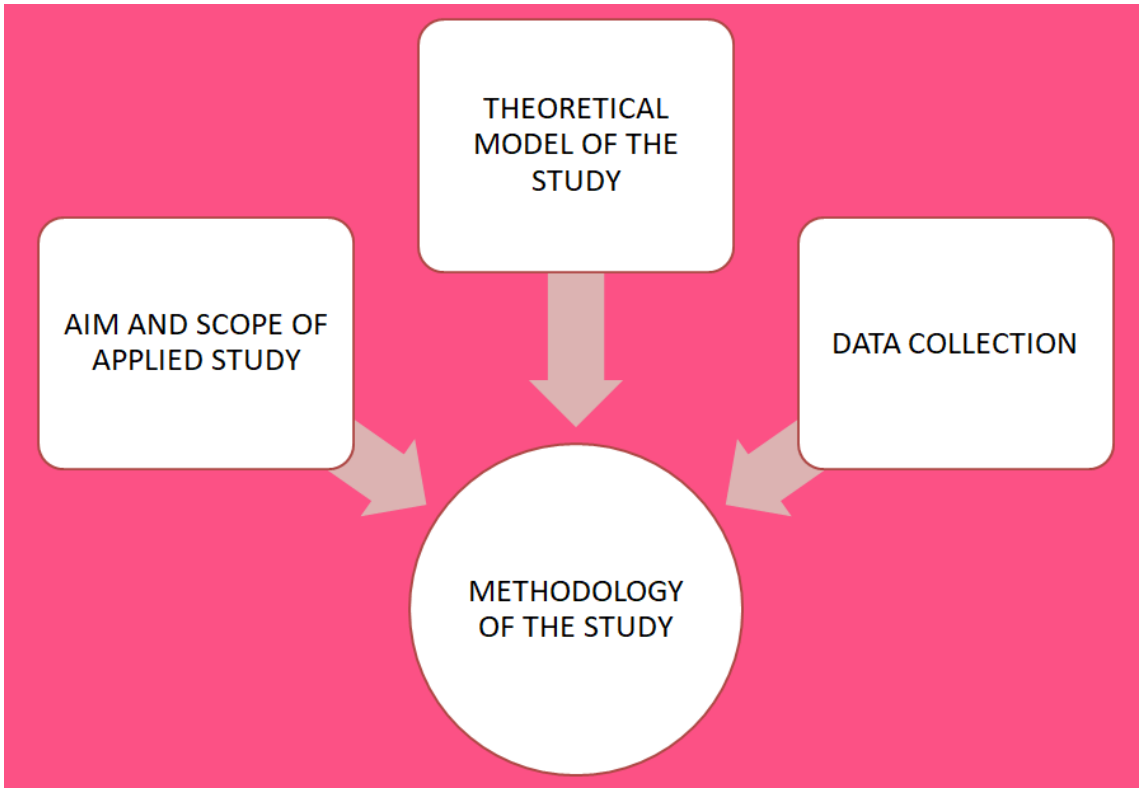

Figure 3.1 Methodology of The Study

3.1. Aim and Scope of Applied Study

To measure and analyse knowledge level, two categories are specified as individual knowledge level and corporate knowledge level. At individual part, a theoretical model is developed for a survey and the survey applied to people via social media platforms. For corporate knowledge level, interviews and researches were done with selected three companies via a checklist that includes questions about Industry 4.0 and its components. To combine each part of this study, survey questions and checklist questions are prepared in a similar direction.

3.2. Theoretical Model of The Study

In this section, there are two parts as survey and case studies. For survey, a model was developed to define knowledge and background level because of necessity of knowledge to achieve the digital transformation. Some interviews and researches were done to define knowledge level of companies that are interested in Industry 4.0. Theoretical model of the study is examines two parts. The parts are shown in Figure 3.2.

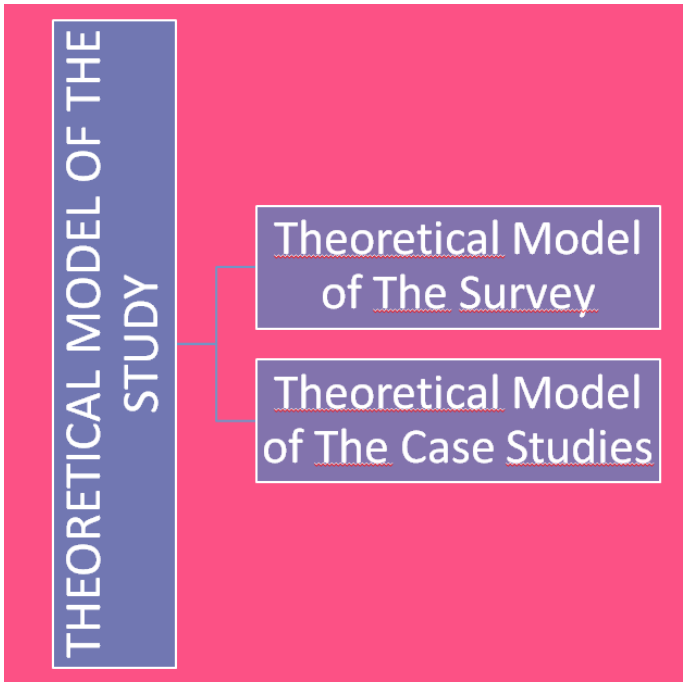

Figure 3.2 Theoretical Model of The Study

3.2.1. Theoretical model of the survey

The model of survey includes questions about thoughts about advantages, disadvantages and challenges besides knowledge. Based on these aims, a model which is shown in Attachment-1 generated is set.

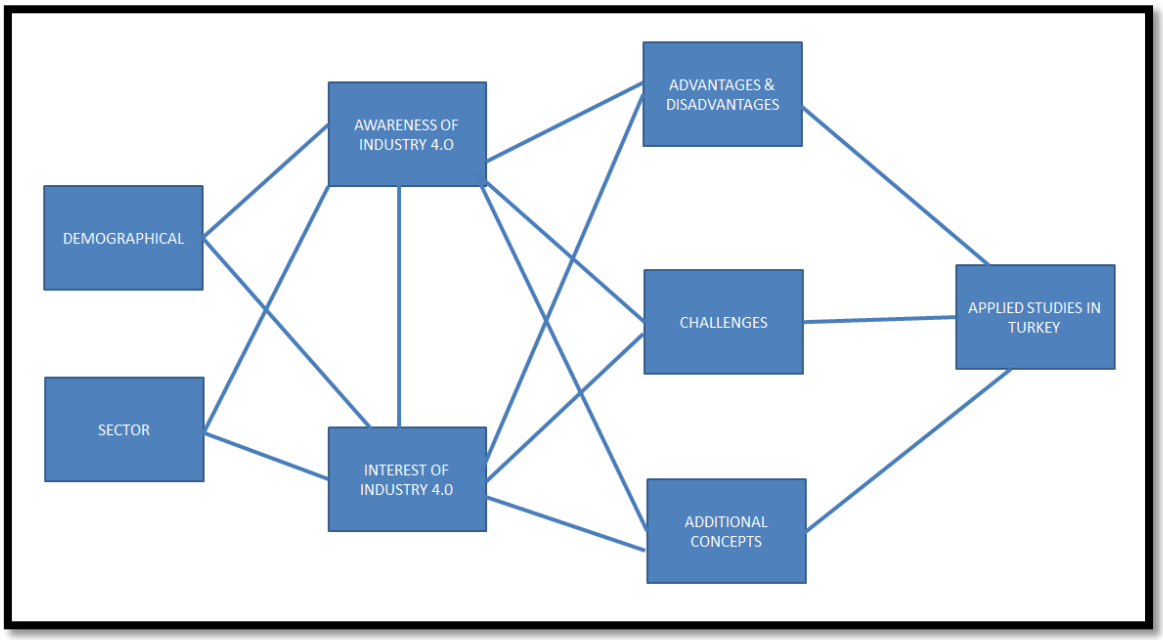

Figure 3.3 Model of The Study

As seen in Figure 3.1, model has eight dimensions to find answers regarding the results. Each dimensions has different number of questions.

Table 3.1 and Figure 3.2 show number of questions and distribution to each dimension.

Table 3.1 Number of Questions in Each Dimension

Dimensions	Number of Questions	Questions
Demografhic	2	1-2
Sector	4	3-6
Awareness of Industry 4.0	10	7-8,29-33
Interest of Industry 4.0	34	9-27,38
Advantages & Disadvantages	24	35-36
Challenges	13	34,37
Additional Concepts	3	28
Applied Studies in Turkey	16	39-53

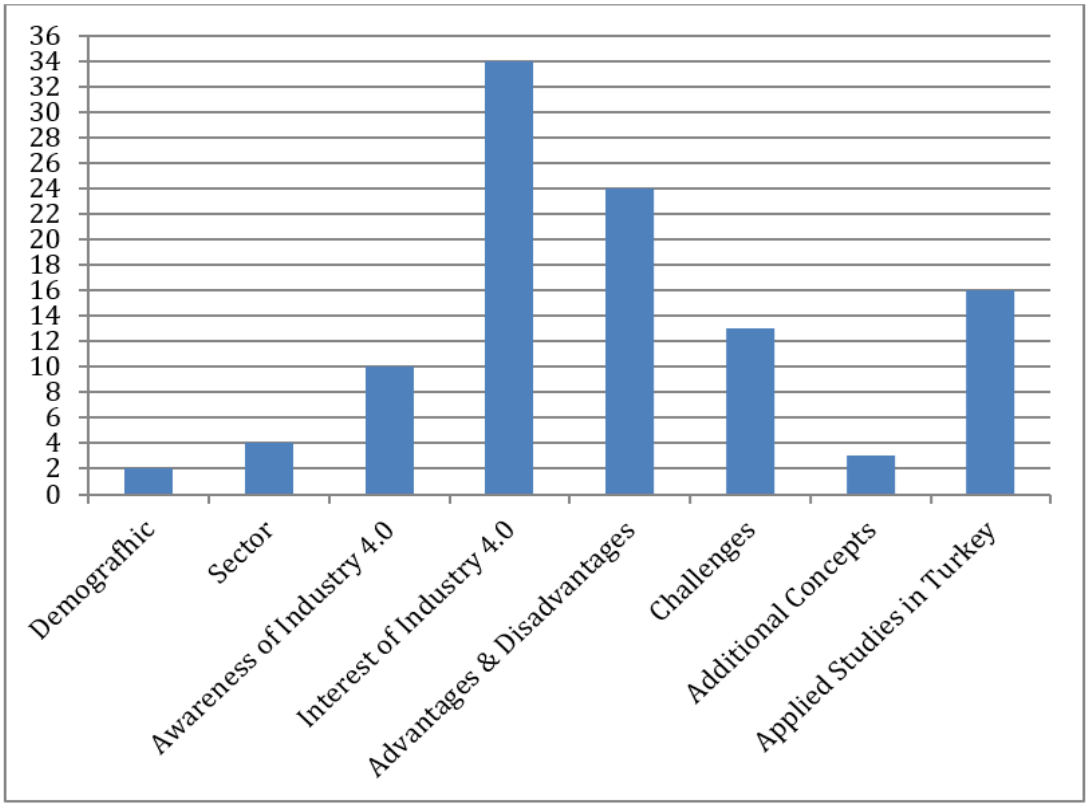

Figure 3.4 Question Distribution

Regarding these items, interest of Industry 4.0 dimension has most questions with 34 questions in the survey. Details about dimensions are as follows:

- Demographic: The dimension includes demographic questions about participants' age and educational status. Question about age has selected four answer choices as 18-25, 26-34, 35-45 and 46 + . To analyse answers, choices are counted as 1,2,3,4.
- Sector: The dimension includes questions that are related sector definitions about participants such as sector, department, positions. To analyse answers, choices are counted sequentially in each question.
- Awareness of Industry 4.0: The dimension was developed to get information about participants awareness. Therefore, questions are related to if participants had ever heard Industry 4.0, where they heard it, how many industrial revolutions there are etc. All questions are multiple choice and answers are counted as sequentially in each question.

- Interest of Industry 4.0: The dimension includes questions about knowledge and interest level of Industry 4.0 and its components. All questions has multiple choice and likert scale is used to answers as between 1-Strongly disagreed and 5- Strongly agreed.
- Advantages and Disadvantages of Industry 4.0: This dimension includes questions designed to find out what participants think about the advantages and disadvantages of Industry 4.0. All questions has multiple choice and likert scale is used to answers as between 1-Strongly disagreed and 5- Strongly agreed.
- Challenges: The dimension includes questions designed to learn what participants think about the challenges and solution for the transition to Industry 4.0. All questions has multiple choice and likert scale is used to answers as between 1-Strongly disagreed and 5- Strongly agreed.
- Additional Concepts: The questions of this dimension are designed to find participants' interest in concepts that arise through technological innovations brought about by Industry 4.0. All questions has multiple choice and likert scale is used to answers as between 1-Strongly disagreed and 5- Strongly agreed.
- Applied Studies in Turkey: This dimension is designed to measure the knowledge about which companies working on Industry 4.0 in Turkey, the improvements and applications, how the changes are achieved during the studies and how the challenges are overcome. In this dimension, there are multiple choice and open ended questions. Multiple choice questions are yes or no questions and answers are counted as yes=1, no=0.

