DOKUZ EYLÜL UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
DEPARTMENT OF BUSINESS ADMINISTRATION
BUSINESS ADMINISTRATION PROGRAM
MASTER'S THESIS

AWARENESS ANALYSIS OF INDUSTRY 4.0

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İZMİR - 2018

APPROVAL PAGE

DECLARATION

I hereby declare that this master's thesis titled as **"Awareness Analysis of Industry 4.0"** has been written by myself in accordance with the academic rules and ethical conduct. I also declare that all materials benefited in this thesis consist of the mentioned resources in the reference list. I verify all these with my honour.

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ABSTRACT

Master's Thesis

Awareness Analysis of Industry 4.0

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Industry 4.0 is a new disruptive (r)evolution that not only affects the production systems of companies but also affects the society as a whole. This new revolution brings several new benefits to firms, such as; a more flexible production system, individual production, digital value chain, new business models, resource, and energy efficiency.

Therefore, it is very important for firms to be aware of the Industry 4.0. In this study, the awareness of the firms located in İzmir and Manisa in Industry 4.0 is investigated. Moreover, various information about the expected obstacles, benefits, value-added areas of industry 4.0 are collected from target firms.

The survey is used as a data collection method. The first part of the survey contained demographic questions about respondents and data about the awareness of firms. To measure awareness of companies, the most used Industry 4.0 terms are asked and it is inquired whether there is any application/evaluation for Industry 4.0 or not in the companies. Furthermore, firms are divided into two categories; those that implement/evaluate for Industry 4.0 and those that do not. After that, information about the expected advantages of various IT integration, usage of the security program, existing and future planned budget of Industry 4.0 and most suitable application areas to apply Industry 4.0 are gathered. The survey also contains open-ended questions to obtain general opinions, evaluations, and advice of firms.

Results show that firms mostly aware of the Industry 4.0, big data, internet of things and factory layout terms. Three out of four are in the evaluation or application stage of Industry 4.0. Standardization, big data management and

acquiring new skills are seen as the main challenges of the fourth industrial revolution, whereas cost saving and faster/agility response to changes were the main benefits of it.

Lastly, the requirement of new technologies, applications, software, machines, budget constraints and the necessity to acquire new skills are the main obstacles for application of Industry 4.0. Production is seen as the most value-added area. Easy and fast problem detection and prevention are identified as the core benefit of digitalization by firms. Robotics workers usage in different manufacturing fields is another benefit expected by the firms to ensure effective and efficient production from industry 4.0.

Keywords: Industry 4.0, Awareness Analysis, Cyber-Physical Systems, Internet of Things, Big Data.

ÖZET

Yüksek Lisans Tezi

Endüstri 4.0'ın Farkındalık Analizi

Kevser YILMAZ

Dokuz Eylül Üniversitesi

Sosyal Bilimler Enstitüsü

İşletme Anabilim Dalı

İngilizce İşletme Programı

Endüstri 4.0, sadece şirketlerin üretim sistemlerini değil, aynı zamanda toplumu bir bütün olarak etkileyen yeni yıkıcı bir (d)evrimdir. Bu yeni devrim, firmalara; daha esnek bir üretim sistemi, bireysel üretim, dijital değer zinciri, yeni iş modelleri, kaynak ve enerji verimliliği gibi birçok yeni avantajlar getirmektedir.

Dolayısıyla, firmaların Endüstri 4.0'ın farkında olmaları önemlidir. Bu çalışmada İzmir ve Manisa'da yer alan firmaların Endüstri 4.0 farkındalığı araştırılmıştır. Ayrıca, Endüstri 4.0'ın beklenen zorlukları, faydaları, katma değer sağlayacağı alanlar gibi farklı bilgiler hedef firmalardan toplanmıştır.

Veri toplama yöntemi olarak anket kullanılmıştır. Anketin ilk bölümü soruyu cevaplayanların demografik özelliklerini ve firmaların Endüstri 4.0 farkındalığını belirleyen sorular içermektedir. Firmaların farkındalığı ölçmek için, en çok kullanılan Endüstri 4.0 terimleri sorulmuş ve aynı zamanda firmalarda Endüstri 4.0 için herhangi bir uygulama ya da değerlendirme olup olmadığı araştırılmıştır. Ayrıca, firmalar Endüstri 4.0'ı uygulama ya da değerlendirme aşamasında olanlar ve olmayanlar olarak iki kategoriye ayrılmıştır. Daha sonra, farklı bilgi teknolojileri entegrasyonlarından beklenen avantajlar, güvenlik programı kullanımı, mevcut ve gelecekte olması planlanan Endüstri 4.0 bütçesi ve Endüstri 4.0' ın uygulanması için en uygun uygulama alanları hakkında bilgiler elde edilmiştir. Anket ayrıca firmaların genel düşüncelerini, değerlendirmelerini ve tavsiyelerini almak için açık uçlu sorular içermektedir

Sonuçlar göstermiştir ki firmalar en çok Endüstri 4.0, büyük veri, nesnelerin internet ve fabrika düzeni terimlerinin farkındadırlar. Dört firmadan üçü Endüstri 4.0'ı uygulama ya da değerlendirme aşamasındadır. Standardizasyon, büyük veri yönetimi ve yeni becerilerin elde edilmesi dördüncü sanayi devriminin ana zorlukları olarak görülüyorken maliyet tasarrufu ve değişikliklere hızlı/çevik cevap verme Endüstri 4.0'ın temel faydaları olarak görülmektedir.

Son olarak, yeni teknolojilerin, uygulamaların, yazılımların, makinaların gerekliliği, bütçe kısıtları ve yeni yetkinlikleri edinme gerekliliği Endüstri 4.0'ın uygulanmasının önündeki temel zorluklardır. Üretim en çok katma değeri artacak alan olarak görülmektedir. Problemlerin kolaylıkla ve hızlıca tespit edilip engellenmesi firmalar tarafından dijitalleşmenin temel faydası olarak vurgulanmaktadır. Etkili ve verimli üretimi sağlamak amacıyla robot işçilerin farklı üretim alanlarında kullanılması ise firmaların Endüstri 4.0'dan beklediği bir diğer faydadır.

Anahtar Kelimeler: Endüstri 4.0, Farkındalık Analizi, Siber Fiziksel Sistemler, Nesnelerin İnterneti, Büyük Veri.

AWARANESS ANALYSIS OF INDUSTRY 4.0

CONTENTS

CHAPTER THREE

ANALYSIS AND RESULTS

ABBREVIATIONS

AR	Augmented Reality
BCG	Boston Consulting Group
CAD	Computer-Aided Design
CAM	Computer-Aided Manufacturing
CCIF	Cloud Computing Interoperability Forum
CPS	Cyber-Physical Systems
DCN	Dynamic Circuit Network
FoF	Factories of the Future
IaaS	Infrastructure as a Service
IDC	International Data Corporation
IIC	Industrial Internet Consortium
IoT	Internet of Things
IP	Internet Protocol
IPv4	Internet Protocol Version 4
IT	Information Technology
MES	Manufacturing Execution Systems
NIST	National Institute of Standard and Technologies
PaaS	Platform as a Service
PPP	Public-Private Partnership
RFID	Radio Frequency Identification
SaaS	Software as a Service
SME	Small and Medium Enterprises
VR	Virtual Reality

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INTRODUCTION

By the end of the 18^{th} century, steam power had started to be used in production and the new machines invented opened the door of the first industrial revolution. This revolution that started in Great Britain did not only affect the production systems, but also the whole society. Migrations from rural to urban increased, a new class that was called as “workers class” was created. These are just some examples of the changes. Afterward, usage of electric in the butchery that triggered the mass production and revealed the mass production terms, which were the main characteristics of the second industrial revolution. Electricity, petroleum, chemicals, telecommunications, and transportation areas were the main inventions areas in that industrial revolution.

Besides these two industrial revolutions, as long as technology is developed, inventions never stops so that the third industrial revolution was reached. Information technology was used more frequently and the automation in manufacturing increased. This revolution also is called the green revolution. Because people have started to see the effects of the using high amount of fossil fuels on the environment. Sustainability has become the main goals of the businesses, governments and the whole world. Also, this new revolution gave some gifts to people such as high-speed railroads systems, fiber optic, satellite, cellular phones. Inventions of the internet, 3D printer technology, and biogenetic research were the main breakthroughs in that era.

In the 21^{st} Century, the new industrial revolution, which is referred to as Industry 4.0, is growing in popularity. In this revolution, all manufacturing systems will face the big changes. With the new technologies some new systems, technologies, and terms will enter the human lives such as internet of things, cyber-physical systems, big data etc. Production and goods will be “smart” and remotely controlled by humans. Additionally, most systems will be managed by robots. Automation in the factories will hit the top. Products will be tailored for just one person. Moreover, jobs descriptions, making business styles and competition dynamics are the other areas that will face the changes.

In the first chapter, firstly three industrial revolutions briefly will be introduced, after that Industry 4.0 will be defined and advantages and challenges will be discussed. In the second chapter, the nine technological advancements of the industry 4.0, which are cyber-physical systems, smart factory, cyber-security, vertical and horizontal integrations, autonomous systems, internet of things, big data and analytics, augmented reality and cloud systems will be defined and discussed. The last chapter will measure the awareness of firms for Industry 4.0 and collect more detail information about its challenges and benefits. Moreover, expectations of firms from new technologies will be discussed. In addition, with the open-ended questions, opinions and recommendations of the firms will be collected.

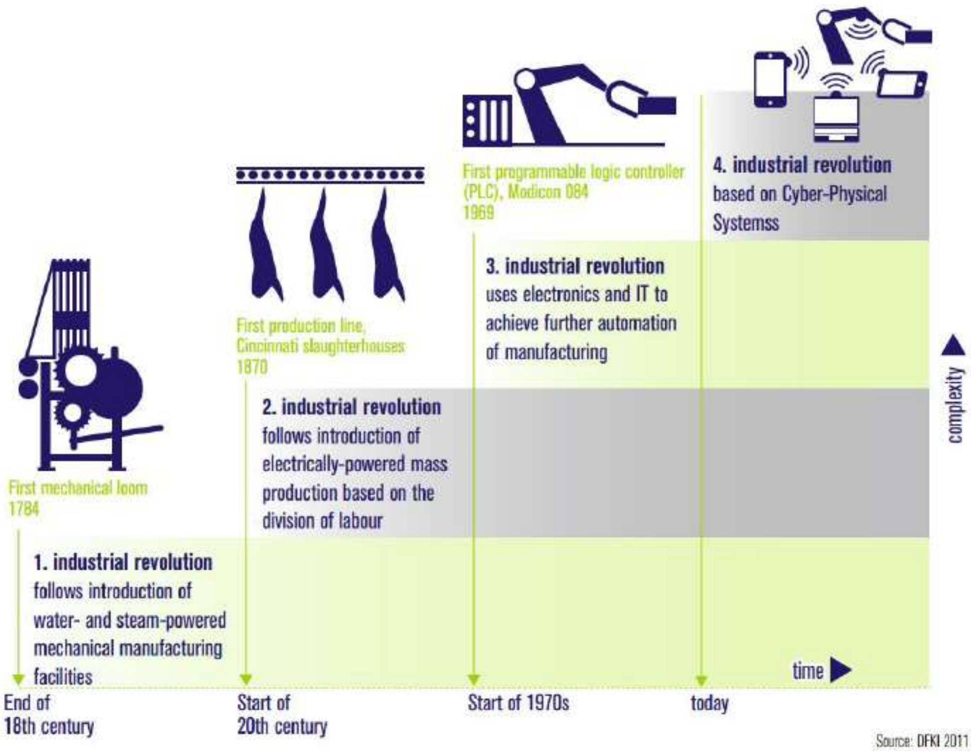
CHAPTER ONE

INDUSTRIAL REVOLUTIONS

1.1. FIRST INDUSTRIAL REVOLUTION

Figure 1 visualizes the four stages of the industrial revolution. End of the 18th century, humankind met the first industrial revolution with the inventions of machines which used steam power and engine. Mechanization is the core characteristic of the first industrial revolution (Kagermann et al., 2013). So that, fabric production systems changed, small work areas gave way to factories (Drath and Horch, 2014: 1). Production could be made more quickly and cheaper than before with the new inventions and machines (Allen, 2006: 29; Jensen, 1993: 834).

Figure 1: Phases of Industrial Revolutions



Source: DFKI 2011 (adopted from Kagermann et al 2013: 13)

Great Britain is the first-place to play host for the first industrial revolution. Some of the factors made suitable to Great Britain for this revolution such as high wage rates and cheap energy. In order to get more benefits from production, numbers of employees should be decreased. In order to do that, energy should be used instead of people. The second reason can be explained by market conditions of the country because to obtain profits from inventions and covering costs depends on the market. Great Britain had a bigger mining industry market so that making inventions in that area was more profitable for the inventor. The third reason was related to the legal rights of the inventor. Great Britain had a patent law that inventors can receive benefits from their inventions. So that, it triggered the inventions speed in that country (Allen, 2006: 2-3).

Industrial revolution caused big changes in some areas. One of them is productivity. With the inventions of new machines and using the steam engine and water when making production boost productivity (Allen, 2006: 29), improved aggregate welfare (Jensen, 1993: 832). Moreover, production systems evolved, usage of human power decreased when capital-intensive production increased (Jensen, 1993: 834; Küçükkalay, 1997: 51). Also, the field of production changed, people started to work the factories instead of the small workshop (Tezge, 2010: 30; Drath and Horch, 2014: 1). Moreover, technological developments triggered to inventions of new types of machines and in production areas, different types of machines were used that beget more productivity (Voigtländer and Voth, 2006: 328; Küçükkalay, 1997: 51; Deane, 1979: 1-2). Improved income level and decreased prices of the product were the other consequences of the revolution (Voigtländer and Voth, 2006: 331). However, production’ supply was more than demand, that called overcapacity this caused problems for capitalism. (Küçükkalay, 1997: 51; Jensen, 1993: 834)

Furthermore, agriculture faced big changes, people had engaged in farming by using large-scale land when making production. Also, efficiency and productivity in agriculture improved thanks to machine usage (Tezge, 2010: 37-39).

A new social class that named working class come to exists, this was the other result of this revolution (Küçükkalay, 1997: 51). Also, living areas faced big transformation, people migrated from rural to urban areas in order to find jobs in the factories (Labor, 1990: 3; Deane, 1979: 1-2; Blinder, 2006: 116), population increased (Tezge, 2010: 33; Deane, 1979: 1-2), living standards of people increased (Jensen, 1993: 834). So that, new class, which lived in urban areas occurred that effects structure of society and economy (Tezge, 2010: 36; Blinder, 2006: 116).

Besides the positive outcomes of the industrial revolution, unfortunately, children affected by this revolution negatively. Children worked as a labor in factories during long hours due to the suitability of the fingers (Labor, 1990: 4).

In addition, the steam power used in the ship and invention of the compass brought about changes in transportation systems. Products could be moved from one place to another with ships that the other factors of cost reduction. Also, people could travel in the open sea. Colonialism had started with the new revolution in order to find the capital to make more production (Tezge, 2010: 48-49). In this section, the consequences and effects of the first industrial revolution briefly given. In the following part, the second industrial revolution will be defined and show results and discuss impacts it on production, society, technologies so on.

1.2. SECOND INDUSTRIAL REVOLUTION

In the 20th Century, using electricity in the production opened the door of the second industrial revolution (Atkeson and Patrick, 2001: 3; Kagermann et al.,2013; Rosenberg,1998: 8). Electricity, petroleum, chemicals, high explosives, telephones, and radios were the main inventions areas in the second industrial revolution (Atkeson and Patrick, 2001: 8; Mokyr, 1998: 230).

Transportation dramatically changed (Engelman, 2015). Cost of producing steel decreased, quality of them increased that positively effects to developments of railroads, buildings, and ships. Also, goods like machines, weapons could be produced with these quality and cheap steel (Mokyr, 1998: 223). Moreover, steel started to use on production in ships so that producing more bigger ships was possible, speed and power of ships improved (Mokyr, 1998: 227). Traveling long distance with railroads, boats and ships become more easy and cheap for people (Engelman, 2015; Mokyr, 1998: 225). So that, people who lived in different geographic areas could more easily interact with each other. More railroad built that made easier of carrying the goods long distance with decreasing time and cost (Engelman, 2015).

Goods transferred directly from Atlantic to America straight-forwardly for the first time. Meaning of the transportation of goods was a very big event for farmers, owners of factories and countries because at that moment goods could be transferred directly to long distance, this opened the door of the new markets and global economy (Engelman, 2015).

Principles of Taylorism started to apply in the factories. Assembly line, mass production, division of labor applications in T-models of Ford company (Blanchet et al., 2014: 7; Drath and Horch, 2014:1; Mokyr, 1998: 228) caused big changes in production such as cost of production decreased and productivity (Atkeson and Patrick, 2001: 2) and production increased (Boyd and Crawford, 2012: 665; Kagermann et al,. 2013; Paul and Zeitlin, 1991).

In that area, migration rate more increased, people had started to live cities than rural areas. Also, people started to move overseas and located. The living standard of people raised thanks to inventions of electricity, communication machines, and some new technologies and machines. For example, the telegraph and telephone invented so that people could send and receive the message from long distance (Engelman, 2015; Mokyr, 1998: 225).

Social welfare, living standard, and incomes increased (Mokyr, 1998: 230). Producing more product with fewer employees increased income level triggered by changes of the consumer preferences. The growth of the service had expanded with the second industrial revolution (Blinder, 2006;116).

The other developing area is the chemical industry. William Perkin found out the first synthetic dye that was purple. So that, the synthetic dyes replaced with a natural one when making production (Mokyr, 1998: 224; Rosenberg, 1998:8). Moreover, the other innovator was John Wesley Hyatt who generated first synthetic plastic that became core materials of the lots of the products such as plastic cups, knives, so on (Mokyr, 1998: 225). This the other factor for decreasing the production cost of materials.

Furthermore, agricultural productivity improved with the use of fertilizers and some chemicals such as potassium. Also, tractors had been started to use in farming so that farmers could harvest more quickly with less human (Mokyr, 1998: 228-229).

However, besides lots of good results of the second industrial revolutions, people got used to living under the unstable economic conditions. In 1929, great depression began in the U.S. however, it affected all over the world. After that time, people understood economies and countries became interconnected with each other. Fed was established by the U. S. government in order to regulate and control the financial market and prevent to the possible new crisis (Engelman, 2015).

1.3. THIRD INDUSTRIAL REVOLUTION

Third industrial revolution has begun to 1970s. In 1969, programmable logic controller invented, so that, automation systems became digitally programmable by humans. Thus, more flexible and efficient systems were possible. Automation in production systems improved (Kagermann et al., 2013). Robots and automated systems have been controlled by humans (Schmidt et al., 2015: 17).

Automation and information technology (IT) were the core elements of this industrial revolution (Blanchet et al., 2014: 7; Jazdi, 2014: 1). Digitalization has been started to use various industries in this revolution era (Kagermann et al., 2013:16; Lasi et al., 2014:1).

Two core events to disclose to the necessity of the third industrial revolution one was the diminishing of the fossil fuels. Because, in 2008 crude oil prices increased very much and everything tied to fossil fuels and they were limited in nature (Jänicke and Jacob, 2009: 9). The second one was the climate change. In 2009 World political leaders came together and discussed the effects of fossil fuels on the environment in the Copenhagen climate change conference. When people analyzed them, they realized of that sustainable growth seem to not possible under these conditions (Jänicke and Jacob, 2009: 2-10; Rifkin, 2013).

Climate changing both affect the resources and the life systems of the whole people, animals so on. (Hawken et al., 2013:4). Day by day, pollution has increased, clean water has decreased, and climate change shows the effects. So that, in this revolution, new forms of energy that are renewable energy technologies became more important for countries and industries. Countries and industries focused on the renewable energy sources (Jänicke and Jacob, 2009:9).

High-speed railroads systems, inventions of the internet, fiber optic, satellite, cellular phones were the main inventions that shaped the third industrial revolution (Jänicke and Jacob, 2009: 5; Jensen, 1993: 842-843). Track the products in the supply chain has been possible with the Radio Frequency Identification Devices (RFID) technology (Brettel et al., 2014). Moreover, a big breakthrough happened in the PCs which became smart (Kagermann et al., 2013: 13). People started to use them like a mini computer and made lots of the jobs online. For example, in the banking sector, people using some specific application can send and receive money to others without going to a bank. More information technology and services invented for smart devices.

Demanded workforce decreased because of the information technology and digitalization. The same amount of jobs was done with less number of employees (Blinder, 2006: 117-118). Whereas, the growth of service sectors has continued in this era. And personnel services become the standard of the market (Blinder, 2006: 120).

The other breakthrough is the 3D printer, which also knows the additive manufacturing. Firstly, product model formed in the computer with the using of the three-dimensional Computer Aided Design (3D CAD) programs. So that, firms can directly reach the prototype of the product (Gibson et al., 2012:1). Usage areas of these new technologies are very big. For examples, lightweight parts of cars and aerospace can be printed, architecture can create a model and publish it immediately. Thus, customers can reach the visual appliance of the model. Also, in medical artificial blood vessels can be printed for patients (Wong and Hernandez, 2012: 5-6). Moreover, researchers printed a working heart with the using 3D printer technologies (Galeon, 2017). Furthermore, only changing printing materials people can print foods whose different design, color etc. (Chadwick, 2017). These new technologies can be used in furniture, fashion industries (Wong and Hernandez, 2012: 7).

Biogenetic is the other field that developed in the third industrial revolution. Biogenetic law started in 1866 by Ernst Haeckel. In his book whose name is General Morphology of Organisms defined biogenetic law, and with the contributions of the new scientist and academicians biogenetic field improved (Olsson et al., 2017: 19). In 1990, human genome projects started aim of the study to create a gene map for humans. In 2003, the whole human genome map completed (Talking Glossary of Genetic Terms, 2016). The aim of this study is to detect and cure of illness more easily.

In the following part, the fourth industrial revolution will be defined, general advantages and challenges will be discussed in order to better understand the new industrial revolution.

1.4. FOURTH INDUSTRIAL REVOLUTION

Industry 4.0 firstly introduced in 2011 at Hannover Fair by the German government (Kagermann et al., 2011). In 2013 German National Academy of Science and Engineering (acatech) declared paper about Industry 4.0 (Kagermann et al., 2013). So that Germany officially has started to put this new revolution on its own agenda and in Europe the Public-Private Partnership (PPP) for Factories of the Future (FoF), in the US the Industrial Internet Consortium (IIC) publicized Industry 4.0 concept in own countries (Commission, 2017). In Turkey TÜSİAD published "Industry 4.0 In Turkey as "An imperative For Global Competitiveness An Emerging Market Perspective" report in 2016 (TÜSİAD, 2016). Thus Industry 4.0 has been accepted and first steps were taken for the fourth industrial revolution by the different countries.

However, different countries and companies have accepted Industry 4.0 philosophy with the different name, for example, Germany mostly has used "Industrie 4.0" term, English- speaking countries and European Union have preferred the name of Internet of Things (IoT) (Kagermann et al., 2013). China has developed a strategic plan whose name is "Made in China 2025" in order to catch up technologic developments of Industry 4.0 (Liu, 2016), Japanese carried the development of the term ones step forward to Industry 4.0 and has used "Society 5.0" term which is integration of technological developments on society's values (Wang et al, 2016) and General Electric uses "Industrial Internet" (Evans & Annunziata, 2012).

Whatever people call the Industry 4.0, it is clear that it is very disruptive new (r)evolution. In order to understand Industry 4.0 deeply, firstly Industry 4.0 will be defined from different perspectives. After that, why Germany announced it will be analyzed and later advantages of Industry 4.0 will be given to comprehend the importance of it. Following section will be clarified that what kind of problems and challenges people and companies will face. Finally, core terms of Industry 4.0 will be discussed at the end of this chapter.

1.4.1. Definition

Kagermann (2015) explains Industry 4.0 like that "Highly flexible control of production and associated areas via Cyber-Physical Systems (CPS) that are networked in real time and are now replacing centrally controlled Computer-Integrated Manufacturing."

With the Industry 4.0, in real time physical world such as devices, factories, all physical machines, products, goods, sensors, software and information technology (IT) systems that called smart objects will connect and communicate each others as well as cyber word through using sensors, software, IT systems (Lasi et al.,2014: 1; Rüßmann et al., 2015:1) and it is just possible with connection of internet technologies and Cyber-Physical Technologies/ Systems. These new technologies will give new advantages for society and businesses in order to improve the quality of predict, better control and plan of their production systems (Industrial Internet Consortium, Fact Sheet, 2013), more individualized product and also allow the last-minute changes during production and delivering phases so that systems and factories will become more flexible (Kagermann et al., 2013). Moreover, the control and communication mechanism not only used inside facilities but also used between different facilities. So that entire value and supply chain may communicate and change information in real time as a result companies face less repair and defects (Varghese and Tandur, 2014: 636). As explained above, technological changes caused by Industry 4.0 defined as fast, disruptive and destructive, however, in some areas will be changed more disruptively and quickly than others, not all areas and fields affected in the same degree from Industry 4.0 (Blanchet et al., 2014: 7).

Internet technologies are the main source of Industry 4.0, these technologies induce internet of things, smart factory, cyber-physical systems, etc. (Brynjolfsson et al., 2010). The other core technology of Industry 4.0 is digitalization because without it, connect and communication mechanism cannot work. It has a very important duty that forms a bridge between the real and virtual worlds (Kagermann, 2015).

Thanks to Industry 4.0, ways of producing of product become more diversifying (Brynjolfsson et al.,2010). Moreover, production and its volume become more flexible and customers will become acquainted with more customized products and whole supply chain- customers, companies, suppliers etc.- become more integrated each other’s (Shrouf et al., 2014: 697). This era also in new ways of creating value and unique business models will come into our lives (Kagermann et al., 2013).

In order to understand this new concept in depth, we have to look at term related to Industry 4.0 is the cyber-physical system. Integrated systems called Cyber-Physical Systems can predict failures and control and plan of businesses in order to reach more efficient and effective businesses result also these systems prepare and structure themselves toward possible of changes (Industrial Internet Consortium, Fact Sheet, 2013; Rüßmann et al., 2015), and people who will face more transparent manufacturing process and better results will be achieved when making decisions (Kagermann et al., 2013).

According to Brettel et al. (2014: 1) the Internet has induced the fourth industrial revolution, because from now on humans and machine can communicate and coordinately work together in one place. However, integration and communication means are more sophisticated than now, even disparate goods where different locations, factories or geographical position also different facilities (Varghese and Tandur, 2014: 634) can send and receive a message through Internet-based systems with using their special ID codes that called Internet of Things. Answer of the how different located factories can easily connect and communication each other is “wireless communication” (Varghese and Tandur, 2014: 634).

Although Industry 4.0 is very flexible systems, it also requires more complicated technologies such as digital manufacturing technology, network communication technology, computer technology, automation technology and other technologies (Zhou et al., 2015).

It is surely beyond doubt that productivity will increase in Industry 4.0 era (Ganzarain & Errasti, 2016; Kagermann, 2015: 34; Rüßmann et al., 2015). Industry 4.0 will not just affect production processes and communication styles, it also will affect competition between companies. The competition will become large-scale, this era corporate networks will compete for each other (Kagermann, 2015: Rüßmann, et al., 2015). Moreover, the fourth industrial revolutions mostly affect and change shop-floor like first three industrial revolutions did (Schuh et al., 2014: 51). However, it will not only affect just production also affect society. In order to analyze the effects of

Industry 4.0, advantages, disadvantages and challenges of the industry 4.0 will be discussed in following chapters.

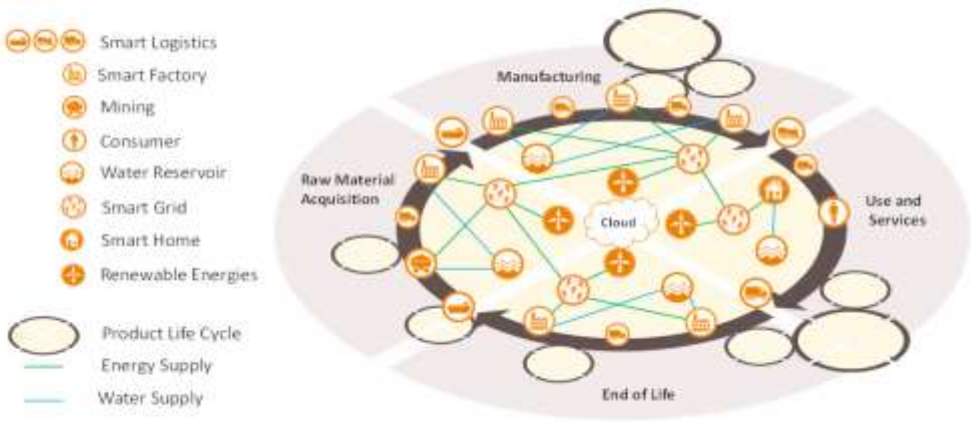
1.4.2. Advantages

In this section, possible advantages of the Industry 4.0 will be explained. Firstly, what kind of benefits people obtain from smart networks and systems and flexible systems will be defined. After that, how productivity will be affected by this new revolution will be analyzed. Later, respectively, individual product, new business model, value chain, resource, and energy efficiency, workers' lives and more detailed target customers segments will be mentioned.

1.4.2.1. Smart Networks & Systems

With the Internet-based technologies, smart factories, people, machines, resources, and suppliers can communicate with each other. Products will become smart and each of them will have special unique identities only belong to them so that they will be able to connect to each other via the internet in real time. Thereby, all information about products such as the history of production, suppliers' identity, when, where and how to produce, status etc. can be reached easily by customers, producers, companies, and stakeholders (Kagermann, 2015, p. 33). Smart networks, manufacturing, services, raw materials and the other objects will be able to communicate with each other via cloud systems. In the Figure 2, smart systems and their effects on manufacturing, services, raw material acquisition etc. can be observable.

Figure 2: Smart Systems from Macro Perspective



Source: Stock and Seliger, 2016: 537

Cloud computing is a core technology for the smart network because smart products and systems will be able to connect, communicate, share data in real time by using this technology. For example, in the future, traffic can be controlled autonomously thanks to smart systems, internet technologies and smart navigation which collect and share traffic information whose taken from cars, buses etc. (Kagermann, 2015: 27). Also, cloud computing systems will provide synchronous data in order to provide information about optimization possibilities in production and estimated repair time. The other advantage of cloud systems is that data from different sources can be reached and continuous data flow can be used by companies, suppliers, and the other smart systems. Moreover, with these systems a large amount of data can be collected, stored and the big data can be used to make analysis and optimize production (Abbott, 2014).

Smart systems will give new opportunities, such as; direct access to processes and services, increase new innovations, optimal resource utilization, smart control (Jazdi, 2014: 1-2), enhance value creation (Kagermann, 2015: 23) and control mechanism become decentralized. Large and complex systems in logistics and transport can be more easily managed and controlled by a decentralized structure. Also, rapid response of disruptive because systems that will be used as sensor technology to give opportunities for early detection of defects in systems in real time

(Kagermann, 2015: 30). Therefore, that quality of engineering, planning, manufacturing, operational and logistics processes will increase (Kagermann et al., 2013: 20). Furthermore, the service sector will be affected by the breakthrough of Industry 4.0. Support services also will be inside in the smart systems so that these services can be easily integrated and consumed by people that are not as easy as was as before (Schmidt, et al., 2015: 18) Data and information can be received during the production processes from smart goods, machines. This information will be used to develop and upgrade new services and increase product quality (Brettel et al., 2014: 4).

Moreover, customers will have authority to interfere with the production process. This era more customer-oriented systems will dominate production systems because customers can select all components of the product according to their wants, needs, wish etc. So, in the future, marketing channels become more customer oriented and marketers will segment the market based on one-customer' wants, needs and wishes (Blanchet et al., 2014: 9-11). Thereby, companies, businesses, and countries will more frequently use three-dimensional (3D) technology due to low sensitivity to labor cost as well as provide a personalized product with affordable prices (Blanchet et al., 2014: 9-11).

In this era, people will meet mobile manufacturing. Future manufacturing systems will be very small and autonomous, these easily will be carried from one place to another even these can be transferred from one country to another without building any full plant. In addition, this will affect industrial foreign direct investment structure, companies start to focus more local need of customers (Blanchet et al., 2014: 9-11). Also, the manufacturing process will become easier because when machines read the ID code of the product, it will reach information about how processed it (Kagermann, 2015: 33).

Moreover, information about the different phases of product life-cycle such as raw material acquisition, manufacturing, use and service phase etc. can be reached by the stakeholders, products, and equipment. (Stock and Seliger, 2016: 537). Thus, firms can make more accurate production planning and manage the supply chain more easily. Because complexity will decrease and in real time all the production processes more accurately observed (Kagermann, 2015: 30) from raw materials phases to finished goods phases by the customers and supply chain members. Also, the supply chain will be controlled by the smart decentralized systems (Stock and Seliger, 2016) which affect the quality of logistic processes positively (Kagermann et al., 2013: 20).

Additionally, decision making will be optimized and take a decision will become more quickly, flexible and accurately with the Industry 4.0 through the transparency of information in real time (Kagermann et al., 2013: 15-16). Estimation of economic crises or infrastructure failure can become more predictable for people by way of the information which as more good as past (Kagermann, 2015: 34).

Also, the engineering part of the design will be faster than it should be. Also, any disruption in the systems easily observed and interfered with by the firm. Lastly, the firm's entire production site can be globally optimized themselves (Kagermann et al., 2013: 15-16). The next part, information about how systems will become more flexible will be given.

1.4.2.2. Flexibility systems

As mentioned above, smart networks and systems integration will give additional benefits to companies and people called this “flexibility”. Today manufacturing and software systems are stable, not suitable for changes. However, with the industry 4.0, companies will acquaint system that is not as flexible as was as before (Kagermann et al., 2013: 26).

Flexibility systems are dynamic systems and real-time optimized, self-organizing value chain (Kagermann et al., 2013: 20), speed, productivity, and quality of the production process are some of the benefits of flexibility (Rüßmann, et al., 2015: 9). According to Kagermann (2013: 15-16) flexibility also will affect risk, robustness, price, and eco-friendliness of business processes.

This flexible system can be used for both shop-floor of production and between supply chain members. For example, while automated systems are working, at the same time customers, workers, suppliers, and the manufacturing will be included in production, change of product specifications and receive data about the different phases of a product lifecycle (Jazdi, 2014: 2; Stock & Seliger, 2016: 537). Moreover, managers can select the best components and services from a large supplier center. Also, replacement parts will be ordered automatically from manufacturing (Jazdi, 2014: 2) with the care of the cost, availability and resource consumption (Kagermann et al., 2013: 20; Stock & Seliger, 2016: 537). Thus, the value chain will become more intelligent, connected and agile (Ganzarain and Errasti, 2016).

Manufacturing systems structure that will be changed by the smart network's systems can connect and communicate more flexible and fast (Blanchetet al., 2014; Ganzarain and Errasti, 2016; Kagermann et al., 2013; Rüßmann, et al., 2015). Smart factories and systems can predict future products and react complicated and diverse production systems changes with minimizing production cost and also decrease environmental impacts (Herrmann et al., 2014: 288) through reuse, remanufacturing, recycling and recovery (Stock and Seliger, 2016: 537). When a machine faces a problem, it will be automatically recognized as problems (Jazdi, 2014: 2).

The connection of systems affects the quality of production because integration robots and systems defect problems and share this information to the other robots and systems so that low-quality product can be more easily identified thereby quality will increase. Furthermore, flexibility will not only affect products quality but also affects the quality of engineering, planning, manufacturing, operational and logistics processes positively (Kagermann et al., 2013: 20). All these will be possible with network systems.

