THE REPUBLIC OF TURKEY

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THE COMPARISON OF INDUSTRY 4.0 IMPLEMENTATIONS BETWEEN TURKEY AND EU COUNTRIES

Master of Science Thesis

SEMİH ANDAÇ

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DEDICATION

This thesis is dedicated firstly to my doughter Zeynep Duru and nephew Kuzey, who have given me energy to finish this thesis during in a very busy period. I am sure that they both will surpass me and hope to see my name in their Dr. thesis dedication parts. I also dedicated my thesis to my lovely wife Elif who has supported me with her generous patiance and personal graces. Another dedicaion is to my mother Sevim ANDAÇ, father Hüseyin ANDAÇ, and sister Seçil Andaç ESENEL. They have always believed me and I have feeled their support all of my life.

Lastly, it is dedicated to all Martry who has fallen down for the sake of our Country. Rest in peace all.

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İstanbul, 2019 Semih ANDAÇ

ABSTRACT

THE COMPARISON OF INDUSTRY 4.0 IMPLEMENTATIONS BETWEEN TURKEY AND EU COUNTRIES

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Industry 4.0 was born as a 'Smart Factory' concept, but in a short time it has broadened it's border and turn into 'Made Smarter' what ever you are producing nearly in every sector. Actually Industry 4.0 is a 'Vision' and firstly used in Hannover Fair at Germany in 2011. Since that date, all developed countries paid attention to this new concept and tried to get initiative as soon as possible. Not only prestige considerations, but also worries of economic competition capabilities, pushed these countries to inspect and examine new forthcoming revoulation. So nearly all developed countries has constituted their industry 4.0 institutions and defined their roadmap in a general way.

Allthough lots of definitions have been written about the Industry 4.0, it is mainly about the digital transformation, and it doesn't just cover the manufactoring area. Digital transformation jumped and converted quickly to the smart transportation and logistics, smart buildings, oil and gas, smart healthcare and even smart cities. Since Industry 4.0 has lots of benefits such as, enhanced productivity through optimization, real time data for a real time supply chain in a real time economy, better quality products, better working conditions and sustainability, personalization and customization for the 'new' consumer, it looks late countries will be faced very critical and serious damages in near future.

So in this study, we tried to describe what Industry 4.0 is and its vision, then we briefly examined leading EU countries Gemany, England, France's Industry 4.0 vision and implemantations also tried to understand how they perceived this new revaluation. Than at the core of the work we tried to scrutinize how Turkey perceived Industry 4.0 and what we did so far both as a govermantal and private sector. Then we compared leading EU Countries and Turkey Industry 4.0 visions and implementations. As conclusion we wrote a roadmap in order to catch this revaluation and to be the foremost Industry 4.0 executive country. Since Turkey has been late to the first, second and third revoulation, it is really critical to be on time for the Industry 4.0 revoluation.

Keywords: Industry 4.0, Internet of Things, Digital Transformation

ÖZET

TÜRKİYE VE AVRUPA BİRLİĞİ ÜLKELERİNDE Kİ ENDÜSTRİ 4.0 UYGULAMALARININ KARŞILAŞTIRILMASI

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Endüstri 4.0 ‘Akıllı Fabrika’ konsepti olarak ortaya çıksa da çok kısa bir süre zarfı içinde bu tanımın sınırlarını genişleterek ne üretirsen üret ‘daha akıllıca yap’ konseptine doğru evrildi ve hemen hemen tüm sektörlere yayıldı. Endüstri 4.0 ilk olarak Almanya’da ki Hannover Fuarında bir vizyon olarak dile getirldi. O tarihten itibaren tüm gelişmiş ülkeler bu yeni kavrama ilgi gösterdiler ve inisayatif almak için hiç vakit kaybetmeden müdahil oldular. Endüsri 4.0’a ilgi gösrermelerinin sebebi prestij kazanmanın yanısıra, yeni konseptin sağlayacağı ekonomik avantajları anlamak ve araştırmaktı. Bu düşünceden hareketle hemen tüm gelişmiş ülkeler Endüstri 4.0 yapılarını oluşturmaya başladılar ve genel hatlarıyla yol haritalarını belirlediler.

Endüstri 4.0 hakkında bir çok tanım olmasına karşın, esas olarak endüstri 4.0 digital dönüşümle ilgilidir ve sadece üretim sektörünü kapsamamaktadır. Digital dönüşüm üretim sektöründe ortaya çıkmasından çok kısa bir süre sonra, akıllı ulaştırma ve lojistik, akıllı binalar, akıllı yakıt tüketimi, akıllı sağlık uygulamaları ve hatta akıllı şehirlere kadar bir çok alana sıçramış bulunmaktadır. Endüstri 4.0’la beraber gelen dijital dönüşüm, daha fazla üretim ve optimizasyon, tedarik zincirinde anlık veri sağlama imkanı, daha kaliteli ve kişiye özel ürünler sağlama yeteneği, daha uygun ve sürdürülebilir fiziki çalışma koşulları sağlayabilme imkanıyla bu dönüşüme geç kalan ülkelere ciddi bir bedel ödetecek şekilde hızla gelişmeye devam etmektedir.

Bu çalışmada, öncelikle tarihteki endüstri devrimlerini inceleyip, endüstri 4.0’ın tanımını ve vizyonunu ortaya koyduk. Müteakiben Avrupa Birliğinin 3 gelişmiş ülkesi Almanya, İngiltere ve Fransa’nın endüstri 4.0 uygulamalarının neler olduğunu ve bu dönüşümün neresinde olduklarını kısaca ortaya koymaya çalıştık. Daha sonra çalışmamızın odak noktasına ülkemizdeki Endüstri 4.0 uygulamalarının neler olduğunu koyarak, bizim bu dijital dönüşümün gerek kamu gerek özel sektör olarak neresinde olduğumuzu anlamaya çalıştık.

Çalışmamızın son bölümünde Avrupa Birliği ülkeleriyle Türkiye’nin endüstri 4.0 uygulamalarını karşılaştırdık ve eksik kaldığımız alanlarda bir yol haritası oluşturduk. İlk üç endüstri devrimine geç kalan Türkiye’nin endüstri 4.0 devriminde öncü rol oynamasının çok önemli ve değerli olduğunu değerlendirmekteyiz.

Anahtar Kelimeler: Endüstri 4.0, Nesnelerin interneti, Dijital Dönüşüm

İÇİNDEKİLER

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ABBREVIATIONS

CES	:	Consumer Electronic Show
CRM	:	Customer Relationship Management
CPPS	:	Cyber-Physical Production System
EEF	:	Engineering Employers Federation
ERP	:	Enterprise Resource Planning
ICT	:	Information and Communication Technologies
IOP	:	Internet of People
IOT	:	Internet of Things
RFID	:	Radio Frequency Identification
M&A	:	Marketing and Advertising
M2H	:	Machine to Human
M2M	:	Machine to Machine
MES/MOS	:	Manufacturing Execution and Operation Systems
MUSIAD	:	Independent Industrialists and Businessmen Association
NIS	:	National Innovation System
PLM	:	Product Lifecycle Management
SMB	:	Small and Medium Business
TIM	:	Turkish Exporters' Assembly
TOBB	:	Union of Chambers and Commodity Exchanges of Turkey
TTGV	:	Technology Development Foundation of Turkey
TUSIAD	:	Turkish Industry and Business Association
YASED	:	International Investors Association

1. INTRODUCTION

Industry 4.0 was born just a few years ago in Germany at 2011 Hannover Fair, but in a short time widely spreaded to the other developed countries. Despite the vastness, definitons and many concepts, Industry 4.0 is the modern face of industry which is being used in automation and data exchange in manufacturing technologies. It includes, Big Data, inter connected machines, connected devices, cyber physical systems, Cloud computing, software and Industrial Internet of Things. (Dhote 2017) In addition to this description it is also a combination of Information Technology (IT) and Operational Technology (OT).

Industry 4.0 is mainly about the digital transformation industrial areas especially in markets. At the beginning, it was containing only manufacturing, but it switched to various sectors in a short time due to ‘made smarter’ concept. Made smarter concept, sounds good and can be thought very easy and quickly implemantable. In fact, just like digital transformation it requires a strategic view and deeper understand.

Today, an increasing number of industries and countries are adopting the technologies, concept and principles of Industry 4.0. While this implemantation process, they are approaching Industry 4.0 race as a series of sprints, and view their program as a marathon. To improve performance and gain a competitive edge, manufacturers are adopting the new digital industrial technologies that are collectively known as Industry 4.0. Leading manufacturers are already implementing these advances in order to bring products to market faster, decline their cost bases, and build new revenue areas. The value created by Industry 4.0 vastly exceeds the minor cost savings that many manufacturers pursue today. The new technologies promise to revolutionize manufacturing, thereby shifting the competitive balance among countries and transforming the industrial workforce (Rose et. al. 2016). So countries and their industries are trying to understand the industry 4.0 quickly but not in a hurry.

Turkey also has some initiatives both in governmenatal and private sector side. Although they will be mentioned at related pages, our stiuational awareness about this

new concept is really good for this time. As first, second and third evoluatons are missed ranging from 30 to 100 years, we don’t have any luxury to be late this time. With this consciousness, Turkey is pursuing the developments closely.

With this short introduction it is time for a deeper dive. As per usual, everything begins with understanding what exactly we are studying, how we have come this point thoughrout the industrial history, the advantages of this new concept, and how it is all evolving and impacting organizations, sectors and generally countires in real life.

2. HISTORY&LITERATURE REVIEW

2.1 HISTORY

2.1.1 Overview of Industrıal Revolution

The term “Industrial Revolution” was introduced by Auguste Blanqui, a French economist, in 1837 to demonstrate the economic and social changes arising out of the transition from industries carried in the homes with simple instruments, to industries in factories with power driven machinery in Britain, but it came widespread when Arnold Toynbee, the great historian, used it in 1882.

However, historians argued the appropriateness of the term on the ground that the Industrial Revolution covers a period far too long to justify a single label. The period is from approximately 1740 to about 1850 in Britain and from 1815 to the end of the nineteenth century in Europe.

Furthermore, the term “Revolution” is misleading for describing a complicated series of forces, processes and discoveries which worked very slowly but gradually and created a new economic organisation. That is also reasonable and better to call it as an evolution and not a revolution.

It is also suggested that instead of calling it the Industrial Revolution, it should be called “The Transition of Industrialism”. Allthough this objection, the term industrial Revolution is preferred and is in common usage.

It transformed an overwhelmingly agricultural society into an industrial society. This revolution was not a revolution in the normal meaning of the word. Revolutions are generally linked with violence, suddenness, and bloodshed. Nevertheless, the Industrial Revolution was independent from all these bad features. It was a long, slow process of transformation, beginning unclearly, we cann’t say definetley when, and just ending recently, if really revoluation has ended yet.

If we ask the question, why this revolution started in England, there are numerous reasons. First of all political and economic conditions in England in the second half of the eighteenth century were the most suitable for the beginning of the Industrial Revolution in that country. Industrial revoluation enriched her and gave her a leading country over all other European countries. Then it spread to the main continent of Europe and further abroad almost fifty years later.

Political condition in England was also suitable for Industrial Revolution. England was a free country at that time. Her parliamentary system of Government had become stable and there were no political upheavals to disturb internal peace, unlike France and other leading European countries. Peaceful political conditions provided a proper environment for the growth and development of commerce and industry. The capitalists and the riches of England felt secure in investing money in them and were not afraid of a any goverment change.

Industrial revoluation soon showed its effect nearly all sectors. Humanity made a big progress nearly all fields and various inventions followed each other. When we inspect them closely, it is very easy to recognize that all inventions were made like hand over take over ceremony of scientists. Firstly inventions were born as an idea in one scientist, and then it is implented by his or her. From the point that he or she left, another scientist took the flag and put it a little bit away. This ceremony has lasted till today. So at the below main sectors are inspected and what has changed during the industrial revoluation in these sectors are submitted.

As for mining and metallurgy, wood was used for smelting iron in previous dates. That process was long and challange. There was also the danger of deplete the countries' forests. It was found that coal was a much better substitute for wood. Coal was available in plenty but the issue was how to take it out of the mines which got flooded with water. Mine explorers began to pay attention to the problem of pumping out water.