3.2.2. Theoretical model of the case studies

To find corporate knowledge level, there are three company were examined. Two of them nearly completed their Industry 4.0 transformation journey and are using almost all components of Industry 4.0. One of them decided to complete Industry 4.0 comcepts to its company. However, it has started to work on it. To gathering data, interviews were done with two of them. Some researches were done about one of them.

According to case study methods, defining the problem is the first step. Therefore, in this study, the problem is lack of knowledge about Industry 4.0 to solve to be ready and

achieve the transformation. Second step is data collection. For this step, a checklist created to find their knowledge level. Questions in checklist are directed to survey's knowledge questions to compare their answers and results. Third is evaluate the data. Evaluation of data will be presented in chapter 4 and results will be compare with individual research results.

3.3. Data Collection

As in section 3.2 , in this section includes two parts : Data collection of the survey and Data collection of the cases. Each part contains its questions and data collection characteristic.This section includes two parts. Figure 3.5 shows the parts.

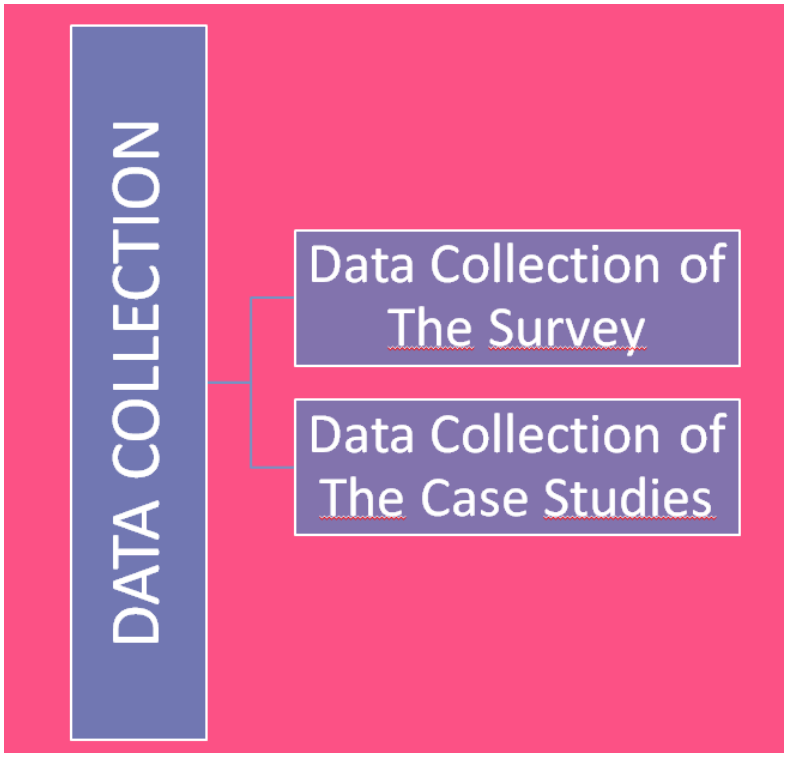

Figure 3.5 Data Collection

3.3.1. Data collection of the survey

The survey has 98 main questions and this number is increasing to 107 questions with subquestions such as 'if your answer is yes to above question, please write what are they'.

There are two questions in demographic dimension and four questions in sector dimension regarding Table 3.2. These dimensions are about participants characteristics.

Table 3.2 Questions of Demographic Dimension and Sector Dimension

DIMENSIONS	Demograpfic	Sector
QUESTIONS		
What is your age?	X	
What is your educational status?	X	
What is your work sector (public /private)?		X
What is your industry?		X
What is your department?		X
What is your position?		X

Table 3.3 shows questions of awareness of Industry 4.0 dimension. All questions are related to Industry 4.0 recognition.

Table 3.3 Questions of Awareness of Industry 4.0

DIMENSIONS	Awareness Of Industry 4.0
QUESTIONS	
Have you ever heard Industry 4.0 before?	X
Where did you hear it?	X
How many industrial revolutions are there?	X
First Industrial Revoluion (Industry 1.0) - Discovery of Steam Power (True or Right)	X
Second Industrial Revolution (Industry 2.0) - Transition to Mass Production	X
Third Industrial Revolution (Industry 3.0) - Transition to Automation	X
Fourth Industrial Revolution (Industry 4.0) - Dark (Unmanned) Factories	X
At what stage is Turkey looking at the industrial revolutions?	X
Rate Turkey for industry 4.0 transition.	X
Is the studies carried out in Turkey for the transition of industry 4.0 sufficient?	X

Table 3.4 shows questions of Interest of Industry 4.0 dimension. This dimension is about components of Industry 4.0. It has two categories as Knowledge and Interest. Regarding these categories, participants answered the questions knowledge level and interest level of Industry 4.0 components.

Table 3.4 Questions of Interest of Industry 4.0

DIMENSIONS	Interest of Industry 4.0
QUESTIONS	
What is your knowledge level about robots?	X
What is your knowledge level about smart factory?	X
What is your knowledge level about big data?	X
What is your knowledge level about augmented reality?	X
What is your knowledge level about cyber systems?	X
What is your knowledge level about cyber security?	X
What is your knowledge level about internet of things?	X
What is your knowledge level about 3D printers?	X
What is your knowledge level about smart products?	X
What is your knowledge level about system integrations?	X
What is your knowledge level about horizontal - vertical integration?	X
What is your knowledge level about simulation?	X
What is your knowledge level about virtual reality?	X
What is your knowledge level about wearable robots?	X
What is your knowledge level about sencors?	X
What is your knowledge level about neurotechnology?	X
What is your knowledge level about automous cars?	X
What is your knowledge level about block chain?	X
What is your interest level about robots?	X
What is your interest level about smart factory?	X
What is your interest level about big data?	X
What is your interest level about augmented reality?	X
What is your interest level about cyber systems?	X
What is your interest level about cyber security?	X
What is your interest level about internet of things?	X
What is your interest level about 3D printers?	X
What is your interest level about smart products?	X
What is your interest level about system integrations?	X
What is your interest level about horizontal - vertical integration?	X
What is your interest level about simulation?	X
What is your interest level about virtual reality?	X
There are structures (institutions, organizations, information lines, websites, publications, conferences, panels, etc.) in Turkey where you can get enough information about Industry 4.0.	X

Advantages and disadvantages of Industry 4.0 is evaluated in the same dimension. Table 3.5 shows the questions of the dimension. Therefore , we can say that the dimension has two categories as Advantages and Disadvantages. Nine questions are in each category.

Table 3.5 Questions of Advantages & Disadvantages of Industry 4.0

DIMENSIONS	Advantages & Disadvantages
QUESTIONS	
Industry 4.0 will increase energy efficiency.	X
Industry 4.0 will have a positive impact on the development of the country.	X
Industry 4.0 will provide employment growth as the shortage of qualified personnel will arise.	X
Industry 4.0 will increase technology development and use.	X
Industry 4.0 will contribute greatly to the rise of our country to the level of countries that are high in technology.	X
Industry 4.0will enable more products to be produced faster and more reliably in the industry.	X
By reducing the use of natural resources,Industry 4.0 will contribute positively to the formation of eco-friendly industry and the prevention of climate change.	X
Industry 4.0 will contribute to production by reducing costs in the long term.	X
Industry 4.0 will increase competitiveness.	X
Industry 4.0 will reduce efficiency by increasing energy use	X
Industry 4.0 will increase costs, especially investment costs.	X
Industry 4.0 will negatively affect the country's development.	X
Robots will replace humans and will lead to unemployment.	X
By increasing the use of natural resources, Industry 4.0 will have a negative impact on the formation of eco-friendly industry and the prevention of climate change.	X
Industry 4.0 will reduce competitiveness.	X
Industry 4.0 will create vulnerabilities in terms of data security.	X
By increasing the use of artificial intelligence, Industry 4.0 will pave the way for future endangerment of the human race.	X
Employees will need more training to meet the need for qualified staff	X

As seen in Table 3.6, challenges dimension has 13 questions. The dimension includes challenges and suggestions to overcome them. That means, there are two categories in this dimension as Challenges and Suggestions. Category of challenges has 7 questions, other category 'Suggestions' has 6 questions.

Table 3.6 Questions of Challenges of Industry 4.0

DIMENSIONS	Challanges
QUESTIONS	
Economic reasons are a challenge for the transformation	X
Lack of infrastructure is a challenge for the transformation	X
Lack of Knowledge / Education is a challenge for the transformation	X
Lack of government support is a challenges for the transformation	X
Lack of qualified workforce is a challenges for the transformation	X
Lack of incentive is a challenges for the transformation	X
Lack of R&D researches is a challenges for the transformation	X
Challenges can be overcome with government support.	X
Challenges can be overcome by teaching subject-related courses to universities.	X
Challenges can be overcome by the trainings provided by the professional chambers to the employees.	X
Special trainings can overcome challenges	X
With social media support, challengescan be overcome by increasing the level of consciousness.	X
Incentives can overcome challenges.	X

Industry 4.0 brings some additional concepts besides its components. Table 3.7 shows both what are these additional concepts and participants' interest level of additional concepts.

Table 3.7 Questions of Additional Concepts

DIMENSIONS	Additional Concepts
QUESTIONS	
What is your interest level about wearable robots?	X
What is your interest level about sencors?	X
What is your interest level about neurotechnology?	X
What is your interest level about automous cars?	X

Applied studies in Turkey dimension is Turkey's implementations and awareness of participants. There are 16 questions in this dimension regarding Table 3.8.

Table 3.8 Questions of Applied Studies in Turkey

DIMENSIONS	Applied Studies in Turkey
QUESTIONS	
Are there companies in Turkey that have industry 4.0 applications?	X
What sectors do you know that Industry 4.0 is being implemented?	X
Are there industry 4.0 conversion works in the company you work for?	X
Are smart technologies used in the company you work for?	X
Is there a smart product production in the company you work for?	X
Is there any use of robots in the company you work for?	X
Is there any use of cloud systems in the company you work for?	X
What kind of software (ERP, management systems, warehouse systems, etc.) is used in your company?	X
Are machines and software integrated into each other in your company?	X
Is your company doing data management?	X
At what stage do you think the transformation in your company is at?	X
What do you think are the effects of Industry 4.0 on your company organization scheme?	X
What do you think the positive effects of Industry 4.0 on your company?	X
What do you think the negative effects of Industry 4.0 on your company?	X
Can you specify the difficulties that you think may be experienced during the transition in Turkey and your company?	X
How have the difficulties experienced/experienced during the transition in Turkey and your company been overcome?	X

The survey shared with the participants via social platforms such as Linkedin, mail etc. at the beginning of August. It was answerable until at the end of the August. During this time, 207 people responded to the questionnaire and contributed to this study.

Before analysis, 15 lines have been deleted to ensure data reliability. In the analysis phase, questions with likert scale are applied rotated varimax PCA factor analysis, correlation with Spearman method, chi-square and t tests. Open-ended questions were analysed with the help of keywords.

3.3.2. Data collection of the case studies

Interviews and researches were made to learn companies' progress of Industry 4.0. However, it is not enough to find their knowledge level. Therefore, all information is collected via a checklist that includes questions about knowledge about Industry 4.0 components.

Table 3.9 shows the checklist that is filled in with information of interviews and researches. The checklist has likert scale. The scale has 5 choices that are from 1- they do not anything about it to 5- they know it very well. The checklist filled regarding companies applications and studies.

Table 3.9 Checklist

SCALE	1-They do not know anything	2	3	4	5 - They know it very well
QUESTIONS					
What is your knowledge level about robots?					
What is your knowledge level about smart factory?					
What is your knowledge level about big data?					
What is your knowledge level about augmented reality?					
What is your knowledge level about cyber systems?					
What is your knowledge level about cyber security?					
What is your knowledge level about internet of things?					
What is your knowledge level about cloud computing?					
What is your knowledge level about 3D printers?					
What is your knowledge level about smart products?					
What is your knowledge level about system integrations?					
What is your knowledge level about horizontal - vertical integration?					
What is your knowledge level about simulation?					
What is your knowledge level about virtual reality?					
What is your knowledge level about wearable robots?					
What is your knowledge level about sencors?					
What is your knowledge level about neurotechnology?					
What is your knowledge level about automous cars?					
What is your knowledge level about block chain?					