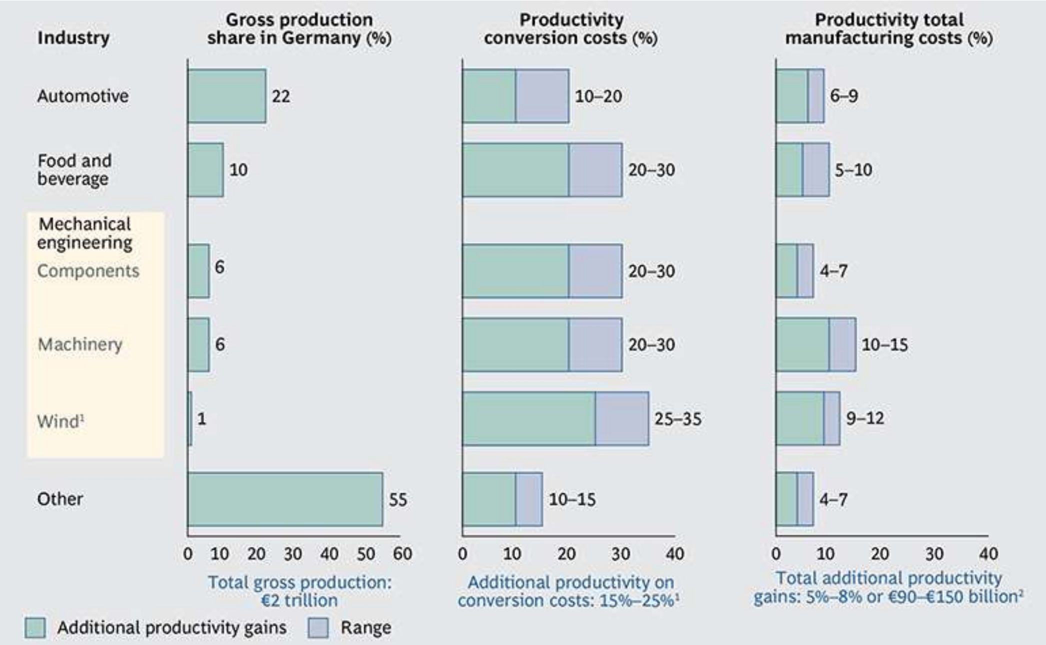
1.4.2.3. Productivity

Industry 4.0 will cause some of changes in the production which are individualized production (Kagermann et al., 2013: 15-16 ; Lasi et al., 2014: 1; Rüßmann, et al., 2015: 9), decrease production life-cycle (Schuh et al., 2014), virtual value chain (Kagermann et al., 2013; Schuh et al 2014) and increase productive (Ganzarain and Errasti, 2016; Kagermann et al., 2013; Rüßmann et al., 2015; Schmidt et al., 2015).

Productivity in Germany manufacturing sector will be expected to increase between €90 billion to €150 billion (Rüßmann, et al., 2015: 5). Figure 3, under the column of the “productivity total manufacturing costs (%)” easily expected productivity gains can be analyzed for Germany. Unfortunately, lots of productivity data are related to Germany because Germany is the first country to announced

Industry 4.0 concept (Kagermann et al., 2011). So that, it has made a huge investment in Industry 4.0 in order to research the effects of its (Koch et al., 2014: 10).

Figure 3: Productivity Total Manufacturing Costs for Germany



Source: Rüßmann et al., 2015: 8

However, still, there are some academicians who work effectiveness of industry 4.0 on production systems and humankind will meet more efficient and faster production systems due to connecting and communication of smart systems and machines (Ganzarain and Errasti, 2016; Rüßmann, et al., 2015).

Schuh et al., (2014: 53) define four mechanisms in order to increase collaborative productivity. One of them is the product development process. It will decrease because the structure of companies will become more decentralized (Kagermann, 2015: 30) and horizontal and vertical integration inside the company will support innovations speed in the firm. So that new machines and smart systems will decrease the time of the production (Kagermann et al., 2013: 20) by the reason of machines can reach information about what they produce (Kagermann, 2015: 33). Moreover, products' problems can be easily detected by the smart systems and problems will be solved quickly (Kagermann, 2015: 30). Also, herewith the 3D technologies, the prototype of the products swiftly will be able to print (Blanchet et al

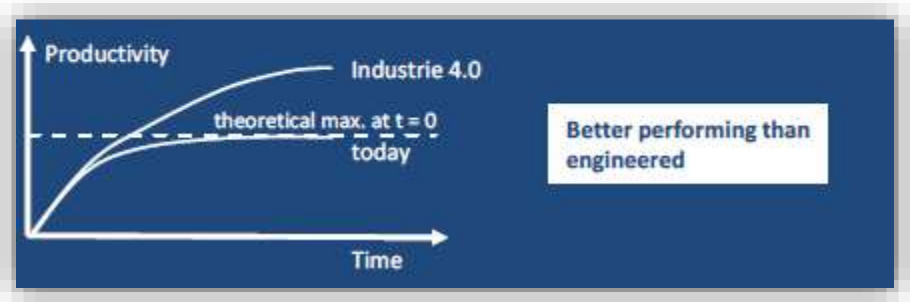
2014: 9). So that, these affect the life cycle of a product which will be shortened in order to catch up on competitors' innovations speed (Schuh et al., 2014: 53).

The other mechanism is related to the value chain. With the smart systems and internet of technologies value chain can be easily observed in the virtual systems (Abbott, 2014; Kagermann, 2015: 33). All the problems about value chain immediately can be detected and the output and performance of the process in real time can be evaluated with details (Abbott, 2014; Kagermann, 2015: 30). Also, when products are developed, at the same time simulations about products start to work, so that future problems of products easily detected, eliminated and problems fixed before produce products (Abbott, 2014; Kagermann, 2015: 30; Schuh et al., 2014: 54).

The third mechanism is related to the customized product, with the industry 4.0, individualized production age will start (Rüßmann et al., 2015: 9). Customers will select components of the product and differentiated products based on their wants so that these will be effect assembly line and production systems will become more complex (Blanchet et al., 2014: 9-11).

But, on the other hand, product process steps will become shortened because smart systems, internet of things and simulations that will work before produce production in order to evaluate quality, detect possible problems, solve them etc. (Kagermann, 2015: 30; Kagermann et al., 2013: 20). Thereby, process steps will decrease, the era of Taylor^{-1} will begin that is a contrast of the Taylorism. In order to decrease the cost per price in Taylor^{-1}, process steps or the number of contributors should decrease when compared to Taylorism. So that, Taylor^{-1} philosophy will become more important in an individualized era (Schuh et al,, 2014: 55). So that firms reach better performance with using them than engineering.

Figure 4: Productivity and Industry 4.0 Relationship



Source: Schuh et al., 2014: 55

The last thing will affect productivity is the performing of engineering. High flexibility and adaptation to changes will be possible with smart production systems. Additional the smart systems, smart machines will be dominant in the production and they will learn themselves. So that when smart systems and machines face structural changes, they will think of new different boundaries that provide new opportunities, so that actual productivity will be more than planned productivity. Figure 4 explains the productivity and time relationship in the context of engineering performance (Schuh et al., 2014: 55).

As well as these four mechanisms, also virtual reality will affect productivity positively. Global production data will be available from the nation in real time and also countries and firms will easily observe changes in the dynamic environment (Brettel et al., 2014). So that understanding changes and giving reactions to changes will become more quickly. Individualized production is another advantage of Industry 4.0 will be discussed following part.

1.4.2.4. Individual Product

Mass customization has been in our lives for a long time but with the Industry 4.0, mass customization will be one-step ahead and customers completely will form unique products which only belong to them. Also, systems will be very flexible and during production, last minute changes can be done (Kagermann et al., 2013: 15-16).

In this era, customer integration will increase through the smart systems, which will encourage customers to the individualized product. Customers will be inside the systems and they prepare their special unique products based on wants and needs. Also automated smart systems will encourage customers to the individualized product (Jazdi, 2014: 2; Kagermann et al., 2013; Rüßmann et al., 2015). Personalized medicine is a good example of individual product & services. With the gene technology, producing personalized medicine will be possible in the future. Gene of human may be detailed identified and the smart systems collect and all times record and analyze information of gene and physiological of human in order to use treatment and prevention of diseases. So that doctors will reach continuously information about patients with smart systems offer personal treatment to patients (Kagermann, 2015: 31-32).

Furthermore, systems can be more easily react to the needs and want of the customers because smart machines will change production systems very quickly (Rüßmann et al., 2015: 9). So that catching trends will become faster.

Firms will be acquainted with a new model of mass customization while maintaining a low-cost policy in production (Lasi et al., 2014: 1; Kagermann, 2015: 34). Another advantage for companies is small and autonomous manufacturing units; which are portable and can be transferred across countries. This will aid in satisfying local demands (Blanchet et al., 2014: 9-11).

1.4.2.5. New Business Model

Production will become highly flexible and ready for changes in the production process. Cloud computing (Schmidt et al., 2015: 18-19), smart systems and processes (Jazdi, 2014: 2) will cause changes in the structure of businesses and people will meet new business models.

Smart systems will have to adapt processes to structural changes. In order to do that, systems will exceed the standard limits and reach new advantages and new boundaries (Schuh et al., 2014: 55). These new advantages and boundaries will create new business models for firms (Jazdi, 2014: 2; Kagermann et al., 2013: 26; Rüßmann et al., 2015: 9; Schuh et al., 2014). For example, smartphones and tablets will become more dominant in the services of smart systems and processes. With these smart devices, getting to know the problems, running the systems and maintaining them will gain new dimension (Jazdi, 2014: 2).

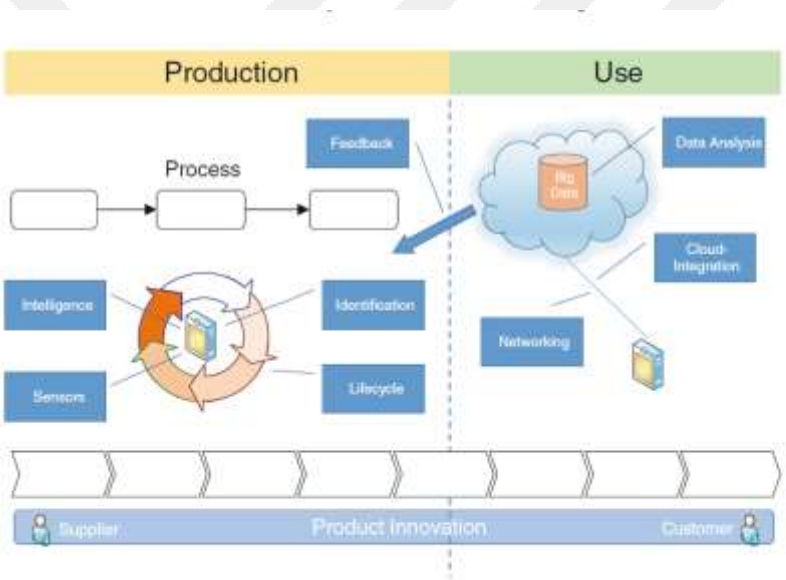
New types of enterprises that affect and changes roles of manufacturing new roles in the manufacturing process and value creation networks will be expected (Lasi et al., 2014). Thereby, firms will meet new competitors because of new business models (Blanchet et al., 2014: 9).

1.4.2.6. Value Chain

All steps in the value chain will be digital and completely connected each other (Kagermann et al., 2013: 15-16; Schmidt et al., 2015: 18; Schuh et al., 2014: 54; Stock and Seliger, 2016: 558). Customers and suppliers will be inside in the production systems using smart systems and internet of things technology (Kagermann, 2015: 33). Also, products will connect via special ID codes with cloud systems and maintain a connection to the cloud systems during all life-cycle (Kagermann et al., 2013: 20; Lasi et al., 2014: 1; Rüßmann et al., 2015: 1).

Any information about products, materials, systems etc. will be recorded by smart data. In the value chain, smart data will give information about stages of value creation. During value creation, smart data can collect information about the product that will be used when knowledge necessary and decision-making states in product lifecycle (Kagermann, 2015; Stock and Seliger, 2016). With the smart logistic, material flow in the product lifecycle can be easily observed (Stock and Seliger, 2016).

Figure 5: Smart Value Chain



Source:https://www.ostwuerttemberg.ihk.de/produktmarken/Innovation-und-Umwelt/Digitalisierung---Industrie-4_0/Industrie-4_0/Industrie_4_0/3293426 (08.02.2018) (translated by; Schmidt, et al., 2015: 19)

Figure 5 is a visual projection of the virtual value chain. With sensors and ID of products, connection and communication each other and smart machines (Kagermann, 2015), identification product specifications, which raw materials are used, when is the product produced, where the product is produced, lifecycle of product etc. easily monitored by the firms, customers and entire supply chain members (Stock and Seliger, 2016: 537). Also, cloud systems collect and hold detailed data about products and give feedback about the product (Schmidt et al., 2015: 18).

Thanks to smart value chain in Industry 4.0 era, distributing materials, energy, water and other resources will be more accurately coordinated (Kagermann et al.,2013), products will be reused and remanufacturing. So, they will positively affect economic and environmental sustainability (Stock and Seliger, 2016: 539-540).

Moreover, smart value chain will give competitive advantages to firms through trade and interchange products, energy, data etc. between varied plants. So that discovering, creating and maintaining competitive advantages will become more easy and fast (Stock and Seliger, 2016: 539-540). Also, it will positively affect small and medium enterprises (SME) and start-ups because using smart data record they will create more innovative services and business-to-business services for customers (Brettel et al., 2014: 4; Kagermann et al., 2013: 15-16).

The other advantage of the smart value chain is transparency (Schuh et al., 2014: 54). When a problem occurred in the systems, finding, detecting and solving the problem out become directly, easily and quickly (Kagermann, 2015: 30). Also process performance and output in real time observed and evaluated in order to reach knowledge about how the objective of the firm will be affected (Schuh et al., 2014: 54).

Furthermore, decision making will be affected by the virtual value chain. When a product produces at the same time different simulations work and they find possible problems or barriers out and solve, and more than one simulation give better results when taking a decision (Schuh et al., 2014: 54). So that data will support workers when taking a decision (Kagermann, 2015: 34-35). Following section, resource & energy efficiency, worker and detailed target customers will be argued.

1.4.2.7. Resource & Energy Efficiency

Industry 4.0 will not only affect firms and production systems but also solve global and national problems such as resource and energy consumption, urban production, demographic change (Kagermann et al., 2013).

Optimization of whole value chain, non-stop manufacturing, more effectively allocation of resources (Kagermann, 2015: 34-35), reduction energy consumption and emission level (Kagermann et al., 2013), more efficiently organized logistic routes and planning of capacity (Kagermann, 2015: 34-35) are some areas which affected by

Industry 4.0. Also, this new evolution will increase the quality of engineering, planning, manufacturing so on (Kagermann et al., 2013).

Industry 4.0 will emancipate employees from repetitive jobs. Because smart systems, machines, and robots will do routine tasks instead of employees. So, workers can become more creative and create added value and can be more productive in business life (Kagermann et al., 2013: 7). Thereby, jobs will be made more stable without giving breaks.

Furthermore, value chain will become more flexible and can reorganize itself against demographic and social factors changes through continuous resource productivity and resources can be allocated and used more efficiently (Kagermann et al.,2013). Moreover, value creation step will become more sustainable in economic, social and environmental framework because materials, energy, water etc. these kinds of resources will be apportioned more appropriately (Stock and Seliger, 2016: 539-540).

Smart systems, factory, machines and smart value chain will allocate resources as effectively as never before (Kagermann, 2015: 34; Stock and Seliger, 2016: 540) with using smart logistics, the smart grid, the self-sufficient supply so on (Kagermann et al., 2013; Kagermann, 2015). Also, Machines will be more actively used by firms which decrease depletion of resources (Herrmann et al., 2014: 288).

Another advantage of industry 4.0 is energy efficiency. Energy consumption will decrease with the start-stop ability of smart machines and systems concepts (Kagermann, 2015: 34-35). For example, robots can enter standby mode if the products give longer breaks. Also, laser-sources that are new systems will be entered production. These two new features-laser-sources and standby mode-will decrease 90 percent of energy consumption within production breaks (Kagermann et al., 2013: 27). Automation will become a core factor for firms which decreasing 20% energy consumption in business (Kagermann, 2015: 34-35).

The other technology on energy efficiency area is smart grids, which regulate demand and supply in giant complicated energy systems in real time (Kagermann, 2015: 27). Furthermore, in the future, renewable energy will become more attractive for firms because of climate change and environmental issues so that they may produce their energies. Also, decentralized small nuclear power can be used as a big energy supplier for firms. So that, all of these may help companies and countries in order to save energy (Blanchet et al., 2014: 9). So that, all of the new technological changes in energy area may provide a more sustainable world for humankind. Following section, effects of Industry 4.0 on workers will be discussed.

1.4.2.8. Worker

Wind of the fourth industrial revolution will also affect job designs, workers, and even firms' processes. As a result of this new revolution, the design of jobs will be evolved and become more suitable to use technology, also communication of employees, integration of works and training in office premises will enhance (Kagermann et al., 2013: 59).

Job and skill profiles will be hanged due to two major trends, which one is concept changes in the division of labor, in this era, people will not face very detailed defined division of labor, instead of it, decision making, controlling, coordinating and supporting services comprise a division of labor duties. The other trend is that many tasks in organizations will be done more comprehensive technological, organizational and social environment due to cyber-physical systems and smart systems. Virtual and real machines, systems and environment will be connected to each other so that they will organize and coordinate each job and duties (Kagermann et al., 2013: 55-56).

Various and flexible career routes, comprehensive and continuing professional training, keep working and become more productive for longer are some challenges which will be affected from industry 4.0 for workers (Kagermann et al., 2013: 15-16; Kagermann, 2015: 37).

In this new era, training will be more comprehensive and interdisciplinary which contain new industry 4.0 technologies (Kagermann, 2015: 37; Stock and Seliger, 2016: 540) and learning procedure can be specialized according to individual needs. (Kagermann, 2015: 37) in order to decrease the deficit between technological and organizational needs. (Schuh et al., 2014: 52). Also, numbers of workers will decrease (Stock and Seliger, 2016: 539) whereas highly skilled labor demand will increase in the workplace (Kagermann et al., 2013: 15-16; Rüßmann et al., 2015: 11).

Mechanical and engineering sector may hire more employees than now. Also, companies will start to hire more skilled workers (Kagermann, 2015: 16) such as at the same time possess ability field of software development and IT technologies (Rüßmann et al., 2015: 6).

Cyber-physical systems, smart factories, and smart systems are new, highly complex, dynamic and flexible concept for all of humanity. (Kagermann et al., 2013: 55-56). Highly qualified and skilled employees should be adapted to autonomous systems (Schuh et al., 2014: 52). Because people and smart systems will begin to work cooperatively (Kagermann et al., 2013: 15-16).

Also smart systems will contain some advantages within itself for workers such as enhancing employee empowerment (Schuh et al., 2014: 52; Stock and Seliger, 2016: 539), more actively participate of firms' decisions, taking their own decisions, receive more training and codetermination right (Kagermann et al., 2013) and attend the engineering activities (Stock and Seliger, 2016: 539). In addition, with the open network and smart systems, employees can exchange information (Schuh et al., 2014: 52).

So that, the organization will become more flexible that ensure workers can equipoise their work and private lives, their personal development and continuing professional development (Kagermann et al., 2013: 15-16).

1.4.2.9. Detailed Target Customers

This new revolution will also affect the marketing department of firms by the reason of target customer dynamism. In the past, collected data hold limited information about customers (Schmidt et al., 2015: 18) which defining target customers based on.

Today, data collection processes have been improved and become more comprehensive form. Continuously data collected from images, used videos (Schmidt et al., 2015: 18), mobile phones application, and internet sites. Moreover, in future data collection will increase because all things will connect each other and continuously information will be collected in the social network about customers, so it will trigger that marketers will more good understand the customers and form more detailed target customers profiles (Kagermann, 2015: 33)

1.4.3. Challenges

In this section, some obstacles of the Industry 4.0 will be discussed. All people and academicians have mentioned the benefits of the new revolution, however, implementation, application phases of firms or developments of new technologies hold some challenges. Technical and technological problems, time-consuming, security, manage complexity, laws and regulation, social challenges, unemployment, the privacy of human, firms structure changes are some of the challenges people will face. In the following sections, they will be discussed.

1.4.3.1. Technical and Technological Problems

All products, goods, systems will be smart, and they can collect data by using sensors and share them with other devices, goods, people with the internet of things technology. At that time, cyber-physical systems will become a part of the activity and create a connection between the virtual and real world (Kagermann et al., 2013; Bahati and Gill, 2011: 161; Rajkumar et al., 2010:731; Schmidt et al., 2015: 17). So that, information will be more used, manufacturing firms can more easily follow the demands and wants of customers and decision-making will become more easy and accurate for managers thanks to reaching knowledge in real time (Lasi et al., 2014: 2). On the other hand, there are some technical problems, which should be solved. For example, real-world conditions not predictable at all times, also managers and people can face the unexpected circumstance and systems failure (Lee, 2008: 364; Rajkumar et al., 2010: 735).

Moreover, reliable and foreseeable software programs should be developed. Nonetheless, it is possible technically unknown (Lee, 2008: 364-365). Also, embedded systems which are currently networking technology, create a unification between physical device and computing. However, the ability of them should be updated in order to create a connection between others' devices. Because today's systems are deprived of that skill (Lee, 2008: 366).

Furthermore, time and geographic scales are the other problems because of various devices, which will be located in different lands and time (Baheti and Gill, 2011: 161-162; Rajkumar et al., 2010: 734-735). Besides, individualized production will be possible with the Industry 4.0. However, each time manufacturing systems should adapt themselves to unique production specifications. So that, to handle these issues smart devices arrangements, systems and networks should be standardized and common regulations should be accepted by firms and countries (Kagermann et al., 2013).

Furthermore, with the technology of the sensors, internet of things goods can create, collect and share all data with each other and people via wireless. However, these cause a huge amount of data and bring some problems such as how these data selected and categorized, how unrelated data select and eliminated (Chen et al., 2014: 171). How huge important data analyzed, interpreted etc. so that proper software programs and algorithms should be developed to select accurate data from a large pool and categorize, analyze and interpret them (Brettel et al 2014; Chen et al., 2014: 202-204; Manyika et al., 2011: 12). Also, they should have abilities to deciding which data hold (Azuma, et al., 2001: 43; Van Krevelen and Poelman 2010), who have abilities to reach (Manyika et al., 2011), how provide security of them (Blanchet et al., 2014: 8) which systems used, what kind of regulations taken (Boyd and Crawford, 2012: 664).

In addition, data will be held and stored on different servers because of the possibility of facing server failure but it begets inconsistency between same or similar data, which store in different servers. Moreover, systems failure (Chen et al., 2014: 319-321), missed or uncompleted data (Wu et al., 2014: 99-102) or low-quality data are the other problems related to big data (Chen et al., 2014: 202-204).

Moreover, location sensing technology should be developed to detect the situation and location of the objects accurately and continually update that information which related to them for increasing manufacturing processes and using time more efficiently (Lucke et al., 2008: 2; Zuehlke, 2010: 2).

Each good, device, sensor etc. will have special ID codes, which give the ability to them to connect the internet (Atzori et al., 2010; Evans, 2011: 9-10). On the other hand, day by day Internet Protocol version 4 (IPv4) addressing usage has been decreased. Thereby, new effective addressing policies should be invented (Atzori et al 2010). Besides, each smart system, device etc. will be rigged from sensors whose batteries of energy is a big problem. So that, renewable energies technologies should be used by batteries of sensors instead of changing them (Evans, 2011: 9-10).

Algorithm usage will increase with the autonomous systems that help the people when making decisions (Redfield and Seto, 2017). Besides them, there are some problems such as it causes biases because it can use some finagle marketing techniques. Moreover, when algorithms help you making a decision that uses your past decision-making data or systems constraints that decided by the designer. Thus, all choices that cannot be seen by people that can cause wrong decisions (Gal, 2017).

Robots workers are new terms for humankind, but they will be used in factories in near future. However, there is not any technics, tools and mathematically models in order to design the efficient robotic teams, decide an optimum number of robots which working in the same area, evaluate team performance systems (Ijspeert et al., 2001: 151), categorize tasks and objectives Redfield and Seto, 2017).

Wireless connection technology should be updated and enhanced permit that more than one users can use and connect the virtual reality objects at the same time. The other problem that related to augmented reality is the low quality of image and rendering (Azuma et al., 2001; Van Krevelen and Poelman, 2010).

With the industry 4.0, people can remotely control and give the order the devices. However, devices should be work other devices in a harmony thereby, proper interoperability policy should be developed for those devices (Botta et al., 2016).

Furthermore, smart devices and machines will use some internet of things components, which have not enough capacity in order to use complicated security plans (Atzori et al., 2010). So that, capabilities of ingredients of smart goods should be amended, also some regulation should be done in order to decide who can access and modify of data (Miorandi et al., 2012).

1.4.3.2. Time-Consuming and Costly

Above mentioned, all systems, devices, things will collect and produce data and share them. However, selecting, categorizing and analyzing the huge amount of data will be time-consuming and costly (Brettel et al., 2014). Also, create a linking between various goods when continuing the operations and processes will need more time than before and uneconomical for firms (Baheti and Gill, 2011: 161).

1.4.3.3. Security

The other big and may be the most important obstacle is the security. By reason of cloud systems will be more frequently used and data will be stored in them. However, these cloud systems will more sensitive to cyber-attacks (Botta et al., 2016: 687; Rajkumar et al., 2010: 734-735). Without providing the security and reliability of the network, any supply members, managers even people will not use them. So that, security problems of networking technologies should be solved by developing new networking technologies (Lee, 2008: 363). In addition, workers and people should receive security education (Kagermann et al., 2013: 51-53).

The other reason why security is more important that smart factories can make an individualized product with the using data that collected in the cloud systems. According to these data, all production process can be changed and adapted themselves to the changes. Also, these big data will be used when deciding the trends and customers' demands, wants. So that, reaching accurate and reliable data will be more important for firms than now in order to form the production processes and following trends, even receiving competitive advantage (Kagermann et al., 2013: 15-16).

Moreover, vertical and horizontal integration inside and between corporation will be possible with the new technologies which Industry 4.0 will induce. Self-organize machines are good examples of the vertical integration. They will automatically and separately collect, receive and send data and continuous communicate each other's (Siemens, 2016). Also, immediately reregulate the production systems based on received data (Wang et al 2016: 2-3). In addition, horizontal integration will induce the new collaboration styles for firms that trigger innovative business models and contributes value network of firms (Stock and Seliger, 2016: 537). Moreover, product, service, finance, materials etc. information can be more easily changed and shared in real time between various companies and inside firm (Kagermann et al., 2013: 20; Wang et al., 2016: 2-3). So that, these kinds of advantages can be gained by firms if the security of data is provided.

Data will not just hold companies' information also private information (Manyika et al., 2011: 3; Rimal et al., 2009: 46). such as credit card numbers, passwords, detailed personal habitual knowledge and national security information (Chen et al., 2014: 176). When data volume increase, traditional methods will be useless and protecting them will be harder (Chen et al., 2014: 202-204; Wu et al., 2014: 98).

1.4.3.4. Manage Complexity

With the Industry 4.0, production process also will face big changes such as individualized production will be possible. All manufacturing processes immediately adapt their systems to the new production process after receiving data about the new product. However, in order to produce new goods, machines will need diverse components (Baheti and Gill, 2011: 166), and manage and control them will not be easy (Kagermann et al., 2013; Lee, 2008: 366). To deal with the complexity, systems should be managed decentralized management philosophy (Stock and Seliger, 2016: 539). Moreover, standard hardware, software programs can abet to decreasing complexity (Lucke et al., 2008: 2; Zhou et al., 2015; Zuehlke, 2010).

Big data is the other area that causes complexity for firms. Because, a huge amount of data which are product, operational, customers etc. data will be collected and stored (Zhou et al 2015: 2150). However, data should be categorized, selected and analyzed by the firms. Also, the relationship between data and other systems (Chen et al., 2014: 172). that are very complex should be evaluated and used by firms. Those are another reason for complexity in the firms (Wu et al., 2014). Moreover, systems, devices, and all things create links, all networks conclusion will be saved in order to analyze and use. Nevertheless, these will induce millions of connections, which will make things difficult for firms (Chen et al., 2014: 172).

1.4.3.5. Standardization

Standardization is the big bottleneck for the implementation and usage of the Industry 4.0. By the reason of that, various systems and devices will be smart that will use diverse models, languages, methods. Without developing an accepted standard language, method and models by the different firms, countries, and producers, using the systems will be hard (Lee, 2008: 364-365; Zhou et al., 2015: 2151). Moreover, information sharing between various systems, devices will be not efficient and fast. In addition, when factories make individualized production, smart systems will have to deal with various systems configurations and connections, which will decrease of the production speed and increase complexity in the systems (Kagermann et al., 2013). Thereby, standard systems, connection, language, methods etc. must hammer out to save time, money, make better strategy and reuse of the goods (Zhou et al., 2015; Zuehlke, 2010; Lucke et al., 2008: 2).

Besides, other area, which must be developed standard method and evaluation criteria for big data such as appraisal standard, benchmarking criteria (Chen et al., 2014: 202), privacy and information sharing are some of the areas should be worked on them to create standard criteria (Wu et al., 2014: 99-102).

Moreover, standardization should be applied in the autonomous systems. Firstly, standard models, which defined autonomous systems should be developed. Also, in order to evaluate the performance of autonomous systems, performance evaluation criteria must be determined and defined according to types of jobs that performed. Moreover, some mathematical models, which will be used in analyses of experimental observation must be invented. Furthermore, if the firms want to more efficiently and effectively use autonomous systems, they should classify tasks, goals, and environment of jobs. However, right now, there is not standard technics or tools in order to categorize them. (Redfield and Seto, 2017). Also, security and privacy of the autonomous systems and data which created by systems another area should be studied by professionals and academicians in order to develop standard protocols (Evans, 2011: 10; Gal, 2017: 5).

Internet of things is another area should be standardization generated. Especially, safeness and private smart devices should be contingent upon standard law, regulation, and protocols. So that, at least a minimum level of security and privacy will be guaranteed (Atzori et al., 2010; Evans, 2011: 9-10; Miorandi et al, 2012). Also, interaction types of smart devices should be defined in order to more effectively communicate each smart device and save time (Lucke et al., 2008: 2; Zhou et al., 2015; Zuehlke, 2010).

By using standard systems, comprehensive information sources can be evaluated and analyzed more accurately, and global optimization will be possible (Wu et al., 2014: 99-102). Moreover, data will be collected from various sources such as smart devices, sensors, machines etc. be integrated that will be possible with common standard and formats (Manyika et al., 2011: 12). Furthermore, storing, networking and controlling of connection phases which produced by smart devices when connecting the others must follow some routine protocol (Botta et al., 2016).

Standard protocol is very crucial for industry 4.0 in order to solve some problems, to create a commonly accepted regulation and maximizes benefits of new technologies. However, laws and regulation are the other core elements of Industry 4.0 to deal with and solve problems. In the following section, why laws and regulations are very crucial for implementing Industry 4.0 will be discussed.

1.4.3.6. Laws and Regulation

New types of cooperation between people and machines in factories will enter production processes of firms (Li et al., 2017). So that, regulation should be revitalized based on safety perspective (Shepherd and Buchstab, 2014:375-378) and workers should reach training in the field of potential advantages and disadvantages of this integration (Gal, 2017).

People can save time when making a decision with using some algorithms, which use predetermined decision-making tree or people’s past decision-making knowledge when helping people making a decision. However, there are some possible problems which people can face when using them. Firstly, people cannot see all possible options if use these programs and when they take a decision based on them, they will be responsible for liabilities of actions or not. Moreover, when people do not receive information about possible dangers of algorithms, who belong to responsibilities of action, user or producer (Gal, 2017). Furthermore, robots can reach abilities to learn from the environment and each of them will have different personalities as human. This brings a new question that private status should be defined or not for robots like an electronic person (Gallon et al., 2017).

Collecting huge amount of data will be more possible with the smart systems, devices, sensors etc. However, these data will not just contain general information also private and special information about people and companies such as health conditions or financial situation can be collected and stored (Chen et al., 2014: 202-204). So that, laws makers should protect the privacy of people, which are the human right of people. Also, digital records and footprint of human and companies will be stored forever that means even they want to delete something cannot do it (Miorandi et al., 2012).

Moreover, various service suppliers, which can be live in different countries and responsible different laws and regulations. So that, they should be responsible for standard and commonly accepted laws and regulations (Botta et al., 2016). Moreover, common standard and formats for data privacy and information sharing must be developed and protected by international laws in possible of facing different laws and regulations standard (Wu et al., 2014: 99-102).

Policymakers should regulate laws to protect private lives of people because protecting privacy will become harder in the new future technology (Boyd and Crawford, 2012: 664; Chen et al., 2014: 172; Manyika et al., 2011: 12; Wu et al., 2014: 99-102). They should consider two aspects; one of the is that people's privacy protection in data collection phases, such as photos, behaviors (Chen et al., 2014: 202-204). Maybe in accessing and recording stages of data can be tied to special regulations such as only authorized parties can reach data (Wu et al., 2014: 99-102).

The other one is sharing the personal data with the others without giving permission of people. Sometimes, one firm can collect data with permission but share them others without taking allowance (Chen et al., 2014: 202-204).

Big data are defined as new money for people, firms, and countries, which can reach economic benefits from big data (DATA, 2012). So that, governments and policymakers should be encouraging of them to use big data (Manyika et al., 2011: 13). For examples, they can create a suitable environment for firms in order to share and obtain data, financially support them, protect intellectual property, copyright and patents of firms more strictly (Kagermann et al., 2013: 51-53) and reregulate education programs to supply new talented workers (Manyika et al., 2011).

1.4.3.7. Social Challenges

Undoubtedly, very disruptive changes in areas of work, lives etc. will wait for society. Working areas for employees will never be the same as today's conditions, robot and autonomous systems will be used more in factories. New types of cooperation between human and machine will become popular (Li et al., 2017). Thus, in order to adapt the employees this type of new cooperation and working with robots, they should receive training about effects and limitations of robots (Gal, 2017). Furthermore, scientist and engineers will train about potentials, limitations and challenges about systems (Baheti and Gill, 2011: 161-162; Rajkumar et al., 2010: 734-735). Moreover, not only receive training and do their homework but also firms should collect data about the reaction of employees about the adaption of situation and confirmation programs should develop (Li et al., 2017).

Security can be another training area for society. Smart systems will be used everywhere in people lives. For examples, lights and heat of houses can remotely have regulated by people (Atzori et al., 2010; Evans, 2011: 4). Also, in the home, cell phones of a human can interact to home devices and use the past data and behaviors of owners can give the order to coffee machines to make coffee on time (Jazdi, 2014). However, people first must trust the devices about security and then they can use them more easefully. Security is very important for people because every device can collect and stored data about people such as rituals, act, personalities of people, financial or health information (Kagermann et al., 2013: 51-53).

Augmented Reality (AR) is a very new technology and has very long ways to develop. However, with the Industry 4.0, they swiftly will be used by human, and the effect of people lives. In the work environment, workers can see the effects and results of projects as virtually before really do that. Possible conclusions, results, and problems can be detected before occurred. Also, people can use augmented reality technology when playing games and working with technological devices that rigged with them. Thus, education about possible constraints, effects, and potential of augmented reality should be an arrangement to inform human (Azuma et al., 2001; Van Krevelen and Poelman, 2010).

Lots of changes that above mentioned will wait for people. People acceptance is keyword to increase usage of these technologies and receiving benefits from them. So that, companies, governments, standards organizations, and academics, scientists and engineers should work collectively (Evans, 2011: 10) to solving problems of new technologies and prepare an adaptation program to whole society (Baheti and Gill, 2011: 161-162; Rajkumar et al., 2010: 734-735).

1.4.3.8. Unemployment and Talented People Needs

Robots and autonomous technology will be more frequently preferred by firms, even, with the decreasing of robots and systems' prices small and medium enterprises will choose them to reach some benefits. However, an increase of using these kinds of technologies will negatively affect employment rate. Robots will do jobs of people who work an assembly line. Lots of people will lose their jobs, unfortunately (Pfeiffer, 2016: 1-2).

On the other hand, business models and job role will have revised. People will start to use their cognitive skills and abilities instead of physical power. New types of jobs will get to people lives such as robot coordinator who control and detect the robots whose work in factories, data security expert who responded to protect data and information from cyber-attack (Eğer, 2017), big data expertise who responsible analyzing and evaluation data (Manyika, 2011: 3-10). However, right now there are not talented workers for filling the gap of new jobs demands. Thereby, governments and academicians should work cooperatively and revitalize the education programs in order to catch wind of new jobs demands (Kagermann et al., 2013; Manyika et al., 2011).

1.4.3.9. Privacy

Collecting detailed data will become possible with the new technological developments such as internet of things, all devices and systems will be smart and rigged with sensors, they create, collect and send the data the cloud about personal data, firms data national security data. Moreover, these data can contain very private information about people lives, habits, personalities, financial instruments, passport (Chen et al., 2014: 202-204; Rimal et al., 2009: 46). Also, civil freedoms rights of people can be affected negatively by detailed data collection technologies (Body and Crawford 2012: 664).

Moreover, data will be collected, stored and shared with others about stakeholders (Miorandi et al., 2012). So that, the privacy of people and stakeholders should be protected by some laws and regulations, people must be trained about their privacy and rights. Lastly, firms, governments, academia should study together (Evans, 2011: 10) to decide which data can be accessible, recorded, who can reach data and how recorded these data with using which title to protect privacy (Atzori et al., 2010; Miorandi et al., 2012; Wu et al., 2014: 99-102).