Thomas Newcomen (1663-1729) explored a steam engine which helped the miners in pumping out water quickly. There were many faults and errors in the engine. It wasted a

good deal of heat and fuel and sometimes it did not start. Its errors were removed by the invention of James Watt. Abraham Derby used coke successfully for fusing iron but its quality was immature. In 1784, Henry Cort (1740-1800) discovered better methods to improve the quality.

George Stephenson (1781-1848) is known the father of steam locomotive. He explored the first locomotive for pulling coal over iron rails. Its speed was just a 3 miles an hour. But by the time, it was improved. As of 1823, a locomotive factory was established at Newcastle. At the opening of the Liverpool-Manchester Railway in 1830 the locomotive had the capability of making 30 miles an hour. The invention of locomotives and introduction of railways was a marvellous present to mankind. It became available to transfer goods more fastly and cheaply from one region of the country to another.

The moving power of steam was also installed to transport by sea. In 1807, a steamboat made by Robert Fulton sailed from New York to Albany, the distance was 150 miles and it took 32 hours.

A lot of development was also done especially for the equipment of communication. In the first half of the nineteenth century, Charles Wheat-stone with the support of two Americans Samuel Morse (1791-1872) and Alfred Vail invented the electric telegraph. It was due to the joint efforts of Sir Charles Bright and Cyrus Field that the first Atlantic telegraphic communication across ocean was located in 1866. Telephone owes its origin to Philip Reis, a German inventor.

Michael Faraday (1791-1867) invented electro-magnetic induction in 1831. In 1839, Louis Daguerre (1789-1851) designed a method of photography by mercury vapour development of silver iodite exposed on a copper plate. In 1836, John Ericsson (1803-1889), who is a naval engineer, made the Monitor, the water screw. In 1844, Charles Goodyear (1800-1860) invented rubber vulcanisation. This was enabled the invention of insulation and it was one of the milestone in revolution.

From the financial perspective; As the Industrial Revolution marched, machinery became more and more complex and expensive. It was difficult to install factories just one person entreproneur or few people's combined endeavour. So cooperation effort was inevitable. This stiuation led to born of cooperations and limited companies in which more than thousands of people invested their capital in the hope of earning good profits.

On the other hand, a variety of other industries like building, furniture making, laundering, and even shoe-making also made tremendous progress. Canning industry, food preservation, heating, gas-lighting and a lot of electrical appliances gave more facilities to all people. The invention of the telegraph made transmission of news from one place to another faster and cheaper and that enabled the newspapers to publish news of the world.

After 1870s, the use of electricity became popular and common. Side by side with the steam engine, there developed a wide range and great variety of electrical devices. Electrical dynamos and motors were improved and multiplied. Lighting by gas or kerosene was largely replaced by lighting. Thomas Edison explored the shining electric light in 1878. Bell invented the telephone in 1876.

By the end of the 1880s, most cities of Europe and America were being provided with systems of electrically-powered street railways. After that, electric railways were also introduced. In 1895, Marconi, a youthful Italian, devised a practical system of wireless telegraphy. In 1898, wireless telegraphic communication was established across the English Channel and in 1901 across the Atlantic.

As well known World War I started in 1914 but Industrial Revolution wasn't stopped by the World War I. As a matter of fact, it emerged a new stage of achievement in the next thirty years. The result of previously mechanised industries was increased by technological improvements. At the same time, new machine industries came into existence and expanded with incredible speed. Industrialisation was become intense not only in the so-called capitalist countries but also in communist countries like the Soviet

Union and also developing countries like Turkey and Mexico. It will not be eveluated as an exaggeretion to write thet whole of Europe was mechanised. Summarily, industrialisation was spread to all regions of the world.

Aviation developed also very rapidly and used for commercial carrying of mails and passengers. Regular airplane services were commenced officially between London and Paris, Alexandria and Paris, and also between India and Baghdad, and from Paris to South America countires such as Brazil and lastly New York to Central and South America and Mexico. In 1929, a Zeppelin aero plane circumnavigated the world from Germany via Tokyo and Los Angeles and New York back to Germany, in 20 days.

In 1927, Lindberg, an American aviator, flew with his airplane alone and without any break from New York to Paris. Admiral Richard Byrd explored the Arctic Ocean and visited the North Pole in 1927. In 1929, he explored the Antarctic Continent and flew over the South Pole. By 1939, commercial airlines were being operated by every major nation and were carrying mail, merchandise and passengers over all the oceans and Continents of the world.

From the political perspective; Results of the Industrial Revolution, there was a strengthening of the middle class. The Industrial Revolution also had intellectual and cultural results. In his book entitled "Wealth of Nations," Adam Smith (1723-1790) stronfully expressed himself against intervene of government with business affairs. His opinion was that every individual is the best judge of his or her own economic decisions (Aggarwal 2015).

Today, the concept known as Industry 4.0 or, the fourth Industrial Revolution, is a natural extension of the technological evolution that has been lasting for years. The technologies that triggered the process which is known as the digital transformation of industries can be divided into four main groups.

The technologies in the first group strengthen the capacity to process data and information. Technology including the Internet of Things technologies, cloud and

sensors which all enable interconnectedness, are some examples. In a world where everything is connected to the internet, cyber security solutions become increasingly important.

The second group consists of technologies that strengthen the capacity to gather and analyze information. For instance, big data technologies, advanced analytical technologies, deep machine learning technologies, and artificial intelligence can be included in this group. In other words, much more information can be gathered, rapidly processed, and analyzed in various ways due to technologicies in the first two groups.

Those in the third group are technologies that facilitate human interaction with machines and make it more effective. New generation user screens, virtual reality, and enhanced reality technologies are included in this group. Some believe that the aforementioned technologies will take human interaction with robots to unprecedented levels, driving us towards the fifth Industrial Revolution.

The last group of technologies can be defined as technologies that fabricate products from digital models. For example, 3D printing machines convert digital data to physical output with using materials such as plastic, metal, and fabrics. Although they can be grouped in different methods, when discussing the digital transformation, we are referring to technologies that generate process, collect, and analyze huge amounts of data, as well as technologies that strengthen human interaction with machines and convert data into physical products.

Those four technology members are expanding and growing at an incredible speed. A study case conducted by Cisco for instance, revelaed the fact that in 2013 there were 10 Billion devices and machines communicating with each other (CISCO White Paper 2014)[1]. The study forecasted that developments at information and data processing capacity and info networks will be able to raise this capacity to 50 billion as of 2025.

[1] Cisco White Paper, Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2014 https://tr.scribd.com/document/244908586/Cisco-white-paper-c11-520862 [accessed 11-03-2018]

Another study conducted by IDC which is an international research organization revealed the fact that amount of data produced globally from the 2013 to 2020 will rise 11-fold which is approximetely 44 zettabytes. Every single piece of data that is produced but not used in reasonable way is now regarded as waste. The market for enhanced and virtual reality applications is also predicted to grow five-fold as of 2020, growing a value of 100 billion dollars. In summary, human interaction with devices and machines will be become a fact soon. As of 2020, it is known that there can be more than three million robots working by thmeselves in factories.

The widespread use of these technologies in the industry is not the only reason that they have advanced and spread so rapidly. Experts forecast that Internet of Things technologies will have an impact of up to trillions of dollars, in various areas ranging from transportation and health, to retail and construction sales. For instance, according to a workshop conducted by the McKinsey Global Institute in 2015, Internet of Things technologies are expected to have an annual economic impact of 11 trillion dollars by 2025, and roughly 40 percent of which will be in manufacturing sector.

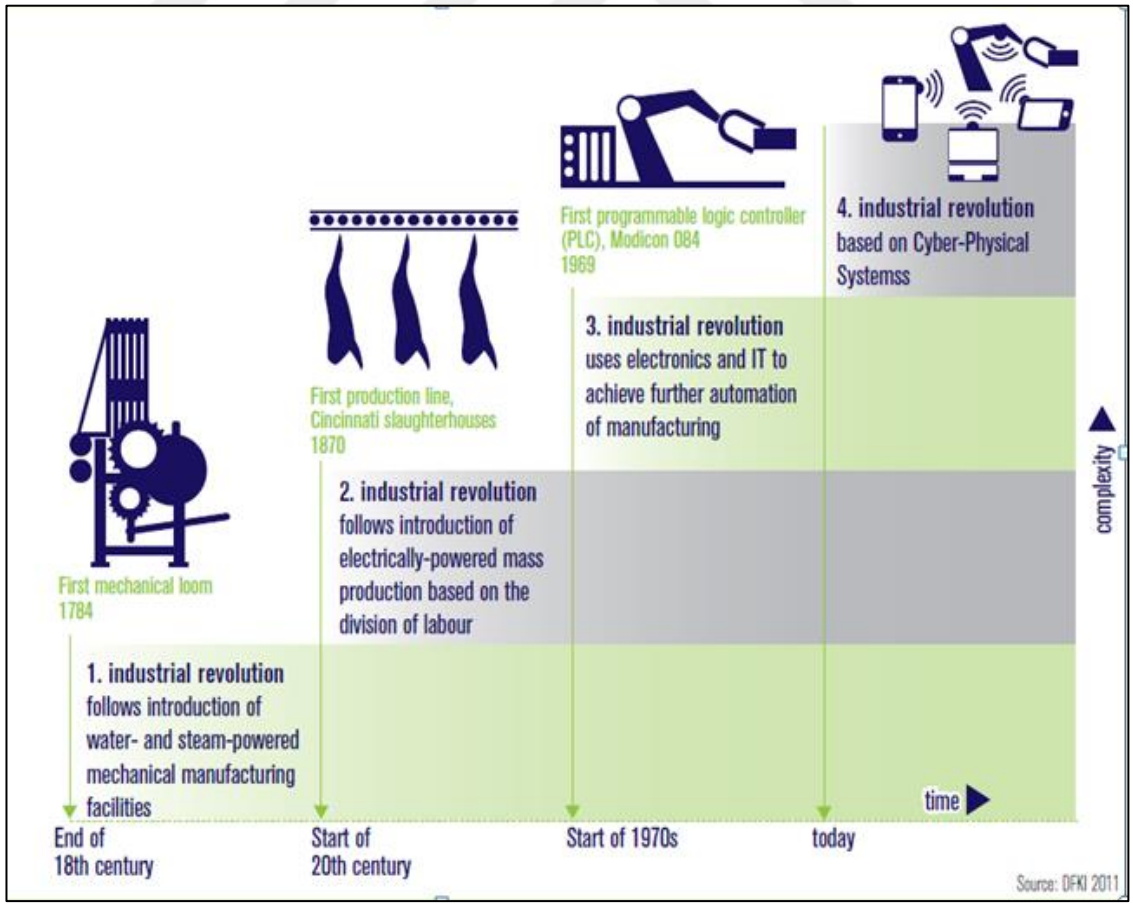
Allthough biggest transformation will be in manufacturing sector; technology will not only transform the manufacturing but also many others as well, and is affecting every segment and sector of society. In many cities, for instance, Internet of Things technologies are expected to have an economic impact worth 0.9-1.7 trillion dollars as of 2025. It is forecasted that only the revenue provided by smart traffic management systems will approximately amount to till 900 billion dollars every year.

As mentioned Digital technologies are expected to have a significant impact on various sectors. One of them is Global digital health market, which will reach to 233 billion dollars bas of 2020. Another sector is agricultural market and agricultural robotics market is expected to approach 20 billion dollars in the same time period. Digital technologies and advanced production technologies also have the potential to cnsiderably soar the efficiency of manufacturing industries and their competitive side. The smart manufacturing technologies currently in use have potential to influx the efficiency of the manufacturing industry by an average of 3-5 percent. These

technologies can decrease the redundancy time of machines ranging from 30 to 50 percent. Furthermore, developments in robotic technologies can influx labor force efficiency by 45-55 percent by getting robots performed both routine and dangerous jobs. While monitoring closely to the latest developments, many countries have begun to taking serious steps with regard to the digital transformation of the manufacturing industry. For instance, the EU has announced its strategy for the "Digitalization of European Industry" as part of the "Digital Single Market Strategy" in 2016. The US recently took an initiative which is called "Made in America" of which the first objective is to rebring the manufacturing sector and factories that left the country in the 1970s. So it is time to back to the US. It looks that this trend will continue to go on vigorously with the President Trump administration (Özlü 2017).