4. CHAPTER 4: FINDINGS AND EVALUATIONS OF THE APPLIED STUDY

In this chapter, statistical analyses will be applied on the data obtained from the questionnaire. The analyses were divided into two titles: assessment of the model and evaluation and comparison of model variables. In the tables of the results of the analysis, questions are shown along with question codes such as S1, S2 etc. The questions themselves are mentioned in the questionnaires below the analysis.

This chapter has three parts as assessment of the model by the factor analysis, data analysed of the survey by descriptive statistical methods and finding and results of case studies. Figure 4.1 shows these parts.

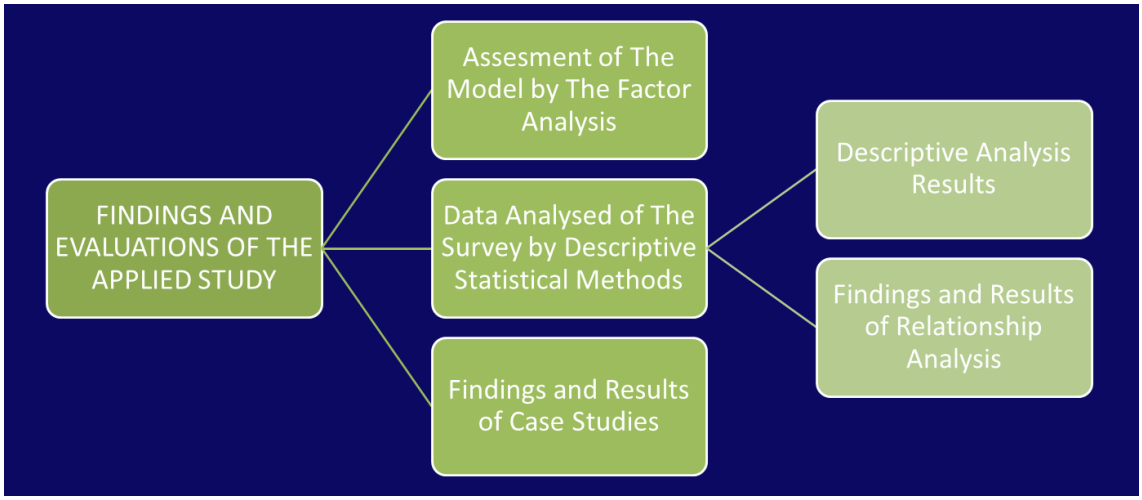

Figure 4.1 Findings and Evaluations of the Applied Study

4.1. Assessment of The Model By The Factor Analysis

For assessment of the model factor analysis is applied on model dimensions. Selection of the dimension is done regarding number of questions of dimensions. From this point of view, the analysis was started with Interest of Industry 4.0.

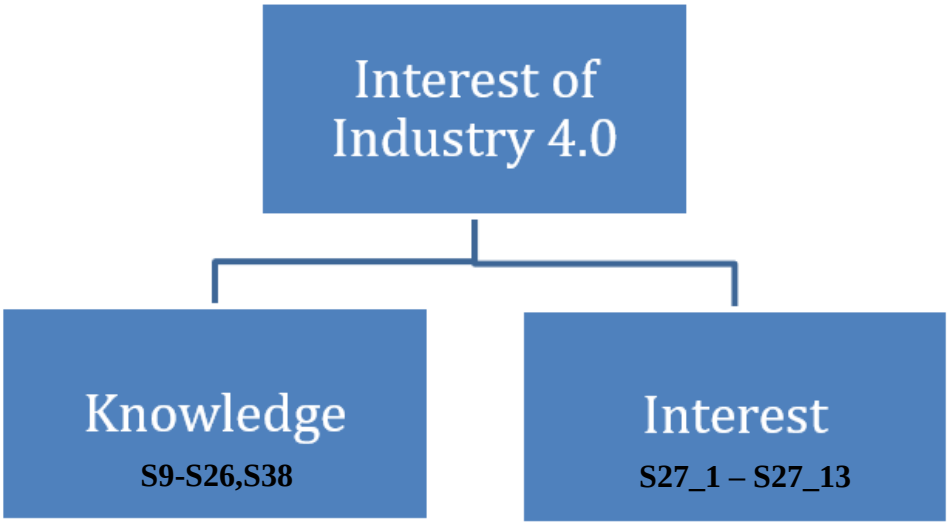

Figure 4.2 Interest of Industry 4.0 Schema

The dimension called Interest of Industry 4.0 has two categories. As shown in Figure 4.1, categories are Knowledge and Interest. In knowledge part, questions are about knowledge level of Industry 4.0 and its components. They are answered regarding likert scale. Also in interest part, interest of Industry 4.0 and its components is the main subject. Likert scale is used for their answers as well. Sample size has been accepted as 6 times the number of questions.(Hair et al, 2013)

Knowledge category has 19 questions, interest category has 13 questions in Table 4.1. All are about industry 4.0 component

Table 4.1 Questions of Interest of Industry 4.0 Regarding Categories

Question	Question Code	Component
Knowledge Level of Robots	S9	Knowledge
Knowledge Level of Smart Factories	S10	Knowledge
Knowledge Level of Big Data	S11	Knowledge
Knowledge Level of Augmented Reality	S12	Knowledge
Knowledge Level of Cyber Systems	S13	Knowledge
Knowledge Level of Cyber Security Studies	S14	Knowledge
Knowledge Level of IoT	S15	Knowledge
Knowledge Level of 3D Printers	S16	Knowledge
Knowledge Level of Smart Products	S17	Knowledge
Knowledge Level of System Integrations	S18	Knowledge
Knowledge Level of Horizontal - Vertical Integrations	S19	Knowledge
Knowledge Level of Simulation	S20	Knowledge
Knowledge Level of Virtual Reality	S21	Knowledge
Knowledge Level of Wearable Robots	S22	Knowledge
Knowledge Level of Sencors	S23	Knowledge
Knowledge Level of Neurotechnology	S24	Knowledge
Knowledge Level of Autonomous Cars	S25	Knowledge
Knowledge Level of Block Chain	S26	Knowledge
Interest of Level of Robots	S27_1	Interest
Interest Level of Smart Factories	S27_2	Interest
Interest Level of Big Data	S27_3	Interest
Interest Level of Augmented Reality	S27_4	Interest
Interest Level of Cyber Systems	S27_5	Interest
Interest Level of Cyber Security Studies	S27_6	Interest
Interest Level of IoT	S27_7	Interest
Interest Level of 3D Printers	S27_8	Interest
Interest Level of Smart Products	S27_9	Interest
Interest Level of System Integrations	S27_10	Interest
Interest Level of Horizontal - Vertical Integrations	S27_11	Interest
Interest Level of Simulation	S27_12	Interest
Interest Level of Virtual Reality	S27_13	Interest
Adequacy of Research Resources Related to Industry 4.0 in Turkey	S38	Knowledge

Kaiser-Meyer-Olkin and Bartett tests were applied to test the conformity of factor analysis. KMO is accepted as the standard limit value of 0.5.

Regarding Table 4.2 KMO value smaller than 0.5. With Bartlett test and significant value, data of Interest of Industry 4.0 is appropriate and significant to apply factor analysis. Principal Component Analysis with Rotated Varimax method is applied for factor analysis. Eigenvalue is accepted as 1 for the analysis.

Table 4.2 KMO and Bartlett's Test Regarding All Variables

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,936
Bartlett's Test of Sphericity	Approx. Chi-Square	6584,706
	df	496
	Sig.	,000

As the anaylsis in Table 4.3, the data separated for 5 components. Consider cumulative % value, these 5 components meet % 75,899 of data. Therefore, the analysis was continued with these components.

Table 4.3 Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings	
	Total	% of Variance	Cumulative %	Total	% of Variance
1	17,318	54,118	54,118	17,318	54,118
2	3,579	11,183	65,302	3,579	11,183
3	1,232	3,849	69,150	1,232	3,849
4	1,105	3,453	72,604	1,105	3,453
5	1,055	3,296	75,899	1,055	3,296
6	,832	2,601	78,500		
7	,684	2,136	80,636		
8	,672	2,099	82,735		
9	,515	1,611	84,346		
10	,478	1,493	85,839		
11	,465	1,453	87,292		
12	,409	1,279	88,571		
13	,385	1,204	89,774		
14	,340	1,062	90,836		
15	,315	,984	91,820		
16	,310	,967	92,788		
17	,277	,866	93,654		
18	,230	,720	94,374		
19	,226	,707	95,081		
20	,204	,639	95,720		
21	,190	,593	96,313		
22	,164	,512	96,826		
24	,144	,450	97,776		
25	,128	,401	98,178		
26	,123	,385	98,562		
27	,102	,317	98,880		
28	,096	,301	99,180		
29	,076	,239	99,419		
30	,075	,234	99,653		
31	,059	,183	99,836		
32	,053	,164	100,000		

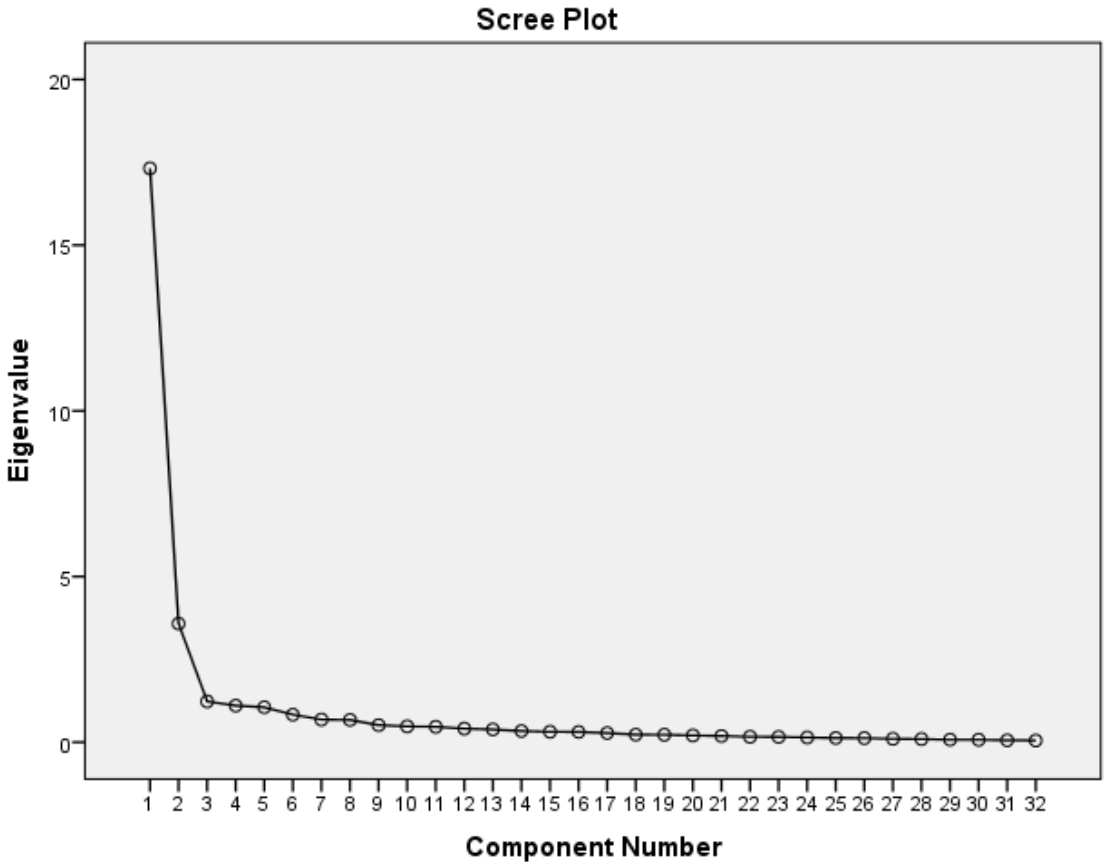

Figure 4.3 Scree Plot for First PCA

As seen in Figure 4.2, the elbow of the line has been made around 5 components is completed.

When seen loading values in Table 4.4, first component meets %32.934 of data, second meets %58.380, third one is %68.439. Remaining component do not contribute the data as much as first three. Therefore, if preferred, analysis can be continued with first 3 components. However, in this study 5 components have been continued to determine the questions involved.