1.4.3.10. Firms Structure Changes

Wind of new technological changes will affect the structure of firms. Companies will start to use big data to more deeply analyze customer wants and needs, receive competitive advantages, increased productivity and profit (McAfee et al., 2012: 5-6). To obtain benefits of big data, companies should work on developing data strategy, models and solutions and evaluate three of them as a whole (Manyika et al., 2011: 13). Moreover, firms should make investment IT department which responded to create a link between internal and external sources. Also, firms should ready to hire talented employees whose have abilities analyzing data, form connections and causation between them (McAfee et al., 2012: 7-9).

Moreover, leaders of firms must be open to the changes, create a strategy to increase usage of big data in work environment by workers. That mean culture of firms should become suitable for using big data when making decisions in daily jobs, analyzing, solving problems etc. (Manyika et al., 2011: 13; McAfee et al., 2012: 7-9). Furthermore, companies give promises about the security of data that will collect from customers and supply chain members (Manyika et al., 2011: 13).

The above, industry 4.0 general definitions, different names, and possible positive and negative effects discussed and in the following chapter, nine technologies of Industry 4.0 will be defined and explained in the manner of advantages and challenges.

CHAPTER TWO

NINE FUNDAMENTAL TECHNOLOGIES OF INDUSTRY 4.0

Kagermann et al. (2013) define Industry 4.0 as the collection of smart factories, cyber-physical systems, self-organization, new systems in distribution and procurement, new systems in the development of products and services, adaptation to human needs and corporate social responsibility.

Moreover, according to Blanchet et al., (2014: 7-9) cyber-physical systems and marketplace, smart robots and machines, big data, a new quality of connectivity, energy efficiency and decentralization, virtual industrialization and factory 4.0 are key characteristics of industry 4.0

Farther, Boston Consulting Group (BCG) published a report about the essential technologies of the Industry 4.0, which are autonomous robots, simulation, horizontal and vertical system integration, industrial internet of thing, cyber-security, the cloud, additive manufacturing, augmented reality and big data and analytic (Rüßmann et al., 2015).

Thereby, in the following sections, nine fundamental technologies which are interdependent and connected to the industry 4.0 will be explained in the light of the articles, scientific reports, and studies.

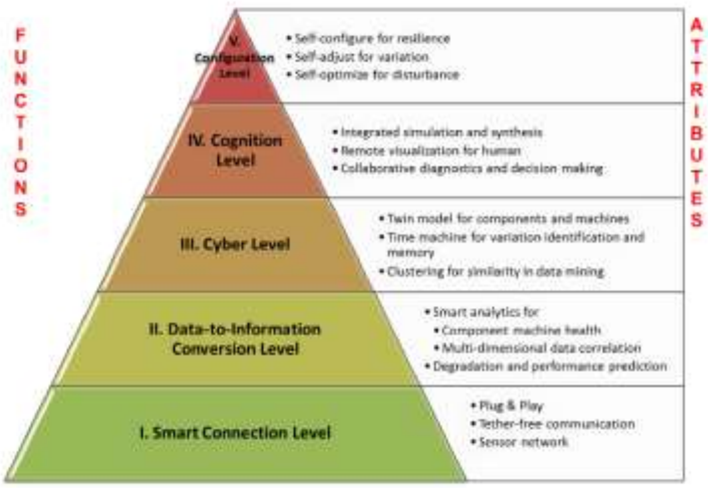
2.1. CYBER-PHYSICAL SYSTEMS

Rajkumar et al. (2010: 731) define cyber-physical systems like that “Cyber-physical systems (CPS) are physical and engineered systems whose operations are monitored, coordinated, controlled and integrated by a computing and communication core.”

Cyber-physical systems can be basically defined as a bridge form a connection between real and virtual world with using internet of things technologies (Kagermann et al., 2013), computing and communication infrastructures (Baheti and Gill, 2011: 161; Rajkumar et al., 2010: 731; Schmidt et al., 2015: 17). With the sensor technology, CPS can collect a huge amount of data automatically from the real world (Kagermann, 2015: 26) with using embedded computers and networks (Lee, 2008: 363) and the data hold the cloud systems (Kagermann, 2015: 26). After, CPS uses some computer technologies to transform the information to virtual. For a long time, embedded systems have been used in order to connect physical systems and computing. However, today's embedded systems do not have the ability to connect with other devices. With the revolution of industry 4.0 and new technologies, these systems will obtain networking skills (Lee, 2008: 366).

Jazdi (2014: 1) explains equipment requirement of CPD in order to create it like that "A CPS consists of a control unit, usually one or more microcontroller(s), which control(s) the sensors and actuators that are necessary to interact with the real world, and processes the data obtained. These embedded systems also require a communication interface to exchange data with other embedded systems or a cloud."

Figure 6: Five Stages of CPS Structure



Source: Lee et al., 2015: 19

Figure 6 clearly shows steps of CPS from initial data collection to end the value creation. The first step of CPS is a smart connection that obtains exact and reliable data from machines with using sensor technologies. Data-to-information conversion is the second step; data are interpreted in to reach meaningful information. The cyber level that is the heart of information central is the third step. Specific technologies have to use so that machines can reach self-comparison ability. In the cognition stage, expert reaches proper knowledge so that they can take a more correct decision. Also, machine status and priority tasks observed in order to optimize the maintaining process. Configuration is the last step that creates the feedback from cyberspace to physical space (Lee et al., 2015: 19-20).

Sharing information to other devices, observation and controlling the other systems, (Kagermann et al., 2013) reaching needs and wants of customers (Lasi et al., 2014: 2) and creating a connection and accessing physical and real world (Jazdi, 2014) are some skills the of CPS.

Autonomous actions will be free from local constraints, organizational borders will ensure broad integration (Lasi et al., 2014: 2; Schmidt et al., 2015: 17) and connection and integration will be very broad from inbound logistics to outbound logistic, service. All of these will be possible with the CPS (Kagermann, 2015, p. 33).

Internet of things will give special ID codes to all products but without CPS connect and communication mechanism will not be possible between goods. Also, identifying identities and location of the machines and products and observing production processes with the possible of smart sensor, systems and internet of things but without CPS technology these are meaningless because the connection of the systems with possible only with the CPS (Brettel et al., 2014; Stock and Seliger, 2016: 539). So that CPS will have more core functions that are to create a bond between the virtual and real world which will give communication, coordination and autonomy abilities to goods (Jazdi, 2014; Schmidt et al., 2015: 17). Moreover, smart goods can directly connect with each other worldwide with using CPS (Kagermann et al., 2013: 15).

2.1.1. Advantages of Cyber-Physical Systems

Information flow will be observed closely and real-time synchronized data between the real and physical world (Lee et al., 2015: 18). For example, chronic diseases can be more easily diagnosed and cured with CPS technology that decreased health cost (Rajkumar et al., 2010: 735). Also, connected machines will work more efficiently and collaboratively than now (Lee et al., 2015: 18). For example, your phone application and coffee machine will connect to each other, share information and prepare your coffee when you wake up (Jazdi, 2014).

Moreover, information usage will increase. Decentralization and flexibility in the manufacturing will open a new door into rapid product innovation (Brettel et al., 2014). Also, production processes will be easily changed in a very short time thanks to flexible systems connection (Blanchet et al., 2014: 7).

The design and development stages of engineering systems that will have new capabilities are often affected by cyber-physical systems. Also, close cooperation among different disciplines will be seen more often with these new systems (Baheti and Gill, 2011: 166).

Micro power generation, efficiency, and safety smart transportation systems are some new capabilities of CPS systems. In addition, energy will be used more efficiently, and fossil fuels used less which will affect positively environmental sustainability (Lee, 2008: 363).

The transformation will be coordinated routes most efficiently ways (Rajkumar et al., 2010: 734). Traffic lights are a good example for CPS. Today they are not communicating with each other so that act independently. However, with the CPS technologies, all the traffic lights will share current color and time programming with the other lights also cars and busses. So that optimum route and waiting time on lights can be calculated easily and car can reach information about next traffic lights so that cars and busses can regulate their speed and use motor on-off features in order to decrease emissions and use shorter routes (Drath and Horch, 2014: 2; Rajkumar et al., 2010: 734).

2.1.2. Challenges of Cyber-Physical Systems

Under this section, some challenges that applying of CPS will be discussed.

Physical world conditions all time do not predictable and unexpected circumstance and systems failure can occur (Lee, 2008: 364; Rajkumar et al., 2010: 735). Unfortunately, today there are not reliable and foreseeable software programs. However, in order to apply CPS properly these programs should be developed but technically, it is possible or not, not know right now (Lee, 2008: 364-365).

Today networking technologies are not enough for applying CPS technologies (Lee., 2008: 363). Also, systems will connect and communicate the different systems located in various geographic regions. However, communication of different systems will face time and geographic scales (Baheti and Gill, 2011: 161-162; Rajkumar et al., 2010: 734-735). Moreover, the connection between different systems while continuing operation working will become time-consuming and costly (Baheti and Gill, 2011: 161). Also, security attacks will be easier (Rajkumar et al., 2010: 734-735). So that networking technologies and concurrency models in computing should be developed (Lee, 2008: 363) and safety and security problems should be solved (Rajkumar et al., 2010: 734-735).

CPS will have very different and huge amounts of components that cause complexity (Baheti and Gill, 2011: 166), so that, to manage systems will become harder (Lee, 2008: 366). Also, the flexible interface will be necessary to connect, communicate and support very different heterogeneous components, but people don't know how to design it (Lee, 2008: 364-365; Zhou et al., 2015: 2151).

Moreover, heterogeneous systems use very different models, languages, methods so that common, widely used models, languages, and methods should be developed and used by different geographic regions (Lee, 2008: 364-365; Zhou et al., 2015: 2151). Also, different computing and communications components should be developed in order to design and development of CPS. So that modeling, simulating and analyzing of different components will be made more accurately (Baheti and Gill, 2011: 161-162; Zhou et al., 2015: 2151).

Lastly, scientists and engineers should receive training about CPS technologies and form a group to solve these challenges and adapt society these huge changes (Baheti and Gill, 2011: 161-162; Rajkumar et al., 2010: 734-735).

2.2. SMART FACTORY

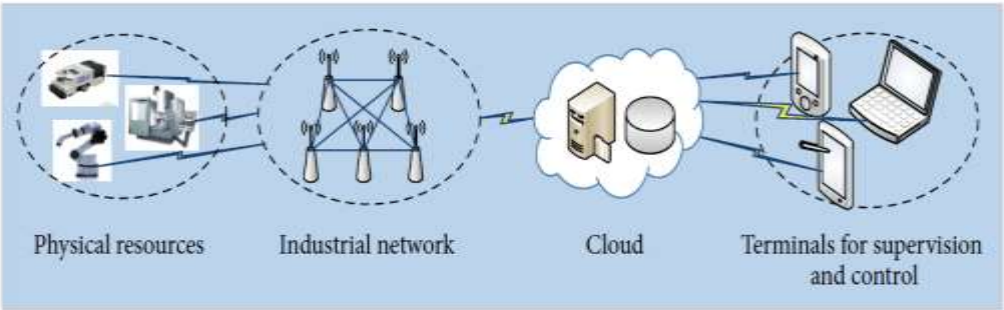
A new approach to production (Kagermann et al., 2013: 7) will be named differently by the countries and academicians for example in Europe, smart production and in U.S. smart factory (Kagermann et al., 2013: 59) terms are used. However, Blanchet et al. (2014: 9) use Factory 4.0 term.

The smart factory is basically defined the implementation of cyber-physical systems in the factory (Wang: 2016: 7; Wang et al., 2016: 159). Employees, machines, sources, and systems will be using the cyber-physical systems in order to communicate with each other inside the smart factory. This will be designed to suitable to share information and communication (Kagermann, 2015: 33). The smart factory goal is to satisfy customers better by providing better service to their customers (Zhou et al., 2015; Shrouf et al., 2014: 698).

Flexible and agile production (Wang et al., 2016: 159), sensitive manufacturing environment, managing disturbance real-time production, decentralized management philosophy and supporting to machines and employees while doing their jobs are some features of the smart factory (Lucke et al., 2008: 1).

Smart factory will be awaited of their environment (Lucke et al., 2008: 2) with using new computing technologies and tools (Lucke et al., 2008: 1), sensors and cyber-physical systems, which will help it to form meaningful context with compound physical and virtual world (Lucke et al., 2008: 2). Thereby, physical and virtual information will be used by the smart factory in order to fulfill its duties. Production process in the factory will become smart. A physical environment such as machines and products and virtual technologies such as Manufacturing Execution Systems (MES) will be integrated (Wang et al., 2016: 159).

Figure 7: Framework of the Smart Factory



Source: Wang et al., 2016: 4-5

In order to more deeply understand of the smart factory, let's look at Figure 7, the first layer comprises smart products and machines. They will communicate with using the industrial network and also cooperate with each other. The second layer is a bridge between physical resources and the cloud to create artifact communication, and cloud layer is a network of servers, collect and hold the giant amount of resource, ensure elastic solutions, promote systems management and optimizing supervision and control (Wang et al., 2016: 4-5).

With the industry 4.0, also inside of the factory and form of doing jobs will face big changes such as robots and people can work cooperatively and hand to hand, also they can communicate each other via wireless systems (Blanchet et al., 2014: 8). Furthermore, factories can be controlled from a distance. For example, employees can reach a message from the smart factory and with using web camera can detect problems, give some advice and solve it without going to the factory as well as during this time no need to stop production (Blanchet et al., 2014: 8).

2.2.1. Advantages of Smart Factory

Production technologies, storing, processing and sharing data will gain new forms in the smart factory environment (Blanchet et al., 2014: 9). Also, process planning and equipment and supporting managers when taking decision are other features of the smart factory (Lucke et al., 2008: 3).

More accurately and faster complexity management, more efficient production and less failure in manufacturing are some features of the smart factory (Kagermann et al., 2013: 19). Also, human-computer, human-robots, things to things connection will be possible in a smart factory environment (Zhou et al., 2015). Furthermore, in the production process, the least number of employees will work so that workers will get rid of repetitive jobs (Kagermann et al., 2013: 21; Shrouf et al., 2014: 699-700).

As well as remotely control of the factory, reaching of manufacturing information in real time in everywhere and every time will be possible in smart factory concept (Lucke et al., 2008: 2; Shrouf et al., 2014: 700). Also, manufacturing systems will be sensitive to the environmental changes and hierarchy structure of factories will evolve and decentralized management will dominate future manufacturing systems which will help to handle production problem (Lucke et al., 2008: 2). Furthermore, manufacturing units will be changed quickly, new materials will be prepared and new links between materials, resources, machines, and humans automatically formed in smart factory concept. So that individualized production, giving reaction to market changes and following customer demands will be more possible (Wang et al., 2016: 6).

Small-lot products can be produced more efficiently, resources and machines usage will increase (Wang et al., 2016: 6), production requirement will be more accurately determined before production process with using big data information. Moreover, systems and machines performance in real time will be observed more exactly. So that taking a decision or making planning more accurately will be done. Also, machines will be used more efficiently which decrease energy consumption (Kagermann et al., 2013: 21; Shrouf et al., 2014: 699-700; Varghese and Tandur, 2014; Wang et al., 2016: 6-7).

Renewable energies will be more used in the smart factories environment because another goal of smart factories is to create a self-sufficient environment for themselves in order to apply non-stop production philosophy in the factory. So that factories will have two features one of the energy suppliers the other is energy consumption. Also, the smart grid will support energy demand of intelligent factories and it will regulate dynamically changed energy supply and feedback of the factories (Stock and Seliger, 2016: 539). Thereby, environmental sustainability will be enhanced.

2.2.2. Challenges of Smart Factory

The production process can adapt itself to individualized production. However, every time when producing new products, factories will need different smart devices configurations, systems, and networks. Manufacturing systems will be more complex (Kagermann et al., 2013). To handle this issue, hardware, software and communication standardization should be developed (Lucke et al., 2008: 2; Zhou et al., 2015; Zuehlke, 2010). Standardization also will help companies to save time and money (Zhou et al., 2015) make better planning and re-utilization of the components. Also, different planning systems such as Computer-Aided Manufacturing (CAM) and Computer-Aided Design (CAD) should have connected with each other in order to better planning, communication and operating (Zuehlke, 2010).

Smart factories concept will perform tasks autonomously with using smart systems and smart products information, which will be held in the cloud. However, every product, system and smart devices every time will produce data, these data amount day by day accumulated and cause big data in cloud systems. So that analyzing, selecting and interpreting the data properly in order to perform the task will be harder for smart factories (Brettel et al., 2014).

Location sensing systems is another challenge for smart factories. Physical location and status of materials should be detected accurately and must be updated frequently in the virtual environment with using specific technologies in order to enhance processes and time efficiency (Lucke et al., 2008: 2; Zuehlke, 2010: 2).

2.3. CYBER-SECURITY

Cyber-attacks can be performed either by using the availability and connectivity of the systems or by using security vulnerabilities (Xie et al., 2010: 213). Also, when analyzing cyber-attack conclusions financial result firstly come to the mind of people. However, results of cyber-attack not only induce damage of factories or production but also company's reputation, image and abilities to controlling processes affect negatively (Byres and Lowe, 2004: 4). The above highlights why cyber-security is so important.

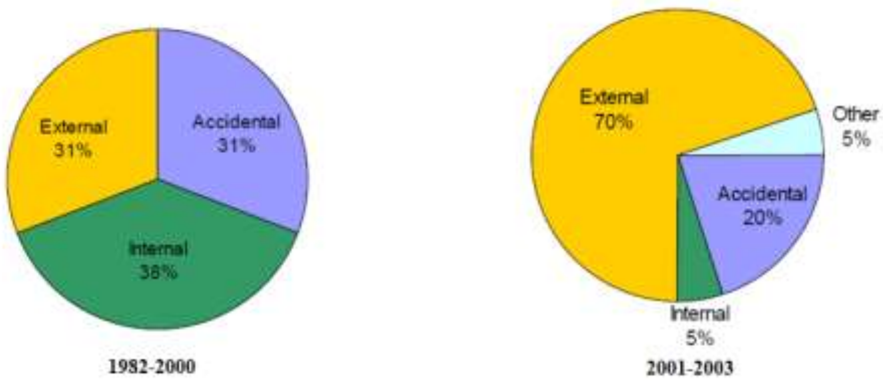
Systems, devices, machines and factories will connect and communicate each other using cloud systems, however, these open network systems may face cyber-security threats more often (Byres and Lowe, 2004: 1; Rüßmann, et al., 2015: 4). So that, to ensure security will be essential (Kagermann et al., 2013: 48-50).

Secure and reliable communications and connection to cloud systems and unique identities of devices must be ensured in order to the successful implementation of industry 4.0 (Kagermann et al., 2013: 23; Rüßmann et al., 2015: 4). The connection will be possible not only between machines, devices, and systems, but also systems connected to much wider networks. Thus, ensuring the safety of all the systems will become even more important in the age of the industry 4.0 (Kagermann et al., 2013: 48-50).

Furthermore, smart factories and products will reach information about what kind of products produced, how produced and how much produced etc. These data must be protected from misuse and unjustified access (Kagermann et al., 2013: 48-50).

However, with the increasing connection of machines, the origin of attack has started to change from year to year and external attacks more threats to the firm and networked system. Figure 8 shows the sources of the cyber-attacks in detail. Between 1982-2000 rates of internal attack are high than external but after 2000, external attack rates are more than doubled (Byres and Lowe, 2004: 3) which explain reasons of emphasizing security issues of systems, factories, and networking.

Figure 8: Security Incidents among Different Time Period



Source: Has been modified from Byres and Lowe, 2004: 3

Moreover, not only inside factories materials should update and strengthen to provide security and reliability but also whole systems should be protected from harmful attacks. Because before the highly connected environment, internal attacks mostly had a higher rate than external (Kagermann et al., 2013: 48-50; Nash, 2003).

The various smart networked systems used by smart factories must be protected from hacker attacks. It is obvious that total security will not possible in a sophisticated environment. However, in order to create more secure environment, various security requirement and IT security strategies should be developed. Also, security architectures must be used in order to detect disused acts in real time, to give properly reactions to problems, to preserve the digital know-how information and smart devices, systems and factories data from the hackers (Kagermann et al., 2013: 48-50; Kagermann, 2015: 38).

2.3.1. Advantages of Cyber-Security

To make an investment in the cyber-security that contains many advantages. For example, all systems, machines will be connected each other, they will share and receive data using cloud system so that when the connection’s security be provided, people can trust the data and use them when making a decision (Kagermann et al., 2013). Also, both inside factories materials and whole systems will be protected from harmful attacks (Nash, 2003).

Moreover, when the firm guarantees data security, customers and all suppliers will trust it more, and the firm can use this ability as a competitive advantage. Also, the company's reputation, image, and abilities will be affected positively (Byres and Lowe, 2004: 4).

Furthermore, a secure connection will be possible between machines, devices, and systems. Also, important data about products, supply chain members can be protected (Kagermann et al., 2013: 48-50).

Additionally, the whole supply chain will be connected and share information with each other (Kagermann, 2015: 33) in order to efficiently planning, ordering and transformation. But without cyber-security to sharing data will not be possible for supply chain members (Kagermann et al., 2013).

2.3.2. Challenges of Cyber-Security

User-friendly solution methods should be used in the systems in order to increase security and reliability of network and systems and usage rate of them. At the same time, employers should receive training about security requirement (Kagermann et al., 2013: 51-53).

Also, corporate and competition laws should be updated and extended in order to protect business know-how skills and product piracy. Because with the increasing connection of systems, machines, value chain the product piracy and plagiarize know-how become easier. Moreover, data protection regulations should be made by companies, trade unions and countries in close cooperation (Kagermann et al., 2013: 51-53).

2.4. VERTICAL & HORIZONTAL INTEGRATION

With the industry 4.0, lots of items, systems, machines will be connected and share data with each other (Kagermann et al., 2013). These data will be used in order to coordinate the systems, decide what kind of product will be produced, how much quantity produced, also supply chain members will make plan, coordinate systems with using these data in real time information (Jazdi, 2014; Lasi et al., 2014; Schmidt et al., 2015: 17).

When thinking all these planning, coordinating, forecasting and networked environment, it is obvious that all systems, network, the smart product must be synchronically coordinated as a maestro does for her/his orchestra. Maestro who is responsible for indicating the right tempo at any moment, leading the whole group, forming a collective focus for orchestra (Burton-Hill, 2014). So that, all machines, systems, networks should be managed simultaneously as if a maestro did because collaborative company processes and business networks will become more important (Kagermann et al., 2013: 24-25) with the increasing integration of vertical, horizontal and end-to-end.

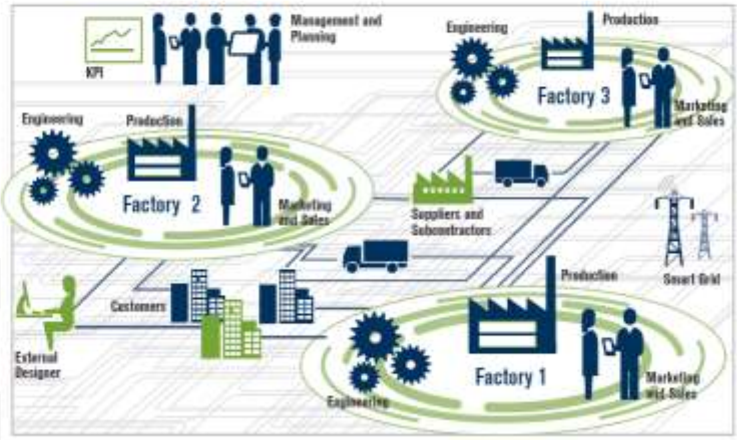
With the technological developments and dropping sensor prices, reaching sensors and using a large quantity of them have become more possible. So that huge amount of data can be collected and reachable from networks which will help to improve communication of varied hierarchy levels (Brettel et al., 2014) that explains why vertical, horizontal an end-to-end integration are important in industry 4.0 era.

The individualized product will be produced much more in the future that induces decreasing standardization so that hierarchy structure of the firm will have to evolve, and decentralized controlling will be used more frequently by the firms in order to give fast reaction and using product-specific information (Brettel et al., 2014).

Three types of integration, which are horizontal, vertical and end-to-end existing right now. Basically, these integration functions can be explaining like that horizontal integration provides intercorporate cooperation with using value network, vertical integration forms hierarchical subsystems inside firm which ensures elastic and reconfigurable manufacturing system and end-to-end integration connect the whole value chain in order to promote customized production (Wang et al., 2016: 2).

With the new industrial revolution, different integrations will enter people’s lives. First one is horizontal integration. Figure 9 is the visual demonstration of it in order to better understand this integration.

Figure 9: Horizontal Integration Within and Between Factories



Source: Kagermann et al., 2013: 22

Firm's planning and production which consist of raw materials supply, design, production, marketing, logistic, customers will be connected. Moreover, this integration will be not limited to the just a single firm also the firm will be a network with the other firms' production and planning information (Siemens, 2016).

The aim of that integration is to reveal end-to-end solution (Kagermann et al., 2013: 20) and to provide global optimization of the production processes (Brettel et al., 2014).

The other type of integration is vertical integration. Figure 10 is a visual demonstration of this integration.

Figure 10: Vertical Integration

Source: Kagermann et al., 2013: 32

Kagermann et al., (2013: 2) define vertical integration as "the integration of the various IT systems at the different hierarchical levels in order to deliver an end-to-end solution."

Various physical and informational subsystems and manufacturing systems of the company will be networked thanks to vertical integration (Wang et al., 2016: 2-3; Zhou et al., 2015). Also, product, equipment, marketing, sales, planning, and human will be networked to production systems and value creation steps (Stock and Seliger, 2016: 539).

2.4.1. Advantages of Vertical & Horizontal Integration

Horizontal integration creates a bond between different corporations in order to create collaboration (Wang et al., 2016: 2-3) and provide a connection between resources and information network (Zhou et al., 2015). Thus, real-time product and service information (Wang et al., 2016: 2-3; Zhou et al., 2015), finance and material can be changed much more easily between both these corporations and inside factory in much more efficient way (Wang et al., 2016: 2-3; Kagermann et al., 2013: 20).

This integration between corporations will lead to the development of value networks and innovative business models (Stock and Seliger, 2016: 537; Wang et al., 2016: 2-3).

Moreover, with the vertical integration, smart devices can be self-organized themselves, collect, send and receive data with using sensors and actuators via networked systems, also immediately can reshape production systems which provide produce different, individualize product (Wang et al., 2016: 2-3).

Additionally, vertical integration provides uninterrupted communication and flow between technologies that used in the processes (Siemens, 2016). For example, actuator, sensor, enterprise resource planning (Wang et al., 2016: 2-3) production management, and corporate planning levels (Kagermann et al., 2013).

2.4.2. Challenges of Vertical & Horizontal Integration

Individualized production causes big complexity in the company and this complexity may not be managed by centralized systems. For this reason, decisions will be taken by smart devices and systems (Stock and Seliger, 2016: 539).

The other challenge is security. Raw materials supply, design, production, marketing, logistic, customers and also different firms will connect and communicate with each other (Siemens, 2016) using cloud systems, however these open network systems may face cyber-security threats (Byres and Lowe, 2004: 1; Rüßmann et al., 2015: 4). So that, taking security precautions is very important.

2.5. AUTONOMOUS SYSTEMS

Robots already have been used in the factory (Rüßmann et al., 2015: 3). However, capabilities, skills and some functions are very restricted. With the Industry 4.0, people will redefine autonomous systems as more flexible, cooperative, self-configuring so on (Blanchet et al., 2014: 8; Kagermann et al., 2013; Rüßmann et al., 2015: 3). What is certain that the fourth industrial revolution will open a new door for new technologies which, will contribute to the development of autonomous systems.

Autonomous systems are about taking decision for actions with using sensors, justifying their actions (Redfield and Seto, 2017:103), in response to the different situations (Kagermann et al., 2013: 20). Decision-making mechanism of the autonomous systems, this is possible in this manner: firstly, designers of algorithm give to machine some data, decision parameters and some rules which form the origin point of machine decision-making process. So that, when the machine makes a decision, it uses the previous data. In addition, it can obtain the ability to make inferences about the conclusions of the problem (Gal, 2017: 6).

Moreover, they can obtain the ability to adapt themselves and other systems, which interact with them for different situations (Blanchet et al., 2014: 8; Rüßmann, et al., 2015: 3) and can use artificial intelligence to deal with some problems. Also, they communicate the other systems, receive from and send to message the others via cloud system (Redfield and Seto, 2017:103). and operated under real world and use real-time constraints (Kramer and Scheutz, 2007: 101). Furthermore, human-machine interaction and working side by side will be possible with smart sensors and cloud systems (Blanchet et al., 2014: 8). Because systems can detect the human and regulate their own actions according to them.

So that, structure and production systems of the factory will face huge changes. Because, these systems are more productive, intelligent (Blanchet et al., 2014: 8), practical than human labor (Pfeiffer, 2016: 1), and can be controlled remotely. For example, when a problem occurred, employees receive a message and connect the systems and give instruction to systems without going to the factory. So that, night shifts and productivity skyrockets (Blanchet et al., 2014: 8) will become forgotten terms. In the following sections, detailed information will be given about the advantages and challenges of the autonomous systems.

2.5.1. Advantages of Autonomous Systems

Future new robots whose main difference and advantage than the current robots is the ability of working with the human safely (Gallon et al., 2017; Kagermann et al., 2013; Kramer and Scheutz, 2007: 102; Li et al., 2017; Shepherd and Buchstab, 2014: 373) with using sensors during working activities and learn from them (Blanchet et al., 2014: 8; Rüßmann et al., 2015: 3) in real time (Redfield and Seto, 2017: 105). Moreover, they will communicate and speak to people and remotely controllable by people (Blanchet et al., 2014: 8). Some of learning technics will be used on robots in order to gain the ability to obtain information overall lifetime (Hangl et al., 2017: 294).

For example, Kuko robots which produced by European manufacturer have the ability to networking to humans and other robots, machines (Shepherd and Buchstab, 2014: 375-378), also arrange their activities based on next incomplete jobs (Rüßmann et al., 2015: 3). Figure 11 there are some applications examples of Kuko robots.

Figure 11: Kuko Robots Usage Areas

Source: Bischoff and Kurth, 2006: 4-5

Also, robots will not just have used in manufacturing but also use logistics, office management etc. areas (Blanchet et al., 2014: 8). Besides, they will not only be bought and used by big companies also small and medium enterprises will start to buy and use of them in production and other areas (Shepherd and Buchstab, 2014: 373) through decreasing cost of robots' prices.

The technical assistant ability of robots, which can perform unpleasant, exhausting, confusing, boring or dangerous jobs is the other benefit for workers (Kiesler and Hinds, 2004).

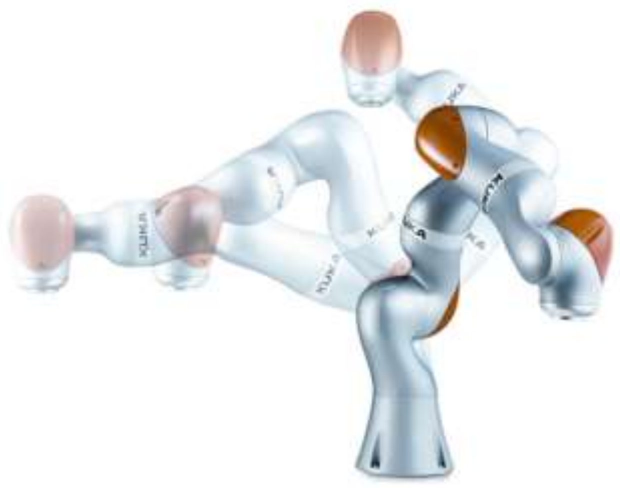
Autonomous robots can be more practical, productive (Blanchet et al., 2014: 8) than employees in manufacturing (Pfeiffer, 2016: 1). Also, they will positively affect the operational cost of firms (Blanchet et al., 2014: 8) through a decreased required number of employees (Redfield and Seto, 2017: 105).

Moreover, these autonomous robots will become smarter, faster, efficient than now (Shepherd and Buchstab, 2014: 373-374). They will be able to adapt themselves

(Blanchet et al., 2014: 8) and react to dynamic changes (Kagermann et al., 2013: 20). Moreover, directly connect and communicate the other systems and robots via cloud systems (Blanchet et al., 2014: 8; Gal, 2017: 6).

Furthermore, these systems will enhance the quality of people lives by helping make a decision via quickly and cost less analyzed more information. Systems will help human with four ways. First one is that customers set some of parameters and system weight them. Another method is that users will select decision parameters based on defined parameters by the algorithm's designer. The other thing is the algorithm use people past choices in order to predict preferences. Last systems make choices based on the best decision for people overall (Gal, 2017).

Figure 12: Special Type of Kuko Robots with Seven Axes



Source: Shepherd and Buchstab, 2014: 375

KUKA LWR product can be shown in Figure 12 as an example of a feature of high flexibility of robots. The product has different types of sensors, which allow users to program it manually. With these sensors, robots can monitor itself and its actions in order to decide its actions whether exceeding the certain threshold or not (Shepherd and Buchstab, 2014: 373-374). Also, these robots can be used as nurses, guards, services such as helping elderly people who live in the assisted living facility, help fireman for fire extinction or coloring hair of customers in a hairdresser (Kiesler and Hinds, 2004: 3).

Two autonomous systems examples will be given in order to show various usage areas of them. First one is about agriculture. In 2002, an experiment was done in cucumber greenhouse using the autonomous robot. Firstly, researchers defined required hardware and software determined, solved some problems such as how to robots determine the location of cucumbers, how to sustain hygiene of the scissors, etc. Later, the robot was used in the greenhouse. Also, systems detected the location of cucumbers with 95% success 80% of the cucumbers were collected without losing quality. Moreover, visual of cucumbers were transferred to the 3D working environment (Van Henten et al., 2002).

Surgical robotics area is another breakthrough in the field of the autonomous systems. Various surgical robots that small, special purpose, higher speed, accuracy and affordable prices will be invented. One of them the daVinci surgical robot has three or four robotic arms, which can be controlled by the surgeon. Also, it can copy hands and fingers movements of doctors in real time during the surgery is operating, provide a 3D image of the surgical field and can make some operations autonomously without any interventions (Gomes, 2011: 261).

2.5.2. Challenges of Autonomous Systems

As well as various advantages of the autonomous system, it has some challenges, which should be solved in order to proper usage of this system.

With the autonomous systems, workers will meet new cooperation style that is machine-human cooperation. However, the effects of this new cooperation should be defined, the reaction of people and adaptation processes of employees should be researched (Li et al., 2017). Also, people should be training about potential benefits and limitation of an autonomous system (Gal, 2017). Moreover, safety regulations will be redefined because right now, employees mustn’t enter robots’ workspace (Shepherd and Buchstab, 2014: 375-378).

Autonomous robots have become easier for both big and small medium enterprises companies. So that workers will be replaced by robots on the assembly line that reveal one of the most problematic areas that are unemployed. A huge amount of people will lose their jobs (Pfeiffer, 2016: 1-2). Governments should develop an effective solution to deal with it (Kagaerman et al., 2013).

Furthermore, usage of algorithms both has positive effects such as will help to people making decisions more quickly and cost less (Gal, 2017) and negative effects such as sometimes people who use algorithms cannot make an efficient choice because it can obstruct people to make an efficient choice (Redfield and Seto, 2017). Also, it can manipulate people decision by using manipulative marketing techniques. Furthermore, when algorithmic makes a decision, it can use wrong assumptions that loaded by the designer or uses past choices of customers, not foresee people preferences. Additionally, special users' groups such as children should not use very much these algorithms which can block the abilities of children making comparisons of alternatives and evaluations (Gal, 2017).

Trust is another obstacle. People want to understand reasons to the behind of robots' actions, decision-making mechanism and receive explanations from robots about their behaviors in order to trust these systems and their actions (de Graaf and Malle, 2017: 3; Gal, 2017). Also, robots cannot explain reasons for their actions naturally. Because they explain their behaviors mechanically, not offering reasons for those behaviors (de Graaf and Malle, 2017; Redfield and Seto, 2017).

Laws and regulation should be reevaluated and redesigned in the autonomous systems perspective. For example, algorithms do not show all results to people and when people make a decision based on algorithms results, whether they will responsible or not obligations of the decision. Also, when a person uses an algorithm which causes harm to something, who is legally responsible for harm. Furthermore, if the designer of the algorithm does not inform the users about any dangers of the algorithm, who is responsible for that, designer or users (Gal, 2017). Moreover, robots will independent decisions and learn from the environment. So that each of them has different characteristics like personality so that may be needed to create a special status for them such as electronic person status (Gallon et al., 2017).