2.1.2 Industrıal Revoluatıon Phases

Figure 2.1: The four stages of industrial revolution



Source: https://www.i-scoop.eu/industry-4-0/

2.1.2.1 First industrial revolution

The first Industrial Revolution which is started in 1760s and lasted till 1830s, the production style evolved from physical strength to machine power. Increasing in quantity and improving in quality, the machines started to use steam power. During this period, coal became more popular when compared to wood, providing more usage of the machines. Starting in the United Kingdom, the Industrial Revolution spread to whole Europe and the America within a short period. This dramatic increase in production considerably affected both the social structure and economical world. Population influxed and also average length of life is extended. Moreover, life started to became more comfortable and easier, and this led to incrase at the life quality. The amount of products generated in Europe soared considerably with the machines, at the same time made easier the production and production style. With these developments European countries looked for crude material for the large manufacturing and turned their eyes to the Near, Middle and Far East countries, where they can supply new raw material sources and market their products. Industry not only completed its first period, but also redrew the country borders affecting the international relations.

2.1.2.2 Second industrial revolution

After production style became mechanized while the first industrial revolution, technology progressed even faster and transition to the second industrial revolution started. The period between 1840 and 1870 is also well known as technological revolution. When technological revolution first emerged, transportation had already developed with the railroads. Facilitation of transportation significantly makes faster the supply of raw materials, and enabled that the products were distirbuted to new and distant markets. When electrical technology also developed in the second industrial revolution it was used in production as well, since this new technology superior to steam power enabled that the machines are far more progresed and the production influxed greatly. By this way, the entire world became aware of the idea of mass production. Steel and iron raw materials became available nearly everywhere and allowed the progress of the heavy industry. At the result of this awareness Germany, England, USA, and Japan became the leading countries in heavy industry.

2.1.2.3 Third industrial revolution

During the first half of the 20th century, two big and disaster world wars had occured one after the other and nearly all country borders had been shattered. Therefore, the industrialization and technological advancement slowed down when compared to the previous time periods. In this slowdown period, negative economic developments such as the Global Crisis in 1929 occurred in many countries, especially the industrialized countries of the first two revolutions. Effects of the crisis had to be diminished in order to the industry revaluotion continue to its development, but this would only happen at the 1950s when the Second World War was finished. When digital technology progressed at 1950s, Third industrial revolution foundations were established. Digital developments especially started with the invention of Z1, which is mechanical calculator that electrically driven, and mad easier the production process of computer. Another noteworthy development while the Industrial Revolution III was the development of network and communication technologies along with the super computer. Small as a size and practical products introduced themselves into our everyday lives with widespread use of communication technologies and computers in production processes. In this process, machines did not only dominate our everyday lives, but also began to remove need for human resources in life (Bosch ltd. 2017)[2]. Since fourth indusrial revoluation requires deeper analysis and related with new terms and concepts fourth industrial revolution will be detailly eexamined in the literature search part.

2.2 LITERATURE REVIEW

2.2.1 Fourth Industrial Revoluation

As stated in the introduction part; Industry 4.0 was born in Hannover Fair-Germany in 2011, but in a very quick time, widely spreaded to the other countries especially to the developed ones. Before deeper diving to subject it will be useful to look what is the main reason for transition to fourth Industrial revoluation? Table 2.1 gives clue for the

[2] Bosch Ltd., 2017, History-Future of Industry http://www.sanayidegelecek.com/en/sanayi-4-0/tarihsel-gelisim/ [accessed21-11-2017].

answer. At the below table, there is a comparison of biggest countries between 2006-2011 as regard of their industrial product revenues. As easily guesed every invention is the result of requirements especially the eonomic requirements which stimuli people and countries more than other factors.

Table 2.1: Industry production revenues of biggest actors

Country	2006	2011	Increase (%)
Europe Union	550	620	13
USA	280	280	0
Germany	190	220	16
Russia	10	15	50
China	170	580	241

Source: https://www.mess.org.tr/media/filer_public/ali_riza_ersoy_sunum.pdf

As seen from the table 2.1, production revenues of world biggest actors between the 2006 and 2011 years show very important indicator and warning especially for Western Countries. Due to cheap labor in eastern countries until recently nearly all factories of western countries were established in eastern countries. At first sight it seemed very lucrative for western countries but in long period they realized that although companies were making good profit, status was not the identical for the countries as it shown on the Table 2.1. So to increase income and reverse the stiuation to opposite, Germany got the initiative and introduced Industry 4.0 in 2011. Therefore we can easily say that reason was the same like previous revolutions, which is a mostly economic concern of the countries (Eğilmez 2017).

Industry 4.0 represents the fourth industrial revolution in manufacturing and industry. Industry 4.0 is the current industrial transformation with automation, data cloud, exchanges, robots, cyber-physical systems, artificial intelligence, Big Data, IoT and semi autonomous industrial techniques to realize smart industry and manufacturing aims in the intersection of people, new technologies and innovation. Also Industry 4.0 introduces the new concept, which is called ‘smart factory’. It is depicted at the below figure 2.2. Prerequests of smart factory and industry 4.0 are interoperability,

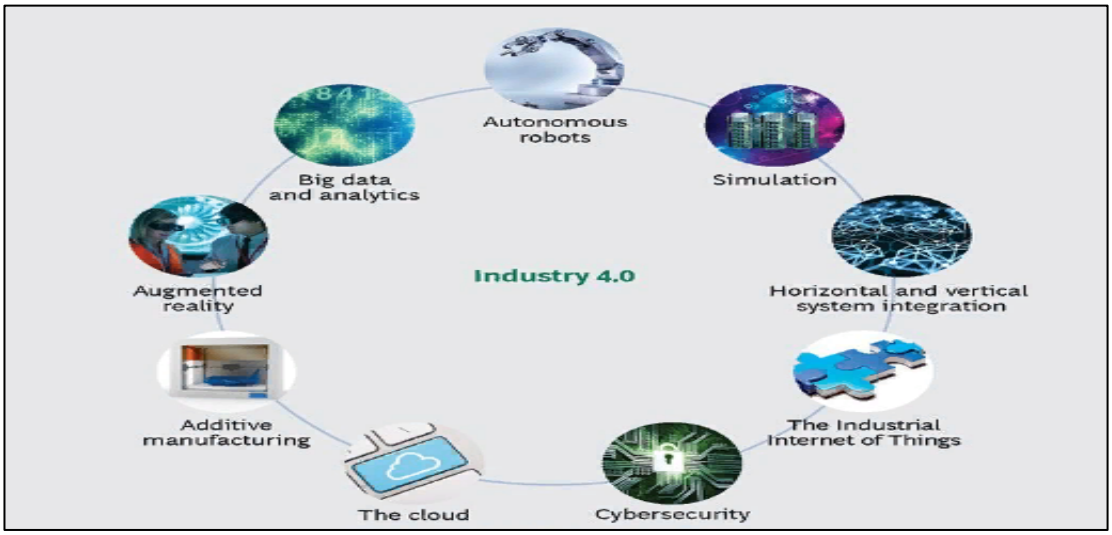
information transparency, technical assistance and lastly decentralized decision making (Marr 2016).

Figure 2.2: Smart factory concept

Despite the vastness concepts, and many terminologies, Industry 4.0 is related with the digital transformation. At the early days of Industry 4.0, digital transformation of manufacturing was the leading sector, and had a big role for the Industrial IoT. But soon it jumped to the other sectors. And just like digital transformation it requires a strategic view and staged approach (i-SCOOP 2017)[3]. Industry 4.0 refers to combination and application of nine digital industrial technologies which are mentioned at the below figure 2.3.

[3] I-SCOOP, 2017, Industry 4.0: the fourth industrial revolution guide to industrie 4.0 https://www.i-scoop.eu/industry-4-0/ [accessed 20-10-2017].

Figure 2.3 Application of nine digital industrial Technologies



Source: https://tr.pinterest.com/pin/460915961642909 88/

The fourth industrial revolution takes the automation of manufacturing processes to a next phase by introducing flexible and customized mass production technologies.This means that machines will operate autonomous, or cooperate with humans in generating a customer-oriented production or when they need anything just for their maintenance or replacing the spare part of them. Except these requirements the machine will be independent for collecting data, analyze and advise for next step process.

This process becomes possible via introducing self-cognition, self-optimization and self-customization to the industry. The manufacturers and producers can have chance to communicate with sytems and computers rather than manage them.

The dramatical changes in the communication and information technologies (CIT) have removed the boundaries within the real world and virtual reality. The concept behind Industry 4.0 is to constitute a social wireless network where machines able to communicate with each other, depicted as an Internet of Things (IoT) and with people, called as an Internet of People (IoP).

By this way, machines can get interaction with each other and with the producers to constitute what we call now a cyber-physical production system (CPPS). All of these

assists are for integrate the real world into a virtual world and enable machines and systems to collect live crude data, analyze them, and make decisions according to analyze results (Martin 2017).

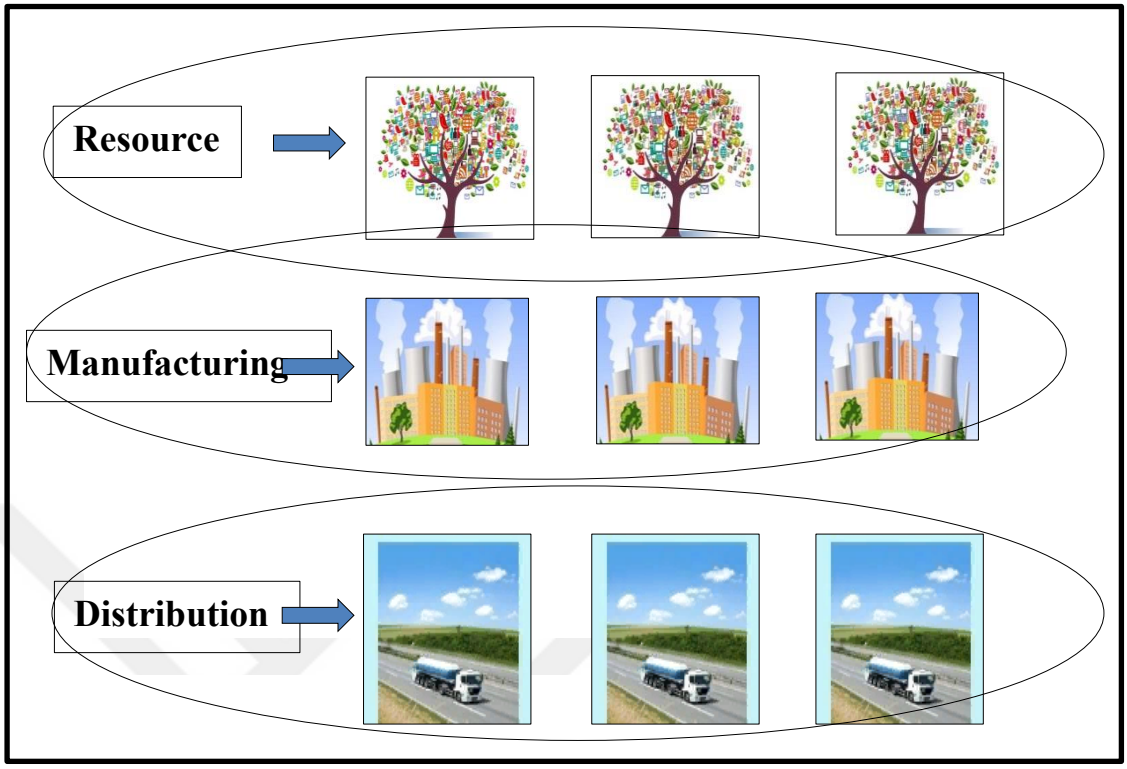
As every dicipline, industrie 4.0 has principles. These are horizontal and vertical integration principles. These principles were established at the 2013 report where the Industrie 4.0 workgroups submitted their findings, as well as other principles and foundations. Allthough it looks there is a difference between vertical and horizontal integration, but the aim is the identical: ecosystem-wide data coomunication between different systems and while doing this, use the data transfer standards and create the base for automated supply and as well as for value chain.

i. Horizontal integration in Industry 4.0:

Horizontal integration means to the combination and integration of IT systems for the various business processes and production. During these various processes, to enable integration, there are flows of energy, materials and information. Beside, it concern both the internal and external (suppliers, partners, customers and also other members of ecosystems, from logistic isues to innovation) flows and also stakeholders.