Table 4.4 Loadings Values After Varimax

Component	Extraction Sums of Squared Loadings	Rotation Sums of Squared Loadings		
	Cumulative %	Total	% of Variance	Cumulative %
1	54,118	10,539	32,934	32,934
2	65,302	8,142	25,445	58,380
3	69,150	3,219	10,060	68,439
4	72,604	1,312	4,101	72,541
5	75,899	1,075	3,358	75,899

Table 4.5 shows replacing the questions to the factor. Between S9 and S26 except S10 belong to Factor 1 which is called ‘Knowledge Level Factor’ from now. Between S27_1 and S27_13 except S27_2 and S27_3 belong to Factor 2 which is called ‘Interest Level Factor’ from now. S10, S27_2 and S27_3 are in Factor 3 which is called ‘Smart Technology Knowledge and Interest Level Factor’. To assign all questions to 5 factors, S27_2 can be put in Factor 4. However, it does not make any sense. For this reason, S27_2 is be in Factor 3. S38 is in Factor 5. To make the analysis more significant, S38 is removed from the data and the analysis is repeated.

Table 4.5 Rotated Component Matrix

	Component				
	1	2	3	4	5
S21	,826	,234	,208	-,138	,030
S17	,806	,232	,133	,020	-,009
S16	,802	,334	,079	-,139	-,034
S25	,797	,254	,190	-,087	,053
S20	,791	,343	,059	,007	,084
S23	,782	,391	,080	-,024	,006
S22	,774	,262	,192	,058	,172
S24	,735	,215	,095	,131	,101
S13	,734	,272	,237	,350	-,172
S18	,727	,271	,219	,387	,079
S19	,706	,267	,173	,441	,092
S14	,706	,308	,175	,358	-,097
S12	,698	,100	,513	-,139	,010
S26	,697	,169	,342	,237	,002
S15	,682	,122	,539	-,003	,000
S11	,655	,135	,555	,107	,088
S9	,636	,239	,372	,099	-,065
S27_6	,171	,846	,034	,185	-,064
S27_5	,204	,846	,120	,203	-,045
S27_12	,269	,826	,077	,017	,017
S27_9	,262	,807	,200	,068	,078
S27_10	,206	,796	,136	,348	,046
S27_13	,300	,788	,159	-,142	-,027

Table 4.5 (Cont.) Rotated Component Matrix

	Component				
	1	2	3	4	5
S27_8	,285	,784	,044	-,155	,007
S27_11	,202	,731	,190	,425	,084
S27_4	,324	,688	,401	-,220	,016
S27_1	,434	,626	,291	-,133	,064
S27_7	,331	,609	,499	-,007	-,036
S27_3	,300	,523	,640	,009	-,015
S10	,477	,197	,631	,205	,055
S27_2	,149	,559	,575	,133	,053
S38	,094	,013	,034	,013	,961

KMO value increased to ,937 that means is ,001 more than before. Bartlett test result decreased from 496 to 465. However, significantly does not change. As a result, removing S38 makes the data more significant to apply factor analysis

Table 4.6 KMO and Bartlett's Test After Removed S38

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,937
Bartlett's Test of Sphericity	Approx. Chi-Square	6564,007
	df	465
	Sig.	,000

.

As the anaylsis in Table 4.7, after S38 removed from the data, 4 components are separated. Covering the data cumulative % value, these 4 components meet % 74,884 of data means that this % is approximately %1 less than before. Furthermore, first component % variance value increases from % 54,118 to %55,821.

Table 4.7 Total Variance Explained After Removed S38

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings	
	Total	% of Variance	Cumulative %	Total	% of Variance
1	17,304	55,821	55,821	17,304	55,821
2	3,573	11,526	67,347	3,573	11,526
3	1,232	3,973	71,320	1,232	3,973
4	1,105	3,564	74,884	1,105	3,564
5	,833	2,688	77,573		
6	,707	2,282	79,854		
7	,674	2,176	82,030		
8	,516	1,665	83,695		
9	,478	1,542	85,237		
10	,473	1,524	86,761		
11	,410	1,321	88,083		
12	,392	1,264	89,346		
13	,344	1,110	90,456		
14	,332	1,072	91,528		
15	,310	,999	92,527		
16	,277	,894	93,421		
17	,231	,744	94,165		
18	,227	,732	94,897		
19	,205	,660	95,557		
20	,190	,614	96,171		
21	,164	,529	96,700		
22	,160	,517	97,217		
23	,146	,469	97,686		

Table 4.7 (Cont.) Total Variance Explained After Removed S38

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings	
	Total	% of Variance	Cumulative %	Total	% of Variance
24	,129	,415	98,101		
25	,123	,398	98,499		
26	,102	,328	98,827		
27	,097	,312	99,138		
28	,079	,256	99,394		
29	,075	,241	99,636		
30	,060	,193	99,828		
31	,053	,172	100,000		

As a result of comparing Table 4.4 and Table 4.8, after S38 removed, all components cumulative % values increased and more coverable.

Table 4.8 Loading Values After Varimax

Component	Extraction Sums of Squared Loadings	Rotation Sums of Squared Loadings		
	Cumulative %	Total	% of Variance	Cumulative %
1	55,821	10,352	33,392	33,392
2	67,347	8,073	26,043	59,435
3	71,320	3,403	10,977	70,413
4	74,884	1,386	4,472	74,884

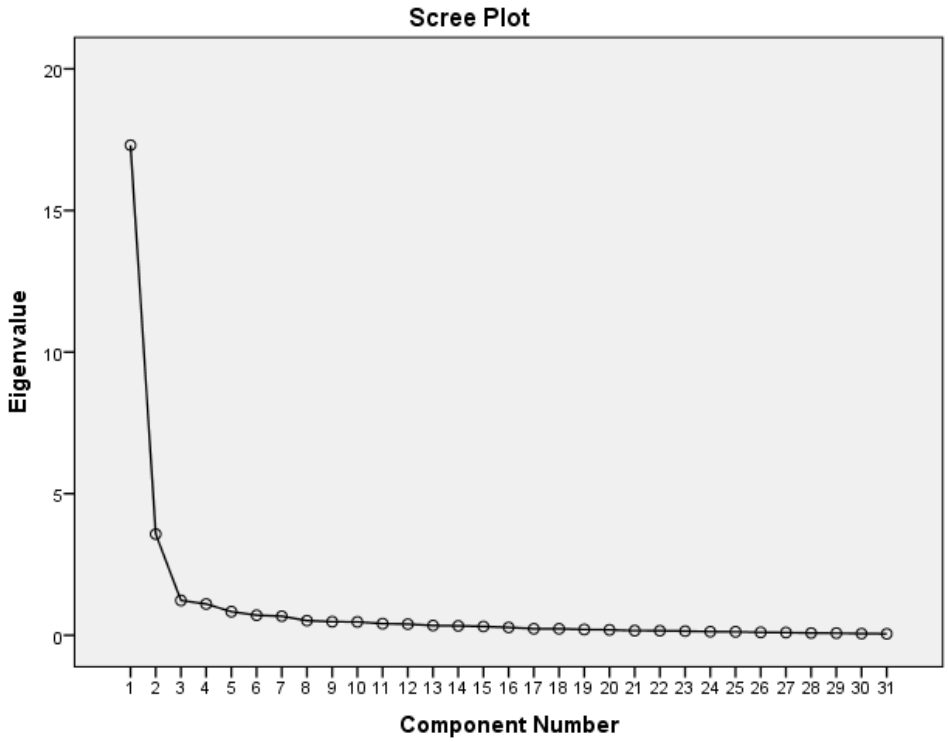

Figure 4.4 Scree Plot for Second PCA

Scree plat in Figure 4.3 approves this result.

Table 4.9 Component Matrix After Removed S38

	Component			
	1	2	3	4
S21	,824	,234	,226	-,123
S17	,802	,230	,148	,035
S16	,801	,334	,096	-,124
S25	,796	,253	,208	-,072
S20	,793	,341	,076	,023
S23	,780	,390	,097	-,008
S22	,775	,258	,210	,073
S24	,734	,212	,111	,144
S18	,720	,265	,232	,402
S13	,719	,267	,245	,365
S19	,699	,260	,185	,456
S14	,694	,304	,184	,372
S12	,690	,098	,527	-,124
S26	,687	,164	,354	,251
S15	,672	,118	,551	,012
S11	,646	,130	,568	,122
S9	,625	,235	,383	,113
S27_6	,166	,845	,039	,196
S27_5	,198	,843	,125	,215
S27_12	,268	,824	,087	,030
S27_9	,260	,805	,210	,081
S27_10	,201	,791	,142	,360
S27_13	,299	,788	,170	-,128
S27_8	,286	,785	,055	-,142
S27_11	,196	,725	,196	,436
S27_4	,321	,688	,413	-,206
S27_1	,433	,625	,305	-,119
S27_7	,321	,606	,507	,008
S27_3	,287	,519	,648	,024
S10	,464	,191	,640	,219
S27_2	,139	,553	,581	,145

Between S9 and S26 except S10 still belong to Knowledge Level Factor. Between S27_1 and S27_13 except S27_2 and S27_3 still belong to Interest Level Factor. S10, S27_2 and S27_3 are in Smart Technology Knowledge and Interest Level Factor.

As the result of the factor analysis, Interest of Industry 4.0 has 3 factors and their names are Knowledge Level, Interest Level and Smart Technology Knowledge and Interest Level. When significant test is applied to the correlation of questions in Table 4.10, all values are seen as ,000 that means the analysis is approved. Knowledge level factor has 17 questions, Interest level factor has 11 questions, Smart Technology Knowledge and Interest level factor has 3 questions.

Table 4.10 Significant Test Results

		S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22	S23	S24	S25	S26	S27_1	S27_2	S27_3	S27_4	S27_5	S27_6	S27_7	S27_8	S27_9	S27_10	S27_11	S27_12	S27_13
Sig. (1-tailed)	S9		,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	S10			,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	S11				,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	S12					,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	S13						,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	S14							,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	S15								,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	S16									,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	S17										,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	S18											,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	S19												,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	S20													,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	S21														,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	S22															,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	S23																,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	S24																	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	S25																		,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	S26																			,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	S27_1																				,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	S27_2																					,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	S27_3																						,000	,000	,000	,000	,000	,000	,000	,000	,000	,000
	S27_4																							,000	,000	,000	,000	,000	,000	,000	,000	,000
	S27_5																								,000	,000	,000	,000	,000	,000	,000	,000
	S27_6																									,000	,000	,000	,000	,000	,000	,000
	S27_7																										,000	,000	,000	,000	,000	,000
	S27_8																											,000	,000	,000	,000	,000
	S27_9																												,000	,000	,000	,000
	S27_10																													,000	,000	,000
	S27_11																														,000	,000
	S27_12																															,000
	S27_13																															

4.2. Data Analysed of The Survey By Descriptive Statistical Methods

In this section, descriptive data, correlations between questions and open ended questions are analysed. For correlations R and SPSS are used. To analyse open ended questions keywords are determined.

4.2.1. Descriptive analysis results

In this section, answers of demographic and sector dimensions questions are analysed and evaluated.

In Figure 4.5 ,%57 of participants are over age 46. The least ratio belongs to between age 18 and 25. On advancing analysis, this data is turned numerical value by given 1- between 18 and 25, 2- between 26 and 34, 3- between 35 and 45, 4 – 46 and over.

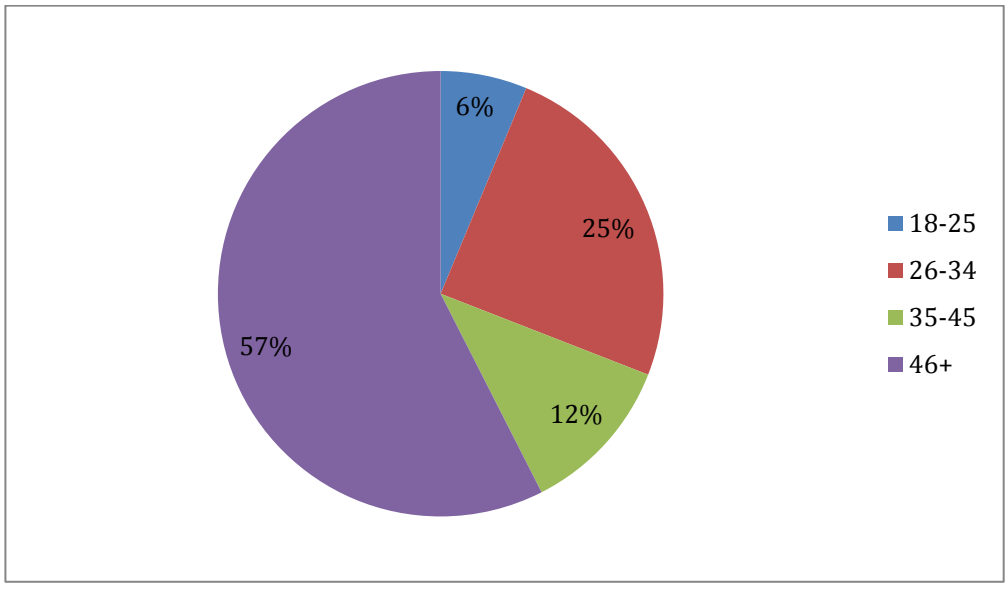

Figure 4.5 Age Distribution of Participants

%62 of participants have barchelor degree from an university. Category 'Other' includes PhD', academicians, high school graduated and associate degree in Figure 4.6. Education status information is turned to numerical values by given 1- high school, 2- associate degree, 3-barchelor's degree, 4- master degree, 5- Phd to used correlation matrix.