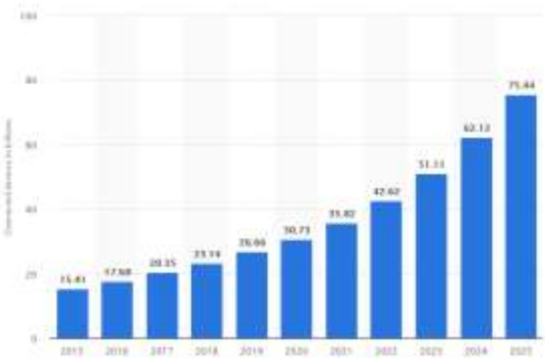
Designing efficient robotic teams, finding the optimum team number of robots, calculating optimum team performance are the other challenge related to robots (Ijspeert et al., 2001: 151). The other challenges areas that there are not standard models to describe autonomous systems, not standard performance evaluation systems, what kind of mathematically models should be developed for formal analysis of empirical observation, what kind of technic and tools should be developed in order to categorize task, objectives, environments (Redfield and Seto, 2017). and protecting security and privacy (Gal, 2017: 5).

2.6. INTERNET OF THINGS

Embedded systems are kind of powerful microcomputers that increase abilities recording, storing and processing data from machines. With the expand Radio Frequency Identification (RFID) technology, embedded systems became more basic technology and today these systems get fitted up with sensors and actuators. So that, with these systems objects and environment will be smart (Kagermann, 2015: 26).

Internet of things technology will play center roles in the revolution of industry 4.0 because with this technology objects will have special identities which with using can be connected to the internet, store all data, share information to and receive information from the other objects in real time (Kagermann, 2015: 25). Also, vertical and horizontal integration, cyber-physical systems etc. technologies will be possible with IoT.

Figure 13: Changed Number of Connected Devices within Years



Source: https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/ (03.04.2018)

Figure 13 shows statistically connected devices numbers. In 2015, connected devices were 15.41 billion year by year this number will grow apace, and in 2025 connected devices number will be expected 75.44 billion. The force behind the number increasing is internet of things technology.

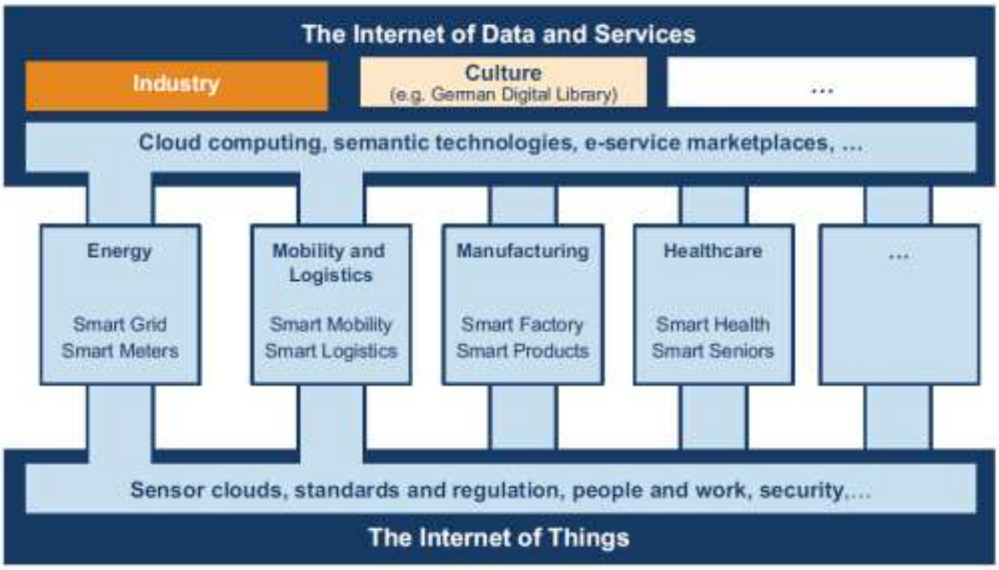
Miorandi et al, defines internet of things like a general term that is the enlargement of the internet and the web into the physical space. Physical objects will be smart and networked the other objects globally (Miorandi et al., 2012: 1497) with using internet protocol (Blanchet et al., 2014: 8-9). So that location, tracking, monitoring, and management will be possible with IoT (Zhou et al., 2015). For example, the machine will receive information about when parts will be manufactured. Also, machines will receive customers' specific needs and wants which immediately regulate production process in order to deliver them. Moreover, produced products will be smart, communicate to machines and send a message via wireless when completed (Blanchet et al., 2014: 8-9).

Furthermore, the connection will be between not only objects but also machines, devices, sensors, and people will be networked with the internet of things (Zuehlke, 2010). So that these kinds of collaborations can be classified into three types which are human to human, human to machine, machine to machine (Schuh et al., 2014).

2.6.1. Advantages of Internet of Things

Figure 14 shows areas that are energy, mobility, logistics, manufacturing, healthcare so on. will be affected from internet of things. For example, with the smart grid and meters, companies will start to produce their energy that will contribute to the reduction of global warming (Kagermann et al., 2013). Moreover, complex logistic systems will be coordinated more efficiently with the smart concept (Kagermann, 2015: 30). In the following sentences, affected areas will be explained more detailed.

Figure 14: Affected Areas from Internet of Things



Source: Kagermann, 2015: 27

Information about machines, devices and systems will be quickly interchangeable between and accessible. Moreover, devices can be tracked, controlled and coordinated by managers or partners regardless of locations. Thus, making business, observing and controlling factories and machines will become easier for businessmen/women (Kagermann, 2015: 26). Also, when unexpected situations which occurs in a factory, emergency shutdown systems automatically work, and the manager will reach information of production line delay which caused by them (Atzori et al., 2010).

Furthermore, the supply chain will react the changes of markets more quickly thanks to the connection of entire supply chain which will in real time reach product related information (Atzori et al., 2010; Kagermann et al., 2013). So that productivity and efficiency will increase, more effectively will be managed just in time operations and delivery schedule (Evans, 2011: 4; Gubbia et al 1649-1650; Miorandi et al., 2012). Moreover, customers, whole supply chain members, and departments of firms can form closer collaboration (Kagermann et al., 2013).

Moreover, IoT will make easier of people's lives with assisted living and smart e-health technologies (Atzori et al., 2010: 2787; Kagermann et al., 2013: 21; Miorandi et al., 2012).

Cars, trains, buses as well as bicycles will be rigged with sensors, actuators which will have capabilities to collect environmental information and receive data from other machines about situation of the traffic in order to better control traffic, navigation, planning (Atzori et al., 2010) which help to decrease gas emissions (Gubbia et al., 2013: 1649-1650; Miorandi et al., 2012), give proper transformation information to tourist (Atzori et al., 2010) and significant information to drivers. Tesla car crash sensor is a good example of that. Tesla’s Autopilot 8.0 software detect potential car crash between two cars which were ahead of the driver and automatic pilot give the alarm to the driver, before a crash happening (Etherington, 2016).

An experimental study was made in Padova city, Italy which different sensors and equipment placed on street lights poles for collecting the temperature, humidity, light, and benzene information from for seven days is a good example of the application of internet of things technology on daily lives (Zanella et al., 2014).

Also, people will live in more comfortable homes and offices which are equipped with sensors and actuators. So that rooms heating and room lighting will be arranged by people remotely or will be regulated themselves according to environmental situations (Atzori et al., 2010; Evans, 2011: 4). Also, energy will be used most efficiently both the homes, offices (Gubbia et al., 2013: 1649-1650) and factories (Miorandi et al., 2012).

Moreover, web-based RFID application which is a search engine will give information about product location (Miorandi et al., 2012) in order to find lost objects or when not remembered locations of them. Also, similar another application will inform you when your objects moved from restricted areas. So that unauthorized usage or a possible theft will be prevented (Atzori et al., 2010).

Besides these realistic applications, Atzori mentions some futuristic applications such as robot taxi which can be used with or without a human driver, respond real-time traffic movement, detect and avoid possible accidents. Likewise, the enhanced game room will organize game activity according to the player’s situation with sensors, which will perceive location, movement, humidity, noise, voice, heart rate etc. So that, in a more realistic environment player can play games (Atzori et al., 2010).

2.6.2. Challenges of Internet of Things

Besides lots of advantages of internet of things, there are some social and technological challenges (Atzori et al., 2010: 2788).

Different IoT-related technologies should be standardized, especially in the areas of security, privacy architecture, and communications (Atzori et al., 2010; Evans, 2011: 9-10; Miorandi et al., 2012). So that, firms, governments, standards organizations, and academia should be work cooperatively (Evans, 2011: 10).

Also, giant number of nodes (Atzoriet al., 2010) and unique Internet Protocol (IP) addresses of new sensors, devices, systems (Evans, 2011: 9-10) will be used in IoT so that effective addressing policies rather than IPv4 should be developed herewith of rapidly decreasing IPv4 addresses (Atzori et al., 2010). Also, the energy of the sensors must be provided from renewable sources because changing billions of batteries is impossible (Evans, 2011: 9-10).

The other challenge is security. Devices that used internet technologies should be protected from physical attack and eavesdropping (Gubbia et al., 2013: 1657). However, IoT components have low capabilities in order to use complex security plans, hence capabilities of components must be enhanced (Atzori et al., 2010). Also, special accessible technologies should be developed, only authorized people can access and modify data (Miorandi et al., 2012).

Privacy is the other challenges area because collecting a huge amount of data about people and stakeholders through smart goods, systems, sensors etc. will become easier than today. So that to protecting personal and stakeholders' information may be not controlled and easy. In order to prevent these problems new laws, regulations and technologies should be launched. Also, with the technological developments cost of information storage has gone down regularly that will cause digital footprint of people will not be forgettable (Atzori et al., 2010; Miorandi et al., 2012).

As mentioned above, all objects, systems, people and machines all times form, collect, share and receive information that creates a huge amount of data called big data. In the following chapter, big data will be discussed.

2.7. BIG DATA AND ANALYTICS

Big data can be defined as large-volume (Blanchet et al., 2014: 8), complicated, heterogeneous and unstructured data. (Chen et al., 2014: 171; Wu et al., 2014: 97). Data will be obtained from multiple sources automatically (Rüßmann et al., 2015: 2-3; Wu et al., 2014: 97), it will not be control by any central not depending on any control mechanism (Wu et al., 2014: 98) and it support the managers when making decisions in real time (Rüßmann et al., 2015: 2-3).

Mostly big data has been defined 3Vs model, which are volume, velocity, and variety. Creating and collecting the amount of data is big that called volume. Velocity has defined the speed of big data that means the collection and evaluating data is fast. Lastly, variety has been used to describe the usage of different types of data sources such as video, pages, web pages etc. (Laney, 2001).

With decreasing sensors and microprocessors prices, almost all goods, machines and things will be rigged with them. So that these sensors can collect all times data from machines, goods, environment (Zhou et al., 2015: 2150). Moreover, the above mentioned, humankind will make acquainted with CPS, IoT, Smart Factory etc. kind of new technologies. They will collect, create and hold data and also connect and communicate with each other at all times (Chen et al., 2014: 179-180).

In 2025 connected devices number will reach 75.44 billion (Statista, 2016). These devices and their connection create and collect the data that is one reason for the big data. These kinds of autonomous data collection and creating causes big data. Furthermore, the other big data source is the firms' internal data. Firms collect and store detailed their production, inventory, sales data also hold some statistics about analysis. (Chen et al., 2014: 179-180). In addition, data has started to exponentially grow (Kagermann, 2015: 23) so that amount of data day by day even minute to minute grow.

Collecting, storing, managing and analyzing phases of data will face transformation with the big data (Manyika et al., 2011: 1). In traditional method mostly have been used sampling and extrapolating technics, however, first time big data can collect and query whole dataset (John Walker, 2014: 183) autonomously not needing any control mechanism, which are the main differences between big data and traditional datasets. The other difference is that the volume of data is not stable, changing and expanding at all times because receiving lots of data from smart goods. Also, there is not the standard volume of data, it changed applications to applications from several terabytes to several petabytes (Chen et al., 2014: 173).

Moreover, data can be transformed with the two methods, which are transmitted from data source to data center that called Inter dynamic circuit network (DCN) transmissions, the other method is to create a connection between data centers so that centers can be networked and communicated to each other that called Intra-DCN transmissions (Chen et al., 2014: 182-184).

Whole information will be collected and hold the big data but it is clear that data should be analyzed according to importance levels. So that some pre-processing techniques such as using a different data source, integrating data can be used to increase data quality. Also, some data which are defective, unfilled and irrational should be identified and change or delete them. Also, excess or repetitive data should be detected and removed from datasets (Chen et al., 2014: 182-184).

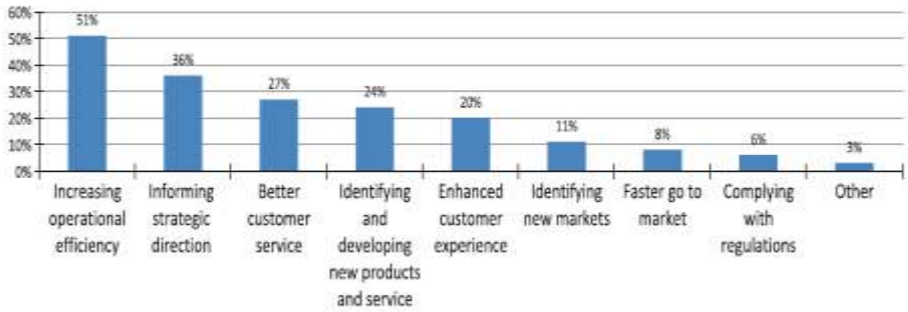
Data mining, neural networks, visualization methods, signal processing and machine learning are data analysis techniques (Chen and Zhang, 2014: 322). Moreover, there are six main data analysis areas. First one is the structure that data mining and statistical methods used to analyze it. Second is the text data, which is emails, business documents etc. are used in order to create beneficial knowledge for users. Web documents analysis is the third area. Images, videos so on materials are categorized multimedia data analysis. Network data analysis contains social networking services such as Twitter, Facebook so on. The last one is the mobile data analysis contains applications of mobile. (Chen et al., 2014: 194-197).

In the following sections, various advantages and challenges of big data will be discussed and defined.

2.7.1. Advantages of Big Data and Analytics

Big data is a new money of the future (DATA, 2012) because companies with using data and relationship among them will get obtain some benefits which are increasing operational efficiency, informing strategic decisions, better customer services etc. shown in Figure 15.

Figure 15: Big Data Opportunities Areas



Source: Chen and Zhang, 2014: 317.

A study, which made in 330 North America companies revealed that when compared to competitors, productivity, and profitability of companies will increase respectively 5% and 6% when using big data (McAfee et al., 2012: 5-6). Moreover, the McKinsey Global Institute revealed some financial benefits of the big data such as U.S. healthcare will earn $300 billion value per year thanks to more good analyzed and designed the treatment procedures. Also, U.S. healthcare cost decreased 8% and increased profit by more than 60%. Also, service providers will reach more detailed information about consumers and serve the better-customized service to customers which boost the value of service providers to more than €250 billion per year. In addition, manufacturing firms save money by decreasing half of the cost of the assembly and production development (Manyika et al., 2011: 8).

Furthermore, algorithms will use big data and various analytics technics, which enhance decision making processes. Various data will be collected from workers, consumers and IoT technology, so that data analyzed as a whole, and evaluated different perspective. So that firms and people can make a better decision (Manyika et al., 2011: 5).

Firms can make more accurate analysis by using more rich data pools, which are created by big data. They can analyze and categorize data according to their strategies and importance level and as well as care of privacy and security of the data (Manyika et al., 2011: 13). Also, firms will reach more detailed information about the location of the product, ship data, how much time used by consumers, when used, etc. (Manyika et al., 2011: 6). So that, decision making, and performance of firms will increase (McAfee et al., 2012).

Moreover, performance data will be more precise and detailed collected so that firms can make analyze the performance of the workers and units and evaluate performance variabilities in order to improve them. Moreover, these data will give ideas about the origin of problems, which can solve to improve the performance of workers and machines (Manyika et al., 2011: 5).

Besides, using big data will become a new competitive advantage for firms (Manyika et al., 2011: 13). Because marketers will reach to detailed information and routines about customers. The algorithm will make to analyze and create a pattern about people preferences. For example, person book preferences analyzed by an algorithm, after it offers books that are more suitable to each person (McAfee et al., 2012). So that marketers can create more unique segments for customers and customize products more accurately (Manyika et al., 2011: 5).

Furthermore, they can better understand and satisfied customers with using big data, want and demands of consumers will analyze more detailed. Also, products and services more customize depend on consumers wants (Manyika et al., 2011: 7). For example, applications will collect and share information about habits of users to firms so that firms can design new products, which better match the consumers' needs (Manyika et al., 2011: 7). Further, analytics can be used as a weapon of promotions and analyzed who is more affected from discounts, promotions etc. according to analyzed offers personnel discount, reviews (McAfee et al., 2012).

Detection faulty and quality problems will become easier because with using big data, these kinds of problems will be easily detected before the production process (Rüßmann et al., 2015: 2-3). So that, efficiency and quality of the products will enhance.

In 2015, one group of academicians made a study that reveals there is a positive relationship between the amount of idle data and potential usage of Industry 4.0. So that, big data can hold huge data and evaluate and interpret them as a whole that not only creates new services and innovative business models (Kagermann, 2015, p. 34) but also the usage of industry 4.0 will increase (Schmidt et al., 2015: 22-23).

Moreover, new products, services, and business models will be possible with big data. Also, qualifications of current products and services will increase with big data. For example, using big data information, the process of product development will be improved. Further, time to enter market and quality of products will increase with the big data concepts because firms can reach the integrated real-time data which contains research and development, engineering and production data and they can evaluate data as a whole. (Manyika et al., 2011: 5).

Usage of big data will affect positively total retailers' operating margins, expected 60% of increase in margins of U.S. Also, this technology will help to reduce the unemployment rate because more than 140.000 deep analytical talent and 1.5 million data-savvy managers should be work in the U.S. in order to use more effectively to big data (Manyika et al., 2011).

Not only the companies can obtain benefits, but also global economies and people obtain some benefits from big data (Manyika et al., 2011: 1). For example, healthcare more positively affected, analyzed conditions of patents all the time, record the situations and plan the treatment more accurately. Cancer diseases will be more detailed researched and may be reasons behind them more accurately analyzed and cured (Body and Crawford,2012: 664). Besides, with the mobile devices or some technologies, which will put into human skin data about the human and whole society all times collected, and doctors can reach data real time. Further, governments with using these data can define population health trends and more effectively allocated health budget (DATA, 2012, p. 3). So that, a society of health increased (Manyika et al., 2011: 6). Also, people can hold the digital payment histories and based on this information they can take loans or use other financial instruments more quickly. Additionally, analyzing the public and sector needs and define the gap and create an educational program in order to create a more strong relationship between them.

2.7.2. Challenges of Big Data and Analytics

Which systems should be used, what kind of regulations should be taken (Boyd and Crawford, 2012: 664), how these kinds of huge data organized, managed (Chen et al., 2014: 171), which data should be held and who have abilities to access to data (Manyika et al., 2011) and how protected from cyber-attacks (Blanchet et al., 2014: 8) are some of the challenges of big data.

Companies should control and manage different types of huge amount of data such as product, operational, external and customers' data (Zhou et al., 2015: 2150). So that complexity and the relationships of data will become complicated in order to analyze and organize them (Wu et al., 2014).

Furthermore, firms and managers should analyze the potential advantages and threats of big data and should make the investment in their IT and data strategy. Also, firms' data strategy, data models, and solutions should be evaluated as a whole. (Manyika et al., 2011: 13).

There are some challenges with related to the management. In order to get benefits from big data and use it more effectively, companies' leadership style should be open to the changes, and update the vision of the firm and create big data strategies. Moreover, firms culture and structure should be evolved, using the big data in decision making will become the daily routine of workers. Also, companies should hire more talented workers who analyzed data under the correlation and causation environment, help the managers about the usage of big data. Lastly, the IT department of the firm should work hard to create a connection between internal and external sources of big data (McAfee et al., 2012:7-9). Additionally, company culture should be redesigned which will become more suitable for using big data in decision making (Manyika et al., 2011: 13).

The other big challenge that will affect both the firms and people private lives are the privacy, security, intellectual property, and liability. Data will be collected from everywhere, with every device. They can contain very specific, unique information about people, such as health conditions or financial situation of people will be collected for the added value of people lives. However, big data holds private information about people (Chen et al., 2014: 202-204).

Big data privacy comprises two aspects one is the protection of personal privacy in the data collection phases such as individual interest, behavior or photos of people can acquire, maybe without the awareness of users. Secondly, maybe personal data that collected after taking permission by people can pass over the other parties during the stages of data storage, transmission or usage. So that not only the protection the just big data, also all the process that is from created data to usage should be properly protected (Chen et al., 2014: 202-204). So that, cyber-security is the more important concept in the big data umbrella (Blanchet et al., 2014: 8).

Moreover, civil freedoms rights of people will decrease (Boyd & Crawford, 2012, p. 664). So that violation of people privacy will be possible with the big data technology (Body and Crawford, 2012: 664; Chen et al., 2014: 172; Manyika et al., 2011: 12; Wu et al., 2014: 99-102). To protect privacy, some regulations can be done such as accessing the data should be restricted, maybe only some authorize can access the whole data. Moreover, when record the data, name of them can be anonymized (Wu et al., 2014: 99-102).

Data security is the other big obstacle for big data because data will contain information about both private lives of people and companies and national security. So that protecting them will be important (Manyika et al., 2011: 3). As the volume of data increases, data safety and possibilities of cyber-attack risks of data increases. The traditional method is not effective to protect the variables in the big data environment (Chen et al., 2014: 202-204; Wu et al., 2014: 98). Private information like credit card numbers, password etc. knowledge hold in big data so that protect them from malevolent parties is very crucial in order to increase trust and usage of big data (Chen et al., 2014: 176). In addition, data collected and send to cloud systems that have a connection to the internet should be protected from cyber-attack (Chen and Zhang 2014: 319-321).

Data that every single thing, relations, movements etc. will be created and collected which causes data bulky, and data which collected from different sources. Further, data create millions of connections to network the other systems, data (Chen et al., 2014: 172). All of them causes qualification of data and the relationship between them will become more complex (Wu et al., 2014: 99-102). Further, data create millions of connections to network the other systems, data. So that some methods should be developed in order to quickly and accurately analyze and forecast of data (Chen et al., 2014: 172).

A huge amount of data should be properly analyzed and used as a competitive advantage by the firms. In order to analyze, evaluate the conclusion and using the result to manage the company under the big data perspective will require talented people who have deep analytical skills or expertise in statistics. However, it is clear that right now there are not enough talented employees in the market. So that, government, academicians, and universities should fulfill the gap between demand and supply of the talented people (Manyika et al., 2011: 3-10). Talented people need because understand sample, deducing from data, analyzing them will become more crucial for firms (Boyd and Crawford, 2012: 668).

When to construct the storage systems, three factors should be taken into account. First one is consistency. To protect data to guard against server failures, data should be stored on various servers. However, it causes inconsistency between the same data that hold different servers. The second one is availability. More servers mean to more serves failure, but systems should be designed which not effect until the unsatisfied customer demand. The last one is the related to the tolerance. Distributed systems should have capabilities to tolerate some network failures (Chen and Zhang, 2014: 319-321).

The other challenge is that how searching, mining and analyzing of the data from a large pool. New analytical techniques, new technologies, innovations (Manyika et al., 2011: 12), models should be developed or invented (Chen et al., 2014: 202-204).

It is clear that all time data cannot be collected as a whole, some part of them can be missing because of problems on sensor or sensors to save energy can skip the data. So that, some methods should be developed in order to complete data whose most parts are collected or used learning models that can deduce with using observed data (Wu et al., 2014: 99-102). Moreover, the quality of data that have more effect to the usage of big data should be increased by using some methods (Chen et al., 2014: 202-204).

Furthermore, standardization is very crucial for big data. There are some inadequacies of big data such as no evaluation standard, benchmarking criteria (Chen et al., 2014: 202), data privacy, information sharing policy. Additionally, various applications use different data privacy, information sharing policy and different laws and regulation in different countries. So that, standard laws, regulation, and constraints should be developed and accepted by different countries and firms in order to the forming standard system to reach global optimization with using and evaluating whole information sources (Wu et al., 2014: 99-102). Also, common standard and formats must be necessary to create data integration that comes from multiple sources (Manyika et al., 2011: 12).

Besides, economic growth of the countries will be affected from big data so that policymakers should use big data opportunities more properly and help the firms creating value with using big data but as well as should be taking care of the protecting privacy of the people and ensure data security (Manyika et al., 2011: 13). So that, privacy should be protected both from laws and regulation and firms. Companies should create a trustful bond with their customers and supply chain members (Manyika et al., 2011).

The government should support firms in the field of talented workers and it can revise education programs and open new programs in order to increase the talented workforce. Also sharing and combining data from various sources are important for big data so that government should provide the proper environment for companies in order to share and receive data more effectively such as reregulate laws and rules field of intellectual property, the arbitration of disputes etc. Moreover, firms will obtain some benefits from analyzing big data and create valuable data so that these data should be protected by governments. Maybe copyright and patents reregulate. Besides, the government should help the firms in order to deal with the technological obstacles of big data it can support the firms financially or help them tax expenditures (Manyika et al., 2011).

2.8. AUGMENTED REALITY

Virtual and augmented reality terms can be thought as a similar word, but these two terms have different in some perspective. For example, virtual reality (VR) provides a synthetic platform for users with adding real objects to the virtual platform consequently virtual has been enhanced. However, users cannot see the real world when using it (Azuma, 1997: 355; Kerawalla et al., 2006: 164; Liu et al., 2007).

On the other hand, augmented reality (AR) enhances the real word (Liu et al., 2007) and improve users experience through creates a bond between virtual and real world (Azuma et al., 2001: 34; Klopfer and squire, 2008; Krevelen and Poelman, 2010: 1; Paelke, 2014: 1; Van Wu et al., 2013). Users can continue to link the real word when using it (Azuma, 1997: 355; Krevelen et al., 2006: 164). Moreover, this technology can offer 3D virtual objects that are created by computers (Paelke, 2014: 1) to the real word, runs interactively and in real time (Azuma, 1997: 355; Krevelen et al., 2006: 164). Also, this technology will not only enhance the sight abilities of users but also it can enhance skills of all senses like smell, touch (Azuma et al., 2001: 34; Van et al., 2010: 2).

Until now, augmented reality could not be used comprehensively because of technological constraints. However, technological developments on the field of the mobile phones, sensor technology (Paelke, 2014: 2) and the increasing number of research and development labs (Paelke, 2014: 1) that are opening new in the field of augmented reality.

Augmented reality will make easier lives of users because people directly reach information about the new tasks such as which parts should be selected, the location of parts and repair instruction (Rüßmann et al., 2015: 5). So that users can more quickly adapt to the dynamic production environment (Paelke, 2014: 1).

Also, with this technology, before launching a new plant or a new product, they will be simulated in virtually, after all the requirements such as software uploaded to the machines and then initial trials will be made. So, firms can earn time and decrease cost (Blanchet et al., 2014: 9). For example, Siemens has started to use augmented reality for workers training through a software program that 3-D environment and augmented-reality glasses (Rüßmann et al., 2015: 5).

There are three approaches to visually present an augmented reality that are video see-through, optical see-through and projection. First one is video-see-through technic. Real world images have collected by handheld devices, which are mostly smartphones and tablets after, them and virtual images to combine digitally. Users can see the unified images through LCD or LED screen. This technic is cheapest and easiest to implement, also goods can be easily removed from real world and virtual objects' brightness and can be adapted themselves to the real environment (Azuma et al., 2001:35; Paelke, 2014; Van Krevelen and Poelman 2010: 2-4; Wu et al., 2013: 43). However, when users use head-mounted devices, they cannot see the real environment and system failure also a low resolution of reality, a limited field-of-view are the disadvantages of this technic (Paelke, 2014; Van Krevelen and Poelman 2010: 2-4).

The other technic is optical see-through. Handheld computers (Wu et al., 2013: 43) which are used in order to create holographic optical elements. Virtual objects overload to the real one and can be seen like as a ghost in a real environment. Low production costs, safety, easy to use, continuing to real-world interaction are some advantages (Van Krevelen and Poelman 2010: 2-4) but removing objects will not possible with this technic (Azuma et al., 2001:35; Paelke, 2014). made a study in using this technic, which provides more flexible working and data-rich environment to employees through forming 3D graphics.

The last one is the projection displays. Virtual information is projected directly on the real-world devices with high quality (Azuma et al., 2001:35). When this technic used, people can maintain a connection to the real world because eyewear devices are not required. However additional technical devices are needed to use this technic also it can be affected by surface changes (Paelke, 2014; Van Krevelen and Poelman 2010: 2-4).

2.8.1. Advantages of Augmented Reality

AR will affect positively fields of education, tourism, design, simulation, entertainment, games, and collaboration which are going to discuss the following sentences.

Education will take a new form with augmented reality technology. Because virtual objects such as text, graphics and computer simulations, complex spatial relationships will be observed in a real environment as three dimensional (Dede, 2009; Kerawalla et al., 2006). For example, students can view solar systems (Liu et al., 2007), dynamic geometry systems (Kaufmann et al., 2005) or chemical reactions (Klopfer and Squire, 2008) etc. as three dimensions that enhance learning abilities of them.

Furthermore, managing personal information will become easier with the “Personal Awareness Assistant” device which collects and hold information about the faces and names of people and conversations contents (Van Krevelen and Poelman, 2010). Moreover, with the Space Design application, design workflow and modification of the cars can be observed in a virtual environment (Fiorentino et al., 2002).

Cultural heritage that was destroyed can be constructed virtually so that visitors can observe historical structures and customs (Höllerer and Feiner, 2004). Furthermore, AR will enhance visibility games. Also, people will meet AR games such as they can fight virtual enemies in the real world (Van Krevelen and Poelman, 2010).

Moreover, the quality of healthcare services will be enriched through augmented reality because valuable information will be delivered to glasses of doctors and nurses (Hayward et al., 2004). Also, 3D visualization will be used as a training tool for surgery (Azuma, 1997).

These are just some examples of the augmented reality technologies. In the future, the usage area of it will be enlarged. Besides all of the advantages of this technology, there are some challenges that will be explained following section has to be solved in order to apply this technology properly.

2.8.2. Challenges of Augmented Reality

A huge amount of data will be collected with the AR devices. However, categorizing and selecting important data among them and deciding which data will be shown to users are big problems which must be solved more quickly (Azuma, 2001: 43; Van Krevelen and Poelman, 2010).

Today's wireless connections are not suitable for flexibly using increased reality. So that proper wireless network should be developed which allows that multi-users connection and usage, and data retrieval (Azuma, et al., 2001).

The other problem is about image quality. Low resolution, rendering quality, dip display are some factors that affect the quality of image negatively. So that, technology firms should develop new technology in order to enhance the quality of augmented reality (Azuma et al., 2001: 43; Van Krevelen and Poelman, 2010).

The social acceptance of this technology is a great challenge because it will affect both the personal daily life and the workers' lives. Thereby, people will be informed about potential, constraints, and effects of the user’s everyday life. Because, without acceptance by people, widely usage of this technology will not possible. In addition, ideal hardware and intuitive interface must be developed that will be suitable for every user usage (Azuma et al., 2001; Van Krevelen and Poelman, 2010).

2.9. CLOUD SYSTEM

National Institute of Standard and Technologies (NIST) define cloud technology like that “Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction” (Mell and Grance, 2011). Basically, cloud systems can be defined as a platform; users can easily reach, manage and reconfigure resources (Vaquero et al, 2008: 51) within minutes or seconds.

Cloud has four different modes that are private, public and hybrid identified in the literature. The private cloud can be defined a system used, managed and operated by a single company (Botta et al., 2016: 687) which manages its own data and processes within the organization, regardless of network bandwidth, security exposures and legal requirements (Mell and Grance, 2011; Rimal et al., 2009: 45)**.** On the contrary of the private cloud, public cloud is an open resource which basis over the internet, web applications and web services (Rimal et al., 2009: 45) for general public usage that managed, owned, operated by business, academic, or government organization (Botta et al., 2016: 687; Mell and Grance, 2011). The third is the community cloud that is used by a particular community of consumers who have shared common concerns like mission, policy etc. organization (Botta et al., 2016: 687) managed by organization or organizations, third party or combination of them. Hybrid is the last cloud mode that is a combination of two or more distinct cloud infrastructures has connected each other by standardized or proprietary technology (Mell and Grance, 2011).

Besides four different modes, there are three cloud architecture layers that are infrastructure, platform and application (Botta et al., 2016: 687; Mell and Grance, 2011; Papanikolaou and Mavromoustakis, 2013; Rimal et al., 2009: 45-46; Vaquer et al., 2008: 50-51). To best understand the cloud system these will be defined below.

First one is Infrastructure as a Service (IaaS) that ensure processing, storage, networks, and other fundamental computing resources (Mell and Grance, 2011; Vaquero et al., 2008: 50-51) to customers. Higher flexibility, latest technology usage, faster service delivery (Rimal et al., 2009: 45-46) managing and controlling operating systems and storage are some advantages of this service (Mell and Grance, 2011). Platform as a Service (PaaS) that provides the software platform where systems operate on (Vaquero et al., 2008: 50-51) contains the programming language execution environment, web services, database services etc. (Mell and Grance, 2011) Microsoft's Azure and Google Apps Engine can be given as examples (Rimal et al., 2009: 45-46). The last one is software as a service (Saas) that provide software for end users. This cloud model allows users to run provider's applications directly from a web browser or a program interface. (Mell and Grance, 2011; (Vaquero et al., 2008: 50-51)**.** IBM, Microsoft, Oracle are some of the providers (Rimal et al., 2009: 45-46).

2.9.1. Advantages of Cloud Systems

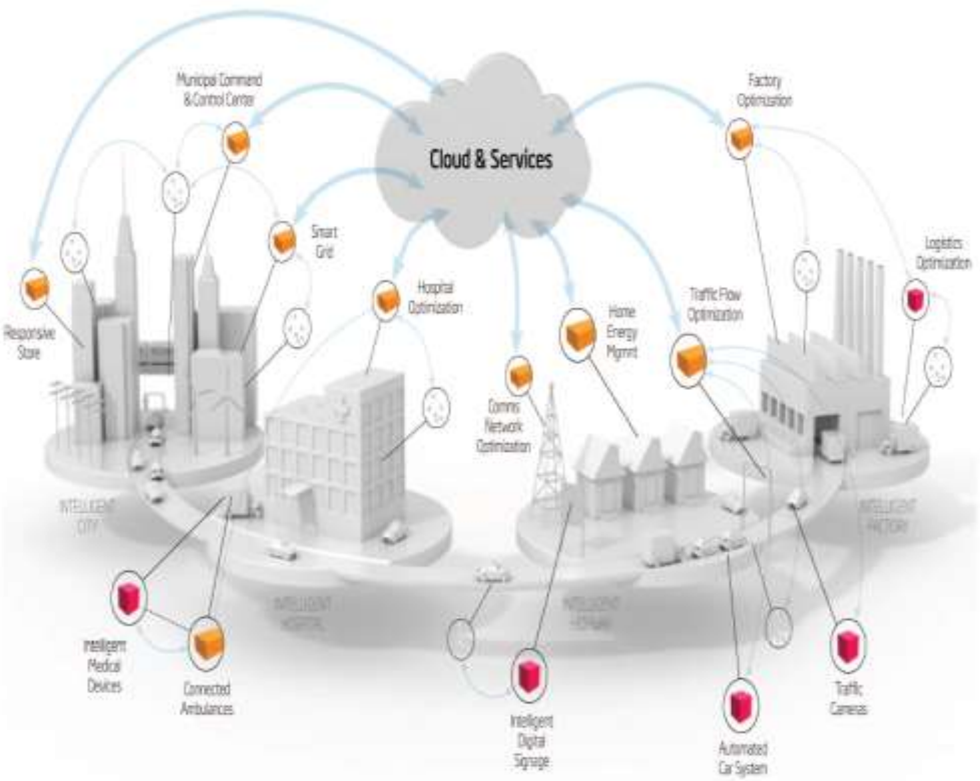
Some big companies already have used cloud systems for service delivery purpose (Botta et al., 2016: 687). However, with the fourth industrial revolution, communication and sharing information will get new forms. So that to sharing and reaching information that obtained from smart goods via a cloud system will become more important. At the moment, the cloud system that will come to the help of firms provides some technological, economical and time-saving benefits (Rüßmann et al., 2015).

All the systems, devices and goods will be connected and communicate with each other with internet of things and cloud systems. Also, with the sensor technologies, smart objects collect a huge amount of data. All the produced data can be available more quickly from everywhere and stored affordable cost (Kagermann, 2015: 26). Also, produced data can be more easily shared with third parties (Botta et al., 2016). So that systems of the company can be managed and controlled by the cloud systems that give flexibility to business (Kagermann, 2015: 26) and offers cloud-based solutions (Rüßmann, et al., 2015: 4).