Horizontal integration is also related with digitization among the supply chain and full value, in which connected information systems and data exchanges take center scene. As easily guessed, this is not a small task. For beginners, within the organizations as guessed there are lots of disconnected systems and machines. This stiuation is challenge for organizations, regardless of they are industrial or not. If you look at uninterrupted data exchange and integration with customers, suppliers, and other stakeholders especially external ones, the picture turn to more complex as easily guessed. So once the integration requirement extended to the end point at the value chain it should be taken in consideration that every player must be at the same or very close level from the point of integration capabilities.

Figure 2.4: Horizontal integration

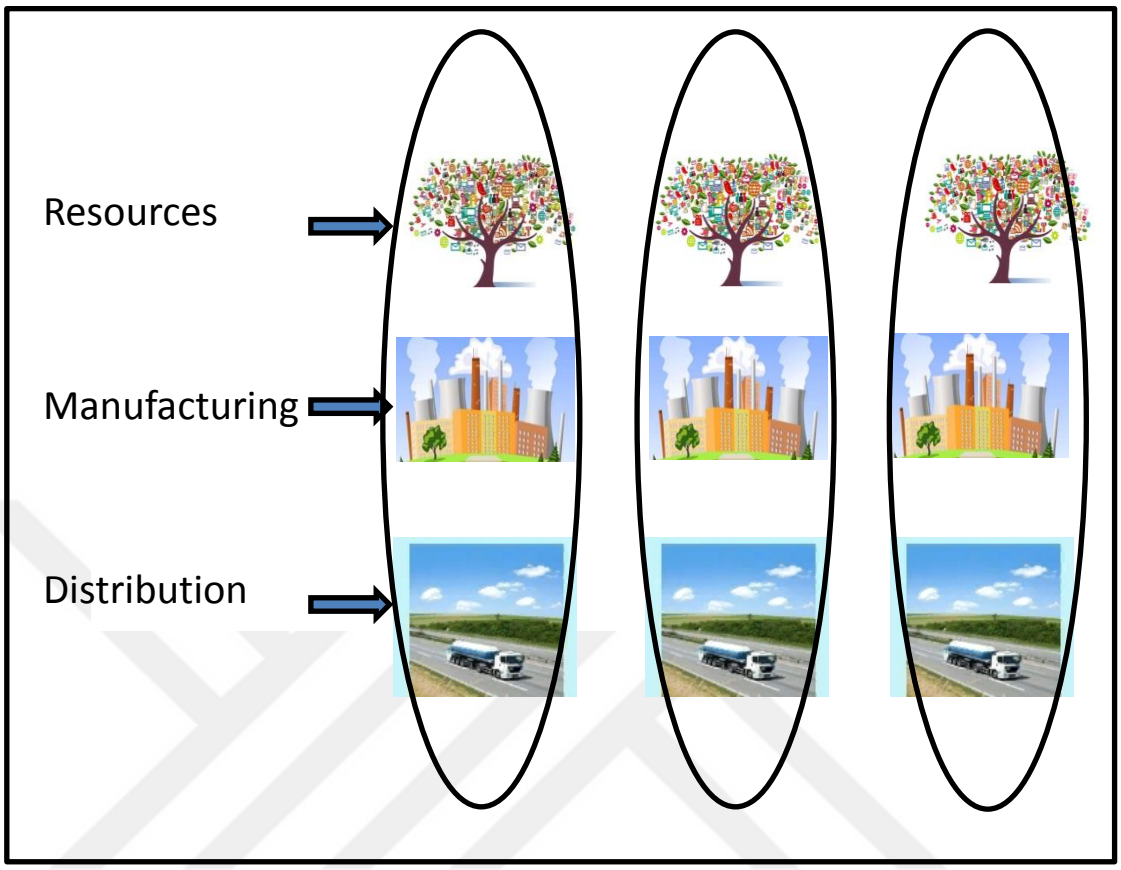


ii. Vertical integration in Industry 4.0:

Allthough horizontal integration is mainly about IT systems, various processes and information flows happening at the same level, the vertical integration is mainly related with hierarchical level integration and componenet. In other words: it's about the integration of IT systems at various hierarchical production and manufacturing levels, rather than horizontal levels, into one comprehensive solution.

These hierarchical levels are respectively the area level (interfacing with the production process through actuators and sensors), the control level (regulate the both systems and machines), actual production process level or the process line level (that needs to be controlled and monitored), the operations level (quality management, production planning, and others) and lastly the enterprise planning level (the bigger overall production planning and order management and processing).

Figure 2.5: Vertical integration



2.2.1.1 Industry 4.0 implemantation

Implementation of Industry 4.0 comprise of 4 levels. Like other sides of Industry 4.0 procedures such as horizontal integration and vertical integration, process is beginning from connected devices, and then it goes on the services installed on the identification of devices with actuators and sensors which carry data that scrutinizely analyzed and send back among networks to the other platforms on which the new services are installed on. At the below Industry 4.0's four main levels will be examined detailly.

i. Level one: actuators and sensors-connecting what should be connected

The first layers of the integration and automation pyramid are actuators and sensors. Also in the internet of things concept called the 'things and device' layers, but of course other systems and technologies are being in this layer as well.

ii. Level two: internal services and systems-manage and monitor

This level is mainly about the managing and monitoring or vice versa, it is obvious that the reason for monitoring is to understand the process and give the right decision for the production process.

iii. Level three: connectivity-connect new capabilities and applications

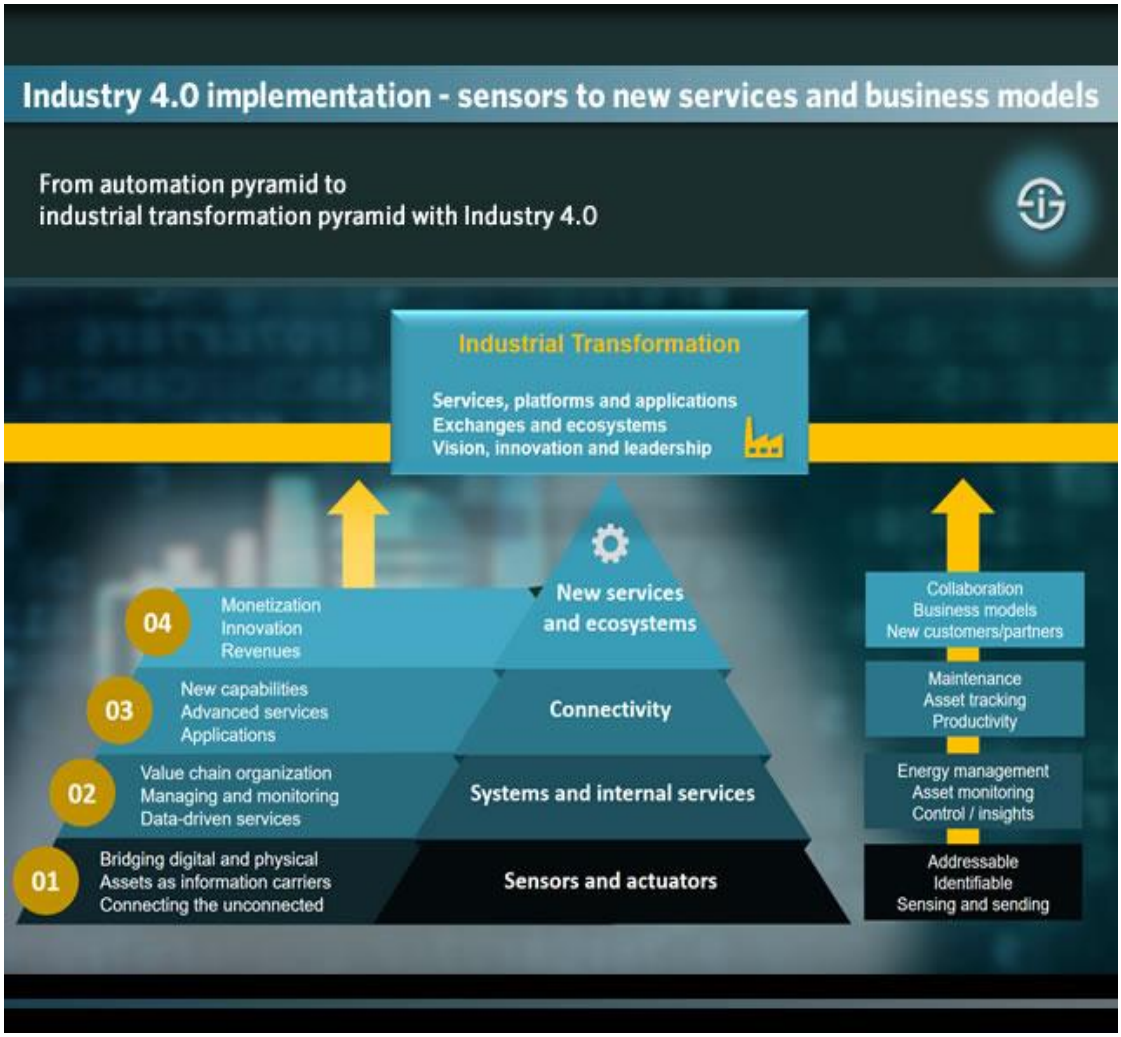
At this third level, it is not only concern with adding the additional assets or devices, but also concerning the integration of data and monitoring process. This have to be managed, since new capabilities and smarter applications like a predictive and preventive maintenance, device tracking and etc. are attaching to current system. So in order to work in cohesion, this level is really very critical.

Initially these tracking, maintenance, and other implemetations are often dealing with internal processes but of course some can create additional revenue in a customer ecosystem context when installed and deployed. For instance, via making maintenance contracts, these can led to less downtime of devices and assets and it means that machines and devices will work nearly at one hundred percent capacity.

iv. Level four: new ecosystems and services-transformation

The last level is related with the transformation of process. These level range from the applications that enable customers to tailor the goods as they order and give advanced services to create new income lines. This is certainly can be managed via integration of services to carry data reach it to the related stakeholders. It's also important to highlight that developing new services mean a significant shift in custom business via aggregating data and information from systems and those of others with complementary systems.

Figure 2.6: Industry 4.0 implementation



Source: https://www.i-scoop.eu/industry-4-0/

2.2.1.2 Industry 4.0 Design Principles

As all systems Industry 4.0 also have the design principles. Before looking at them detailly it is important to shortly describe the basic principle as a point of understanding easily the concept. The basic principle of the Industry 4.0 is connecting machines, systems, and units to create data, information and intelligent networks to work in a cohesive manner but at the same time autonomously. Industry 4.0 has six main design principles that producers or manufacturers use them for integration efforts during the production processes.

Interoperability: The production process doesn't consist of just a set of steps or methods and not contain only the person who is directly related with them. Rather, it encompasses all environments in which all players have significant roles. Assembly lines are not regarded fully separate from the products that are being produced, or the people that are working with them. Interoperability applies to the ability of whole elements to connect, communicate and operate with each other via the Internet of Things. This process includes the smart factories, humans and the technologies.

Virtualization: As to monitor the real production processes, sensors and actuators are used to produce virtual models or that the models created through simulation. Once these virtual copies of smart factories are established, then it becomes availiable for producers to use that data for producing and maintenance issues.

Decentralization: Aforementioned previously, Industry 4.0 enables quick decision-making, pave way the bureaucratic issues that many businesses already have found time consuming and bothersome. Industry 4.0 facilitiate and support vigorously the decentralization, by which different systems and devices in the Smart Factory can make decisions separately. And also while they are taking single decisions, these systems take into consideration the the ultimate organization goal and working according to this aim in a cohesion.

Real-Time Capability: One of the main attribute of Industry 4.0 is making everything in a real time or near real time. This is essential especially while collecting and gathering data in each production process and during the monitoring and fedback phase. Evaluating the strength and weaknesses of each phase of the production can be made quickly, nearly immediately, and definetely this permit management to get decisions faster than ever before.

Service Orientation: Since the Internet of Things is does not just mean the interconnection of all major players, and not finished with these integration is established, service orientation is required by the nearly all smart factories, and so that is why the internet of services has become one of the principles of the Industry 4.0.

Modularity: Flexibility is the last design principle for Industry 4.0, but it is also indispensable principle, because with this principle factories that called as a smart can easily adopt themselves to the rapid cahanging circumstances. So while designing the smart factories it is very critical to foresee that requirements will change and so the design too (Ghariye 2017).