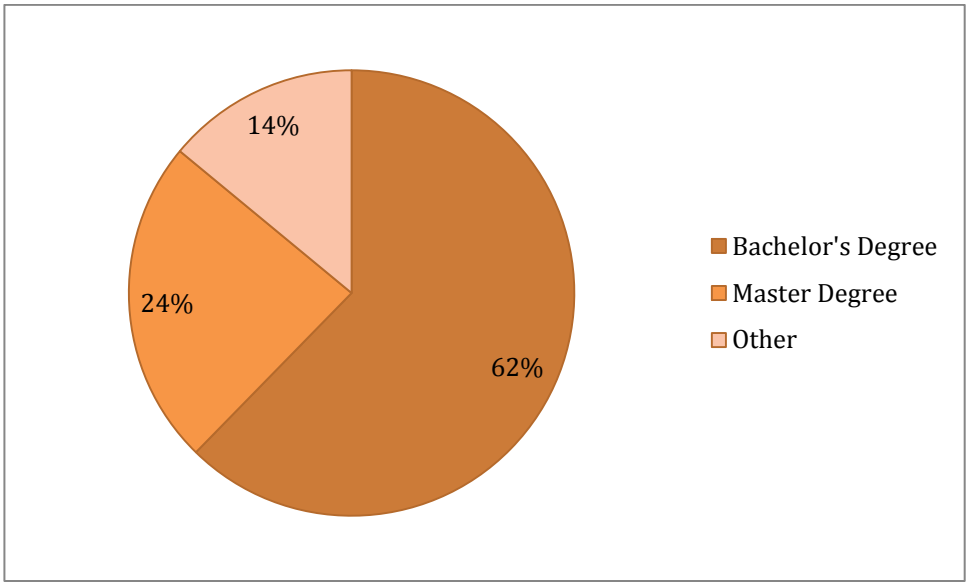

Figure 4.6 Educational Status of Participants

Figure 4.7 and Figure 4.8 are about the sector that participants work in. %75 of participants work in private sector that includes automotive, informatics, building, food etc. Health, education are in public sector.

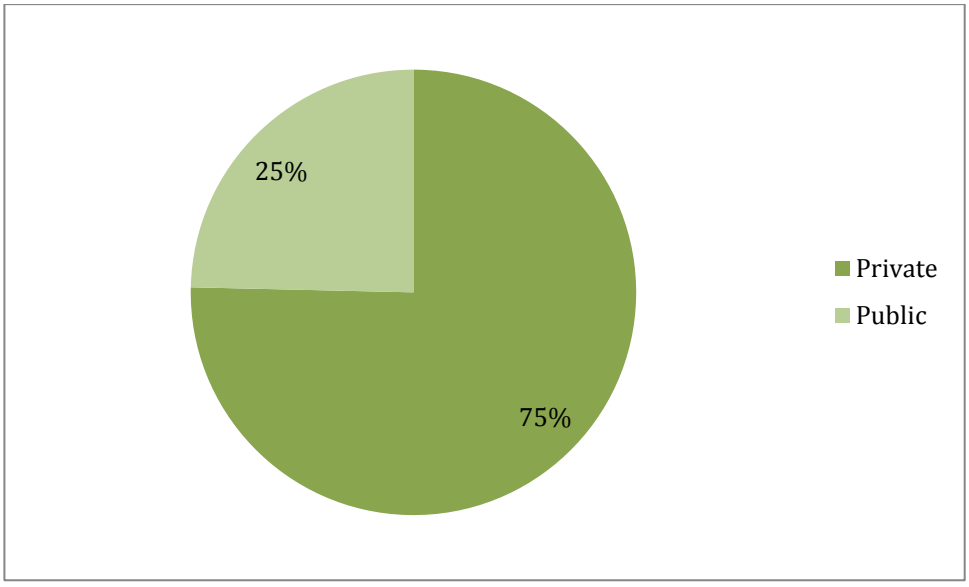

Figure 4.7 Sector of Participants (Public /Private)

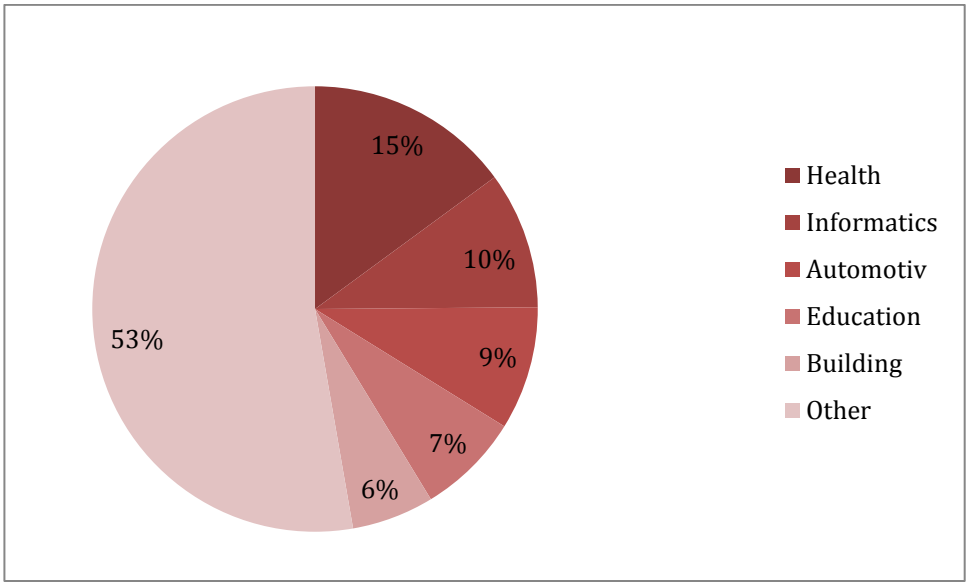

Figure 4.8 Sector of Participants

%22 of participants work in Sales or Marketing departments. R&D department is one the most important departments for Industry 4.0. %5 of participants work in this important department. Other department category includes information technology, project management, strategy management etc.

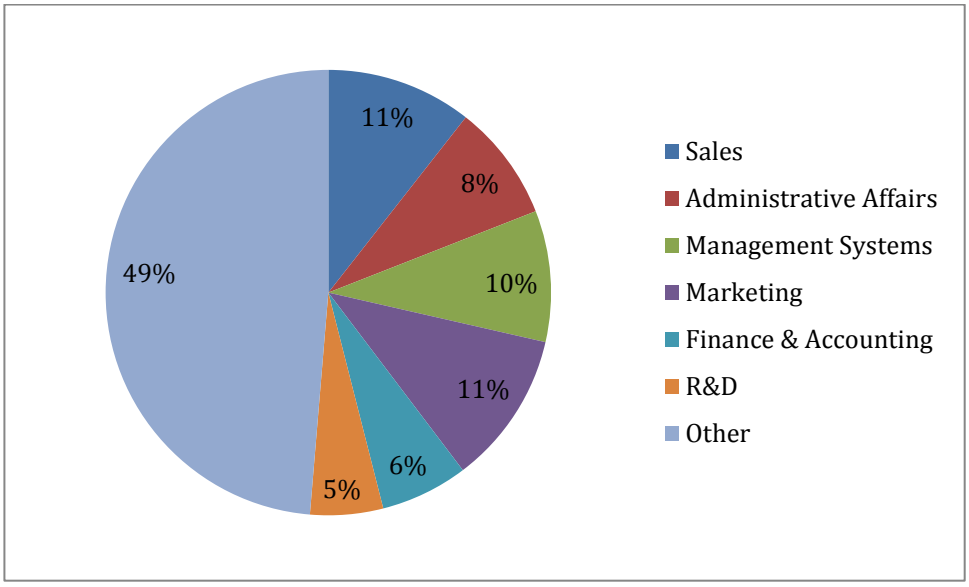

Figure 4.9 Departments of Participants

%42 of participants work as manager regarding Figure 4.10. This data is used in correlation analysis. For this analysis, data is grouped and digitized as manager, consultant/academician and other because of numbers of frequency are smaller than 5.

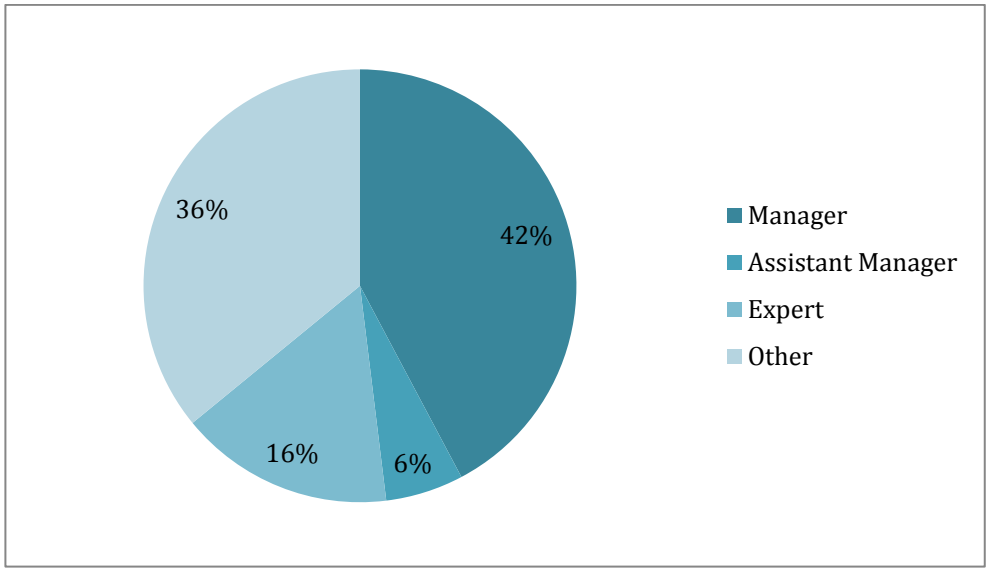

Figure 4.10 Positions of Participants

Figure 4.11 and Figure 4.12 are about participants who heard Industry 4.0 before. %67 of participants give 'yes' for this question, %33 of them did not hear this concept before. %27 of those who said 'yes' stated that they had heard the concept on the Internet, while %37 of them chose the other option that includes 'First time I have heard this concept on this questionnaire' answer.