The cloud network, smart devices, internet of things will have enhanced the quality of people lives. For example, the quality of the medical services will be increased because important information about patients that will be collected with smart systems can be shared by the doctors via cloud systems. Thereby, conditions of patients will be pursued more accurately than today. In addition, with the smart home concept daily home goods can be remotely controlled by people (Botta et al., 2016).

Huge amounts of data and information that collected from various sources can be analyzed and processed thanks to cloud systems so that logistic services more accurately managed and information that will be collected by sensors used to increase road safety, reduce traffic jam, manage traffic and parking (Botta et al., 2016).

Figure 16: Cloud and Services Integrations to Virtual Systems



Source: Intel®, 2012

Figure 16 visualizes services areas that will be affected by cloud systems. Smart cities and communities, smart home and smart metering, automotive and smart mobility, smart energy and smart grid, smart logistics and environmental monitoring are some services that will be possible with cloud systems.

2.9.2. Challenges of Cloud Systems

Besides these advantages, there are some challenges that are security, standardization, laws, and interoperability in the cloud system. On the following chapters will be explained these challenges.

Security of cloud becomes big problems for humankind (Botta et al., 2016: 687; Rice, 2012). Because, in 2014, every day 2.5 quintillion bytes of data were created (Dobre and Xhafa, 2014: 267). However, in 2050, 50 billion devices are expected to be connected. As well as sensors technology will be collected a huge amount of data. All of these created big data that will be held in the cloud. Hence, the security of these data which hold in the cloud must be provided.

Another reason why security is important that customers, people, and companies will share important data, personal information etc. with the cloud system (Rimal et al., 2009: 46). So that the systems have to be protected from hacker attacks, privilege abuse (Botta et al., 2016: 687).

Furthermore, the industry 4.0 revolution, varied devices will create a connection but store, connect and managing these varied connections will be very hard without a standard protocol. Moreover, without standardization, implementing effective authentication and authorization mechanisms and managing the systems effectively will not possible (Botta et al., 2016).

Standardization is not only comprising use of cloud but also laws and regulation should be standardized because of different service providers who responded from various laws and regulation duties (Botta et al., 2016: 687).

The last issue is interoperability before cloud will be widely used by firms, all applications must be integrated via one or multiple cloud infrastructures. (Rimal et al., 2009: 46) For example, in the smart home concept, people can control the home devices but in order to control them, the interaction of them should be uniform (Botta et al., 2016: 687). The Cloud Computing Interoperability Forum (CCIF) has mostly studied on this and similar issues (Cloud Industry Forum).

CHAPTER THREE
ANALYSIS AND RESULTS

3.1. OBJECTIVE OF THE RESEARCH

Usage of steam power on production and the mechanization of production systems opened the door of the first industrial revolution. Industrial revolution caused big changes in human lives, production systems, agriculture products etc. Inventions of new technologies begeted the second and third industrial revolution.

Nowadays, human society has met the fourth industrial revolution. Like the other revolutions, this revolution will affect the dynamics of the production systems, business, a society so on. Smart factories, smart goods, and systems, cyber-physical systems, internet of things, big data are some of the new terms in which the fourth industrial revolution brings. The main objective of the study is to identify awareness of firms located in İzmir and Manisa cities about Industry 4.0’s terms.

The sub-objectives of this study are as follows:

- To find out how many firms are in which Industry 4.0 stages
- To find out which applications describe the Industry 4.0 initiatives for firms
- To learn the main challenges of the Industry 4.0 for firms
- To find out expectations of firms about the benefits of various IT integration when to apply Industry 4.0
- To reach information about the usage of the security program in companies
- To learn which security problems firms face
- To reach information about existing and future Industry 4.0 budget of firms
- To find out whether Kosgeb and various Industry 4.0 incentives triggers of firms’ investment or not.
- To find out whether there is a relationship between firm size and awareness of Industry 4.0’s terms
- To learn obstacles of the applying the Industry 4.0 into reality for firms
- To find out value-added areas of Industry 4.0 for firms
- To learn which problem can be solved in production with digitalization
- To learn the benefits of augmented reality for firms

- To learn which innovations, robots and automation are desired by firms.

3.2. HYPOTHESES

When the literature is examined, it is found that a firm's capacity and innovation level are connected to each other. Introduction of new products, new processes, or new marketing or organizational methods are related activities to innovations and large firms can obtain more benefit in those fields when compared with the SME's (Golgeci and Ponomarov, 2015; Hult et al., 2004). Because large firms have a greater technological ability, can allocate more cash flow and assets for innovation (Rogers, 2004) and make more R&D activities due to their financial abilities (Kort, 2010; Scherer, 1991). Moreover, a research that is made in the European manufacturing industry in 2008 reveals that product and process innovation performances of large firms are better than the small and medium-sized enterprises (Vaona and Pianta, 2008).

When all factors that are mentioned above are evaluated, it is revealed that large firms can easier follow innovation and technological changes thanks to their financial abilities and R&D budget than SME's. It is thought that large firms can more aware of the Industry 4.0's terms. So that, hypotheses are constructed to reveal whether there is a relationship between firm size and awareness of Industry 4.0's terms.

Independent variable of the study is the firm size. Firm size is divided into four categories according to employees' numbers. These categorizations are formed according to Kosgeb categorization (Kosgeb, 2018). If firms have 0-9 employees they are named as micro small and medium enterprises (SME), 10-49 employees as small scaled SMEs, 50-249 employees as medium scaled SMEs, 250 or above employees as large-scale firms. However, to reach more properly firm size distributions, micro, small-scaled and medium scaled enterprises are categorized as SME category. So that, firm size categories are decreased from 4 to 2 which are small and medium-sized enterprises and large firms. They formed to independent variables of the hypotheses. Moreover, Industry 4.0, made in China 2025, big data, society 5.0, advanced manufacturing partnership, internet of things, factory layout and cyber-physical systems are the dependent variables of the hypotheses.

The hypotheses constructed are as follows:

H_1: There is an association between the firm size and awareness of “Industry 4.0”.

H_2: There is an association between the firm size and awareness of “Made in China 2025”.

H_3: There is an association between the firm size and awareness of “Big Data”.

H_4: There is an association between the firm size and awareness of “Society 5.0”.

H_5: There is an association between the firm size and awareness of “Advanced Manufacturing Partnership”.

H_6: There is an association between the firm size and awareness of “Internet of Things”.

H_7: There is an association between the firm size and awareness of “Factory Layout”.

H_8: There is an association between the firm size and awareness of “Cyber-Physical Systems”.

H_9: There is an association between the firm size and usage of the security program.

3.3. METHODOLOGY

3.3.1. Questionnaire Design

Data are collected using a structured questionnaire which includes separate sections. The survey is distributed to general managers. Because general managers have responsibilities to manage firms, and as the fourth industrial revolution affects the firms, it is thought that the general managers can aware of the fourth industrial revolution and the firms’ approach. However, some of the surveys are answered by other white-color personnel. The unit of analysis is the firm level.

The questionnaire that is developed for this study consists of four parts. The first part contains questions about the descriptive features of both respondents and firms. First 6 questions are demographic characteristics of white-color workers like gender, age, education level, career, work experience and graduate faculty. Questions

7 to 10 ask information about firms such as research and development budget of firms, sector of firms, company operation time.

The second part of questions, there is only one statement that aims to clarify which terms are known by firms. Industry 4.0, made in China 2025, big data, society 5.0, advanced manufacturing partnership, internet of things, factory layout and cyber-physical systems terms are related to Industry 4.0 or the synonymous name of the Industry 4.0 or effected technologies/areas by Industry 4.0. In the following paragraph, the reasons for the selected terms that asked in question will be explained.

Industry 4.0 term has been used as the fourth industrial revolution in 2011 by Germany government (Kagermann et al., 2011). Made in China 2025 is the Chinese version of the fourth industrial revolution (Liu, 2016), big data and internet of things technology are the result of the new industrial revolution (Kagermann et al., 2013). Society 5.0 that is adaptation society to the changes of Industry 4.0 has been used by the Japanese (Wang et al., 2016). Also, advanced manufacturing partnership had been launched by Obama in U.S. (Secretary, 2011), that is a kind of partnership consist of the industries, universities and the federal government to invest in emerging technologies like as Industry 4.0. (Johnson, 2016). Vertical and horizontal integration and smart factories concept will change the design of factory, manufacturing systems. So that, factory layout is one of the most affected areas from the fourth industrial revolution (Wang et al., 2016). Finally, the cyber-physical systems used as a synonym of Industry 4.0 (Vogel-Heuser and Hess, 2016).

Third and fourth parts of the questions (between 12-27) are taken by International Data Corporation (IDC) Report (Schulte, 2016). IDC is a market research firm that collects and analyzes data and prepares a report for IT professionals, business executives, and the investment community. In 2016, Dassault Systèmes sponsored to IDC to make a research named "Digital Transformation in the Manufacturing Industry, Industry 4.0: From Vision to Reality” (Schulte, 2016). In this report, data are collected from 200 manufacturing firms in Germany to learn the opinions of firms about digital transformation, planned Industry 4.0 projects etc. In this study, third and fourth parts of the questions are taken from IDC report because the firm is the market leader in the collecting data in the field of digital transformation and questions asked IDC report are prepared by experts.

In the third part of the survey, the 13th question asks firms whether there is an evaluation or application phase of Industry 4.0. If there is not any evaluate or application for Industry 4.0 in the firm, companies do not continue the surveys because in the following questions are related to the evaluated or application phase of Industry 4.0. Later, more detailed questions such as the obstacles, expectations, the benefit of Industry 4.0 are asked. These questions are taken by the IDC Report (Schulte, 2016).

Last part of the survey contains structured open-ended questions to collect exhaustive opinions of the firms about the obstacles and value-added areas of Industry 4.0, problem-solving in production with digitalization, benefits of augmented reality and new Innovations, robots and automation for firms. These questions are taken by the IDC Report (Schulte, 2016).

First 6 questions and questions between 11 to 22 are multiple choice questions. In some questions, respondents select just one answer, the other questions respondents can select more than one answers, also there is "other" part in case of not suitable answer(s). Questions 4,8,9 and 10 ask for specific information such as; the career of the respondents, R&D budget of firms, the sector of the firm, company operation time. In those questions, respondents write the answer directly. Questions 23 to 27 are structured open-ended questions.

In the survey, data are collected by the nominal scale and there are both multiple-choice and dichotomous questions. In the multiple-choice questions, firms select one or more of the alternatives given. Also, there is an alternative labeled as other. In the dichotomous questions have two alternatives; yes or no.

After the questionnaire is prepared, survey questions pass three pretest stages to increase the content validity of the research. Firstly, 10 academicians read and evaluate the questions in the survey and give feedback. According to these feedbacks, survey questions are modified. Secondly, a native speaker evaluates the survey questions because some of the questions are taken from the English language survey. She appraises and compares the survey questions, and according to her commend and criticize survey questions are revised. Lastly, to learn whether there is an unnecessary question or problem of the understanding meaning of questions, face to face interviewed with two production managers are made, and as to their evaluations, the survey is modified and take its final shape. In this study, reliability analysis of survey could not be conducted because to make a reliability analysis, questions' numbers must be bigger than 30 (except demographic questions) and sample size must be bigger than 50, also the survey should have additivity feature (Kalaycı, 2010: 404). In this research, the survey has 27 questions and 10 of them are demographics and sample size 38. Moreover, in this research nominal scale is used, it does not have an additivity feature.

3.3.2. Sampling

The sample of the study is determined by non-probabilistic methods. The survey contains questions about specific information of firms and their strategies about Industry 4.0. So that survey questions should be answered by the general managers, however, some of the surveys are answered by other white-color personnel. Difficulties in reaching general managers, time and budget constraints are the main reasons to select the convenience sampling method. Moreover, the survey questions are distributed by the people who had already answered. The snowball and convenience sampling methods are used in determining the sample.

Survey questions were sent to firms located at Aliağa, Buca Ege Sanayicileri, Atatürk and Manisa organized industrial zone, İzmir, and Ege free-trade zones. These organized zones and the free-trade zones were selected due to easy accessibility. E-mail informations of firms were reached through the internet web site of industrial zones and free-trade zones. Under the firms' sections of websites, e-mails of firms were downloaded, and the survey was distributed. General information about survey such as the purpose of the study, who can answer the questions, information protection policy etc. were written in the e-mails, the survey was attached to e-mails and 600 e-mails were sent to firms on 17.12.2017.

4 firms were located at the Atatürk organized zone, 5 firms were located at the Gaziemir free-trade zone and 4 firms were located at the Manisa organized industrial zone. These firms answered the questions to the sent e-mail. The other organized zones and free trade zones did not respond. The other data were collected by the snowball sampling method. The end of the survey collection period was between December to May, 2018. The sample size for the study was 38.

3.3.3. Data Analysis

Data analysis of thesis can be collected under three parts. In the first part, descriptive analyses are used to evaluate demographic characteristics of the respondents and firms. Moreover, under this section, firms' phases of Industry 4.0 application, opinions about incentives, obstacles and benefits of Industry 4.0 and whether firms have or not an Industry 4.0 budget are analyzed with using bar and pie charts. In the second part, data collected through survey are analyzed using SPSS 24 version. In the hypotheses testing phase, one of the nonparametric tests is chi-square which is used to find out whether there is a relation between firm size and awareness of the terms related to industry 4.0. Chi-square test is used when data are nominal and the aim of the study is to learn whether there is a relation between two variables or not (McHugh, 2013: 143; Rencher, 2003). It explains reasons of the using the chi-square test to analyze the hypotheses of this thesis.

However, data must meet some assumptions of chi-square.

1) There are two categorical variables (nominal or ordinal data)
2) Each variable should have two or more groups
3) Independent observations, there are no relations between study groups
4) Each group should have at least 1 expected frequencies and expected frequencies are 5 or more in each cell in a 2 by 2 tables (Kent State University Libraries, n.d.; Laerd Statistics, n.d.; McHugh, 2013: 144).

In the last part, content analysis is used to evaluate the answers to the open-ended questions.

3.3.4. Limitations of Study

This study has some limitations, which create opportunities for future research. The most important limitation of this research is the sampling method that is used. Convenience and snowball sampling are a type of non-probabilistic sampling technique which results in a generalizability issue of the findings.

Moreover, data are collected from in İzmir and Manisa cities of Turkey is regarded as the limitation in this study. The third limitation relates to the sector of firms. In this study, data are collected from various sectors, so there is not to draw a pattern between sectors and awareness of the terms.

3.4. DATA ANALYSIS

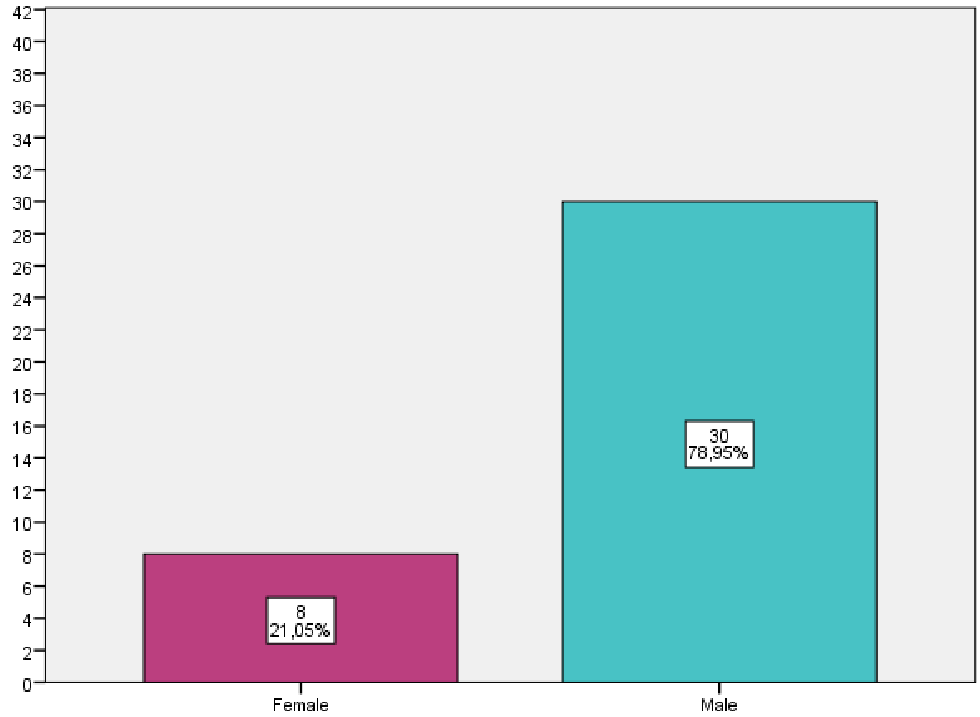
3.4.1. Descriptive Analyses

Under this section, some descriptive features of respondents such as gender, age, education level, work experience etc. will be explained. Afterward, information about the firms that are the employees' numbers, sectors, operation time will be clarified. Lastly, data from firms about the Industry 4.0 will be analyzed using the bar, pie charts, and custom tables.

3.4.1.1. Gender

Distribution of the samples according to gender are shown in Figure 17. The sample size is 38 and 8 of them (21,05%) are women and 30 of them (78,95%) are men. Male respondents are approximately four times more than women.

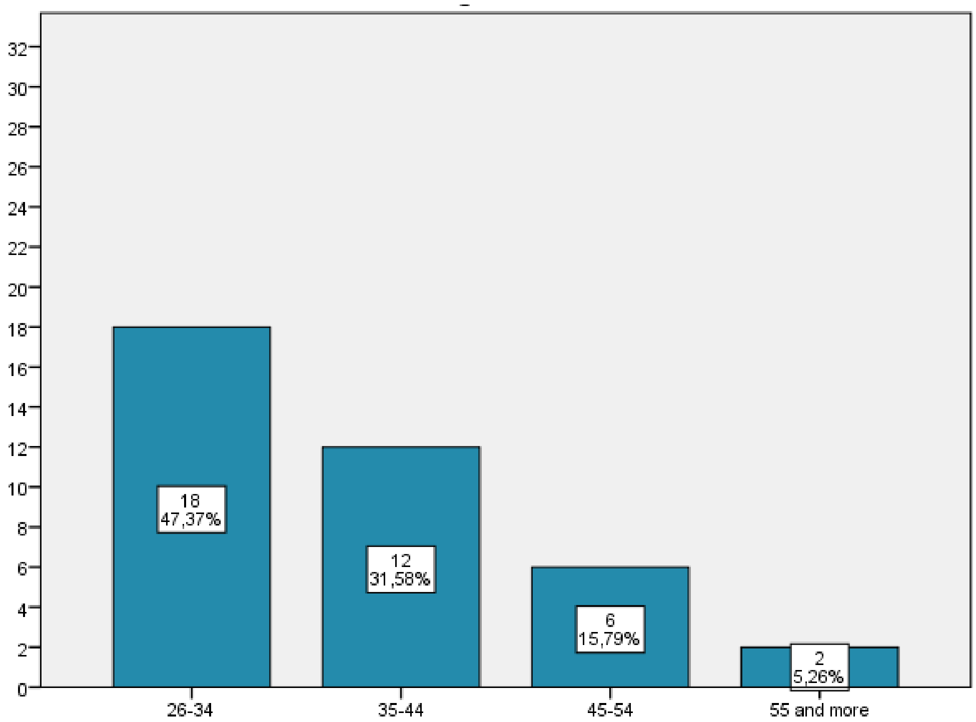
Figure 17: Gender Distribution of Sample



3.4.1.2. Age

Distribution of the samples according to age is shown in Figure 18. According to the figure, there is no respondent whose age between 18-25. 18 people (47,37%) are between ages 26-34, 12 people (31,58%) are between ages 35-44, 6 people (15,79%) are between age 45-54 and 2 people (5,26%) are ages 55 and more than 55. Nearly 80% of respondents are younger and their ages less than 45.

Figure 18: Age Distributions of Sample



3.4.1.3. Education Level

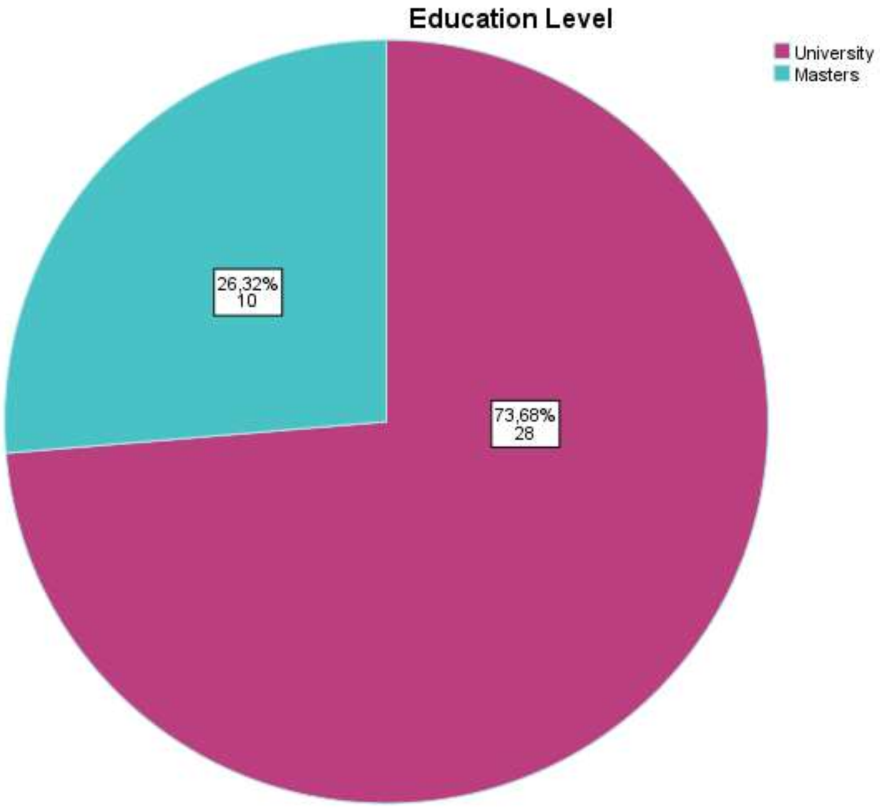
The education level of the sample is as shown below Table 1. There is no respondent whose education level is primary school and high school. All the respondents have graduated from universities, some of them have a master's degree. However, there are no respondents whose has a doctorate degree.

Table 1: Distribution of Education Level

		Count
Education Level	Primary School	0
	High School	0
	University	28
	Masters	10
	Doctorate	0

When analyzed the data more in-depth, 28 (73,68%) of respondents have graduated from university and 10 (26,32%) of respondents have graduated master program. It can have observed, data collected from people who have a higher education level.

Figure 19: Education Level of Sample

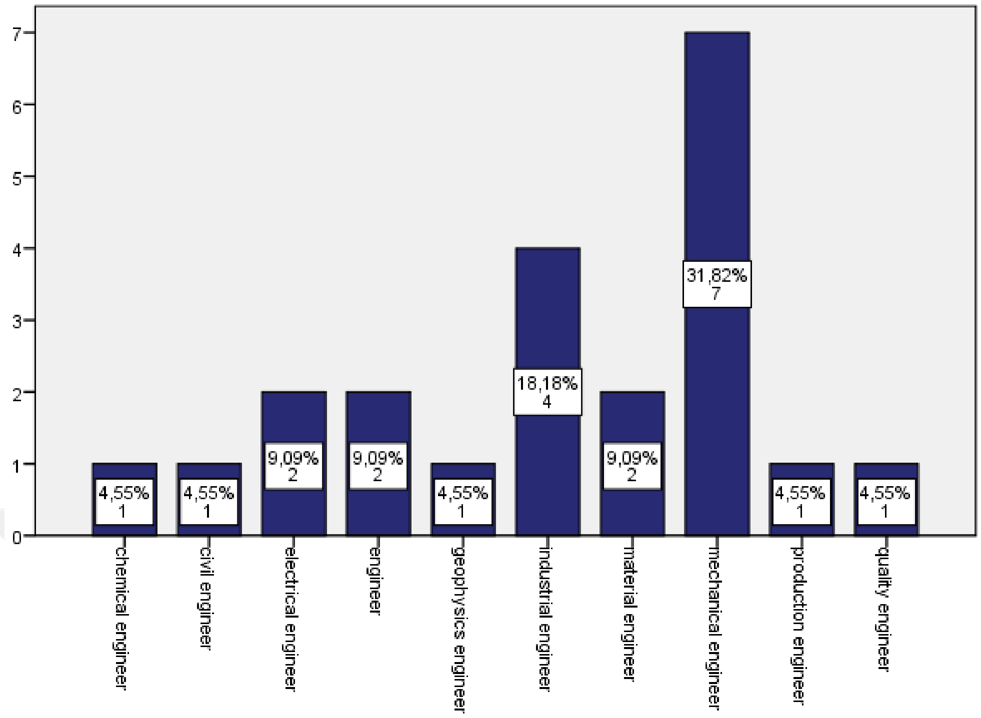


3.4.1.4. Career

Data of career is analyzed after forming two groups, the first group is an engineer, the second group is the manager. Most of the respondents' career whether an engineer or manager so that in order to more easily evaluated data two groups are formed. The first group is as shown in Figure 20.

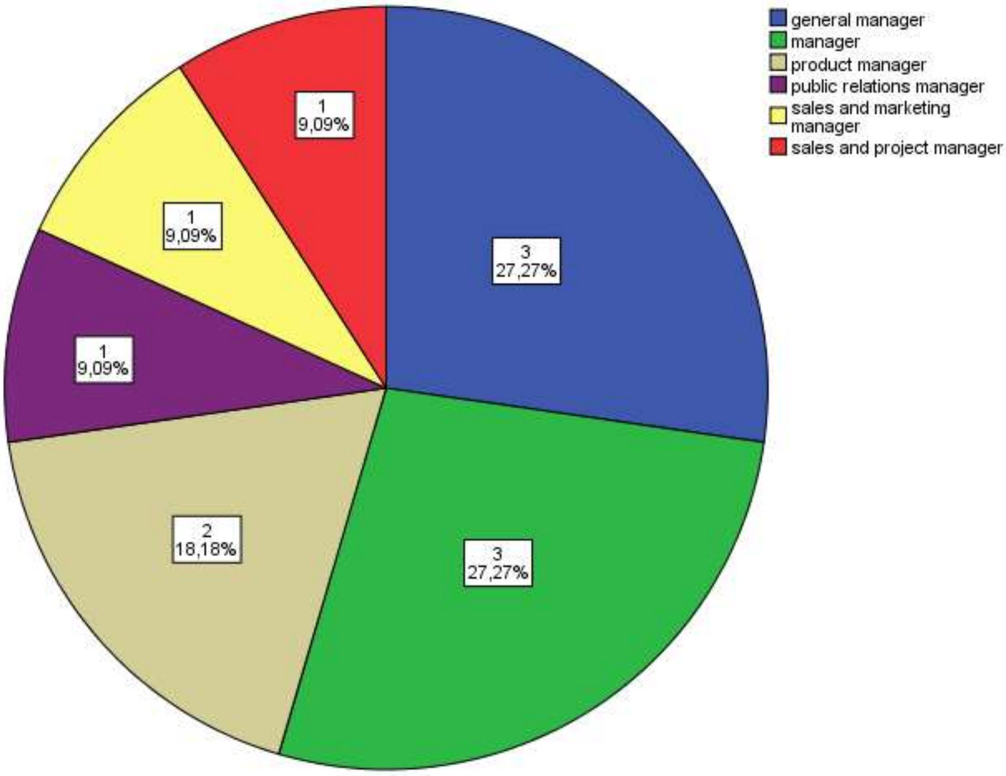
22 of 38 respondents are engineers. There is one engineer in each of the fields, which are chemical, civil, geophysics, production and quality engineer. There are 2 engineers in the field of an electrical and material engineer. 4 engineers are a field of industrial, 7 engineers are the field of the mechanical engineers. 2 of the respondents only wrote the engineers. Nearly 49% of them are mechanical and industrial engineers. In Figure 20, more detailed information about engineer types can be reachable.

Figure 20: Engineer Types



11 of 38 respondents are managers. There is one manager in each of the fields, which are public relations, sales and marketing and sales and project manager. There are 2 product managers and 3 general managers. 3 of the respondents only wrote the manager. 45,45% of them are general and product managers. In Figure 21, more detailed information about managers types can be reachable.

Figure 21: Manager Types

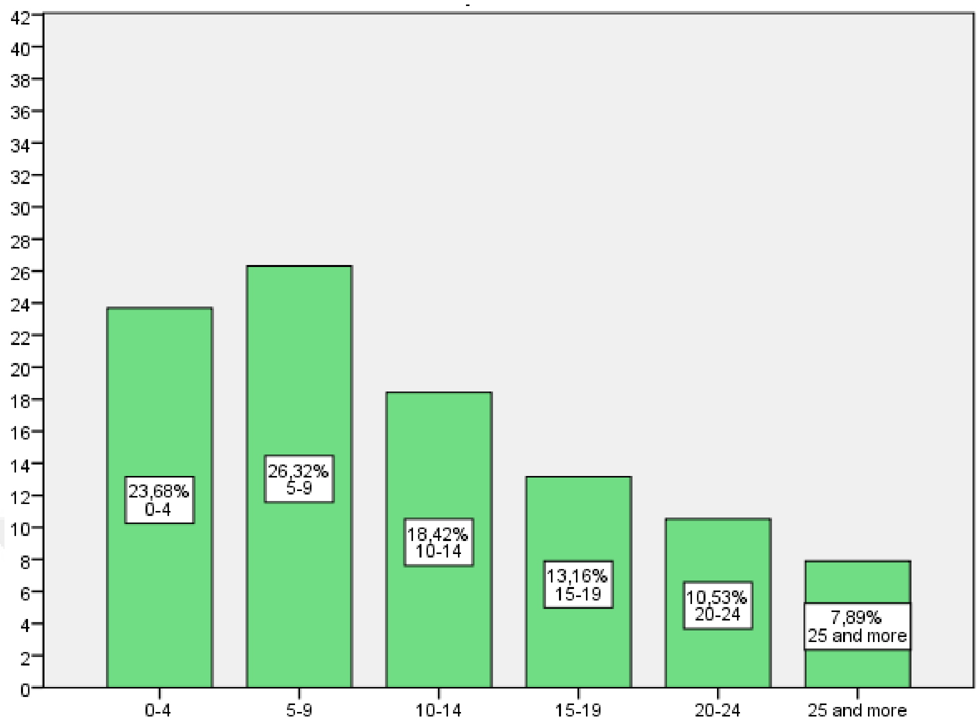


The other respondents' jobs that one of them is a market research specialist, one respondent just wrote business administration and three of them did not answer the question.

3.4.1.5. Work Experience

The work experience of the sample can be seen in Figure 22. Sample size is 38 and 9 of them (23,68%) have 0-4 years' work experience, 10 of them (26,32%) have 5-9 years' work experience, 7 of them (18,42%) have 10-14 years' work experience, 5 of them (13,16%) have 15-19 years' work experience, 4 of them (10,53%) have 20-24 years' work experience, and lastly 3 of them (7,89%) have 25 or above years' work experience. Nearly, three fourths of the sample have 0-14 years' work experience.

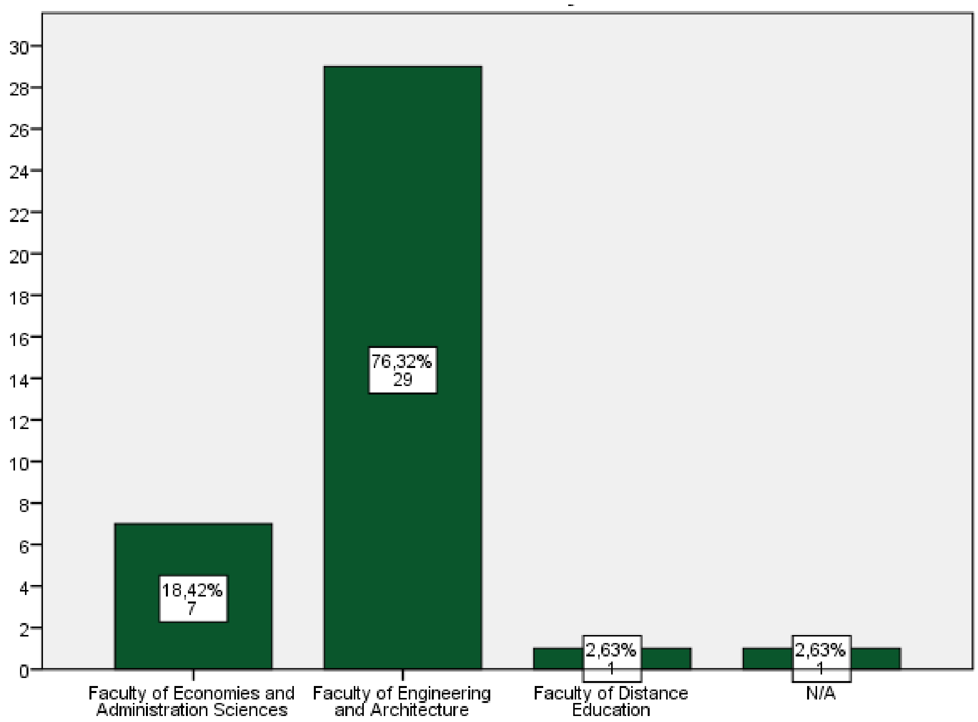
Figure 22: Work Experience Distributions of Sample



3.4.1.6. Graduate Faculty

The work experience of the sample can be seen in Figure 23. Sample size is 38 and 29 of them (76,32%) have been graduated from faculty of engineering and architecture, 7 of them (18,42%) have graduated from faculty of economics and administration sciences, 1 of them (2,63%) have graduated from faculty of distance education, and lastly 1 of them (2,63%) did not answer the question, which coded as N/A. Most of the respondents have been graduated from the engineering faculty.

Figure 23: Graduated Faculty Distributions of Sample

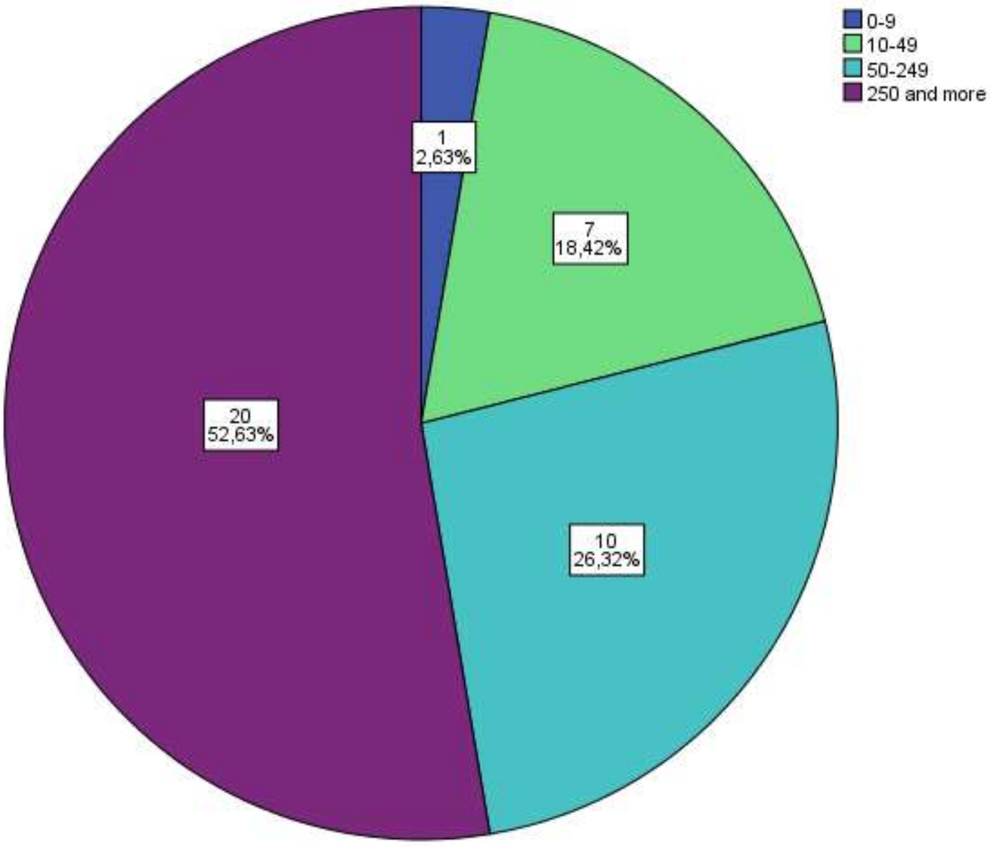


3.4.1.7. Firm Size

In the survey, firm size is divided into four categories. These categorizations are formed based on Kosgeb website (Kosgeb, 2018). According to website information, firms have 0-9 employees named as micro small and medium enterprises (SME), firms have 10-49 employees named as small scaled SMEs, firms have 50-249 employees named as medium scaled SMEs, and firms have 250 or above employees that named as large-scale firms. Firm size distribution of the sample is as shown in Figure 24.