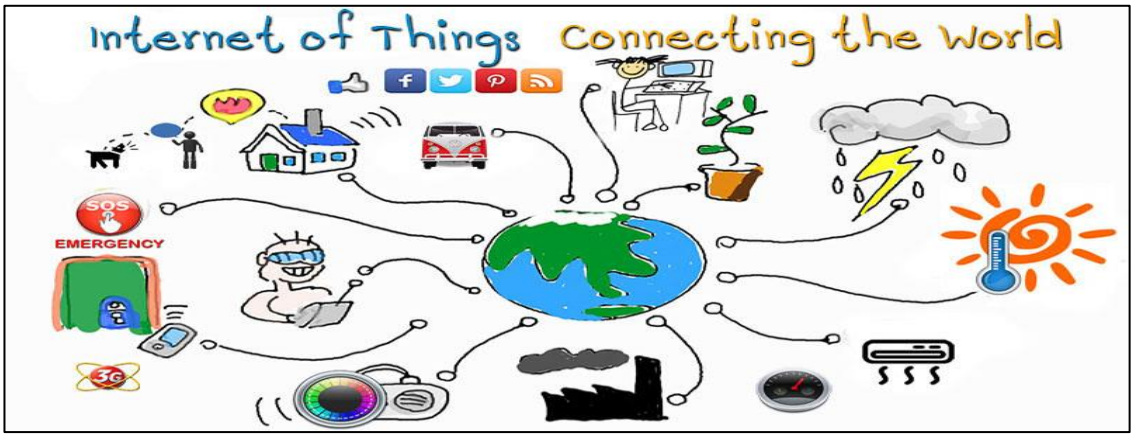
2.2.1.3 Internet of Things

As a term Internet of Things is 19 years old. But the actual concept of connected devices had been argued longer, at least since the 1970s. This concept was often mentioned as “pervasive computing” or “embedded internet”. But the actual term “Internet of Things” was invented by Kevin Ashton in 1999 with his work at Procter&Gamble.

IoT (Internet of Things), the integration and convergence of IT and OT,consists of lots of sub-systems, principles and implementations such as, rapid application development, cyber-physical systems, digital twin simulation models, additive manufacturing, advanced robots and cobots, autonomous production, additive manufacturing, consistent engineering among the whole value chain, via data collection and provisioning, vertical and horizontal integration, big data analytics, the cloud, and the virtual reality. All these are the essential components of the fourth industrial revolution.

Ashton, who was focusing on in supply chain optimization, wanted to take the management board’s attention to a new breathtaking and exciting technology which is called RFID. Since the internet was the topic trend at the 1999 and somehow related with it he preferred the give a name to his presentation “Internet of Things”. Allthough, Kevin took the interest of some high level executives, the Internet of Things term did not get global attention till 2010 (Lueth 2014).

Figure 2.7: Internet of things



Source: http://teknologi/internet_of_things_konsep_semua_perangkat.html

After the 2010, when the term is widespread, lots of people made the different definitions. Generally all the definitions have the same purpose but of course there are some slight differences betwen them. But before looking at the definitions one other issue we should keep in mind that Internet of Things definitions mostly related with which area we are interested: These are the technological perspective, the application perspective, value benefits and etc. So while reading to definitions this should be taken into consideration.

One of the most well known definitions is Mckensey's description: Internet of Things, actuators and sensors embedded in physical objects from roadways to pacemakers are linked through wireless and wired networks, with mostly using the same Internet Protocol (IP) that connects devices tothe Internet (Chui et. al. 2010).

Actually the potential and reality of the Internet of Things does not lie in the capability to connect IoT enabled objects and devices nor in the embedded technologies and electronics such as actuators, sensors and connectivity capabilities. It takes its power form the capability of processing data, and to automate, digitalize, digitize, optimize and in more advanced phases convert processes, models of business and also industries in a view of digital transformation.

Important point is: not all connected devices are IoT-connected devices but all IoT-connected devices are connected devices. This is very critical and moreover at the Internet of Things, Internet Protocol (IP) is used, especially IPv6 adresses are used since its capacity is 2^{128}. So, we can uniquely give IP address to the each device or system, using an IP address form of IPV6 or Uniform Resource Identifier.

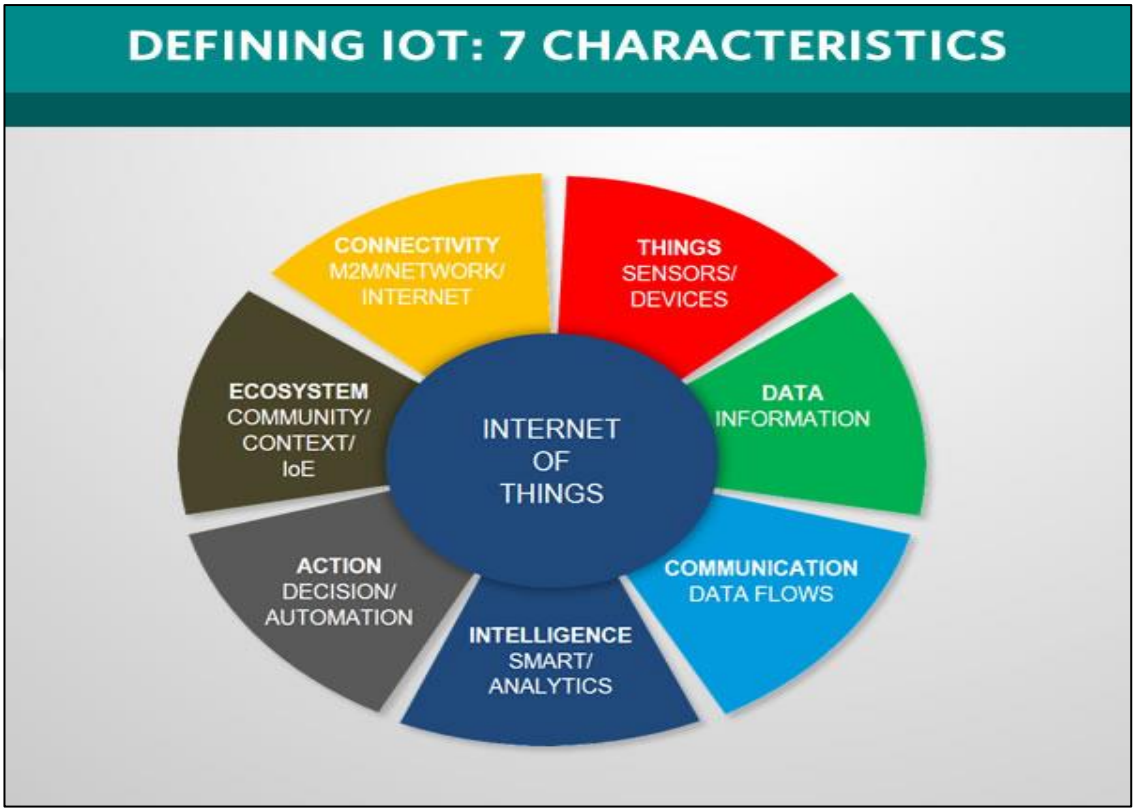
Internet of Thıngs Vision; it is a concept and a paradigm that considers pervasive presence in the environment of a variety of things and objects that through wireless and wired connections and unique adressing schemes are able to communicate interact with other things or objects to create new services or applications and reach shared common objectives. In this context the research and development challenges to create a smart world are really very much as easily gueassed. This challange task can be accomplished with the RFID. (Gubbi B et. al.2010) A world where the digital, real and virtual are combining and converging to generate smart factories and environments that makes more intelligent wherever touch (Patel & Patel 2016).

All these communications and interactions gave way to dramatic increase with the number of Internet-connected devices and increasing demand of real-time data flow. So it looks that even low latency services will have difficulties for responding the requirements of this new framework (Sarkar et al 2018).

In addition to this challange another requirment has raised because of interaction with such big information. Sharing so much information has made the IoT objects desirable and easy target especially for cyber attacks. Moreover, some IoT points or nodes are collecting and proessing with private data or information became goldmine of information for hackers and malicious actors. Therefore, security has become more important than ever have been. While installing IoT, this security and information assurrance concern should take the first priority and should be well known that succesful installition will be valid only if security and infornation assurance conditions are provided (Conti et. al. 2018, pp.544-546).

There are 7 critical Internet of Things characteristics: These are showed at the below figure 2.8.

Figure 2.8: IoT Chaacteristics



Source: https://www.i-scoop.eu/industry-4-0/

Connectivity: This charecteristic doesn't need much more explanation. Sensors, devices need to be connected to another device, actuators, and sensor or connect the whole network to another network.

Things: Anything that could be connected or tagged to the network can be 'things'. This can be anything that ranging from sensors to house appliciances. Thing should contain sensors in order to send their status.

Data: Data is the cornerstone of the Internet of Things; it is the first step for action and intelligence.

Communication: Devices which are connected, by this way they could communicate with each other and data can be carried on between them.

Intelligence: Intelligence is occurred from the output of the analytics which are made according to gathered data.

Action: This charecteristic is natural result of intelligence. This could be either manual or automated action.

Ecosystem: This last charecteristic is mainly about the Internet of Everything dimension, including the platform dimension, communities, goals and everything in which the IoT fits.

3. FINDINGS

3.1 ENGLAND AND INDUSTRY 4.0

Britain pioneered for the first industrial revolution, which brought her considerable economic and social change. Being the World 9'Th largest country, England, definetely has potential to transform to Industry 4.0, but it seems some challanges wait her on the way.

Manufacturing is essential to Britain's successful since it accounts for the nearly half of whole total exports, and it is also employing more than 2 million people among the UK. This definetely contributes to the tax revenues of country. The clue behind the success is very clear. England investing huge amount of revenue that provided from manufacturing back to the R&D. This provides the continous innovation at the sector.

As not surprise, England has foreseen that Industry 4.0 will be a business fact and reality while the forthcoming years, and speed rate will increase in a exponental way. So following this latest developments England percent 62 of manufacturers and companies has decided to invest more to the internet and network connected equipment in upcoming five years. But while deciding to invest more, manufacturers have some considerations. EEF's Digital Survey, shows that they are worried about future digital infrastructure.

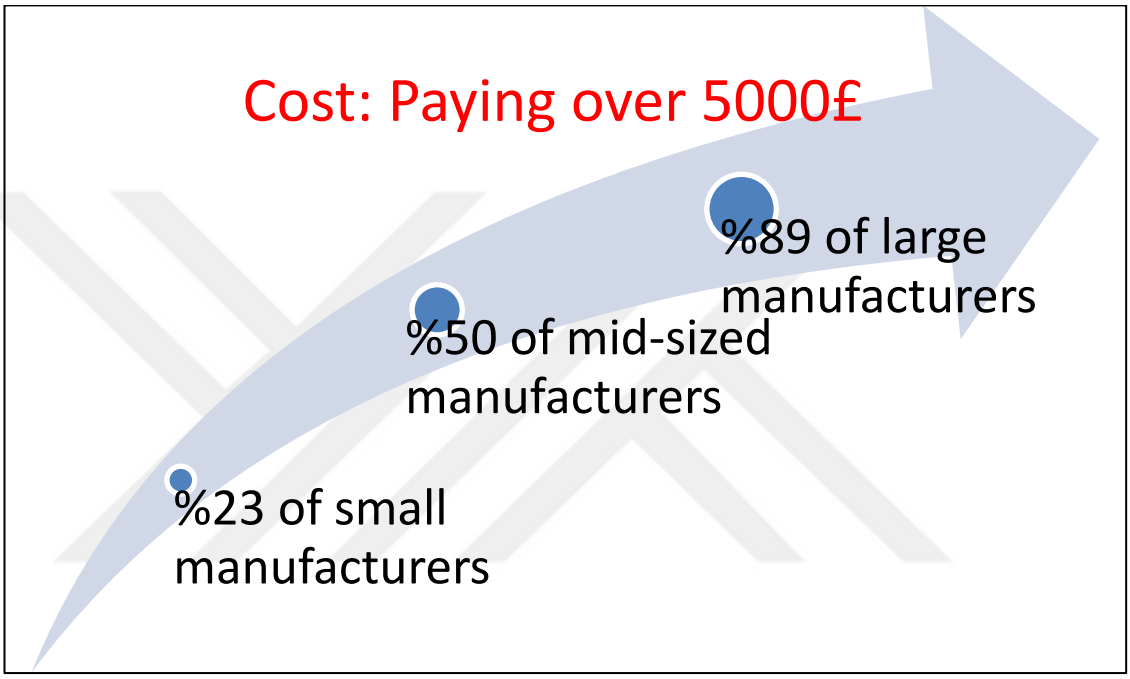
Figure 3.1: EEF's digital connectivity survey

Future Provision:	**Just over 50%of manufacturers say their current internet connection isn't adequate**
Competition:	36% of companies disagree that compared to other EU countries, the UK is at forefront of internet connectivity.
Cost:	44% say their internet connection costs have been more expensive especially latest years.