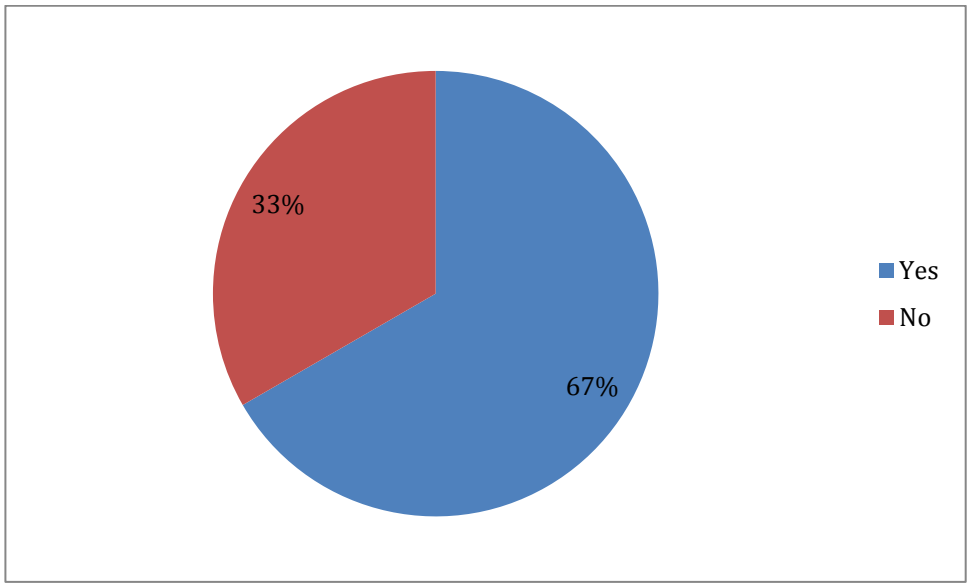

Figure 4.11 Participants Who Heard Industry 4.0 Before

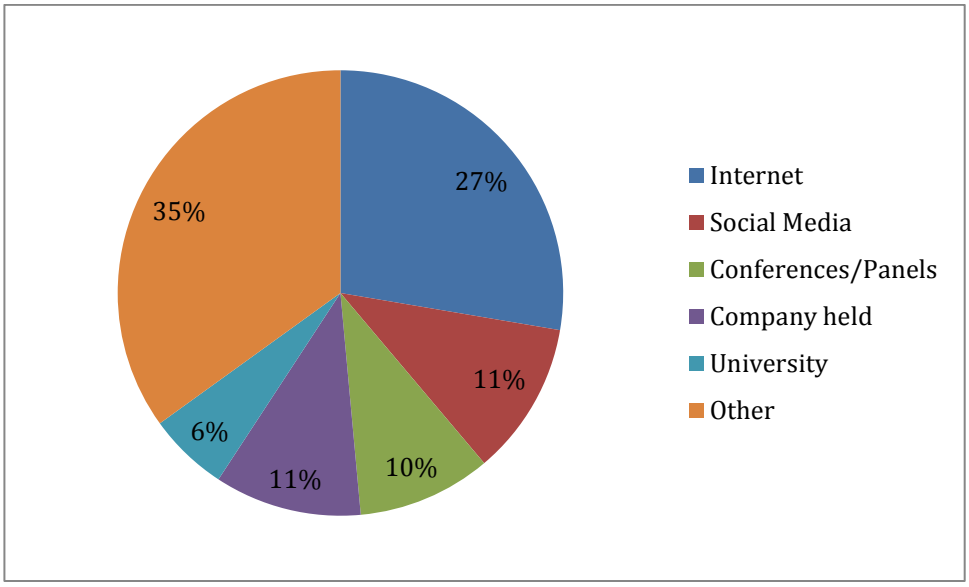

Figure 4.12 Participants Where Heard Industry 4.0

4.2.2. Findings and results of relationship analysis

Spearman Correlation Analysis is applied to the data to find relation between questions or dimensions. α value is accepted as 0.01 (Devore, 2015 , Navidi, 2018).

Before the analysis, in order to find between interest level and other dimensions, all interest level scores are summed up and generated unique score. The same operation is applied other dimensions that have more than one subquestions. After that, SPSS and R programme are used to find correlations. Also keywords are determined to evaluate open ended questions such as advantages, disadvantages, challenges.

Regarding Table 4.11, although awareness of Industry 4.0 and position is not related, being an engineer is related to awareness of Industry 4.0 . At the first level, knowledge level, position and age are seen not to be related to awareness. However, these results may change if the correlation analysis is performed by taking the questions individually.

Table 4.11 Test for Independency in Dimension: Awareness of Industry 4.0 (α=0.01)

No	Hypothesis	rho	p-value	Decision	Result
1	H_0 : Awareness level and age is not related. H_1: Awareness level and age is related.	-0,130	0,062	H_0 is accepted.	Awareness level and age is not related.
2	H_0 : Hearing Industry 4.0 before and being engineer is not related. H_1: Hearing Industry 4.0 before and being engineer is related.	0,298	0,000	H_0 is rejected.	Hearing Industry 4.0 before and being engineer is related.
3	H_0 : Awareness level and position is not related. H_1: Awareness level and position is related.	-0,013	0,854	H_0 is accepted.	Awareness level and position is not related.
4	H_0 : Awareness level and knowledge level of Industry 4.0 is not related. H_1: Awareness level and knowledge level of Industry 4.0 is related.	0,103	0,156	H_0 is accepted.	Awareness level and knowledge level of Industry 4.0 is not related.

In Table 4.12, some correlations are shared between dimensions. In general, for Interest of Industry 4.0 dimension H_0 is accepted that means this dimension is not related to others. However, for knowledge level and interest level which are categories in Interest of Industry 4.0 dimensions , H_0 is rejected with p value=0,000.

For awareness of Industry 4.0 dimension H_0 is rejected with different p values except Interest of Industry 4.0 and additional concepts.

For additional concepts and advantages, H_0 is accepted with p=0,438, for additional concepts and disadvantages, H_0 is accepted with p value=0,286 and for challenges with H_0 is accepted with p value=0,348 besides awareness dimension. For advantages of Industry 4.0 and challenges, H_0 is accepted with p value=0,742.

Table 4.12 Test for Independency Between Dimensions (α=0.01)

No	Hypothesis	rho	p-value	Decision	Result
1	H_0 : Knowledge level and interest level is not related. H_1: Knowledge level and interest level is related.	0,508	0,000	H_0 is rejected.	Knowledge level and interest level is related.
2	H_0 : Awareness and additional concepts is not related. H_1: Awareness and additional concepts is related.	0,479	0,008	H_0 is rejected.	Awareness and additional concepts is related.
3	H_0 : Interest of Industry 4.0 and additional concepts is not related. H_1: Interest of Industry 4.0 and additional concepts is related.	0,084	0,246	H_0 is accepted.	Interest of Industry 4.0 and additional concepts is not related.
4	H_0 : Interest of Industry 4.0 and awareness of Industry 4.0 is not related. H_1: Interest of Industry 4.0 and awareness of Industry 4.0 is related.	0,017	0,816	H_0 is accepted.	Interest of Industry 4.0 and awareness of Industry 4.0 is not related.

Table 4.12 (Cont.) Test for Independency Between Dimensions (α=0.01)

5	H_0 : Interest of Industry 4.0 and advantages of Industry 4.0 is not related. H_1: Interest of Industry 4.0 and advantages of Industry 4.0 is related.	0,019	0,000	H_0 is rejected.	Interest of Industry 4.0 and advantages of Industry 4.0 is related.
6	H_0 : Challenges of Industry 4.0 and advantages of Industry 4.0 is not related. H_1: Challenges of Industry 4.0 and advantages of Industry 4.0 is related.	0,668	0,742	H_0 is accepted.	Challenges of Industry 4.0 and advantages of Industry 4.0 is not related.
7	H_0 : Disadvantages of Industry 4.0 and awareness of Industry 4.0 is not related. H_1: Disadvantages of Industry 4.0 and awareness of Industry 4.0 is related.	0,202	0,791	H_0 is accepted.	Disadvantages of Industry 4.0 and awareness of Industry 4.0 is not related.

In the dimension of Turkey Applications, whose aim is to measure awareness of the studies carried out in Turkey and to learn the studies, there are mostly open-ended questions.

%53.9 of the participants stated that there was no industry 4.0 application in Turkey, while %46.1 stated that there was no application. Among the answers given for the sectors where applications are intensive are automotive, food and aviation sectors. Arçelik, Siemens, Şölen, TAI, Ekol Lojistik, Mercedes are the most known companies that are working on Industry 4.0.

Robot and assembly words are identified as keywords in the question regarding the use of robots in their companies and the most assembly lines are answered.

%52 of the participants' firms do not have system integrations. The systems used extensively in companies were document management system with %48.1, ERP with 40% and warehouse management systems with %35.6.

The question of what the effects will be to the organization is also determined as the key word employment, decrease, and employee words. Consequently, it was determined that the biggest impact in the organization was that the firms were reduced in terms of employees.

Keywords for the positive effects of Industry 4.0 have been determined as increased, decreased, and the most common responses have been productivity increase, cost reduction, flexibility increase.

For negative effects, the words cost, education, reduction were used as keywords. Consequently, the most widely answered responses were investment cost, increased adaptation difficulties, reduced employment and lack of education.

The question, which was asked to mention the suggestions for overcoming the challenges to be encountered, was focused on the words of education, strategy and support, and with the help of training and strategies, the answers were collected to overcome the difficulties.

4.3. Findings and Results of Case Studies

In this section, regarding collected information from the selected three companies , checklist filled with their implementations.

As seen in Table 4.13, first company is using robots, CPS, big data, integrations, horizontal – vertical integrations, IoT, cyber security applications, simulation, sencors. Therefore , knowledge levels of these components are high. However, cloud computing is not used because of concerns about security. Knowledge levels of augmented reality , virtual reality are enough, but have not been using yet. Wearable robots, neurotechnology, autonomous cars and block chain are known, but they are not related to its sector because they are related to the sector of the company.

Table 4.13 Checklist Results of Case 1

SCALE	1-They do not know anything	2	3	4	5 - They know it very well
QUESTIONS					
What is your knowledge level about robots?					X
What is your knowledge level about smart factory?					X
What is your knowledge level about big data?					X
What is your knowledge level about augmented reality?			X		
What is your knowledge level about cyber systems?					X
What is your knowledge level about cyber security?					X
What is your knowledge level about internet of things?					X
What is your knowledge level about cloud computing?			X		
What is your knowledge level about 3D printers?			X		
What is your knowledge level about smart products?			X		
What is your knowledge level about system integrations?					X
What is your knowledge level about horizontal - vertical integration?					X
What is your knowledge level about simulation?					X
What is your knowledge level about virtual reality?			X		
What is your knowledge level about wearable robots?		X			
What is your knowledge level about sencors?					X
What is your knowledge level about neurotechnology?		X			
What is your knowledge level about automous cars?		X			
What is your knowledge level about block chain?		X			

As seen in Table 4.14, second company is using robots, CPS, big data, integrations, horizontal – vertical integrations, IoT, cyber security applications, simulation, sencors, 3D printer for protypes. Therefore , knowledge levels of these components are high as well as first one. There is projects about augmented reality and smart products so knowledge levels of augmented reality , virtual reality and smart products are higher than first one, Wearable robots, neurotechnology, autonomous cars and block chain are known, but they are not related to its sector because they are related to the sector of the company.During researches, there is no information to using cloud system, but according to usage level of other components, assumed that there is enough knowledge about cloud.

Table 4.14 Checklist Results of Case 2

SCALE	1-They do not know anything	2	3	4	5 - They know it very well
QUESTIONS					
What is your knowledge level about robots?					X
What is your knowledge level about smart factory?					X
What is your knowledge level about big data?					X
What is your knowledge level about augmented reality?					X
What is your knowledge level about cyber systems?					X
What is your knowledge level about cyber security?					X
What is your knowledge level about internet of things?					X
What is your knowledge level about cloud computing?			X		
What is your knowledge level about 3D printers?					X
What is your knowledge level about smart products?				X	
What is your knowledge level about system integrations?					X
What is your knowledge level about horizontal - vertical integration?					X
What is your knowledge level about simulation?					X
What is your knowledge level about virtual reality?					X
What is your knowledge level about wearable robots?		X			
What is your knowledge level about sencors?					X
What is your knowledge level about neurotechnology?		X			
What is your knowledge level about automous cars?		X			
What is your knowledge level about block chain?		X			

The third company has decided to work on Industry 4.0. Therefore, there is not enough knowledge about components as seen in Table 4.15. However, robots, sencors,cloud system, cyber security applications, integrations are used in the company. There are ongoing projects about big data, cloud computing, cyber systems, integrations, IoT. Wearable robots, neurotechnology, autonomous cars and block chain are known, but they are not related to its sector because they are related to the sector of the company.

Table 4.15 Checklist Results of Case 3

SCALE	1-They do not know anything	2	3	4	5 - They know it very well
QUESTIONS					
What is your knowledge level about robots?				X	
What is your knowledge level about smart factory?			X		
What is your knowledge level about big data?				X	
What is your knowledge level about augmented reality?		X			
What is your knowledge level about cyber systems?			X		
What is your knowledge level about cyber security?					X
What is your knowledge level about internet of things?		X			
What is your knowledge level about cloud computing?				X	
What is your knowledge level about 3D printers?		X			
What is your knowledge level about smart products?		X			
What is your knowledge level about system integrations?					X
What is your knowledge level about horizontal - vertical integration?		X			
What is your knowledge level about simulation?		X			
What is your knowledge level about virtual reality?		X			
What is your knowledge level about wearable robots?		X			
What is your knowledge level about sencors?					X
What is your knowledge level about neurotechnology?		X			
What is your knowledge level about automous cars?		X			
What is your knowledge level about block chain?		X			

As a result, companies that are working on Industry 4.0 have enough knowledge about Industry 4.0 and its components. Also two of the cases are the most known companies as Industry 4.0 researcher companies by survey participants.

5. CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

Since its introduction in 2011, Industry 4.0 has been an industrial revolution that has been tried to be captured by all countries of the world. Especially considering that the developing category will cause the countries in the developing category to lose their labor benefits, it is obvious that they have an obligation to carry out their transformations according to this revolution in order not to lose the competitiveness they have.

Turkey's awareness of Industry 4.0 has been demonstrated by many academic studies. However, the number of studies done to determine whether there is sufficient information to make the transformation is too small to be called. It must be knowledge that it is not possible to be prepared for such a big and profound change without sufficient knowledge.

In this study, primarily to determine whether there is sufficient data from Industry 4.0 and its components, how much is prepared for transformation based on the level of information and interest, and the challenges that may be encountered during transformation are tried to be determined.