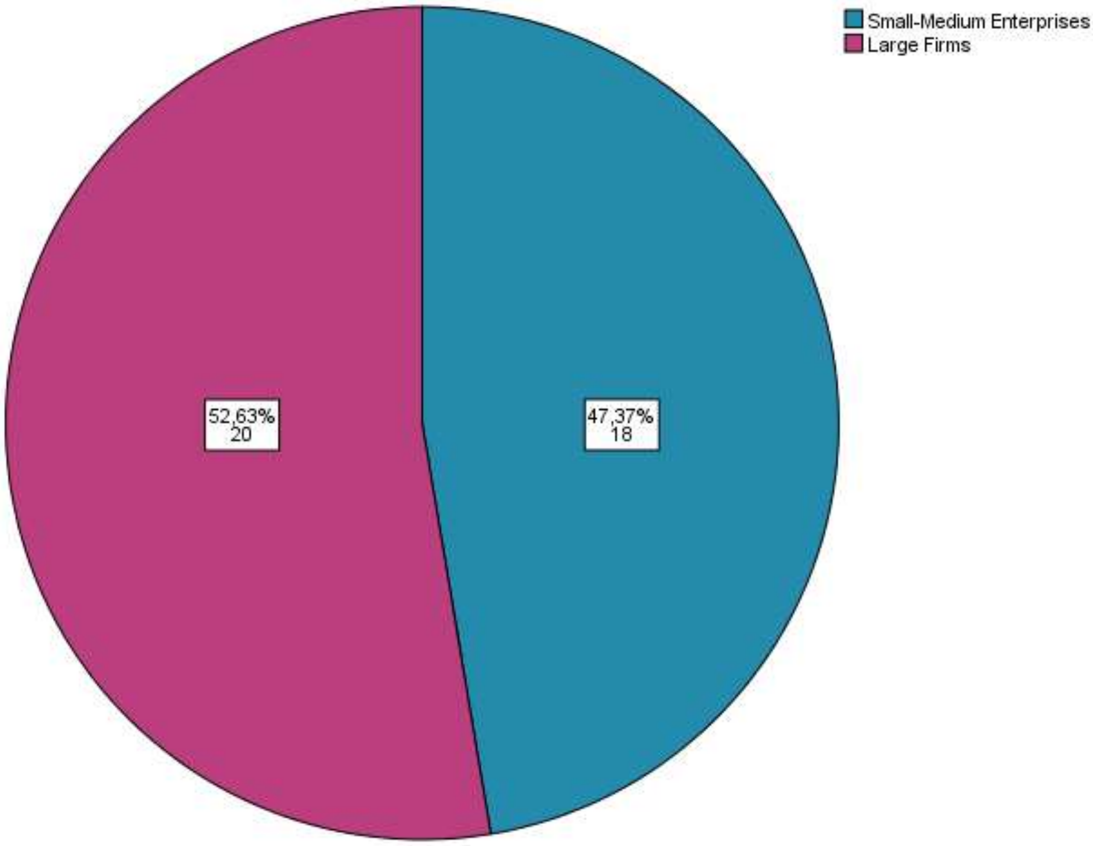
The sample size is 38 and 20 of them (52,63%) are large firms, 1 of them (2,63%) is micro SME, 7 of them (18,42%) are small-scaled SMEs, and lastly, 10 of them (26,32%) are medium scaled SMEs. Most of the respondents are large firms.

Figure 24: Firm Size Distributions



Firms size is categorized into two parts, which are SME and large firms that as shown in Figure 25 in order to reach more properly respondents distributions. After categories are decreased from 4 to 2, there are 20 large firms (52,63%) and 18 SMEs (47,37).

Figure 25: Small-Medium Enterprises and Large Firms Distributions of Sample

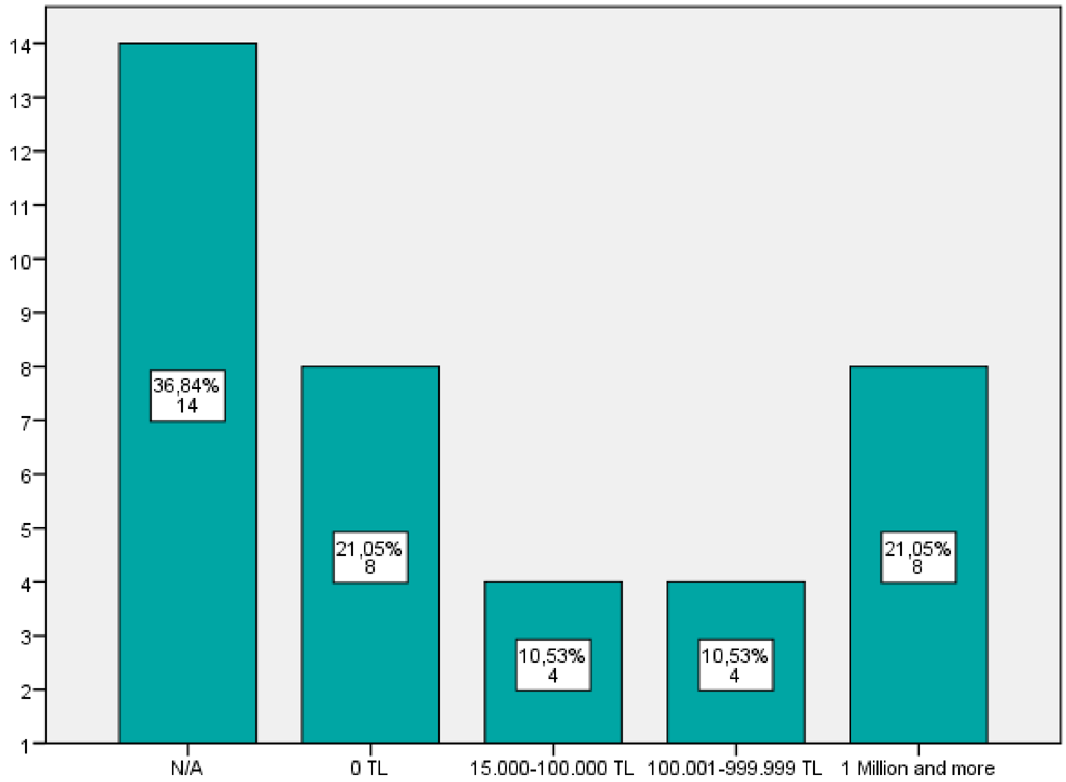


3.4.1.8. R&D Budget of Firms

Some of the firms write their research and development budget as Euro and dollars. These currencies were converted to Turkish Lira using 16.05.2018 data 15.30 p.m. currencies rate of Central Bank of Turkey (Central Bank of Turkey, 2018).

The visual appearance of the Research and Development (R&D) budget of firms can be available in Figure 26. Sample size is 38 and 14 of firms (36,84%) intentionally leave the question blank, which is coded as N/A, 8 of firms (21,05%) have no R&D budget, 4 of them (10,53%) have an R&D budget of between 15.000-100.000 TL, 4 of them (10,53%) have an R&D budget of between 100.001-999.999 TL and lastly 8 of them (21,05%) have an R&D budget of 1 million TL and above.

Figure 26: R&D Budget of Firms

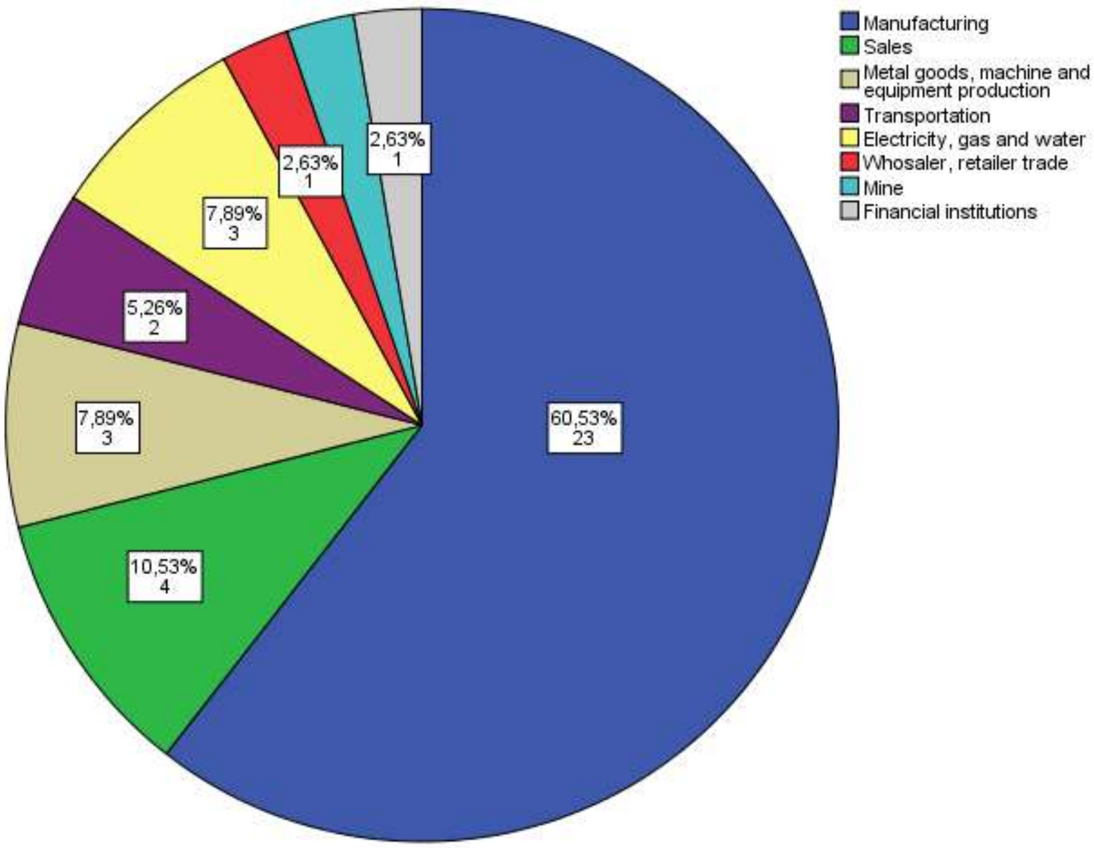


3.4.1.9. Sector of Firms

In the survey, each respondent wrote their jobs as text. After that, sectors of jobs were categorized based on “Kamuyu Aydınlatma Platformu” (KAP) sector categorization information (KAP, 2018) to easily categorize and analyze the firms of sectors.

The sector of firms can be seen in Figure 27. Sample size is 38 and 23 of them (76,32%) are in the manufacturing sector, 4 of them (10,53%) are in the sales and marketing sector, 3 of them (7,89%) are in the metal goods, machine and equipment production sector, 3 of them (7,89%) are in the electricity, gas and water sector, 2 of them (5,26%) are in the transportation sector and there is one firm each of these sectors which are wholesaler, retailer trade, mine and financial institutions. More than half of the firms are in the manufacturing sector.

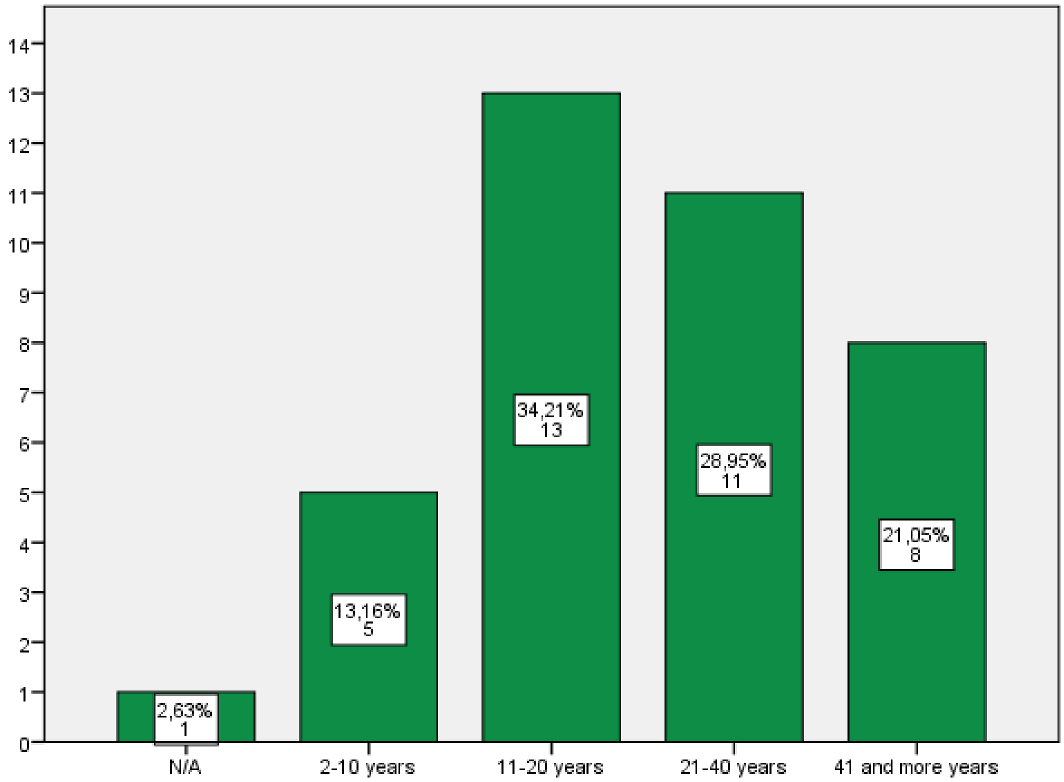
Figure 27: Distribution of Firms by Sector



3.4.1.10. Company Operation Time

Company operation time of the sample can be seen in Figure 28. Sample size is 38 and 5 of them (13,16%) have been operated between 2-10 years, 13 of them (34,21 %) have been operated between 11-20 years, 11 of them (28,95%) have been operated between 21-40 years, 8 of them (21,05%) have been operated 41 and above years, and lastly 1 firm (2,63%) did not answer the question that coded as N/A. More than half of the firms have been operated between 11-40 years.

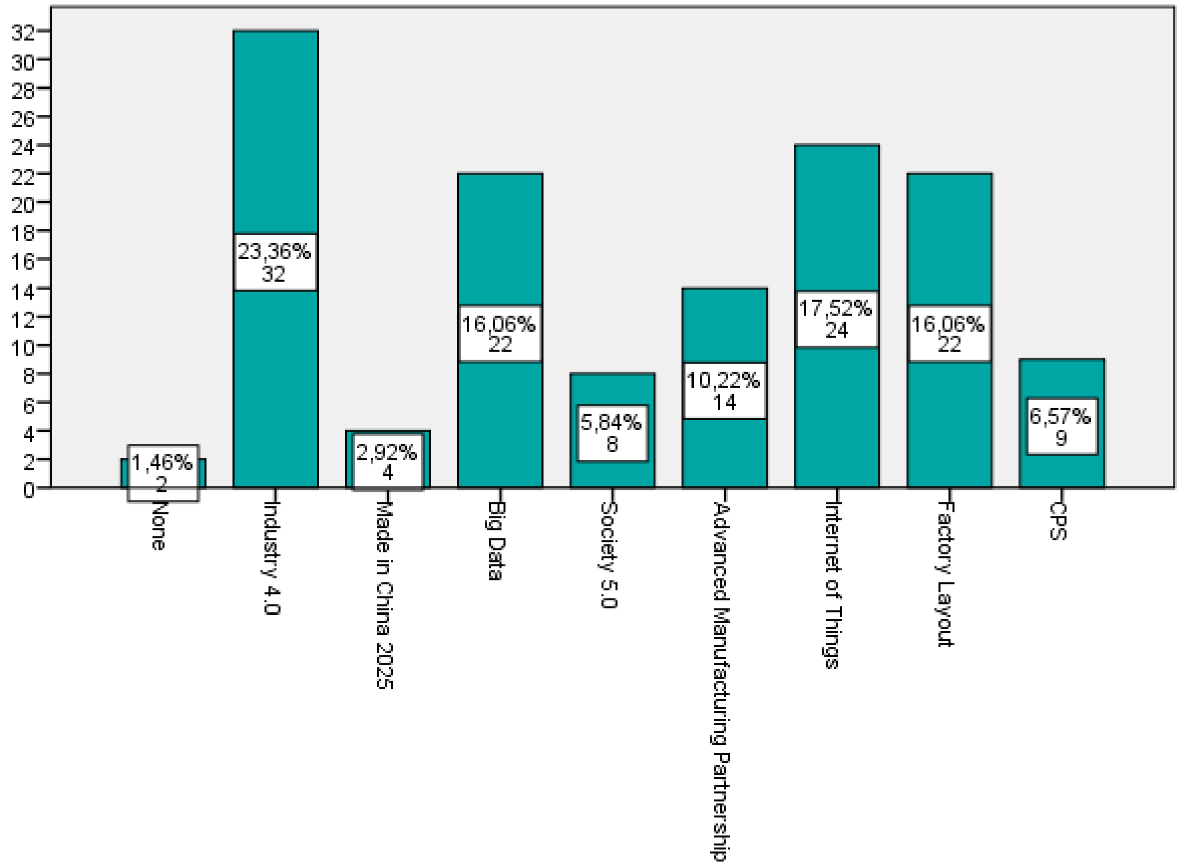
Figure 28: Operation Time Distributions of Company



3.4.1.11. Term Related to Industry 4.0

Each firm chose terms that they are aware. They can pick more than one terms so that frequency is 137. The firms' awareness about the terms related to Industry 4.0 can be seen in Figure 29. Industry 4.0 term have been heard by firms 32 times (23,36%), made in China 2025 term have been heard by firms 4 times (2,92%), big data term have been heard by firms 22 times (16,06%), society 5.0 term have been heard by firms 8 times (5,84%), advanced manufacturing partnership term have been heard by firms 14 times (10,22%), internet of things term have been heard by firms 24 times (17,52%), factory layout term have been heard by firms 22 times (16,06%), cyber-physical systems term have been heard by firms 9 times (6,57%), and lastly 2 firms (1,46%) did not know the any terms. Industry 4.0, internet of things, big data and factory layout are the most known terms by firms.

Figure 29: Firms Awareness About Terms Related to Industry 4.0

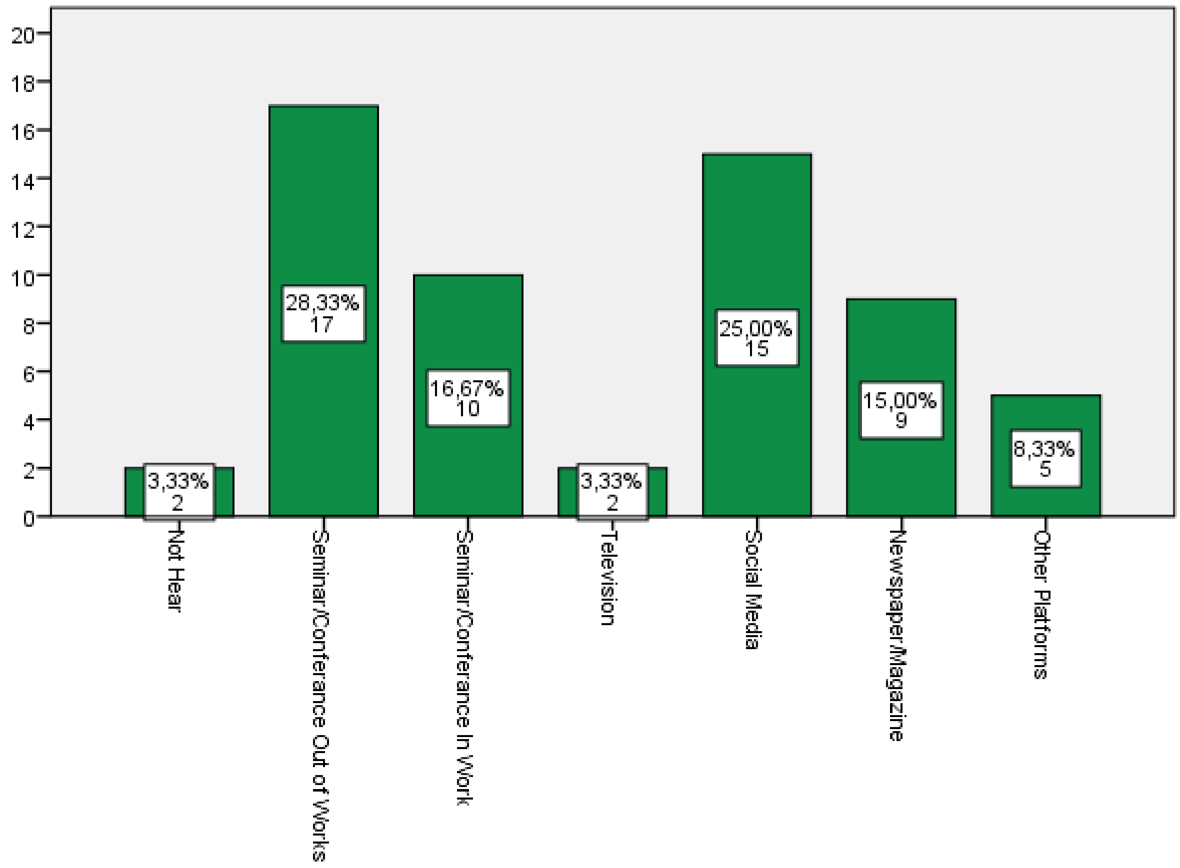


3.4.1.12. Places to Learn Terms

Each firm chooses areas they heard terms, results are as shown in Figure 30. They can pick more than one areas so that frequency is 60.

Terms have been heard by firms 17 times (28,33%) at seminar/conference out of works, 15 times (25%) at social media, 10 times (16,67%) at seminar/conference in work, 9 times (15%) at newspaper/magazine, 2 times (3,33%) at television, 5 times (8,33%) at other platforms (8,33%) which are internet, university and friends. Lastly, 2 firms (3,33%) did not hear the terms. It can be observed that seminar/conference both in work and outwork, newspaper and social media have crucial roles to learning of the terms.

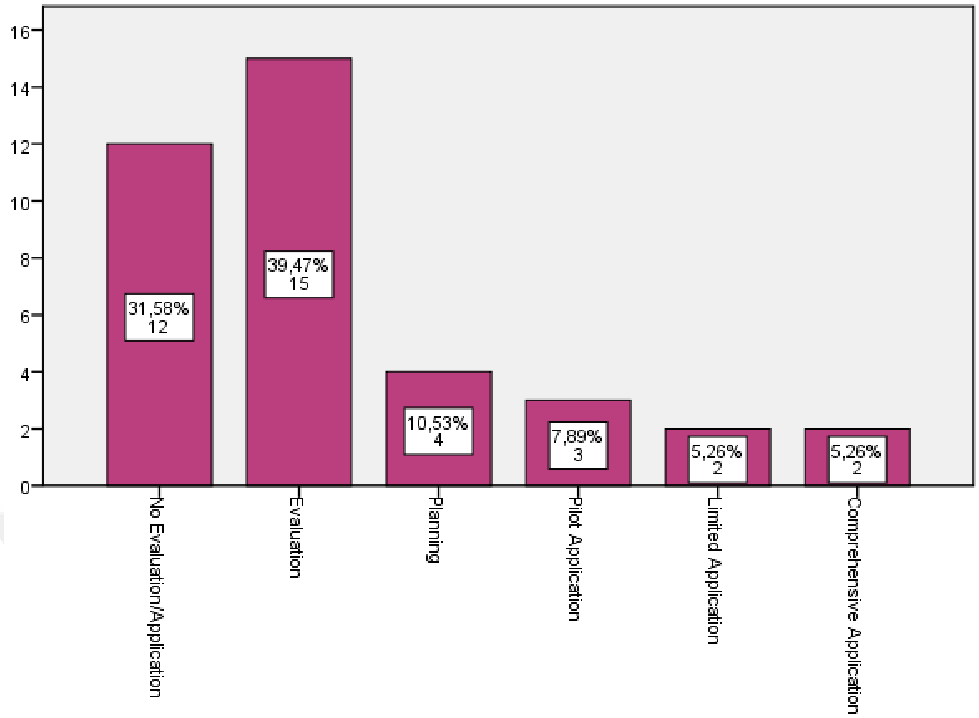
Figure 30: Places to Learn Term/s



3.4.1.13. Stages of Industry 4.0

Distribution of companies by Industry 4.0's stages can be seen in Figure 31. Sample size is 38 and 15 of them (39,47%) are in the evaluation stage, 4 of them (10,53%) are in the planning stage, 3 of them (7,89%) are in the pilot application stage, 2 of them (5,26%) are in limited application stage, 2 of them (5,26%) are comprehensive application stage, and lastly 12 of them (31,58%) are no evaluation/application of Industry 4.0. At this stage, firms that have no evaluation/application of Industry 4.0 did not continue the answering survey. So that, after that question sample size decreased from 38 to 26.

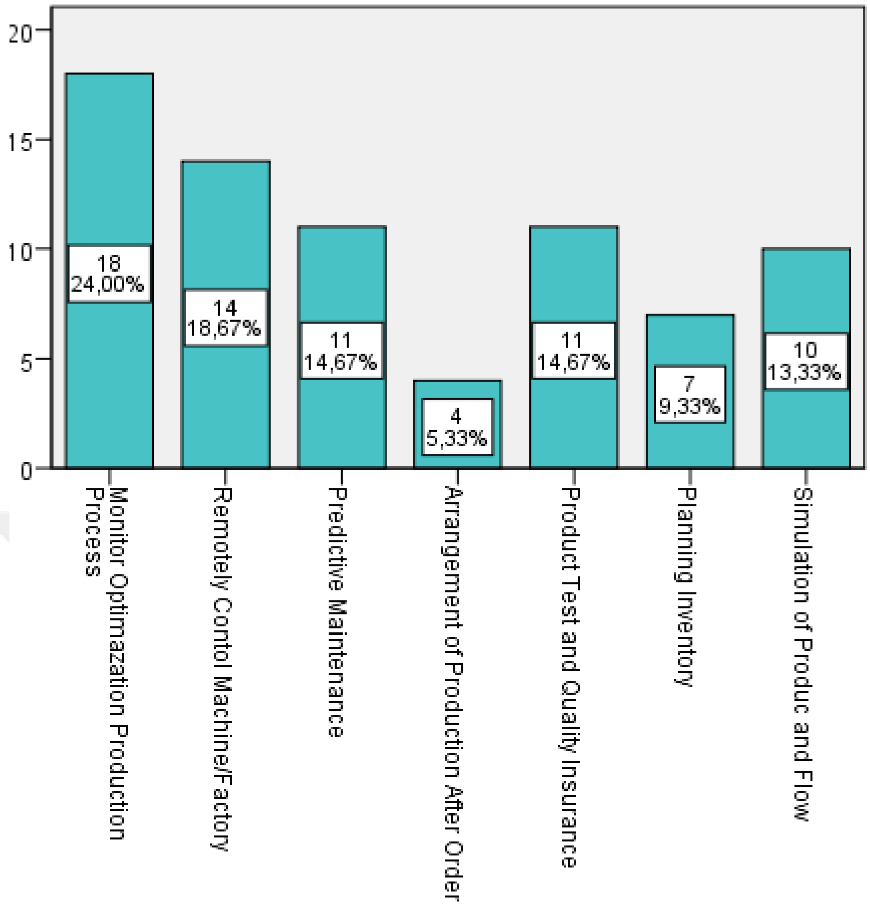
Figure 31: Distribution of Firms by Industry 4.0's Stages



3.4.1.14. Applications Describe the Industry 4.0 Initiatives

Distribution of Industry 4.0 initiatives' applicants can be seen in Figure 32. The sample size for this question is 26 and companies can pick more than one, so that frequency is 75. Monitor optimization production process initiative has been chosen 18 times (24%), remotely control machine/factory initiative have been chosen 14 times (18,67%), predictive maintenance initiative has been chosen 11 times (14,67%), arrangement of production after order initiative have been chosen 4 times (5,33%), product test and quality insurance initiative have been chosen 11 times (14,67%), planning inventory initiative has been chosen 7 times (9,33%), and lastly simulation of product and production flow initiative have been chosen 10 times (13,33%). It can be concluded that monitor optimization production process, remotely control machine/factory and simulation of product and production flow are the better applications than other to describe the Industry 4.0 initiatives.

Figure 32: Applications Describe the Industry 4.0 Initiatives

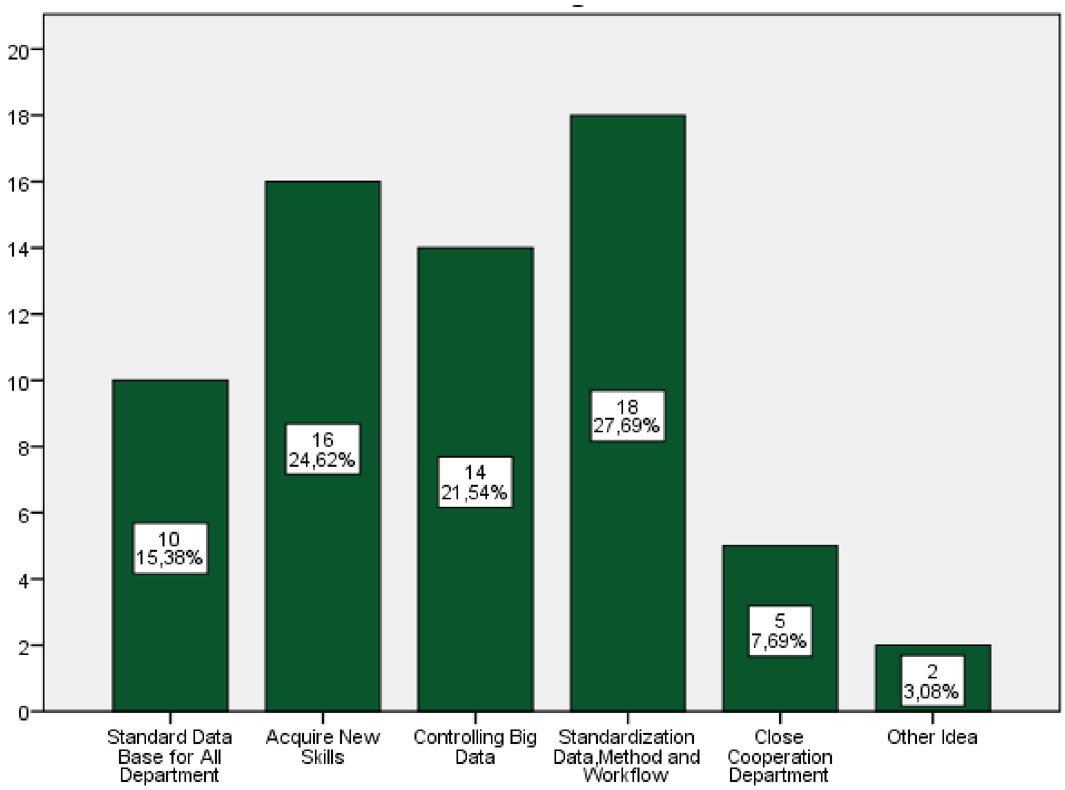


3.4.1.15. Main Challenges of Industry 4.0

Distribution of main challenges when applying the Industry 4.0 can be seen in Figure 33. Firms can pick more than one challenges but they can choose maximum 3 challenges to prevent the randomly chosen. So that sample size in this question is 26 and frequency is 65. Standard database for all department challenge has been chosen 10 times (15,38%), acquiring new skills challenge have been chosen 16 times (24,62%), controlling big data challenge have been chosen 14 times (21,54%), standardization data, method, and workflow challenge have been chosen 18 times (27,69%), close cooperation department challenge has been chosen 5 times (7,69%), and lastly other ideas that reachable trust information and preventing information pollution, risk of the artificial intelligence defined the challenges have been written by

2 firms (3,08%). It can be concluded that standardization data, method, and workflow, acquiring new skills and controlling big data seen as more problematic areas by firms when apply the Industry 4.0.

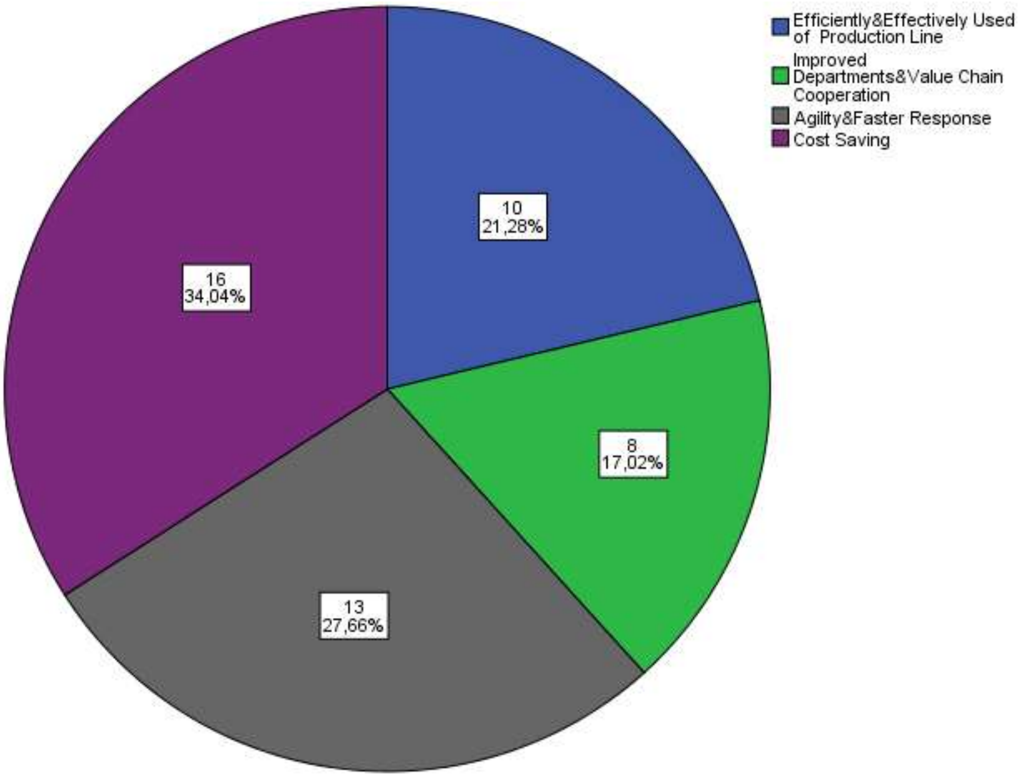
Figure 33: Main Challenges of Industry 4.0



3.4.1.16. Benefits of Various IT Integration

One firm did not answer that question and the following questions. So that, the sample size decreased from 26 to 25.The aim of that question to reach expectations of firms about the benefits of various IT integration when to apply Industry 4.0 in companies. Firms can pick more than one answers but they can choose maximum 2 answers because prevention randomly chose. Thus, the sample size in this question is 25 and the frequency is 47. Efficiently and effectively used of production line benefit have been chosen 10 times (21,28%), improved departments and value chain cooperation benefit have been chosen 8 times (17,02%), agility and faster response benefit have been chosen 13times (27,66%), and lastly cost-saving benefit have been chosen 16 times (34,04%). After the analyzed result of that question, it can be concluded that cost saving, and agility and faster response benefits are more demanded by firms.

Figure 34: Benefits of Various IT Integration

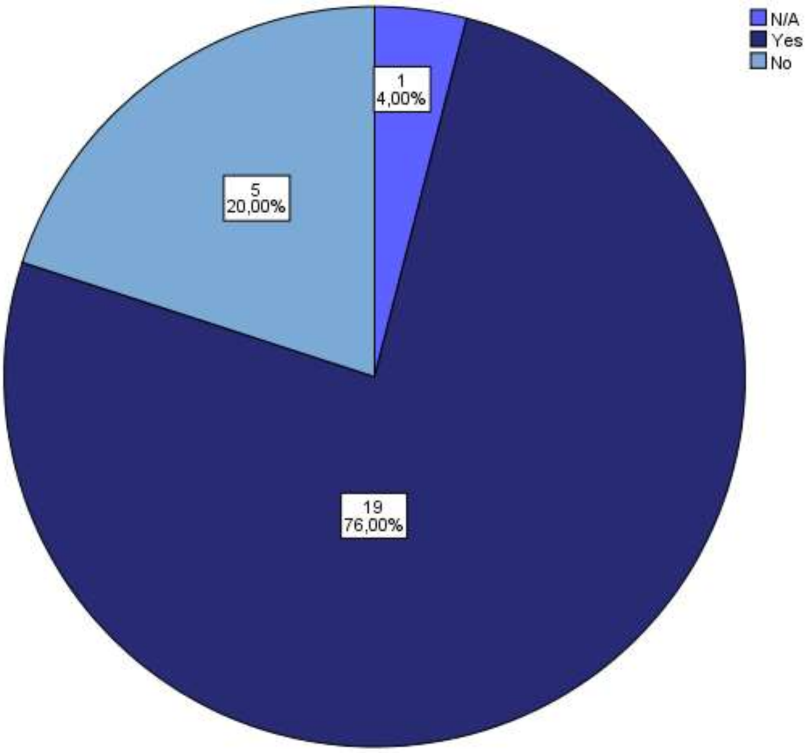


3.4.1.17. Security Program

With the increase of the data volume, all things will hold in the cloud. However, to protect information from cyber-attack will be more important than now. So that, aim of this question to reaching information about the usage of security program by firms.