Source: https://www.eef.org.uk

Survey show that nearly half of the middle sized manufacturıng are spending over 5000£ to internet and network connections for their business. Meanwhile a quarter of small sized companies are spending this amount.

Figure 3.2: EEF's Digital Connectivity Survey



Source: https://www.eef.org.uk

While being the leading country during the previous industrial revoluations, England is looking for cost effective and optimal solution to smooth transform for Industry 4.0. So the queation is what can or should be done? This will totaly rely on the decisions. These Decisions which will taken now or near future directly effect that Britain will have a leading role as previous ones or attend the Industry 4.0 compettiton this time as a follower. EEF suggest some measures should be taken by England Goverment or at least pave the way for them. These are:

i. Give task to the National Infrastructure Commission for assessing the England's current digital infrastructure network and take the screenshot of its status. According to current stiuation, make a reasonable investment plan through which

England will have capable internet access when compared to the other developed countries.

ii. Find a sloution for business broadband, especially for those leased lines. Cost of leased lines should drop down to reasonable levels.

iii. Ensure Innovate UK has the funding to work with industry to develop cluster networks of early adopters by easing the uptake of digital technologies across industrial supply chains. This should include supporting investment in physical industry 4.0 demonstrators. The values of Industry 4.0 will be seen more vehemently when all supply chains became familiar with new styles of working and technologies. Also For some, especially small companies, risk for invest to the Industry 4.0 will be seriously reduced when actual results are realized via physical demonstrators. So small size companies' motivaiton is really important in this journey.

iv. To be proactive while pushing the implementation of goods and services which are related with digital single market among the all Europe wiil definetely provide unvaluable profit to the England.

The most effective finding at this survey was about the future scenarios of the single digital market, (which means demolishing the country borders and converting the 28 different markets to just a single one) 74 percent of participants agreed on that "The UK should push for the completion of a digital single market to allow businesses to seamlessly access online goods and services across the EU".

Just 1 percent of participants were disagreed. The Single Digital Market is actually a three pronged approach by which significant benefits can be delivered to the England in the fields of ensuring trade online beyond cross border, developing the digital networks' security and removing the barriers in front of the digitalisation with developing digital skills and improving interoperable standards. Also what has learned form this survey, catch up mode will be more costly rather than sataring to invest on Industry 4.0. So stiuation is shortly looks: Much to do, little time to do it (Richard 2016).

During investigation of the countries Industry 4.0 level, in addition to gathering information from various resources, relied on some objective critierias. So in order to measure the Industry 4.0 level of the countries also looked at the GDP and the Export values of the countries and investigated their range in the World. That is why, the GDP and Export values of countires are used has very simple reason, since Industry 4.0 effects can be directly observed form these values.So in this context England has the below values with the terms of GDP, Export and range of the world.

Table 3.1: England GDP and export values

		2012	2017	Percentage	World Range
England	GDP	2.470 Billion $	2.905 Billion $	%18	7
	Export	430 Billion $	458 Billion $	% 6	10

Source: https://www.cia.gov/library/publications/the-world-factbook/rankorder/2078 rank.html[4]

Above table 3.1 shows that England has to rely on Industry 4.0 since its Export values between 2012 and 2017 and world range position is behind the GDP values. So in order to increase export values and make parellel with the GDP as aforementioned England has much to do but little time to do.

[4] The World Factbook /https://www.cia.gov/library/publications/the-world-factbook/rankorder/2078rank.html[accessed 18-10-2018]

3.2 GERMANY AND INDUSTRY 4.0

If it is called that Industry 4.0 is the baby of Germany, propably it will not be an exaggeration term since it was born in Hannover Fair 2011. Industry 4.0 is a concept and national strategic initiative from the German government especially from the Ministry for Economic Affairs and Energy (BMWI) and Ministry of Education and Research (BMBF). Its aim is to drag digital manufacturing ahead with soaring digitisation and increasing integration of products, business models and value chains. Another aim is to endorse research, standardisation and enable the network between industry partners. Industry 4.0 concept has been over a 10 to 15 year time frame, and it is predicated on the High Tech 2020 Strategy of the German government. But the actual initiative was taken in 2011 with the Communication Promoters Group of the Industry Science Research Alliance that was come together and organised by BMBF and adopted via the High-Tech Strategy 2020 Action Plan. Industry 4.0's task was to reduce the discrimination across the industry sectors, to rapidly take research and theories into practice in a really short time period. Of course final aim is to make Germany to biggest economy as the point of manufacturing. As roughly 15 million jobs in Germany are directly or indirectly linked to the production of goods, it is not a fiction aim for Germany to be the biigest manufacturer or to be the most effective manufacturer which produces most per each person. As a forefront supplier and provider of industrial material and equipment among the world, this digital transformation really offer very good opportunities to the Germany as her work force is really well educated.

Germany's High Technlogy Strategy started at 2006 for just research the innovations actions. Then in July 2010 Germany announced 2020 High Technology Strategy plan which aimed to preserve Germany's position as a leading country from technology, innovation and science point of views.

At the 2020 High Technology Strategy plan of the Germany government's 10 "Future Projects", which also include Industrie 4.0 got the goverment support and priority at the agenda, not only the Industry 4.0 by itself take the attention but also digitalisation via smart factories, digital workplaces and digital economy were the trend topics of Germany goverment and took their places at the fore front of agenda.

As a father of Industry 4.0, Germany aims to fit it for her future manufacturing. So Germany saw the big picture and support the integration and cohesion of Internet of Things and services, cyber physical systems and industry 4.0 for the purpose of efficiency, flexibility and productivity of all production process which led to economic growth. Her leading position at the industrial manufacturing give courage her for managing the smooth transformation to Industry 4.0. Once this objective is accomplished than Germany wants Industry 4.0 to be understood by all stakeholders, and wants to show how industrial masnufacturing can be digitilised.

"We must … deal quickly with the fusion of the online world and the world of industrial production. In Germany, we call it Industrie 4.0." Angela Merkel, German Chancellor[5].

Industry 4.0 was at the beginning developed via researching groups, but in 2015 Digital Platform was established. Digital platform's task is to improve recommendations and give advice to the decision makers especially those policy makers for the Industry 4.0 implementations, endorsing the improving of Industry 4.0 standards, widespread the Industry 4.0 understanding and finding the practical solutions to the Industry 4.0 implementation challenges. Also this platform supports the companies who are conducting R&D on Industry 4.0. The members of this platform are the Minister for Education and Research, Minister for Economic Affairs and Energy, and industry, scientific and trade union directors.

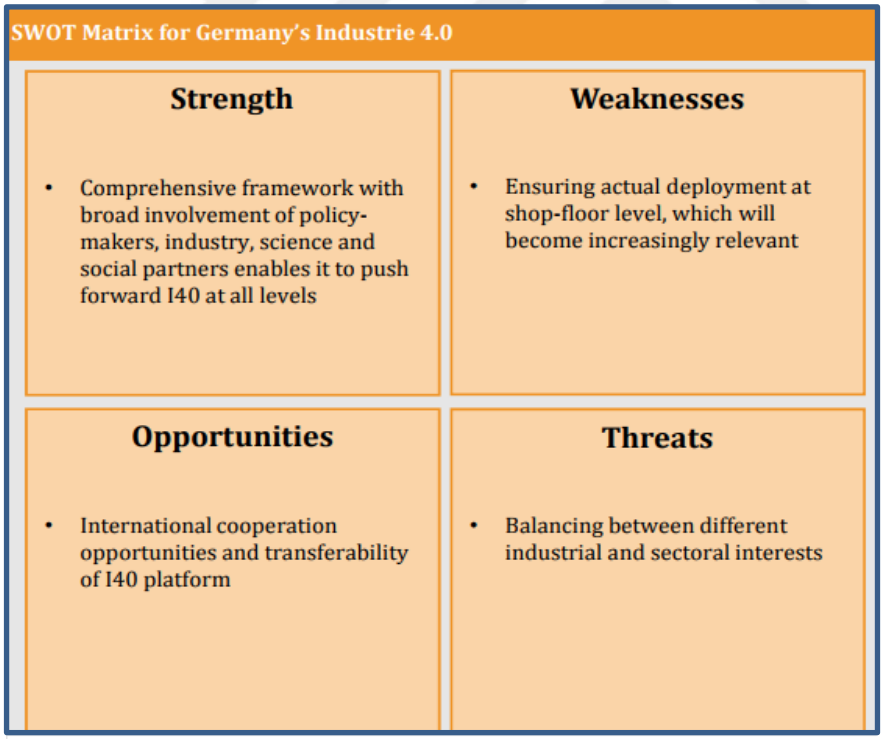
While the Digital Platform Strategy group enables guidance especially politic and agenda adjusting, the Project and Secretaria office have function of coordination and organisation. A Scientific Advisory Committee is recommending on scientific and program related matters; it has a bugdet for which it can endorse projects. Finally, five working groups enable the thematic work on reference architecture and standardisation, security, research and innovation, legal framework and training. Aiming to enhance the digitisation of industrial processes and provide know how for different sector groups, Industry 4.0 aims large entrepreneurs and corporations, and especially subject matter

[5] Merkel's this quote is very popular and issued at various articles and blogs.One of them is EU Commision Digital Transformation Monitor Report.

experts in all industry sectors. Representatives from research, policy, industry, social, and business affairs need to collabarete and cooperate for deep understanding of Industry 4.0.

So especially the know how is giving the advantage to the Germany for Industry 4.0. But in addition to govermantal stiuational awareness and leading position, private sector's eagerness and awareness have another chance for Germany. Maybe it is wrong to call it as a chance since quality is never coincidence. Being at the World's forefront nation in Industry 3.0, Germany seems eager to success and fulfill her Industry 4.0 aims. While table looks really very positive for Germany, of course there are some challanges also for Germany. At the below, swot analysis table demonstrate the threat, opportunities, strength and weaknesses sides of Germany's Industry 4.0 journey.

Figure 3.3: SWOT matrix for Germany's Industrie 4.0



Source: https://ec.europa.eu/growth/tools-databases/DTM_Industrie4.0.pdf

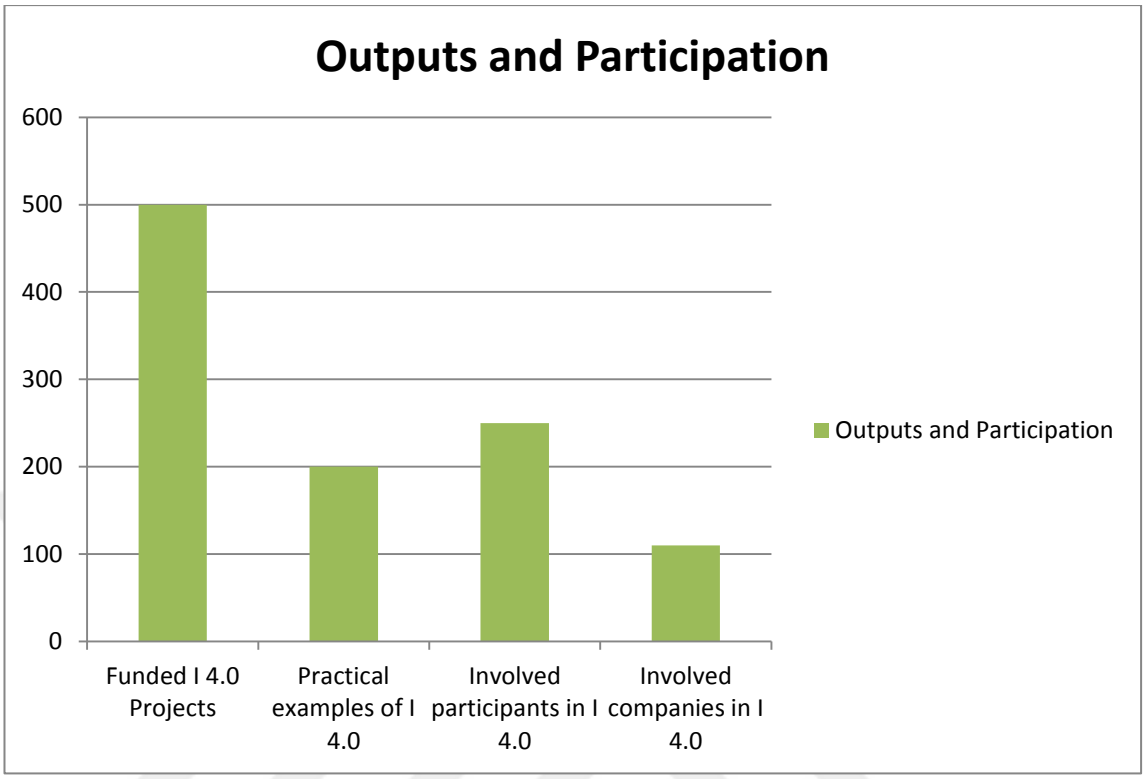
As seen form the above swot table, Allthough opportunities, weaknesses and threats can be same for all countries, strength side is rather peculiar to Germany and this make her really very advantage in this course.