In the survey application conducted for this purpose, the most important dimension is undoubtedly the knowledge dimension. With correlation and factor analysis, together with the relationship of the questions to each other, the compatibility of the model was determined. In order to determine average knowledge levels about Industry 4.0 components, mode is used as descriptive analysis.

As seen in Table 5.1, almost mode values of almost all questions are 1 which means that participants said ‘I have no idea about it’. Robots and 3D printers has been know at intermediate stage with choice 3. However, it is not enough to achieve the transformation.

Table 5.1 Descriptive Analysis Result For Knowledge Level Questions

		Robots	Smart Factories	Big Data	Augmented Reality	Cyber Systems	Cyber Security	IoT	3D Printer	Smart Product	Integrations	Horizontal - Vertical Integration	Simulation	Virtual Reality	Wearable Robots	Sencors	Neurotechnology	Autonomous Cars	Block Chain
Mean		2,65	2,14	2,34	2,09	2,27	2,22	2,16	2,76	2,78	2,41	1,95	2,52	2,43	2,07	2,81	1,96	2,64	1,98
Median		3,00	2,00	2,00	2,00	2,00	2,00	2,00	3,00	3,00	2,00	2,00	2,00	2,00	2,00	3,00	2,00	2,00	1,00
Mode		3	1	1	1	1	1	1	3	2	1	1	1	2	1	2	1	2	1
Std. Deviation		1,193	1,235	1,379	1,244	1,189	1,170	1,360	1,256	1,225	1,241	1,129	1,286	1,256	1,221	1,248	1,155	1,299	1,249
Variance		1,424	1,525	1,902	1,547	1,413	1,368	1,850	1,579	1,502	1,541	1,275	1,654	1,577	1,492	1,556	1,334	1,687	1,560
Minimum		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maximum		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Percentiles	25	2,00	1,00	1,00	1,00	1,00	1,00	1,00	2,00	2,00	1,00	1,00	1,00	1,00	1,00	2,00	1,00	2,00	1,00
	50	3,00	2,00	2,00	2,00	2,00	2,00	2,00	3,00	3,00	2,00	2,00	2,00	2,00	2,00	3,00	2,00	2,00	1,00
	75	3,00	3,00	3,00	3,00	3,00	3,00	3,00	4,00	4,00	3,00	3,00	4,00	3,75	3,00	4,00	3,00	4,00	3,00

According to correlations analysis, dimensions are related to each other . Also categories in dimensions are related to each other as well.

Regarding survey results, Industry 4.0 is a concept that people had heard before. Although robots and 3D printers are well known components, other nearly have not been heard. Besides individual survey research, there is the same situation in the companies that decided to work on Industry 4.0.

Furthermore, knowledge levels of Industry 4.0 components are below:

- Knowledge level of robots - %33.3 of participants knows them at level 3
- Knowledge level of smart /unmanned factories - %43.8 of participants knows them at level 1 that means they do not know anything about smart factories.
- Knowledge level of big data - %40.8 of participants knows it at level 1 that means they do not know anything about big data.
- Knowledge level of augmented reality - %45.4 of participants knows it at level 1 that means they do not know anything about augmented reality.
- Knowledge level of cyber security systems - %32.5 of participants knows them at level 1 that means they do not know anything about cyber security systems.
- Knowledge level of cyber security - %34.7 of participants knows it at level 1 that means they do not know anything about cyber security systems.
- Knowledge level of internet of things - % 48.7 of participants knows it at level 1 that means they do not know anything about IoT.
- Knowledge level of 3D printers - %33.3 of participants knows them at level 3
- Knowledge level of smart products - %27.7 of participants knows it at level 1 that means they do not know anything about IoT.
- Knowledge level of system integrations - %29.3 of participants knows it at level 1 that means they do not know anything integrations.
- Knowledge level of horizontal – vertical integrations - %47.6 of participants knows it at level 1 that means they do not know anything about horizontal and vertical integrations.

- Knowledge of simulation - %29.3 of participants knows it at level 1 that means they do not know anything about it.
- Knowledge of virtual reality - %30.9 of participants knows it at level 1 that means they do not know anything about it.

Before analyse, 15 lines were deleted that was mentioned in chapter 3. Regarding analyse of whole data, there are a lot of empty answers in knowledge questions and almost all of them were left empty by academicians. As a result, universities must encourage their professors to study on Industry 4.0. Because during completing the transformation contributions of university is one of most important support resources to companies.

In case studies results, although robots and sencors are well known components , augmented reality, using cloud systems, internet of things and others are not enough level to complete the transformation successfully. However, companies that have almost complete the transformation can lead other factories though sharing their experiences and suggestions.

This study with these results, Turkey has not enough knowledge about Industry 4.0 to be prepared and achieve Industry 4.0 transformation. Even if technological competence is not researched in this study, it would not be wrong that assume regarding knowledge questions about Industry 4.0 components which are related to technology directly can be made that this competence is not at desired level.

In addition, it has been proven by the survey results that the following challenges will be encountered during transformation:

- Failure to cover investment costs
- Reduced communication between employees
- Unemployment occurs as the number of robots in the workspaces increases
- The number of qualified employees is small due to lack of adequate training
- Difficulty adapting to transformation due to employee resistance
- Lack of government support
- Inadequate legal regulations
- The scarcity of institutions to consult

On the contrary, challenges can be solved. For this aim, some suggestions that are proven by questionnaire results below:

- Training about Industry 4.0 should be organized
- Government incentives and subsidies should be increased
- Strategies should be created to prepare and complete the transformation on a country-by-country basis
- The number of R&D studies should be increased
- Infrastructure deficiencies should be identified and addressed
- Studies on industry 4.0 should be increased both academically and in the industry
- Increase the number of institutions and organizations that can provide support in case of need for Industry 4.0

It is expected that this study will create awareness on climate change, its impacts and the importance of renewable energy sources. If this study can also be inspirational for future studies, an important achievement will be provided.

It is expected that this study will create awareness on how important knowledge level is to achieve for the transformation and what we are in Industry 4.0 revolution. If this study can also be lead for future studies, an significant achievement will be provided for Turkey.

ATTACHMENTS

Attachment-1 Industry 4.0 Awareness and Knowledge Questionnaire

ENDÜSTRİ 4.0 YÜKSEK LİSANS TEZ ÇALIŞMASI

Bu anket Marmara Üniversitesi Fen Bilimleri Enstitüsü Endüstri Mühendisliği Anabilim Dalı'nda yapılan yüksek lisans tez çalışması için hazırlanmıştır. (Türkiye'de Endüstri 4.0 - Sanayi 4.0)

* Gerekli

1. **1.Yaş aralığınızı belirtiniz.** *
   Yalnızca bir şıkkı işaretleyin.
   - ◯ 18-25
   - ◯ 26-34
   - ◯ 35-45
   - ◯ 46 +

2. **2.Eğitim durumunuzu belirtiniz.** *
   Yalnızca bir şıkkı işaretleyin.
   - ◯ İlkokul
   - ◯ Ortaokul
   - ◯ Lise
   - ◯ Önlisans
   - ◯ Lisans
   - ◯ Yüksek Lisans
   - ◯ Doktora
   - ◯ Akademisyen

3. **Önlisans veya lisans mezunuysanız bölümünüzü belirtiniz**

4. **3.Çalışma alanınızı belirtiniz.** *
   Yalnızca bir şıkkı işaretleyin.
   - ◯ Özel
   - ◯ Kamu

Attachment-1 (Cont.) Industry 4.0 Awareness and Knowledge Questionnaire

5. **4.Çalıştığınız sektörü belirtiniz.** *

Yalnızca bir şıkkı işaretleyin.

- ◯ Otomotiv (veya Otomotiv Yan Sanayi)
- ◯ Gıda
- ◯ Sağlık
- ◯ Bilişim
- ◯ İlaç
- ◯ Perakende
- ◯ Tekstil
- ◯ Kimya
- ◯ Enerji
- ◯ Finans
- ◯ Telekomünikasyon
- ◯ Eğitim
- ◯ Danışmanlık
- ◯ Ağaç İşleri, Kağıt ve Kağıt Ürünleri
- ◯ Ambalaj
- ◯ Maden
- ◯ İnşaat
- ◯ Tarım
- ◯ Lojistik
- ◯ Turizm
- ◯ Medya
- ◯ Cam, Çimento ve Toprak
- ◯ Diğer: _____

Attachment-1 (Cont.) Industry 4.0 Awareness and Knowledge Questionnaire

6. **5.Çalıştığınız departmanı belirtiniz.** *
Yalnızca bir şıkkı işaretleyin.

- ◯ Üretim
- ◯ IT
- ◯ IK
- ◯ Tedarik Zinciri
- ◯ Satın Alma
- ◯ Pazarlama
- ◯ Satış
- ◯ Kalite
- ◯ Yönetim Sistemleri
- ◯ Strateji ve İş Geliştirme
- ◯ Performans İzleme
- ◯ İdari İşler
- ◯ Ar-ge
- ◯ Finans - Muhasebe
- ◯ Diğer: _____

7. **6.Çalıştığınız pozisyonu belirtiniz.** *
Yalnızca bir şıkkı işaretleyin.

- ◯ Yönetici
- ◯ Yönetici Yrd
- ◯ Uzman
- ◯ Uzman Yrd
- ◯ Temsilci
- ◯ Proje Yöneticisi
- ◯ Analist
- ◯ Operatör
- ◯ Akademisyen
- ◯ Danışman
- ◯ Diğer: _____

8. **7.Endüstri 4.0 kavramını daha önceden duydunuz mu?** *
Bu soruya cevabınız Evet ise lütfen sonraki soruları da yanıtlayınız
Yalnızca bir şıkkı işaretleyin.

- ◯ Evet
- ◯ Hayır

Attachment-1 (Cont.) Industry 4.0 Awareness and Knowledge Questionnaire

9. **8.Endüstri 4.0 kavramını ilk nereden duydunuz?**
   Yalnızca bir şıkkı işaretleyin.

   - ◯ Üniversite
   - ◯ Çalıştığınız firma
   - ◯ Katıldığınız konferans / panel vb
   - ◯ İnternet
   - ◯ Sosyal medya
   - ◯ Akademik çalışmalar
   - ◯ Diğer: _____

10. **9.Robotlar ile ilgili bilgi düzeyinizi belirtiniz.**
    Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Bilgim yok	◯	◯	◯	◯	◯	Bilgi düzeyim yüksek

11. **10.Akıllı/ karanlık fabrikalar ile ilgili bilgi düzeyinizi belirtiniz.**
    Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Bilgim yok	◯	◯	◯	◯	◯	Bilgi düzeyim yüksek

12. **11.Big data (büyük veri) ile ilgili bilgi düzeyinizi belirtiniz.**
    Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Bilgim yok	◯	◯	◯	◯	◯	Bilgi düzeyim yüksek

13. **12.Arttırılmış gerçeklik (augmented reality) ile ilgili bilgi düzeyinizi belirtiniz.**
    Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Bilgim yok	◯	◯	◯	◯	◯	Bilgi düzeyim yüksek

14. **13.Siber sistemler ile ilgili bilgi düzeyinizi belirtiniz.**
    Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Bilgim yok	◯	◯	◯	◯	◯	Bilgi düzeyim yüksek

15. **14.Siber güvenlik çalışmaları ile ilgili bilgi düzeyinizi belirtiniz.**
    Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Bilgim yok	◯	◯	◯	◯	◯	Bilgi düzeyim yüksek

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16. **15.Nesnelerin interneti (IoT) ile ilgili bilgi düzeyinizi belirtiniz.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Bilgim yok	◯	◯	◯	◯	◯	Bilgi düzeyim yüksek

17. **16.3D yazıcılar ile ilgili bilgi düzeyinizi belirtiniz.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Bilgim yok	◯	◯	◯	◯	◯	Bilgi düzeyim yüksek

18. **17.Akıllı ürünler ile ilgili bilgi düzeyinizi belirtiniz.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Bilgim yok	◯	◯	◯	◯	◯	Bilgi düzeyim yüksek

19. **18.Sistem entegrasyonları ile ilgili bilgi düzeyinizi belirtiniz.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Bilgim yok	◯	◯	◯	◯	◯	Bilgi düzeyim yüksek

20. **19.Yatay - dikey entegrasyon ile ilgili bilgi düzeyinizi belirtiniz.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Bilgim yok	◯	◯	◯	◯	◯	Bilgi düzeyim yüksek

21. **20.Simülasyon ile ilgili bilgi düzeyinizi belirtiniz.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Bilgim yok	◯	◯	◯	◯	◯	Bilgi düzeyim yüksek

22. **21.Sanal gerçeklik (virtual reality - VR) ile ilgili bilgi düzeyinizi belirtiniz.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Bilgim yok	◯	◯	◯	◯	◯	Bilgi düzeyim yüksek

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23. **22.Giyilebilir robotlar ile ilgili bilgi düzeyinizi belirtiniz.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Bilgim yok	◯	◯	◯	◯	◯	Bilgi düzeyim yüksek

24. **23. Sensörler ile ilgili bilgi düzeyinizi belirtiniz.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Bilgim yok	◯	◯	◯	◯	◯	Bilgi düzeyim yüksek

25. **24.Nöroteknoloji ile ilgili bilgi düzeyinizi belirtiniz.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Bilgim yok	◯	◯	◯	◯	◯	Bilgi düzeyim yüksek

26. **25.Sürücüsüz arabalar ile ilgili bilgi düzeyinizi belirtiniz.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Bilgim yok	◯	◯	◯	◯	◯	Bilgi düzeyim yüksek

27. **26.Blok zinciri (block chain) ile ilgili bilgi düzeyinizi belirtiniz.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Bilgim yok	◯	◯	◯	◯	◯	Bilgi düzeyim yüksek

27.Endüstri 4.0 içerisinde yer alan aşağıdaki konulara duyduğunuz ilgiyi puanlayınız.