Answers of the samples according to security program usage are shown in Figure 35. The sample size is 25 and 19 of them (76%) use a security program, 5 of them (78,95%) do not use a security program and 1 respondent (4%) does not the answer that question. It is obvious that information protection is very important for firms.

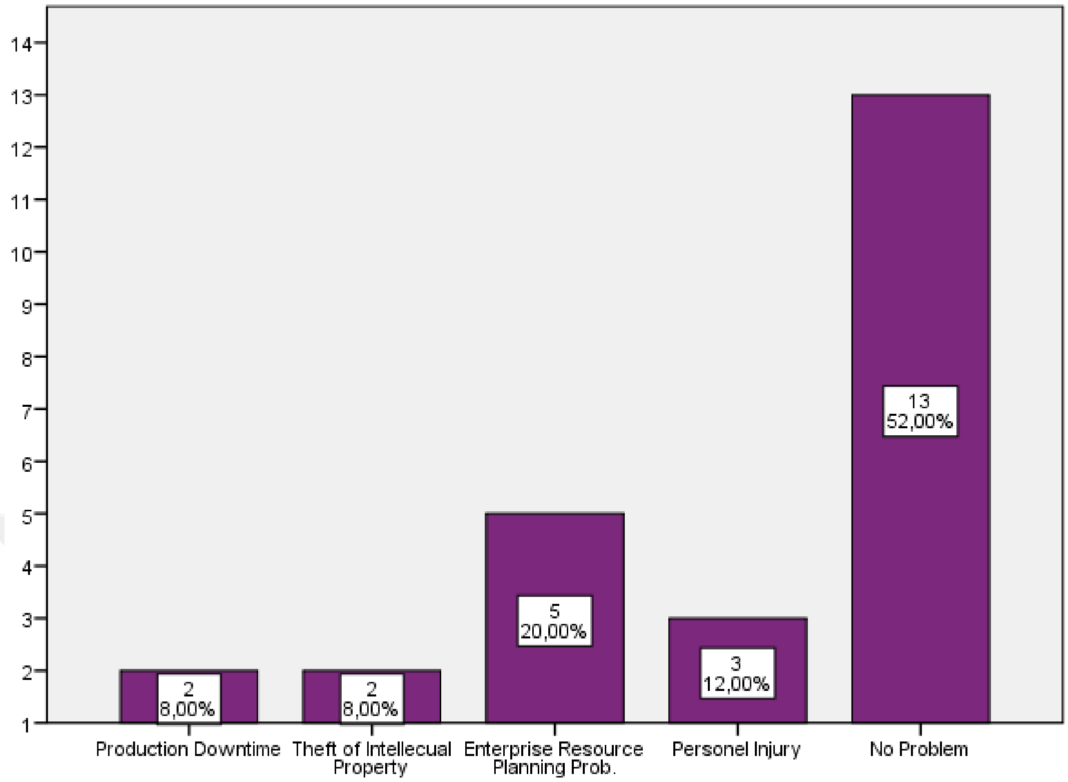
Figure 35: Security Program of Firms



3.4.1.18. Security Problems

Security problem that firms faced can be seen in Figure 36. Companies can pick more than one, but they can choose maximum 2 problems, aim of that to prevent randomly chosen. Sample size is 25 and no problem has been chosen 13 times (52%) by firms, personal injury has been chosen 3 times (12%) by firms, enterprise resource planning problems have been chosen 5 times (20%) by firms, theft of intellectual property have been chosen 2 times (8%) by firms, and lastly production downtime have been chosen 2 times (8%) by firms. Half of the firms did not face any security problems.

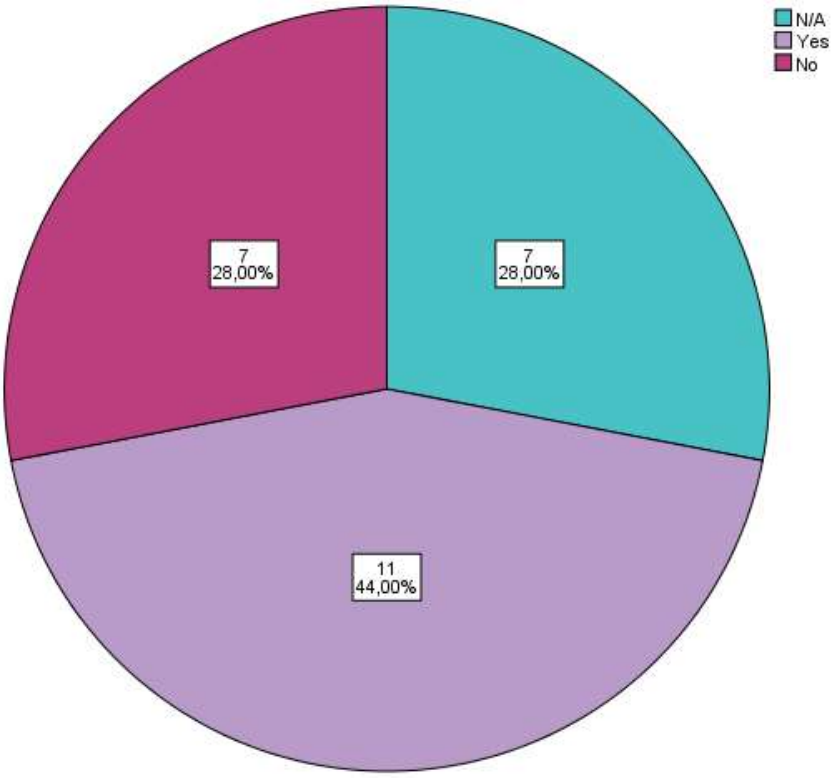
Figure 36: Security Problems that Firms Face



3.4.1.19. Industry 4.0 Budget

Answers of the firms according to Industry 4.0 budget are shown in Figure 37. The sample size is 25 and 11 of them (44%) have Industry 4.0 budget, 7 of them (28%) do not have Industry 4.0 budget and 7 of them (28%) did not the answer that question coded as N/A. Nearly half of the firms have a budget for a new industrial revolution.

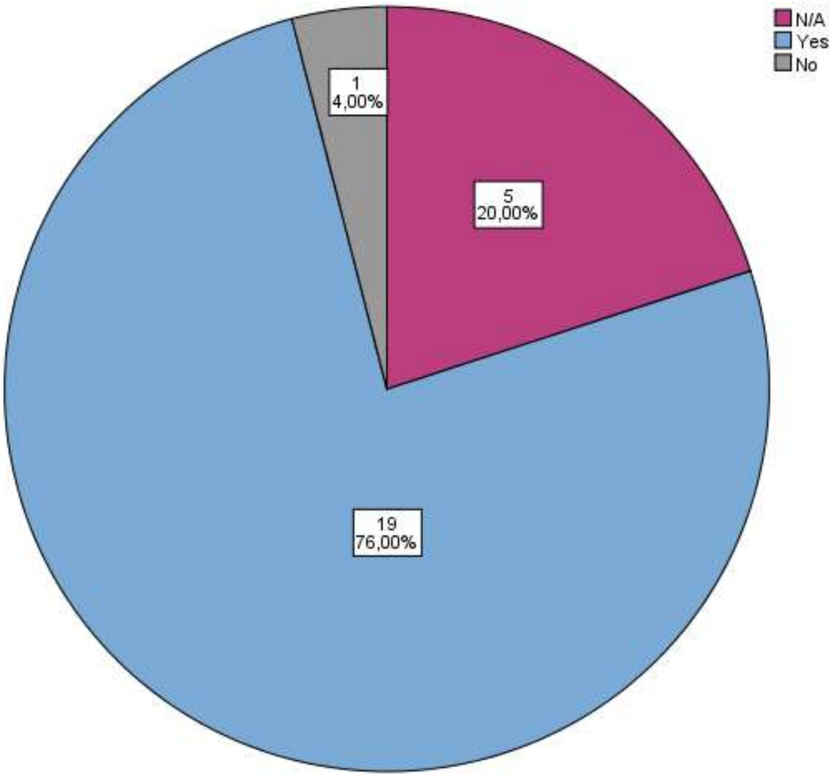
Figure 37: Industry 4.0 Budget of Firms



3.4.1.20. Future Industry 4.0 Budget

Answers of the firms are shown in Figure 38. The sample size is 25 and 19 of them (76%) will allocate budget for Industry 4.0 in next year, 1 of them (4%) will not form a budget for Industry 4.0 in next year and 5 of them (20%) did not the answer that question coded as N/A. Nearly, three-fourths of firms have planned to create a budget for Industry 4.0.

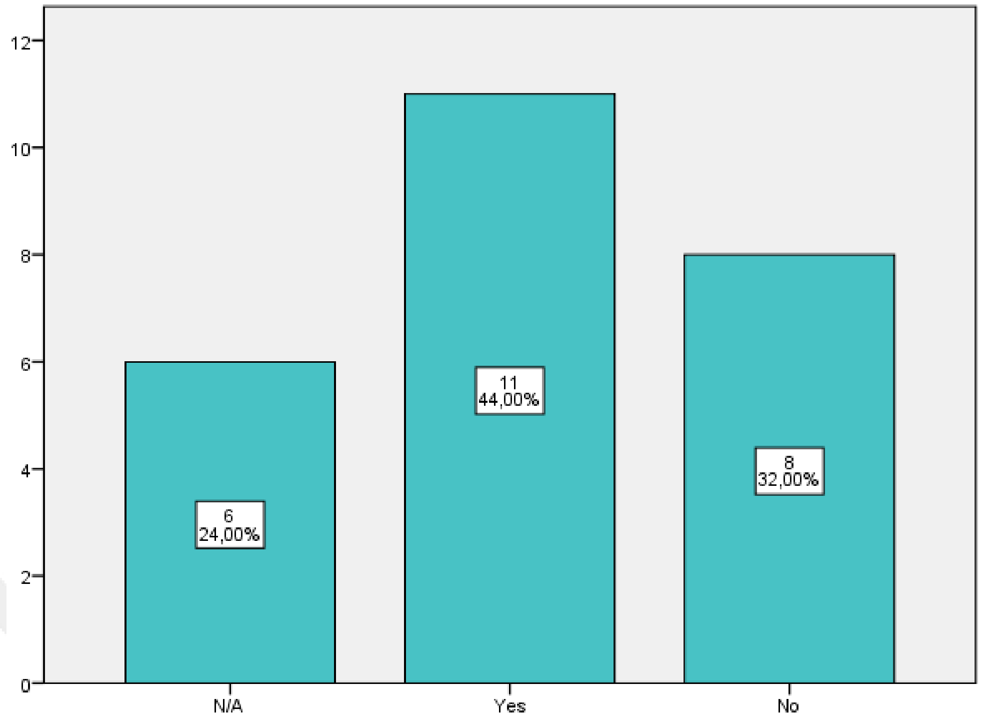
Figure 38: Future Industry 4.0 Budget of Firms



3.4.1.21. Kosgeb Industry 4.0 Incentives

The aim of that question to learning the opinion of firms about Kosgeb Industry 4.0 incentives. It whether triggers of firms' incentives or not is the main learning objective of the question. Answers of the firms are shown in Figure 39. The sample size is 25 and 11 of them (44%) can increase their investment and 8 of them (32%) cannot increase their investment if reach Kosgeb Industry 4.0 incentives. 6 of them (24%) did not the answer that question coded as N/A. Nearly, half of the firms can invest more money in Industry 4.0 technologies when reaching the Kosgeb Industry 4.0 incentives.

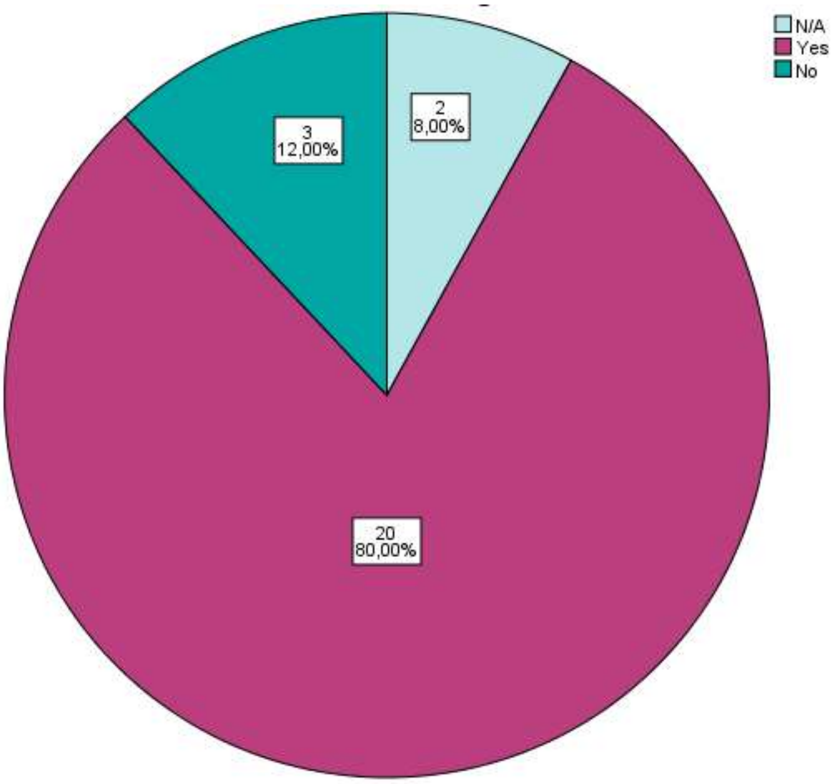
Figure 39: Kosgeb Industry 4.0 Incentives Trigger Firms' Investment



3.4.1.22. Incentives Encourage to Firms' Investment

The aim of that question to learning the opinion of firms about various Industry 4.0 incentives triggers of firms' investment or not. Answers of the firms are shown in Figure 40. Sample size is 25 and 20 of them (80%) can increase their investment if reach various Industry 4.0 incentives, 3 of them (12%) cannot increase their investment if reach various Industry 4.0 incentives, and 2 of them (8%) did not the answer that question coded as N/A. Nearly, four of five the firms can invest more money in Industry 4.0 technologies when reaching the various Industry 4.0 incentives.

Figure 40: Industry 4.0 Incentives Trigger Firms' Investment



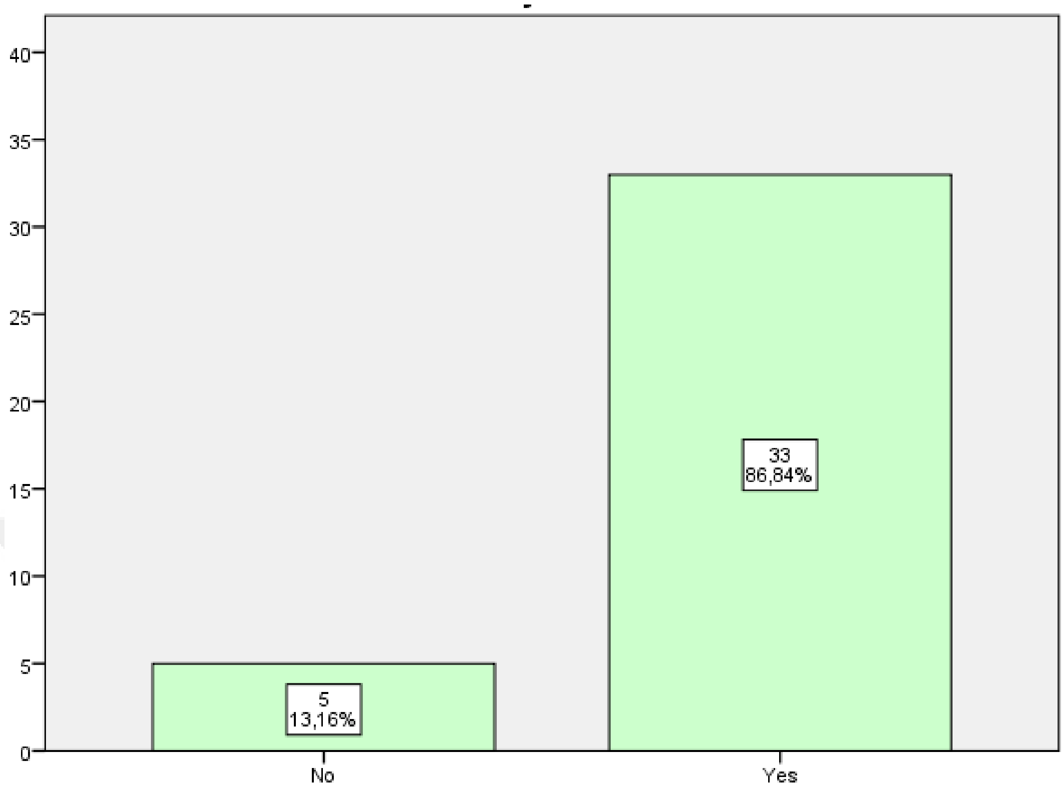
3.4.2. Hypotheses Testing and Results

In this section, nine different hypotheses will be analyzed. Chi-square method will be used to evaluate the hypotheses and reveal the relations between two categorical variables.

3.4.2.1. Relationship Between Firm Size and Industry 4.0 Term

The sample size is 38 and 33 firms (86,84%) know the Industry 4.0 term and 5 firms (13,16%) do not know the Industry 4.0 term. Distribution of the samples is shown in Figure 41.

Figure 41: Industry 4.0 Term Awareness



Firm size and awareness of the Industry 4.0 term is as shown in the Table 2. 3 SME's and 2 large firms do not know the term, 15 SME's and 18 large firms know the term.

Table 2: Firm Size and Industry 4.0 Crosstabulation

			Industry 4.0		
			No	Yes	Total
Firm Size	Small-Medium Enterprises	Count	3	15	18
		Expected Count	2,4	15,6	18,0
	Large Firms	Count	2	18	20
		Expected Count	2,6	17,4	20,0
Total		Count	5	33	38
		Expected Count	5,0	33,0	38,0

In line with this information, the following hypotheses have been developed;

H_0: There is no association between the firm size and awareness of "Industry 4.0".

H_1: There is an association between the firm size and awareness of "Industry 4.0".

Table 3: Chi-Square Test Results of Industry 4.0

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,368[a]	1	,544		
Continuity Correction[b]	,016	1	,899		
Likelihood Ratio	,369	1	,543		
Fisher's Exact Test				,653	,448
Linear-by-Linear Association	,359	1	,549		
N of Valid Cases	38				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is 2,37.

b. Computed only for a 2x2 table

Table 4: Symmetric Measures of Industry 4.0 and Firm Size

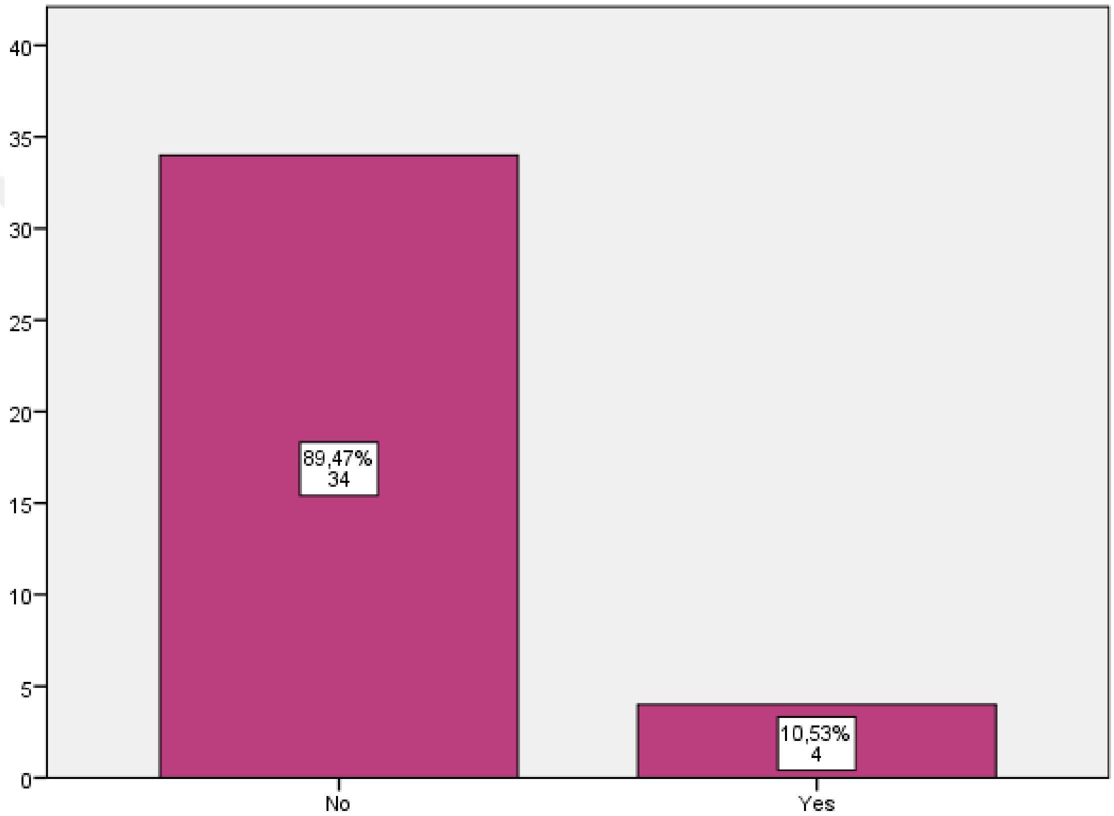
		Value	Approximate Significance
Nominal by Nominal	Phi	,098	,544
	Cramer's V	,098	,544
N of Valid Cases		38	

From chi-square test, data do not meet the chi-square assumption of all expected frequency, 2 cells have expected less than 5, that are "no" part of the SME's and large firms are shown in Table 2. However, Fisher's Exact Test is an alternative to chi-square when data do not meet assumptions of expected frequency (Fisher, 1925). $\chi 2(1, N=38) = .653$ (Table 3) , $p>0.05$; $\Phi=0.098$ (Table 4), $p>0.05$. So that, the exact significance (2-sided) value is 0.653 which is bigger than 0.05. Therefore, the H_0 hypothesis is not rejected and there is no association between the firm size and awareness of Industry 4.0.

3.4.2.2. Relationship Between Firm Size and Made in China 2025 Term

The sample size is 38 and 4 firms (10,53%) know the Made in China 2025 term and 34 firms (89,47%) do not know the Made in China 2025 term. Distribution of the samples is shown in Figure 42.

Figure 42: Made in China 2025 Term Awareness



Firm size and awareness of the Made in China 2025 term is as shown in Table 5. 16 SME's and 18 large firms do not know the term, 2 SME's and 2 large firms know the term.

Table 5: Firm Size and Made in China 2025 Crosstabulation

			Made in China 2025		
			No	Yes	Total
Firm Size	Small-Medium Enterprises	Count	16	2	18
		Expected Count	16,1	1,9	18,0
	Large Firms	Count	18	2	20
		Expected Count	17,9	2,1	20,0
Total		Count	34	4	38
		Expected Count	34,0	4,0	38,0

In line with this information, the following hypotheses have been developed;

H_0: There is no association between the firm size and awareness of "Made in China 2025"

H_1: There is an association between the firm size and awareness of "Made in China 2025"

Table 6: Chi-Square Test Results of Made in China 2025

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,012[a]	1	,911		
Continuity Correction[b]	,000	1	1,000		
Likelihood Ratio	,012	1	,911		
Fisher's Exact Test				1,000	,656
Linear-by-Linear Association	,012	1	,912		
N of Valid Cases	38				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is 1,89.

b. Computed only for a 2x2 table

Table 7: Symmetric Measures of Made in China 2025 and Firm Size

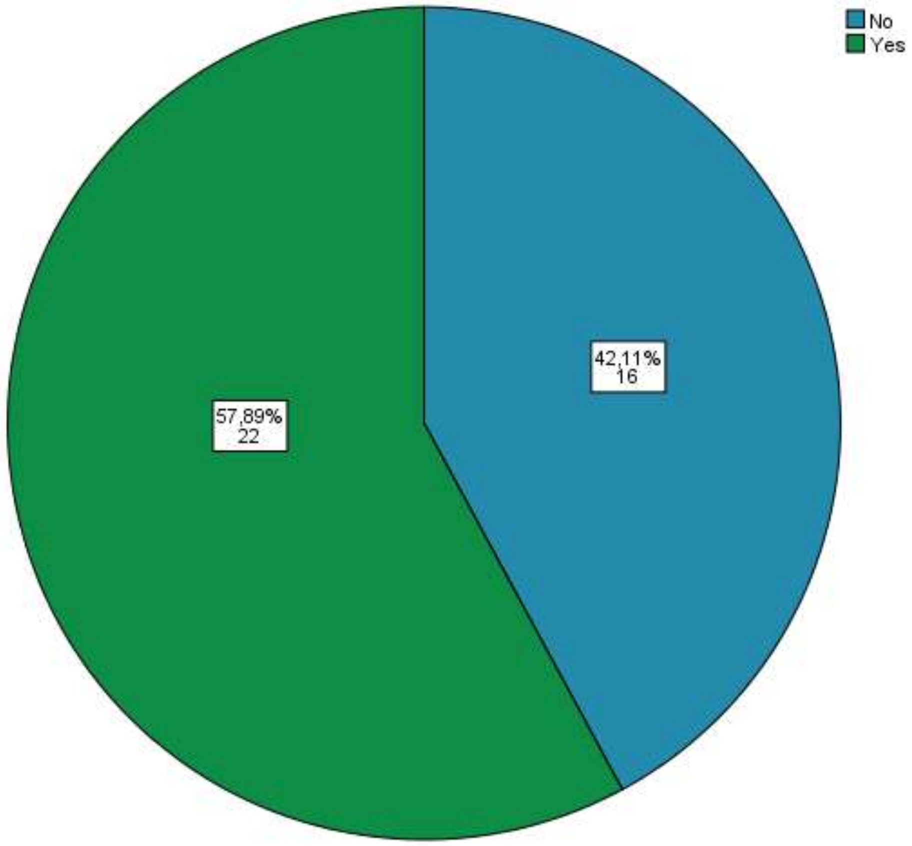
		Value	Approximate Significance
Nominal by Nominal	Phi	-,018	,911
	Cramer's V	,018	,911
N of Valid Cases		38	

From chi-square test, data do not meet the chi-square assumption of all expected frequency, 2 cells have expected count than 5, that are “yes” part of the SME’s and large firms are shown in Table 5. However, Fisher’s Exact Test is an alternative to chi-square when data do not meet assumptions of expected frequency. $\chi 2(1, N=38) = 1.00$ (Table 6), $p>0.05$; $\Phi=-0.018$ (Table 7), $p>0.05$. So that, the exact significance (2-sided) value is 1.000 which is bigger than 0.05. Therefore, the H_0 hypothesis is not rejected and there is no association between the firm size and awareness of Made in China 2025.

3.4.2.3. Relationship Between Firm Size and Big Data Term

The sample size is 38 and 22 firms (57,89%) know the Big Data term and 16 firms (42,11%) do not know the Made in China 2025 term. Distribution of the samples is shown in Figure 43.

Figure 43: Big Data Term Awareness



Firm size and awareness of the Big Data term is as shown in the Table 8**.** 13 SME's and 3 large firms do not know the term, 5 SME's and 17 large firms know the term.

Table 8: Firm Size and Big Data Crosstabulation

			Big Data		Total
			No	Yes	
Firm Size	Small-Medium Enterprises	Count	13	5	18
		Expected Count	7,6	10,4	18,0
	Large Firms	Count	3	17	20
		Expected Count	8,4	11,6	20,0
Total		Count	16	22	38
		Expected Count	16,0	22,0	38,0

In line with this information, the following hypotheses have been developed;

H_0: There is no association between the firm size and awareness of "Big Data".

H_1: There is an association between the firm size and awareness of "Big Data".

Table 9: Chi-Square Test Results of Big Data

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	12,725[a]	1	,000		
Continuity Correction[b]	10,486	1	,001		
Likelihood Ratio	13,549	1	,000		
Fisher's Exact Test				,001	,000
Linear-by-Linear Association	12,391	1	,000		
N of Valid Cases	38				

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 7,58.

b. Computed only for a 2x2 table

Table 10: Symmetric Measures of Big Data and Firm Size

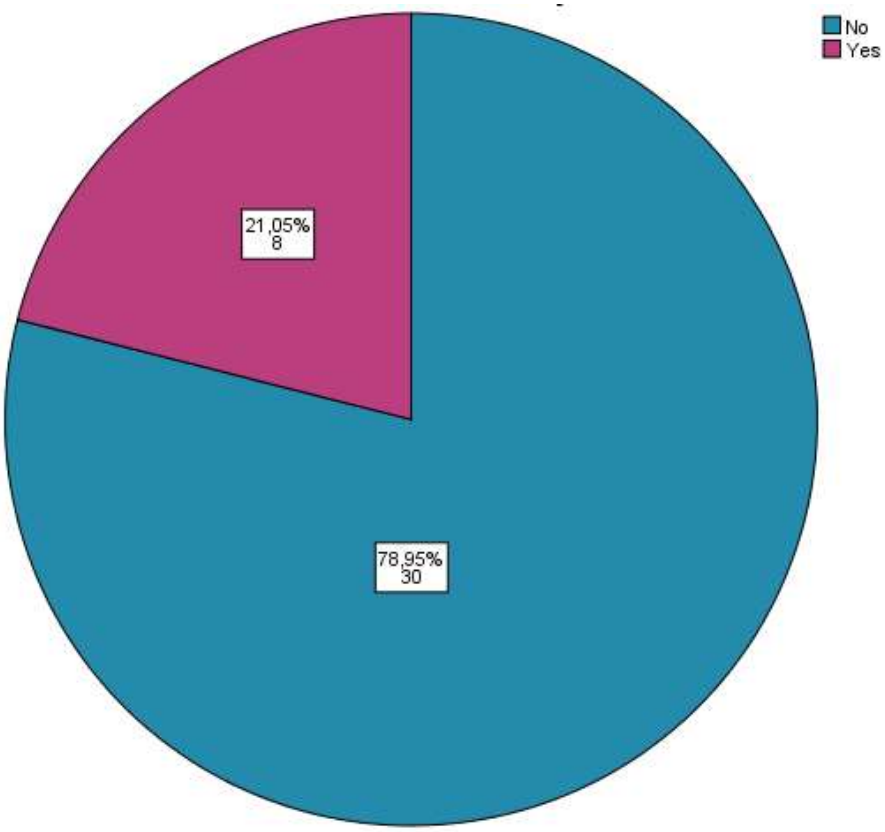
		Value	Approximate Significance
Nominal by Nominal	Phi	,579	,000
	Cramer's V	,579	,000
N of Valid Cases		38	

In the chi-square test, $\chi 2(1, N=38)$ =.000 (Table 9), $p<0.05$; $\Phi=0.579$ (Table 10), $p<0.05$, asymptotic significance (2-sided) value is 0.000 which is less than 0.05. Therefore, H_0 hypothesis is rejected and there is a significant association between the firm size and awareness of Big Data. Large firms are more aware and know the term than the SME's. When to look the Phi value in Table 10**,** it is 0.579 and according to (Cohen, 1988: 25-27) if phi value is 0.5 and above there is a large effect. So that, there is a strong significant association between the firm size and awareness of the term.

3.4.2.4. Relationship Between Firm Size and Society 5.0 Term

The sample size is 38 and 8 firms (21,05%) know the Society 5.0 term and 30 firms (78,95%) do not know the Society 5.0 term. Distribution of the samples is shown in Figure 44.

Figure 44: Society 5.0 Term Awareness



Firm size and awareness of the Society 5.0 term is as shown in Table 11. 17 SME's and 13 large firms do not know the term, 1 SME and 7 large firms know the term.

Table 11: Firm Size and Society 5.0 Crosstabulation

			Society 5.0		
			No	Yes	Total
Firm Size	Small-Medium Enterprises	Count	17	1	18
		Expected Count	14,2	3,8	18,0
	Large Firms	Count	13	7	20
		Expected Count	15,8	4,2	20,0
Total		Count	30	8	38
		Expected Count	30,0	8,0	38,0

In line with this information, the following hypotheses have been developed;

H_0: There is no association between the firm size and awareness of "Society 5.0".

H_1: There is an association between the firm size and awareness of "Society 5.0".

Table 12: Chi-Square Test Results of Society 5.0

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4,942[a]	1	,026		
Continuity Correction[b]	3,329	1	,068		
Likelihood Ratio	5,492	1	,019		
Fisher's Exact Test				,045	,031
Linear-by-Linear Association	4,812	1	,028		
N of Valid Cases	38				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is 3,79.

b. Computed only for a 2x2 table

Table 13: Symmetric Measures of Society 5.0 and Firm Size

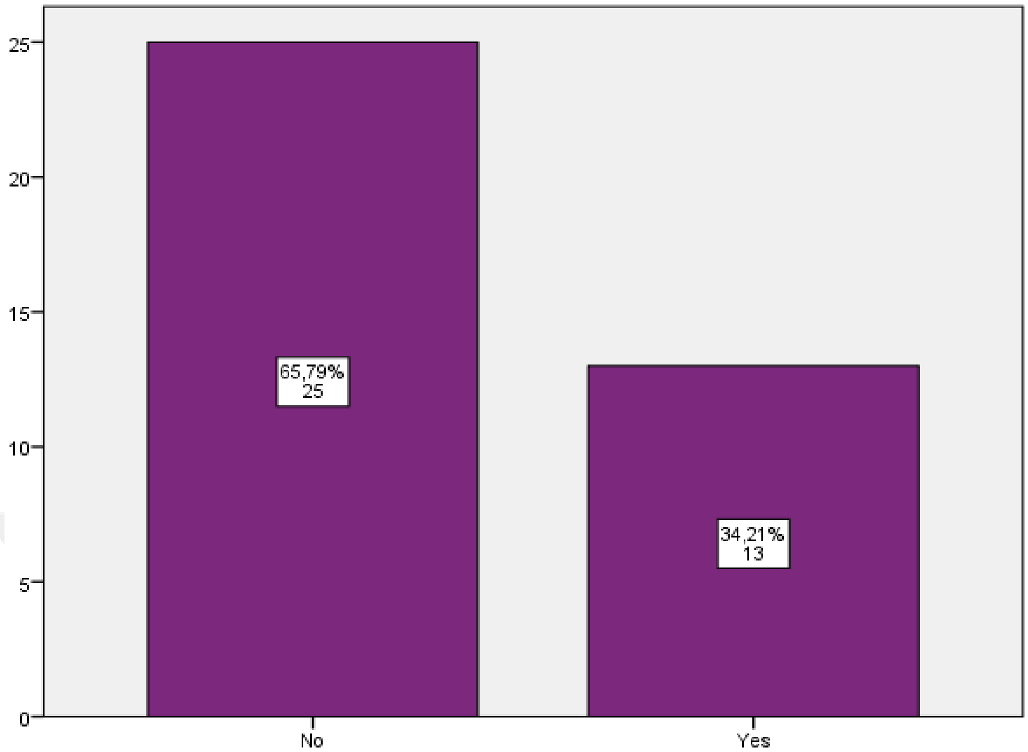
		Value	Approximate Significance
Nominal by Nominal	Phi	,361	,026
	Cramer's V	,361	,026
N of Valid Cases		38	

From the chi-square test, data do not meet the chi-square assumption of all expected frequency shown in Table 12. However, Fisher's Exact Test is an alternative to chi-square when data do not meet assumptions of expected frequency. $\chi 2(1, N=38) =.045$ (Table 12), $p<0.05$; $\Phi=0.361$ (Table 13), $p<0.05$. So that, the exact significance (2-sided) value is 0.045 which is less than 0.05. Therefore, H_0 hypothesis is rejected and there is an association between the firm size and awareness of Society 5.0. Large firms are more aware and know the term than the SME's. When to look the Phi value in Table 13, it is 0.361 and according to (Cohen, 1988: 25-27) if phi value is between 0.3-0.5, there is a medium effect. So that, there is a medium significance association between the firm size and awareness of Society 5.0.