By the way, it is also importont to give the detail that Industry 4.0 was initially designed for the reaearch puposes and just a concept. When the Industry 4.0 idea and the concept were grown from various resources, network paltform of Industry 4.0 was installed on Industry 4.0 concept. Also Industry 4.0 structured design constitutes bridges between science, policy-makers and industry. This facilitated coordination, cooperation and exchange of know how and innovation at the technological side. This design includes the steering role of BMWI and BMBF with the terms of determining and implementing strategies, also funding issues and taking initiative for the practical implementation.

With these collaborative efforts, Industry 4.0 has fielded via cross sectoral comprehensive approach. This means that implementation of Industry 4.0 layout is well organized and well prepared. Especially long term and gradual implementation plan has encoureged all sectors that this Industry 4.0 implementation plan can be feasibly conducted. Another good point was the migration strategies that are well defined and led to smooth transformation for the Industry 4.0. This is also one of the secret of Germany's success for implementing Industry 4.0 to her every sector and area.

The Industry 4.0 implementation execution phase for Germany, consist of various steps. After being installed by Industry Science Research Alliance in 2011 January, Industry 4.0 was adopted via the Action Plan of High Technology Strategy 2020. According to the High Technology Strategy 2020 action plan, the Industry 4.0 Working Group, moderated by Prof. Kagermann and Dr. Dais, working with and under the coordination of Acatech, was funded and created by BMBF and charged to layout and prepare an weel defined implementation strategy. This working group issued its final document report in 2013 April, defining actions for an Industry 4.0 implementation strategy. After this report, the Industry 4.0 Platform was assembled by VDMA, ZVEI and BITKOM, (which are the forefront electronic companies in Germany) and platform take the responsibility of industry 4.0 implementation. This implementation plan also supported via technology programmes, like an 'Autonomics for I4.0' and "Smart Service World".

Figure 3.4: Outputs and participation to Industry 4.0



Source: https://ec.europa.eu/growth/tools-databases/DTM_Industrie4.0.pdf

At the implemetation and execution phase, success didn't come so easily. As expected, lots of problems occured and needed to be solved. At first; the key challenge was to bring all stakeholders together. The different aims between trade unions and companies and competing among the German industrial sectors and groups initially restricted the platform's speed and influence in broader manufacturing landscape. The government first hesitated to join the platform as a very active role, but then decided to involve and to enhance the group for improving collaboration, coordination, and uptake. While business sector participants run the platform, BMBF and BMWI took an active role for enhancing the initiative of the platform, via both agenda setting and political leadership.

While focusing on the advancement of standards and concepts, Industry 4.0 needs to engage with the shop level and SMEs, at which most of the transformations will happen. This is essential for succesful integration of new industry digital process and to adapt the all work organisation.

One key lesson learned concerns the need to enlarge the I4.0 platform model with more participants and give it a stronger political basis, in order to overcome competition among industry groups through collaboration on common norms and standards as well as the integration of industry domains. In this respect, data driven business models will become a major driving force of Industrie 4.0 in the future (European Commisison 2017)[6].

Consequently, with large industrial sector and having an innovative style and spirit are Germany's main strengths. Germany is really well equipped to convert this potential to the kinetical. They have huge industrial sector, which accounts for approximately 23 percent of her total gross domestic value and product. This figure is at the USA for instance, just 13 percent. That is why German companies are world leaders in lots of high technology industries, including automotive, machinery, pharmaceuticals, chemicals, aerospace and electronics.

Beside these facts, German industrial companies and as a whole sector is fore most innovative. According to Innovation Indicator, issued from the the BDI and Deutsche Telekom Stiftung , Germany sits in sixth place, ahead of the other developed countries biggest competitors, the USA (13), China (24),S. Korea (18) and Japan (20) .

Germany's innovation success is not surprising since Germany has unique and peculiar medium sized companies and enterprises culture which is totally different form the USA's Silicon Valley. This strongest side of Germany for the innovation. Instead of focusing in a one specicific place for innovation Germany choose the gather innovative ideas from very large and different sectors. Germany may not have Silicon Valley IT giants. But instead they employ more Information Technical personnel than normal engineers. So they spread the automation, programming operating systems to nearly every industrial sector. By this way they can already convert crude data into valuable and beneficial information. This also led to integrate and cooperate embedded systems and give opportunity to work in a good cohesion.

[6] European Commission, 2017, Digital Transformation Monitor Germany: Industry 4.0

One more issue about Germany; in additon to swot analysis result, Germany have some more challanges to deal with such as data protection, high speed internet Access and IT security. Allthough Platform has some conceptual preperations for these issues, it is inevitable not to face any challange while implemeting and installing them. That is mostly due to their huge production size.

Allthough it is a golden rule and for sure current even Germany, while looking her leading position in Industry 4.0, she doesn't have luxury to isolete herself from others. Because, Industry 4.0 doesnt't have any national borders (Christian K., 2016).

Lastly, as done for England, it is Germany's turn to inspect her from GDP and Export value and world range point of view. Germany is at the below table;

Table 3.2: Germany GDP and Export Values

		2012	2017	Percentage	World Range
Germany	GDP	3.450 Billion $	4134 Billion $	%31	3
	Export	1.250 Billion $	1.480 Billion $	% 18	3

Source:https://www.cia.gov/library/publications/the-world-factbook/rankorder/2078 rank.html

As seen from the above table, it can easily understand that is why Germany has started Industry 4.0 and sat in a very advantage position in this competition. Germany with its very dynamic and huge economy, seeking way to preserve her position. Allthouh it looks that export values are not parellel with GDP values, it should be taken into consideration that to increase such a big Export values are not so easy. So Germany is in a good position and it seems she will go on with sure steps.

3.3 FRANCE AND INDUSTRY 4.0

The French Industry 4.0 journey is actually different from other developed countries. At first, Industry 4.0 plan and concept or alias Industrie du Futur only has been mentioned in a very few articles, and not managed to take attention from industrial sector. However it was significant program both from depth and breadth, directly aiming the disruptive technologies, and focusing on the innovation in order to manage economic progress and objectives.

The first part of the program was installed by Arnaud Montebourg in 2013, who became later reindustrialization minister in France. With the support of the media he tried to advertise and increase stiuational awareness about the Industry 4.0. Then he launched 34 industry projects directly targeting industrial progress. One year later In 2014 April, Emmanuel Macron, at that time he was the minister of Economy, now he is the president of France, has installed the second part of program, aimed to narrow area of interest and tried to focus on directly industry including innovation, Macron's nine solutions to the industry especially for the markets were:

a. New resources
b. Sustainable cities
c. Ecological mobility
d. Transportation of the future
e. Health of the future
f. Digital economy
g. Intelligent objects
h. Digital trust
i. Intelligent food

The Table 3.3 below gives more details about the program. 3 projects of the first phase of program merged with other programs: renewable energies, heavy loading drones, and e-learning for all level scholls. Each project at the program were assigned to one maybe two high level executive project managers and some sponsors, which are especially well known companies. For instance, CEO of Renault Carlos Gohn, and CEO of Dassault Systems Bernard Charlès, were chosen and given initiative to conduct the chosen

projects. While conducting projects, project leaders had great initiative to reach the defined innovative target. That target was fully compatible with the economic, social and environmental targets of France in big picture. In addition to national targets Europe regulation developments were also included to the project targets. While this project structure created accountability and clarity, as normal there have been some critics. Most important one is the challange of coordination in a huge number of researches, economic and industrial organizations which are involving the project. Participation of such a large quantity of organizations to the projects may lead the losing of real focus area, due to the different expectations and targets.

SME's ,Research institutions, startup's, and other national major cooperates in the projects target a wide and various economic objectives, from support to growing of low technological SME's till high tech world class of advanced services and products. Whole projects are directly engage with industrial production in specific industrial areas and sectors, with focusing on digital products, digitization, applications and solutions, but often show impact at broader economic affairs, citizens or maybe in a whole society. Most of the projects targeted development in underlying physical, biological, and digitization technologies, such as nanotechnology, biotechnology, and electric propulsion, or the applications of OT and IT.

While conducting these projects, one project has gained exception when compared to the others. It is dubbed as 'Factory of the Future'. This project was considered and eveluated as a key project of France's industrial progress as done of the most important engine at the industry 4.0 competition. Why France has put forward such an ostentatious name and gives so importance to the future of Factory project is very obvious. France has started the slow down at the terms of economy and industrial products. That is mostly due to the underinvestment to the Technologies, facilitites, and even education of work labour. So to compansate the underinvestment, more than 330 small projects have started as a part of big projets or the program, including more than 400 companies and organizations, Amount of the investments are approximately €3.7 billion, and roughly €1.5 billion part of it will be funded and supported directly by French Government.

It looks that not in a short term but actually in the long period, this program and projects will show their butterfly effect and will make good impact on all industrial sectors. Also since the projects are conducted with large quantities of companies from low tech to very advanced one that will show substantial economic effect to France economy at all. Visible benefits of these projects and program will be seen especially on material and energy sustainability, accessibility, mobility, quality at food and even on healthcare fields. If France go on to implement these projects and replace the disruptive technologies, can be one of the leading country about industry 4.0. But France also should be careful like Germany, regarding not to miss global connectivity and internatioanal cooperation.

After all, this program has a clear targets, strategy, and well defined tactics on the paper, which give confidence converting to realization (Valentijn 2015).

Table 3.3: Industrie du Futur Program

Automotive	small sustainable and affordable car	sustainability (CO2 130->50g/km) and affordability (focus on the small segment)
	charging infrastructure for electric and hybrid cars	Sustainability, growth of e-car business
	charging infrastructure for electric and hybrid cars	Sustainability, growth of e-car business
	Battery power and life	increase e- and h-car range, stabilization of electric networks with renewable producers
	Autonomous car	safety, reduction of transportation time, improve accessibility
Aerospace	hybrid, electrical aeroplanes	sustainability, mobility
	electrical propelled satellite	
Rail	Next generation high speed train	flexibility, modularity, sustainability, increased mobility

Marine	Hybrid and electrica ships	sustainability:50% environmental footprint reduction
Textile	technical and intelligent textiles	connected, for medical treatment, energy harvesting
Medical devices	instruments, implants, diagnostics, textiles	Price and quality of healthcare
Food and beverage	Innovative packaging, functional foods, sustainable refrigeration	quality, safety, sustainability and competitiveness
Wood products	construction materials	produce wood products in France, sustainable construction materials
Digital / electronics	Big Data	industrial clusters, data infrastructure, digital education
	Cloud computing	secure cloud, protective regulation, big data
	Telecom	industrial clusters, cloud integration, security and control, 5G
	Nano electronics	low consumption integrated circuits, vertically integrated with engineering, assembly and production
	Connected objects 1	household and industrial appliances: industrialisation of innovation in startups, shortening of innovation cycles
	Connected objects 2	infrastructure for contactless payment and contactless public transport ticketing
	Augmented reality	Smart solutions for aerospace, culture, health and cities
	Supercomputing	infrastructure for SaaS, modeling and simulation for health, energy, cities, etc.
	Cyber security	Trust in digital economy
	Embedded systems	h/w and s/w for household, commercial

		and industrial ‘objects’
Electronics / mechanical / digital	Robotics	industrial production, personal assistance, environment, remote autonomous agents, mobility
Smart utilities	Smart electricity distribution	sustainability, economic growth, affordability
	low footprint waste water treatment, smart water management, water desalination	reduce usage and optimise recycling
Chemicals	green chemicals and biofuels	usage of biofeedstock, biofuels from biomass waste, decreased energy usage
Pharmaceuticals	biotechnological products	cell therapy, vaccination (cancer, immunity, heart, retina
Health care	e-Health	IT supported ‘extended’ hospital, remote health monitoring, coordination of complex treatments
Factory of the future	Industrial production	sustainability, human-system integration, flexibility/agility, urban-social integration

Source: https://industrial-iot.com/2015/08/frances-industrie-du-futur-is-well-on-track/

Another issue about French companies has been producing large quantity of connected devices for IoT. At 2017 January, in the Las Vegas tech fair, more than 200 French companies participated, which make the France, third represented country at the range. What’s interesting, roughly two to thirds of these companies and organizations were startups. Especially smart home products and devices are strongly exhibited at the fair.