28. **Robotlar**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Yok	◯	◯	◯	◯	◯	Çok

29. **Akıllı - Karanlık Fabrikalar**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Yok	◯	◯	◯	◯	◯	Çok

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30. **Big data (büyük veri)**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Yok	◯	◯	◯	◯	◯	Çok

31. **Arttırılmış gerçeklik (augmented reality)**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Yok	◯	◯	◯	◯	◯	Çok

32. **Siber sistemler**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Yok	◯	◯	◯	◯	◯	Çok

33. **Siber güvenlik çalışmaları**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Yok	◯	◯	◯	◯	◯	Çok

34. **Nesnelerin interneti (Iot)**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Yok	◯	◯	◯	◯	◯	Çok

35. **3D yazıcılar**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Yok	◯	◯	◯	◯	◯	Çok

36. **Akıllı ürünler**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Yok	◯	◯	◯	◯	◯	Çok

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37. **Sistem entegrasyonları**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Yok	◯	◯	◯	◯	◯	Çok

38. **Yatay - dikey entegrasyon**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Yok	◯	◯	◯	◯	◯	Çok

39. **Simülasyon**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Yok	◯	◯	◯	◯	◯	Çok

40. **Sanal gerçeklik (virtual reality)**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Yok	◯	◯	◯	◯	◯	Çok

41. **Giyilebilir robotlar**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Yok	◯	◯	◯	◯	◯	Çok

42. **Sensörler**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Yok	◯	◯	◯	◯	◯	Çok var

28.Endüstri 4.0 içerisinde yer almayan ancak etkilediği aşağıdaki konulara duyduğunuz ilgiyi puanlayınız

Endüstri 4.0 içerisinde yer alan aşağıdaki konulara duyduğunuz ilgiyi puanlayınız

43. **Nöroteknoloji**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Yok	◯	◯	◯	◯	◯	Çok

44. **Sürücüsüz arabalar**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Yok	◯	◯	◯	◯	◯	Çok

45. **Blok zinciri (block chain)**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Yok	◯	◯	◯	◯	◯	Çok

46. **29.Dünya'da bugüne kadar kaç tane endüstri devrimi olmuştur?**
Yalnızca bir şıkkı işaretleyin.

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4

30.Aşağıda verilen endüstri devrimi ve dönüm noktaları eşleştirmelerinin doğruluklarını belirtiniz.

47. **Birinci Endüstri Devrimi (Endüstri 1.0) - Buhar Gücünün Keşfi**
Yalnızca bir şıkkı işaretleyin.

- ◯ Doğru
- ◯ Yanlış

48. **İkinci Endüstri Devrimi (Endüstri 2.0) - Seri Üretime Geçiş**
Yalnızca bir şıkkı işaretleyin.

- ◯ Doğru
- ◯ Yanlış

49. **Üçüncü Endüstri Devrimi (Endüstri 3.0) - Otomasyona Geçiş**
Yalnızca bir şıkkı işaretleyin.

- ◯ Doğru
- ◯ Yanlış

50. **Dördüncü Endüstri Devrimi (Endüstri 4.0) - Karanlık (İnsansız) Fabrikalar**
Yalnızca bir şıkkı işaretleyin.

- ◯ Doğru
- ◯ Yanlış

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51. **31.Endüstri devrimlerine bakıldığında Türkiye hangi aşamadadır?**
Yalnızca bir şıkkı işaretleyin.

- ◯ Endüstri 2.0
- ◯ Endüstri 2.0 - Endüstri 3.0 arası
- ◯ Endüstri 3.0
- ◯ Endüstri 3.0 - Endüstri 4.0 arası
- ◯ Endüstri 4.0
- ◯ Endüstri 4.0 üstü

52. **32.Endüstri 4.0 geçişi için Türkiye'yi puanlayınız.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Geçiş sağlayamaz	◯	◯	◯	◯	◯	Geçişi çok kolay sağlar

53. **33. Endüstri 4.0 geçişi için Türkiye'de yapılan çalışmalar yeterli midir?**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Yeterli değildir	◯	◯	◯	◯	◯	Yeterliden de fazladır

34.Endüstri 4.0 geçişini zorlaştıracağı aşağıdaki konuları maddeleri puanlayınız.

54. **Ekonomik sebepler**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlike katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

55. **Altyapı eksikliği**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

56. **Bilgi / Eğitim eksikliği**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

57. **Devlet desteği eksikliği**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

58. **Nitelikli iş gücü eksikliği**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

59. **Teşvik eksikliği**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

60. **Ar-ge araştırmaları eksikliği**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

35.Endüstri 4.0'ın sağlayacağı avantajları puanlayınız.

61. **Enerji verimliliğini arttıracaktır.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlike katılıyorum

62. **Ülke kalkınmasına olumlu etki sağlayacaktır.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

63. **Nitelikli eleman açığı ortaya çıkacağı için istihdam artışı sağlayacaktır.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

64. **Teknoloji gelişimi ve kullanımının daha da artmasını sağlayacaktır.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

65. **Ülkemizin teknoloji açısından yüksek seviyede olan ülkelerin seviyesine çıkmasına büyük katkı sağlayacaktır.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

66. **Sanayide daha fazla ürünün, daha hızlı ve güvenilir şekilde üretilebilmesine olanak sağlayacaktır.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

67. **Doğal kaynak kullanımını azaltarak doğa dostu sanayinin oluşmasına ve iklim değişikliğinin önlenmesine olumlu katkı sağlayacaktır.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

68. **Üretim maliyetleri uzun vadede düşürmeye katkı sağlayacaktır.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

69. **Rekabet gücünü arttıracaktır.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

36.Endüstri 4.0'ın yaratacağı dezavantajları puanlayınız.

70. **Enerji kullanımını arttırarak verimliliğini azaltacaktır**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

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71. **Başta yatırım maliyeti olmak üzere maliyetleri arttıracaktır.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

72. **Ülke kalkınmasını olumsuz etkileyecektir.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

73. **Robotlar insanların yerine geçeceği için işsizliğe yol açacaktır.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

74. **Doğal kaynak kullanımını arttırarak doğa dostu sanayinin oluşmasına ve iklim değişikliğinin önlenmesine olumsuz etki sağlayacaktır.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

75. **Rekabet gücünü azaltacaktır.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

76. **Veri güvenliği açısından açıklar oluşmasına neden olacaktır.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

77. **Yapay zeka kullanımını arttırarak ileride insan neslinin tehlikeye girebilecek olmasının önünü açacaktır.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

78. **Nitelikli eleman ihtiyacını karşılayabilmek için çalışanların daha fazla eğitime ihtiyacı olacaktır**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

37.Geçiş sırasında yaşanabilecek zorlukları ortadan kaldırmak için sunulan aşağıdaki önerileri puanlayınız.

79. **Devlet desteği ile zorluklar aşılabilir.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

80. **Üniversitelere konu ile ilgili dersler koyularak zorluklar aşılabilir.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

81. **Meslek odalarının çalışanlara sağlayacağı eğitimler ile zorluklar aşılabilir.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

82. **Özel eğitimler ile zorluklar aşılabilir.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

83. **Sosyal medya desteğiyle bilinç seviyesini arttırarak zorluklar aşılabilir.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

84. **Teşvikler ile zorluklar aşılabilir.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Kesinlikle katılmıyorum	◯	◯	◯	◯	◯	Kesinlikle katılıyorum

85. **38.Türkiye'de Endüstri 4.0 ile ilgili yeteri kadar bilgi alabileceğiniz yapılar (kurum,kuruluş,bilgilendirme hattı, internet siteleri,yayınlar, konferanslar, paneller vs) vardır.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Yok	◯	◯	◯	◯	◯	Çok var

86. **39.Türkiye'de Endüstri 4.0 uygulamaları yapan firmalar var mıdır?**
Yalnızca bir şıkkı işaretleyin.

- ◯ Evet
- ◯ Hayır

87. **Var ise hangi firmalardır?**

88. **40.Endüstri 4.0'ın uygulandığını bildiğiniz sektörler hangileridir?**

89. **41.Çalıştığınız firmada Endüstri 4.0 dönüşüm çalışmaları var mıdır?**
Var ise lütfen sonraki soruları da yanıtlayınız
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
Yok	◯	◯	◯	◯	◯	Dönüşüm tamamlandı

90. **42.Çalıştığınız firmada akıllı teknolojiler kullanılıyor mu?**
Yalnızca bir şıkkı işaretleyin.

- ◯ Evet
- ◯ Hayır

91. **Kullanılıyor ise hangileridir?**

92. **43.Çalıştığınız firmada akıllı ürün üretimi var mıdır?**
Yalnızca bir şıkkı işaretleyin.

- ◯ Evet
- ◯ Hayır

93. **Var ise nelerdir?**

94. **44.Çalıştığınız firmada robot kullanımı var mıdır?**
Yalnızca bir şıkkı işaretleyin.

- ◯ Evet
- ◯ Hayır

95. **Var ise hangi noktalarda robotlardan destek alınmaktadır?**

96. **45.Çalıştığınız firmada bulut sistem kullanımı var mıdır?**
Yalnızca bir şıkkı işaretleyin.

- ◯ Evet
- ◯ Hayır

97. **Yok ise neden kullanılmadığı ile ilgili bilgi verebilir misiniz?**

98. **46.Firmanızda hangi tür yazılımlar (ERP, yönetim sistemleri, depo sistemleri vb) kullanılmaktadır?**
Uygun olanların tümünü işaretleyin.

- [ ] ERP
- [ ] Depo Yönetim Sistemi
- [ ] Operasyonel Mükemmellik Yazılımı
- [ ] İş Akışı Otomasyon Yazılımı
- [ ] Doküman Yönetim Sistemi
- [ ] Sahadan Veri Toplama Sistemi
- [ ] Kalite Yönetim Sistemi
- [ ] Diğer: _____

99. **47.Firmanızda makinalar ile yazılımlar birbirine entegre midir?**
Yalnızca bir şıkkı işaretleyin.

- ◯ Evet
- ◯ Hayır

100. **48.Firmanızda veri yönetimi yapılıyor mu?**
Yalnızca bir şıkkı işaretleyin.

- ◯ Evet
- ◯ Hayır

101. **Yapılıyor ise veri yönetiminin işleyişini kısaca anlatabilir misiniz?**

_____

_____

_____

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_____

102. **49.Firmanızda dönüşüm sizce hangi aşamadadır?**

_____

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103. **50.Endüstri 4.0 ın firma organizasyon şemanıza etkileri sizce nelerdir?**

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_____

104. **51.Endüstri 4.0 ın firmanıza pozitif etkileri sizce nelerdir?**

105. **52.Endüstri 4.0 ın firmanıza negatif etkileri sizce nelerdir?**

106. **53.Türkiye'de ve firmanızda geçiş sırasında yaşanan/yaşanabileceğini düşündüğünüz zorlukları belirtebilir misiniz?**

107. **54.Türkiye'de ve firmanızda geçiş sırasında yaşanan/yaşanabilecek zorluklar nasıl aşılmıştır?**

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PROJECTS&PUBLICATIONS

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Vodafone – Operational Excellence Software Project

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Dicle Elektrik Dağıtım A.Ş – Corporate Performance Management Software Project

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PUBLICATIONS

Cihan, E., Firat, S. U. (2019), Endüstri 4.0 'In İş Sağliği Ve Güvenliğine Etkileri Üzerine Bir Vaka Çalişmasi. The 25th National Ergonomics Congress, 18-20 October, Samsun, Turkey.

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INTERESTS

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