3.4.2.5. Relationship Between Firm Size and Advanced Manufacturing Partnership Term

The sample size is 38 and 13 firms (34,21%) know the Advanced Manufacturing Partnership term and 25 firms (65,79%) do not know the Advanced Manufacturing Partnership term. Distribution of the samples is shown in Figure 45.

Figure 45: Advanced Manufacturing Partnership Term Awareness



Firm size and awareness of the Advanced Manufacturing Partnership term is as shown in Table 14**.** 13 SME's and 12 large firms do not know the term, 5 SME's and 8 large firms know the term.

Table 14: Firm Size and Advanced Manufacturing Partnership Crosstabulation

			Advanced Manufacturing Partnership		
			No	Yes	Total
Firm Size	Small-Medium Enterprises	Count	13	5	18
		Expected Count	11,8	6,2	18,0
	Large Firms	Count	12	8	20
		Expected Count	13,2	6,8	20,0
Total		Count	25	13	38
		Expected Count	25,0	13,0	38,0

In line with this information, the following hypotheses have been developed;

H_0: There is no association between the firm size and awareness of "Advanced Manufacturing Partnership".

H_1: There is an association between the firm size and awareness of "Advanced Manufacturing Partnership".

Table 15: Chi-Square Test Results of Advanced Manufacturing Partnership

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,629[a]	1	,428		
Continuity Correction[b]	,203	1	,652		
Likelihood Ratio	,633	1	,426		
Fisher's Exact Test				,506	,327
Linear-by-Linear Association	,612	1	,434		
N of Valid Cases	38				

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 6,16.

b. Computed only for a 2x2 table

Table 16: Symmetric Measures of Advanced Manufacturing Partnership and Firm Size

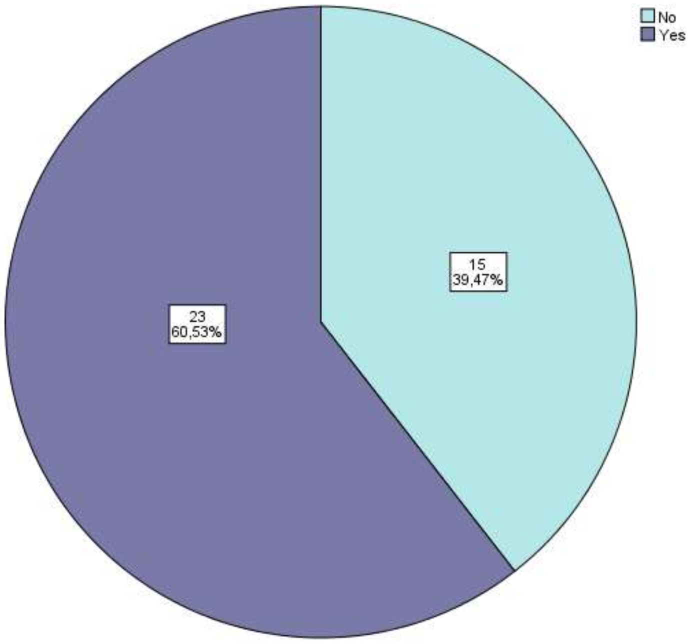
		Value	Approximate Significance
Nominal by Nominal	Phi	,129	,428
	Cramer's V	,129	,428
N of Valid Cases		38	

In the chi-square test, $\chi 2(1, N=38) = .428$ (Table 15), $p>0.05$; $\Phi=0.129$ (Table 16), $p>0.05$, asymptotic significance (2-sided) value is 0.428 which is bigger than 0.05. Therefore, H_0 hypothesis is not rejected and there is no association between the firm size and awareness of Advanced Manufacturing Partnership.

3.4.2.6. Relationship Between Firm Size and Internet of Things Term

The sample size is 38 and 23 firms (60,53%) know the Internet of Things term and 15 firms (39,47%) do not know the Internet of Things term. Distribution of the samples is shown in Figure 46.

Figure 46: Internet of Things Term Awareness



Firm size and awareness of the Internet of Things term is as shown in Table 17. 11 SME's and 4 large firms do not know the term, 7 SME's and 16 large firms know the term.

Table 17: Firm Size and Internet of Things Crosstabulation

			Internet of Things		
			No	Yes	Total
Firm Size	Small-Medium Enterprises	Count	11	7	18
		Expected Count	7,1	10,9	18,0
	Large Firms	Count	4	16	20
		Expected Count	7,9	12,1	20,0
Total		Count	15	23	38
		Expected Count	15,0	23,0	38,0

In line with this information, the following hypotheses have been developed;

H_0: There is no association between the firm size and awareness of "Internet of Things".

H_1: There is an association between the firm size and awareness of "Internet of Things".

Table 18: Chi-Square Test Results of Internet of Things

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6,702[a]	1	,010		
Continuity Correction[b]	5,091	1	,024		
Likelihood Ratio	6,909	1	,009		
Fisher's Exact Test				,019	,011
Linear-by-Linear Association	6,525	1	,011		
N of Valid Cases	38				

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 7,11.

b. Computed only for a 2x2 table

Table 19: Symmetric Measures of Internet of Things and Firm Size

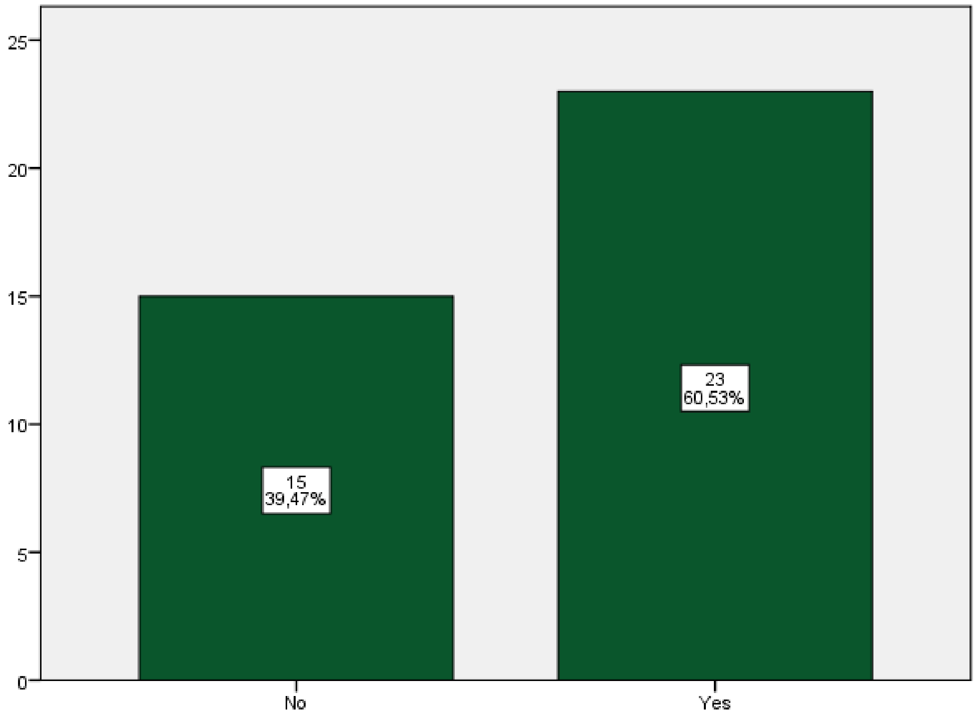
		Value	Approximate Significance
Nominal by Nominal	Phi	,420	,010
	Cramer's V	,420	,010
N of Valid Cases		38	

In the chi-square test, $\chi 2(1, N=38) = .010$ (Table 18), $p<0.05$; $\Phi=0.420$ (Table 19), $p<0.05$, asymptotic significance (2-sided) value is 0.010 which is less than 0.05. Therefore, H_0 hypothesis is rejected and there is a significant association between the firm size and awareness of Internet of Things. Large firms are more aware and know the term than the SME's. When to look the Phi value in Table 19, it is 0.420 and according to (Cohen, 1988: 25-27) if phi value is between 0.3-0.5 there is a medium effect. So that, firm size moderately affects the awareness of Internet of Things.

3.4.2.7. Relationship Between Firm Size and Factory Layout Term

The sample size is 38 and 23 firms (60,53%) know the Factory Layout term and 15 firms (39,47%) do not know the Factory Layout term. Distribution of the samples is shown in Figure 47.

Figure 47: Factory Layout Term Awareness



Firm size and awareness of the Factory Layout term is as shown in Table 20. 8 SME's and 7 large firms do not know the term, 10 SME's and 13 large firms know the term.

Table 20: Firm Size and Factory Layout Crosstabulation

			Factory Layout		Total
			No	Yes	
Firm Size	Small-Medium Enterprises	Count	8	10	18
		Expected Count	7,1	10,9	18,0
	Large Firms	Count	7	13	20
		Expected Count	7,9	12,1	20,0
Total		Count	15	23	38
		Expected Count	15,0	23,0	38,0

In line with this information, the following hypotheses have been developed;

H_0: There is no association between the firm size and awareness of "Factory Layout".

H_1: There is an association between the firm size and awareness of "Factory Layout".

Table 21: Chi-Square Test Results of Factory Layout

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,354[a]	1	,552		
Continuity Correction[b]	,069	1	,793		
Likelihood Ratio	,354	1	,552		
Fisher's Exact Test				,741	,396
Linear-by-Linear Association	,344	1	,557		
N of Valid Cases	38				

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 7,11.

b. Computed only for a 2x2 table

Table 22: Symmetric Measures of Factory Layout and Firm Size

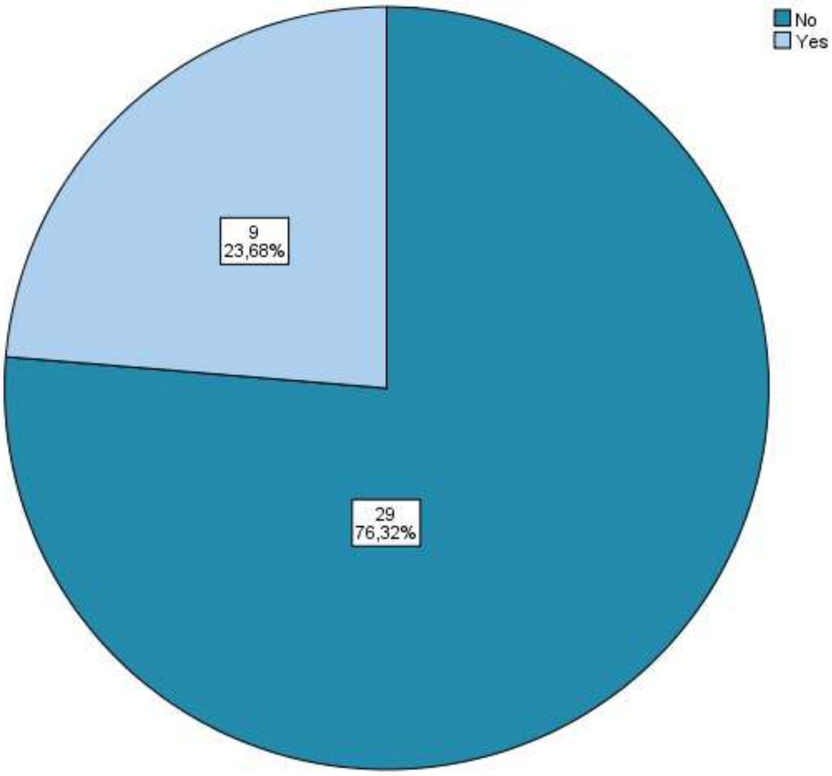
		Value	Approximate Significance
Nominal by Nominal	Phi	,096	,552
	Cramer's V	,096	,552
N of Valid Cases		38	

In the chi-square test, $\chi 2(1, N=38) = .552$ (Table 21), $p>0.05$; $\Phi=0.096$ (Table 22), $p>0.05$, asymptotic significance (2-sided) value is 0.552 which is bigger than 0.05. Therefore, H_0 hypothesis is not rejected and there is no association between the firm size and awareness of Factory Layout.

3.4.2.8. Relationship Between Firm Size and Cyber-Physical Systems Term

The sample size is 38 and 9 firms (23,68%) know the Cyber-Physical Systems term and 29 firms (76,32%) do not know the Cyber-Physical Systems term. Distribution of the samples is shown in Figure 48.

Figure 48: Cyber-Physical Systems Term Awareness



Firm size and awareness of the Cyber-Physical Systems term is as shown in Table 23. 16 SME’s and 13 large firms do not know the term, 2 SME’s and 7 large firms know the term.

Table 23: Firm Size and Cyber-Physical Systems Crosstabulation

			Cyber-Physical Systems		Total
			No	Yes	
Firm Size	Small-Medium Enterprises	Count	16	2	18
		Expected Count	13,7	4,3	18,0
	Large Firms	Count	13	7	20
		Expected Count	15,3	4,7	20,0
Total		Count	29	9	38
		Expected Count	29,0	9,0	38,0

In line with this information, the following hypotheses have been developed;

H_0: There is no association between the firm size and awareness of “Cyber-Physical Production Systems”.

H_1: There is an association between the firm size and awareness of “Cyber-Physical Production Systems”.

Table 24: Chi-Square Test Results of Cyber-Physical Systems

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2,991[a]	1	,084		
Continuity Correction[b]	1,815	1	,178		
Likelihood Ratio	3,148	1	,076		
Fisher's Exact Test				,130	,088
Linear-by-Linear Association	2,912	1	,088		
N of Valid Cases	38				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is 4,26.

b. Computed only for a 2x2 table

Table 25: Symmetric Measures of Cyber-Physical Systems and Firm Size

		Value	Approximate Significance
Nominal by Nominal	Phi	,281	,084
	Cramer's V	,281	,084
N of Valid Cases		38	

From chi-square test, data do not meet the chi-square assumption of all expected frequency, expected less than 5 shown in Table 24. However, Fisher's Exact Test is an alternative to chi-square when data do not meet assumptions of expected frequency. $\chi 2(1, N=38) = .130$ (Table 24), $p<0.05$; $\Phi=0.281$ (Table 25), $p<0.05$. So that, the exact significance (2-sided) value is 0.130 which is more than 0.05. Therefore, H_0 hypothesis is not rejected and there is no association between the firm size and awareness of Cyber-Physical Production Systems

3.4.2.9. General Evaluation of Chi-Square Results

In

Table ***26*****Hata! Başvuru kaynağı bulunamadı.**, rejected and not rejected hypotheses can be seen clearly. To find that there is not a relation between firm size and awareness of some Industry 4.0 related terms, which were Industry 4.0, made in China 2025, advanced manufacturing partnership and factory layout terms. Whereas, to detected there is a relationship between firm size and awareness of some terms that are big data, society 5.0, internet of things and cyber-physical systems. Large firms were more aware of those these terms than SMEs.

Table 26: General Hypotheses Evaluation

Firm Size and Awareness of Terms	H_0	Chi-Value	Phi Value
Industry 4.0	Not Rejected	0.653	0.098
Made in China 2025	Not Rejected	1.000	-0.018
Big Data	Rejected	0.000	0.579
Society 5.0	Rejected	0.045	0.361
Advanced Manufacturing Partnership	Not Rejected	0.428	0.129
Internet of Things	Rejected	0.010	0.420
Factory Layout	Not Rejected	0.552	0.096

CPS	Not Rejected	0.130	0.281

3.4.3. Open-Ended Questions

This section is the last part of the questionnaire that contains open-ended questions about Industry 4.0. The aim of this part is to collect the detailed opinions of the firms. The first question is about the obstacles of the Industry 4.0. When the companies decide to apply the new revolution requirements and challenges that await them. The second question is about value-added areas of Industry 4.0. If the firms use the Industry 4.0, which areas should receive more value from the new technologies. Another question is about digitalization technology. The aim of the question is to receive judgments of firms about what kinds of problems in the production can be solved by using the digitalization technology. Next question is about the benefits of augmented reality. The last question is about innovations, new robots, and automation.

3.4.3.1. Obstacles of The Applying the Industry 4.0 into Reality

This question is answered by 22 firms. All opinions were written under Microsoft Word and the most frequently used words were identified. After, answers were categorized.

The absence of the necessities technologies and software’s programs answers, which are written by 18 firms is one of the big obstacles for firms. To apply the Industry 4.0, old machines should be converted or changed to new ones. Moreover, it is not enough to just upgraded to old machines or buy new ones, also the firm’s vision, mission, strategy, technological infrastructure should be revitalized according to requirements of a new revolution.

The second obstacle is budget and time problems are written by 10 firms. Firms should have to allocate a huge amount of budget to upgrade old machines or buy new ones, built the new technological infrastructure such as software programs, data collection and analyzing department. Moreover, all of these will take lots of time for firms, so that efficient use of available time is necessary.

The third obstacle is the absence of skilled employees that is written by 8 firms. Because, with the new revolutions, requirements skills and abilities of the jobs will change. Firms will need employees who use the new technologies, infrastructure, and machines.

Low degree of openness to changes of firms, supply chain and employees is the other obstacle written by 5 firms. Structure of firms should become more open to innovations and flexible to easily react and follow the changes and trends in the market. Whole departments, employees, firms, and supply chain should be ready to radically changes. However, acceptance level of people to changes is not high usually, so that firms should be ready to for resistance.

Lack of standardization and knowledge, which is the last obstacle, was stated by 4 firms. There is not yet qualified knowledge about the changes and affections. Moreover, standard systems should be developed for firms. Standardization of data collection and analyzing procedures and standard database for all departments can be given as an example of obstacles of standardization.

3.4.3.2. Value Added Areas of Industry 4.0

This question is answered by 20 firms. All opinions were written under Microsoft Word and the most frequently used words were identified. After, answers were categorized.

14 of firms write the production as the most value-added areas of Industry 4.0. With the new innovations, firms expect the more efficient, flexible and faster production, and desire the new manufacturing technologies. Quality is written by 5 firms. Lots of the firms expect to produce more quality products.

Information technologies are seen as another value-added area by 5 firms. The new information technologies must be developed to collect and analyze data, track the products, monitor inventory and to make more accurate planning.

Lastly, the supply chain cycle is the other value-added area written by 4 firms. Each member in the chains can reach the data of the other members. So that, making manufacturing planning, organizing the delivery and minimizing the problems can be eliminated with the new technologies.

3.4.3.3. Problem Solving in Production with Digitalization

This question is answered by 21 firms. All opinions were written under Microsoft Word and the most frequently used words were identified. After, answers were categorized.

Firms’ expectations from digitalization are very high. 10 firms want to detect the root(s) of problems swiftly. They want to solve the production, purchasing processing problems. The goal of the companies is to prevent manufacturing defects, faulty workmanship, and wrong logistics.

Tracking of products, inventory, supply chain is the answer written by 8 firms. They want to easily monitor their products, manage and track their inventories. Moreover, 5 firms are looking forward to getting rid of the bureaucracy in the firm with digitalization. The other answers are written by 1 or 2 firms are; time-saving, reaching more accurate and real-time information, reducing security problems and collecting and storing data properly.

3.4.3.4. Benefits of Augmented Reality for Firms

This question is answered by 17 firms. All opinions were written under Microsoft Word and the most frequently used words were identified. After, answers were categorized.

Problem detection is written by 8 firms. With the augmented reality, firms expect to more accurately identify possible problems and to minimize the problem detection time. Moreover, 6 firms think that this technology gives them time advantages as production and test phases of products and education time of workers will decrease.

Reaching possible outcomes with simulation is written by 5 firms. With the augmented reality, simulations result can be observable by firms that give ideas about the results of the process, possible risks and conclusions. Efficiency increasing and cost advantage in the production are the other expected outcomes from augmented reality by 5 firms, because the design of products will be more accurately and tested faster.

3D assembly line is written by 4 firms. With this technology, each process in the lines can be observable by workers, that will minimize the human errors. Lastly, one firm mentions that reaching the remote maintenance service to save time.

3.4.3.5. Innovations, Robots and Automation for Firms

This question is answered by 16 firms. All opinions were written under Microsoft Word and the most frequently used words were identified. After, answers were categorized.

In this question, firms write their own needs, wants, desired machines and robots. Mostly, answers are written by 1 or 2 firms. Answers of the firms are; software and hardware programming for all robots and automation systems, test machines, efficiency comparisons programs, automatic weld and dye machines or robots, digital order and tracking systems, faster reaching data and analyzing data programs, voice control of assembly line, robotic transformation systems inside factory, software systems that holds all actions of manufacturing, transporting the products from trucks to the inventory and inside factories.

To sum up, firms are looking forward to using the robotic workers in production, a transformation so on. Moreover, digitalization of the orders, assembly line and manufacturing, and some special software programs are another demand of firms.

CONCLUSION

The new industrial revolution, which is called Industry or Industrie 4.0, started to officially in 2011 at Hannover Fair. Internet technologies and digitalization are the primary power behind the Industry 4.0. This revolution like the others will not only cause changes in production systems but also the whole society, markets, competition dynamism and jobs duties.

Production will gain a new perspective with this revolution. More flexible, autonomous, smart and robotics production in factories will be possible. Almost all production will be made by robots. Moreover, the autonomous system and robots can control, manage and change the production systems when necessary and make decisions based on the data without receiving any orders from managers. Additionally, they can learn new things from the environment and gain new abilities. Also, factories can be controlled by managers remotely is another feature of the new revolution.

The other big revisions will happen in receiving data because in real time data observation will be achievable for managers, employees, and the whole supply chain. Because with the internet of things technology, all goods, systems, machines etc. will be smart and gain the ability to connect internet, so that they can communicate each other, send and receive orders directly to from customers, companies and supply chain member with using the wireless network. Also, all time they can obtain data from the real environment and send them to digital platforms, so that a huge amount of data can be collected, and more detail analyzed will be made. Thus, this will lead to a more connected and networked world for the humankind.

Managing the supply chain network will be easy for firms. Whole firms in the supply chain can receive real-time data and information on the others and authority of firms on making planning, controlling and managing the chain will be improved.

Quickly changed production process and the smart connection will open doors to the unique and completely individualized production. That means eras of mass production and mass customization will end with the new revolution. More quality production and the customized product will become more possible for all firms so that these features cannot be used as competitive advantages by firms. As a result, competition dynamism of market must be revised.

Furthermore, employees will affect new production systems, Job duties will get change and some jobs will be disappeared or taken over completely by robots. However, new business fields will be developed that bring the new job opportunities to people.

Consequently, massive changes will wait for the firms, employees and whole society that explains the motivation of this study. In this thesis, information is collected from firms to locate in İzmir and Manisa cities in order to evaluate the awareness of them about Industry 4.0's terms. According to the analysis, Industry 4.0 term (23,36%) is the most known term by the firms. Internet of things (17,52%), factory layout (16,06%), and big data (16,06%) are the others mostly known terms by firms.

To find out whether there is a relationship between firm size and awareness of Industry 4.0's terms, one of the non-parametric method chi-square are used and found that; large firms are more aware of the big data, society 5.0 and internet of things terms when compare to SME's.

Moreover, according to descriptive analysis, When the data is analyzed, information about firms' Industry 4.0 stages are reached. 15 firms (39,47%) are in evaluation stage, 4 firms (10,53%) are in planning stage, 7 firms are in different application stage, and 12 firms (31,58%) are no evaluation/application stage for Industry 4.0. To sum up, almost 70% of firms are in the evaluated/application or implementation phase. That indicates that most of the firms interested in the new revolution.

Additionally, according to companies; monitor optimization production process, remotely control machine/factory and simulation of product and production flow and product test and quality insurance initiative are the applications that describe the Industry 4.0. It can be concluded that firms want to reach and use those new applications with the new technologies that Industry 4.0 bring.

As well, main challenges of the Industry 4.0 for firms are that; standardization data, method, and workflow challenge (27,69%), acquiring new skills (24,62%), controlling big data (21,54%) and standard database for all department (15,38%). It can be concluded that standardization is seen as the biggest obstacle for firms. Government, academicians, and engineers should come together to solve the problems, standard data collection and storing principles should be accepted by all governments.

Universal standards should be accepted by all companies because various firms, service providers, customers etc. located different part of the world and responsible different standard. The other most important obstacle is talented employees. With the new revolution and technologies, necessary skills and abilities of jobs will face the big changes and will affect the employees. Government and universities should detect the new requirement of sectors and educate the new and existing human resource.

Furthermore, different IT can be used together that bring some advantages for firms. Cost saving, and agility and faster response to changes are two main expectations of firms about the benefits of various IT integration when to apply Industry 4.0.

Big data is one of the results of the new technologies. Smart goods, products, and systems will produce and collect the new data from real-world environment. Data analyzing will get a new form with the fourth industrial revolution. Companies information, data collected from customers etc. all information will be held in the cloud. Therefore, protecting the data from cyber-attack will be more important for firms in that era. Using the security program becomes more vital for firms day by day. In this study, information about the usage of the security program in companies are collected and 76% of firms use a security program. It is the good indicator, firms care about the data protection. Moreover, in this thesis, firms face enterprise resource planning problems, personal injury, theft of intellectual property and production downtime problems even if the used the security problems. So that the most powerful and advanced security problems must be used by firms to prevent these problems and protect their data.

Industry 4.0 will bring lots of the advantages for firms such as flexible production, digital value chain etc. However, using new technologies require the special budget for buying new technologies or adapted old them. Thus, firms should allocate budget for Industry 4.0. In this study, information about existing and future Industry 4.0 budget of firms are collected and 44% of firms have Industry 4.0 budget and 76% of firms will allocate budget for Industry 4.0 in next year. It can be deducted that firms want to follow new technologies and changes and allocate budget to follow changes.

Additionally, data is collected about whether Kosgeb and various Industry 4.0 incentives trigger of firms' investment or not. Nearly, half of the firms can invest more money in Industry 4.0 technologies when reaching the Kosgeb Industry 4.0 incentives. Moreover, 80% of firms can increase their investment if reach various Industry 4.0 incentives. Almost four of five the firms can invest more money in Industry 4.0 technologies when reach the various Industry 4.0 incentives. So that governments should prepare the incentives programs for firms to increase investment in firms and develop new technologies.

When analyzed the problems of firms when the apply the Industry 4.0, the absence of the necessities technologies and software's programs are the biggest problem for firms. To apply the Industry 4.0, old machines should be converted or changed to new ones. Also, the firm's vision, mission, strategy, technological infrastructure should be revitalized according to requirements of a new revolution. Budget and time problems, the absence of skilled employees, a low degree of openness to changes and lack of standardization and knowledge are the other problems of firms when the apply the Industry 4.0. In order to solve these problems, engineers should develop new software and technologies for firms. Also, special incentives programs should be launched to help firms to convert their machines faster. Also, academician, managers should study together to revitalize the management systems and vision of firms. Additionally, academicians and government should work cooperatively to inform firms and employees about a new revolution. Lastly, standard procedures and principles should be developed and accepted as universally.

With the new revolution, production, information technologies, and digital supply chain are seen as the most value-added areas of Industry 4.0 for firms.

Usage of digitalization in firms will be a peak with industry 4.0. When the firms use digitalization inside factories, they want to detect the root(s) of problems swiftly, the track of products, inventory, save time, reach more accurate and real-time information, reduce security problems and collect and store data properly.

Moreover, with the Industry 4.0, augmented reality technology will be used more frequently in the various field. Firms want to receive some benefits from using augmented reality. These benefits can be explained like that; firms want to more exactly detect possible problems and to minimize the problem detection time, to save time in production and in test phases of products, to observe assembly line as 3 dimensional and lastly, to reach the remote maintenance service.

Additionally, software and hardware programming for all robots and automation systems, test machines, efficiency comparisons programs, automatic weld and dye machines or robots, digital order and tracking systems, faster reaching data and analyzing data programs, voice control of assembly line, robotic transformation systems inside factory are the some of the innovations, robots, and automation are desired by firms.

In this study, the questionnaire is applied to firms operated in İzmir and Manisa. Moreover, firm size is very small in this study. So that, it is a good change for the next studies, which can reach firms operated to different geographic areas and extend the sample size. Furthermore, there is no pattern between awareness of Industry 4.0 and specific sectors. Thus, future studies can focus on a specific sector/s and collect data about expectations, opinions, challenges of firms that when decide to apply the Industry 4.0. Also, the specific needs of a sector can be analyzed when they change the production systems to Industry 4.0. Lastly, an action plan for a sector can be prepared contains what kind of requirements, needs, plans, tools, skills etc. need when the firm adapt its systems to Industry 4.0.

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APPENDIX

Appendix 1: Survey

Sayın Katılımcı,
Endüstri 4.0'ın farkındalık analizi amacıyla yapılan bu ankete katılmanız, araştırmada doğru bilgiler elde etme bakımından son derece önemlidir. Elde edilecek bilgiler, GİZLİ tutulacak olup; sadece bilimsel amaçlarla kullanılacaktır. Talep etmeniz durumunda hazırlanacak tez sizlere de gönderilecektir. İşbirliğiniz ve katkılarınız için teşekkür eder, saygılar sunarız.
1. Cinsiyetiniz: ( ) Kadın ( ) Erkek
2. Yaşınız: ( ) 18-25 ( ) 26-34 ( ) 35-44 ( ) 45-54 ( ) 55 ve üzeri
3. Eğitim durumunuz: ( ) İlköğretim ( ) Lise ( ) Üniversite ( ) Yüksek Lisans ( ) Doktora
4. Mesleğiniz: ___________________
5. İş deneyiminiz: ( ) 0-4 yıl ( ) 5-9 yıl ( ) 10-14 yıl ( ) 15-19 yıl ( ) 20-24 yıl ( ) 25 yıl ve üzeri
6. Mezun olduğunuz fakülte hangisidir?
( ) İktisadi ve İdari Bilimler Fakültesi ( ) Edebiyat Fakültesi ( ) İletişim Fakültesi
( ) Mühendislik Mimarlık Fakültesi ( ) Açıköğretim Fakültesi ( )Diğer:_________
( ) Güzel Sanatlar Fakültesi ( ) Hukuk Fakültesi
7. Şirketin Çalışan Sayısı: ( ) 0-9 ( ) 10-49 ( ) 50-249 ( ) 250 ve üstü
8. Firmanızın Ar-Ge bütçesini belirtiniz: ___________
9. Firmanız hangi sektör ve alanda faaliyet göstermektedir? ______________
10. Firmanız kaç yıldır faaliyet göstermektedir? _______________
11. Aşağıdaki kavramlardan hangilerini duydunuz? Duymuş olduğunuz kavramları lütfen işaretleyiniz.
( ) Endüstri 4.0-Industry 4.0-Industrie 4.0 ( ) Advanced Manufacturing Partnership-İleri Üretim Ortaklığı
( ) Made in China 2025 ( ) Internet of Things, Nesnelerin İnterneti
( ) Big Data- Büyük Veri ( ) Factory Layout -İş Yeri Düzenlenmesi ( ) Hiçbiri
( ) Society 5.0-Toplum 5.0 ( ) Cyber-Physical Production Systems-Siber-Fiziksel Üretim Sistemleri
12. Endüstri 4.0 terimini nereden duydunuz ?
( ) İş yeri dışında duzenlenen seminer/ konferans
( ) İş yerinde düzenlenen eğitim/bilgilendirme toplantıları/seminer/konferans
( ) Televizyon ( ) Sosyal medya ( ) Gazete/Dergi ( ) Diğer (belirtiniz)__________
13. Şirketiniz endüstri 4.0 uygulamasında hangi aşamadadır?
( ) Herhangi bir değerlendirme ve uygulama yok (bu seçeneği işaretleyenler için anketimiz sonlanmıştır, teşekkürler.)
( ) Değerlendirme ( ) Sınırlı uygulama
( ) Planlama ( ) Kapsamlı uygulama
( ) Pilot uygulama ( ) Diğer (belirtiniz)___________

14. Aşağıdaki uygulamalardan hangisi, şirketinizde planlanan veya uygulanan Endüstri 4.0 girişimlerini tanımlıyor ve/veya hangileri Endüstri 4.0'ın entegrasyonu için uygundur? (Birden çok seçenek işaretleyebilirsiniz.)
( ) Üretim ağı içi işlemlerin izlenmesi ve optimizasyonu ( ) Ürün testleri ve kalite güvencesi
( ) Makine ve tesisin uzaktan izlenmesi ( ) Envanterin planlanması
( ) Kurum içi makine ve sistemlere bakım, temizleme, tadilat ( ) Üretim akışlarının simülasyonu
( ) Sipariş hazırlığı sonrasında ürünlerin üretim modüllerinin düzenlenmesi ( ) Hiçbiri
15. Endüstri 4.0'ı gerçek hayatta kullanmaya başladığınızda sizin bakış açınıza göre karşılaşmayı beklediğiniz zorluklar nelerdir ve/veya endüstri 4.0 nedeniyle var olabilecek mühendislik sorunları ne olabilir? (En fazla 3 şık işaretleyiniz.)
( )Tüm departmanlar için standart bir veri tabanının geliştirilmesi
( ) Gerekli yeni beceri ve yeterliliklerin kazanılması
( ) Artan veri hacimlerinin, çeşitliliğinin ve karmaşıklığının kontrol altına alınması
( ) Veri, yöntem ve iş akışlarının standardize edilmesinin gerekliliği
( ) Şirket içi departmanlar arasında daha yakın işbirliğinin gerekliliği
( ) Diğer(belirtiniz)_______________
16. Kurumunuzda çeşitli bilgi sistemlerinin (IT) entegrasyonundan hangi faydaları bekliyorsunuz? (En fazla 2 şık işaretleyiniz.)
( ) Geliştirilmiş üretim kullanımı (üretim hattının daha etkin ve verimli kullanımı)
( ) Bölümler arası ve/veya değer yaratmadaki işbirliğinin daha iyi olması ( ) Maliyet tasarrufu
( ) Daha yüksek çeviklik / yeni gereksinimlere daha hızlı tepki verilebilmesi ( ) Diğer__________
17. Büyüyen veri (big data) ile tüm verilere tam zamanında ve doğru şekilde ulaşım artacak ancak bu beraberinde güvenlik sorunları getirecek. (Bilgilerin bulut (cloud) programlar üzerinden paylaşılması ve bu bilgilere daha kolay ulaşım nedeniyle bilgi hırsızlığı gibi) Bilgi ve veri güvenliğini sağlayabilmek için kullandığınız/kullanmayı planladığınız programlar var mı? ( ) Evet ( ) Hayır
18. Geçen yıllarda şirketinizde **çalışanlardan kaynaklanmayan** ne tür bir güvenlik (bilgi güvenliği, siber saldırı vb.) oldu? (Gerekirse 2 taneye kadar seçim yapabilirsiniz.)
( ) Üretim manipülasyonu ( ) Kişisel yaralanma (işçilerin yaralanması)
( ) Üretim duruşu ( ) Hiç bir şey olmadı
( ) Fikri mülkiyetin çalınması ( ) Diğer:_______
( ) Kurumsal kaynak yazılımı vb. ile ilgili problemler
19. Şirketinizde Endüstri 4.0 için ayrılmış bir bütçe var mı? ( ) Evet ( ) Hayır
20. Önümüzdeki yılda Endüstri 4.0 planları ve/veya uygulamaları için bir bütçe olacak mı? ( ) Evet ( ) Hayır
21. Kosgeb'in endüstri 4.0 için hibe/destek planı sayesinde yatırımlarınızı arttırmayı planlıyor musunuz? ( )Evet ( )Hayır
22. Sizi bu ve bunun gibi destekler teşvik ediyor mu? ( ) Evet ( ) Hayır
23. Endüstri 4.0'ı hayata geçirmenin üç ana zorluğu nedir?

24. Endüstri 4.0’ın katma değer üretebileceği işletme alan ve/veya alanlarınızı tanımlayınız.
25. Endüstri 4.0 sayesinde ürünlere, üretim hattına, sistemlere ve belgelere dijital erişilebilirlik ve aynı zamanda ürün, üretim hattı, sistem ve belgeler arasında eş zamanlı olarak bilgi akışı ve değişimi olacaktır. Bu sistem hayata geçtiğinde üretim bölümü olarak en çok hangi problemlerden kurtulmuş olacaksınız?
26. Endüstri 4.0 sayesinde montaj hattına mobil cihazlar ile 3-boyutlu olarak ulaşım sağlanabilecektir. (akıllı gözlükler, arttırılmış gerçeklikler vb.) Bu size ne gibi avantajlar sağlar?
27. Hangi tür yenilik, robot ya da otomasyon sizin işlerinizi hızlandırır ve kolaylaştırırdı? Endüstri 4.0’ın getirdiği teknolojik yenilikleri düşündüğünüzde hangi teknolojilerin işletmenizde kullanılmasını isterdiniz?