France also has funded the IoT center which is located in Angers, named Cité de l’Objet Connecté, and addition to this center, France recently diminished barriers for market entry especially for startup companies and organization. Also giving considerable amount of incentives to those which are dealing with the innavotion or R&D about the ndustrial affairs.

Not so surprisingly, famous with her cities, France is also strong in smart cities. Smart cities need consistent and omnipresent network access. After testing in Grenoble, the French telecommunications company Orange has announced that it will be deploying the low-power and wide-area wireless network.

Once implementing all targets to the her own cities, France will use the advantage of her smart cities wide experience for developing Nagpur, Chandigarh, and Puducherry, which are the cities of India's, who give importance to convert them in a smart cities.

The famous Tour de France also has gone to IoT, by hiring Dimension Data and IBM to turn every bike in the race into a GPS enabled data collection point. This will provide fans with an immense amount of real-time data to view, analyze, and argue about (Jablakov 2018).

Finally as a classic evoluation it is France's turn to inspect her GDP and export values and world range. At the below table we can see the France's grade, but before that it will be not wrong to say that allthough France has initiated lots of effort for Industrie de future, France has more homework than Germany and near to England. Table 3.4 show France's performance between 2012 and 2017.

Table 3.4: France GDP and Export Values

		2012	2017	Percentage	World Range
France	GDP	2.688 Billion $	2.833 Billion $	%5.5	6
	Export	510 Billion $	540 Billion $	% 6	6

Source:https://www.cia.gov/library/publications/the-world-factbook/rankorder/2078 rank.html

When looked at the above values it is seen that France's GDP and Export values are paralel, and at the same range. This is good news for France but bad news is growth speed is very low and this is really alarming percentage rate. So France has to focus and rely on Industry 4.0 more than England and Germany. This actually bad performance

also has showed its side and dire effect like a demonstrations and protest againist France Government (Johnstone 2018).

3.4 TURKEY AND INDUSTRY 4.0

As mentioned at the introduce part, it is difficult to say Turkey has made good performance and be on time for the previous Industrial revoluations. But this time it looks Turkey is not so inadvantage position due to her most factories and organziations are located in a place which is between Industry 2 and 3 levels (Ersoy 2017). So transition to industry 4.0 will be rather smoothly. Of course lots of home work is waiting for Turkey, but there is no need to be pessimistic.

In this portion of the study larger part reserved to the Turkey's Industry 4.0 implementations both from academic and fielded sides. Allthough our topic looks comparison of the Industry 4.0 implementations, it is normal to give priority and deep dive to Turkey, rather than take her generally. So in addition to some academic studies and their results also goverment and private sectors current studies and plans will be examined.

Among the many significant studies on the concept of Industry 4.0 in Turkey, there is an article which is "New Industrial Revolution Intelligent Manufacturing Systems Technology Road Map" prepared by TUBITAK in 2016. In this article, 10 technological aims of Turkey are determined in order to reach world current most developed level. In addition to this preparation, The Aegean Region Chamber of Industry took the 4.0 Industry subject and issued a study "Industry 4.0" to raise the stiuational awareness of transformation in new production technologies. Also, TUSİAD prepared another report which is named "Industry 4.0 in Turkey as an Imperative for Global Competitiveness" to courage the efforts for industrial transformation throughout the Turkey's business sector. The main target of this study is actually to define current and future possible effects of Industry 4.0 at organizational and structural level, as for it is a new concept and no doubt it will have various impications nearly on every business area and whose boundry is not clearly defined yet.

While these organizations were working on Industry 4.0, another study has made survey (Yüksel A., Şener E. 2017) to collect the opinions of business experts from the different business sectors. These experts chosen form especially the managers of their organizations dealing with, information technology, and information processing, research, and human resources departments. That survey was done with 26 person, 13 of them chosen from above mentioned experts, 10 of them chosen from different sectors including education, electronics, furniture, banking and technology, 3 of them are chosen form academic personnel. The table 3.5 at the below has shown the some members of survey who has participated in to study.

Table 3.5: Features of the Working Group Participants

P1	Inspector	Male	Inspection Board	Banking
P2	Human Resources and Development Chief	Male	Human Resources Directorate	Furniture
P3	Director of Educational Technologies	Male	Information Technologies	Education
P4	Technical Product Manager	Male	Research and Development, Product Development	Technology
P5	Head of Department	Male	Faculty of Economics and Administrative Sciences	University
P6	Head of Department	Male	Faculty of Economics and Administrative Sciences	University
P7	Head of Department,	Male	Faculty of Economics and Administrative Sciences	University
P8	Project Manager	Female	Information Technologies	Banking
P9	Production Consultant	Male	Electronic Manufacturing Factory	Electronics
P10	Section Manager	Male	Automation and Project Development Department	White goods

P11	Chief Executive Chairman	Female	Executive Board	Machine
P12	Assist. General Manager for Technical Affairs	Male	Management	Machine
P13	Data Manager	Female	Information Processing	Food

Source: http://www.pressacademia.org/journals/jbef

At this survey several questions directed to the participants, but from our area of interest the most important was **"**What is your opinion about the current impact of the high technology's use characterised by internet of things and services and named as Industry 4.0 on the organizations? And also what do you think about the potential impact of Industry 4.0 on organizations, institutions and firms? And why?" Each participant gave different answers to this question and the given answers were categorized mainly in two categories. The first one is individual organizational impacts of the Industry 4.0, which is listed at the below Table 3.6.

Table 3.6: Organizational and Individual Effects of Industry 4.0.

Organizational Effects	**Individual Effects**
Pressure of job and efficiency	Increased pressure on personnel
Faster and better works	Reduced workload on personnel
More work done with less workforce	Provided social benefits to personnel
Internal processes and automations of organization are faster, more accurate and more secure	Increased need for qualified labour
Increasing organizational efficiency and reducing costs	Human relationships leave their place to electronic environment
Provide convenience to the symmetric information flow between stakeholders	Transformation of relationships from human dimension to digital dimension
Acceleration of organizational processes	
Nearly Zero error and minimum loss	
Increasing effectiveness, facilitating	

control	
Place independent work system	

Source: http://www.pressacademia.org/journals/jbef

The second answer to the question is negative and positive impacts of Industry 4.0, which is listed in Table 3.7 at the below.

Table 3.7: Positive and Negative Effects of Industry 4.0

Positive Effects	**Negative Effects**
Real time traceability of production performance	Disappear of businesses that can not catch Industry 4.0
Increased labor quality	Decreased employment of the workforce with operational capability
Ability to manage factories and businesses remotely	Limited effects on countries where public services are not at a certain level
Increased client experience	Difficulties of data storage
The emergence of new technology giants	Disappear of businesses that can not manage the data
Digitalization of all devices and networking between them	Disadvantages in terms of employment
Finding solutions to quality, standard and aesthetic options of products	Weakening of handwriting ability
Provide faster, more efficient and personalized products	

Source: http://www.pressacademia.org/journals/jbef

As seen in Table 3.6 and Table 3.7, it is understood that there has been awareness about Industry 4.0 and digitalization in Turkey. Also it has been observed that answers which are given by the participants are fairly similar, and nearly all sector representatives are more or less at the same opinion about the current status and possible impact of Industry 4.0.

Besides these studies; 'Turkey's Digital Transformation Platform' was established under the control, coordination and leadership of Ministry of Science, Industry and Technology. This model was based on private and public cooperation to accelerate the process of digital transformation in the industry and aimed to bring together biggest business sector organizations including, Turkish Industry and Business Association (Türk Sanayicileri ve İşadamları Derneği – TÜSİAD); Union of Chambers and Commodity Exchanges of Turkey (Türkiye Odalar ve Borsalar Birliği – TOBB); Turkish Exporters' Assembly (Türkiye İhracatçılar Meclisi – TİM); Independent Industrialists and Businessmen Association (Müstakil Sanayici ve İşadamları Derneği - MÜSİAD); International Investors Association (Uluslararasi Yatirimcilar Dernegi – YASED); Technology Development Foundation of Turkey (Türkiye Teknoloji Geliştirme Vakfı – TTGV), and additionally consists of 6 working groups who are engaged with Industry 4.0 priorities of Turkey (Özlü 2017).

While establishing this platform, former Minister of Science, Industry and Technology ÖZLÜ explained the main reason briefly "If we do not invest in smart manufacturing systems or if we delay these investments, our low added value manufacturing trend will remain largely unchanged, which means that Turkey will lose its competitive edge."[7]

In Digital Transformation Platform, each member has different responsibilities and functions. TOBB will chair the "infrastructure" working group, which will define Turkey's physical and technological infrastructure requirements and the measures that should be taken.

The "Open Innovation" working group will be chaired by TİM, who will tackle and deal with strengthening platforms and creating an environment of coordination and cooperation which will enable to to develop technology.

[7] Faruk ÖZLÜ explained this in his article at Turkish Policy Quarterly.

TÜSİAD will engage with “digital technologies in industry.” It will define Turkey’s requirements in this field and focus on measures which will enable opportunities to the business sector not only to use digital technology effectively but also means to create it

MÜSİAD will focus on “advanced manufacturing techniques” and define Turkey’s requirements in this field. Via this study, Turkish business sector will learn, which measures should be taken in order to increase industrial production. So this study will directly show its effects with economic terms. As more advanced manufacturing techniques are found and as faster they are implemented, positive results of them will be seen in a short time period.

Another working group chaired by YASED will work on legislation, standards, and intellectual property rights issues of new digital transformation and Industry 4.0.

Finally, the last working group chaired by TTGV will tackle with may be the most important area, the education issue. In order to accomplish the Industry 4.0 objectives there is no doubt that well educated work force is the must criteria that cannot be ignored. Since Industry 4.0 and the new digital transformation require the educated labour force more than any other time in the history, education part is really very critical part of this tranformation process.

As it seen from the purposes and organizational structure of working groups, the establishment of digital transformation platform and its defined strategy will support to Turkey’s industry for this transformation and digitizing endeavour. Digital Transformation vision is, to make the Turkey in near future producing her own required technology instead of importing as did so far. Also Platform vision is not limited with just producing technology, it aims to go one further step and wants to convert Turkey to the technology exporter country.

In order to accomplish these ambitiouses; there are some works to be done urgently to pave the way for digital transformation. Firstly, business and industrial capacity for producing technology must be supported, and secondly, digital transformation of

business sectors should be supported including tax reduce or some kinds of subventions. Once these conditions provided via legislation or decree law, then Digital Transformation platform will get the aimed results quicker than expected.

With the support of the government and in accordance with the Digital Transformation Platform' plans, Turkey's another target is to improve professional competencies and enterprises, which will not only having capability to produce technology, but also using it very effective.

For the financing support of this digital transformation, Turkey'a aim is to dedicate sufficient budget for R&D and innovation. Since Turkey wants to accomplish digital transformation via developed manufacturing technologies, allocating budget to the innovaiton is very critical part of transformation. On the other hand while supporting innovation studies on Indutry 4.0 and improved manufacturing technologies, Turkey will assist to the sector's organizations especially to the SMBs, those who has shown courage for digital transformation.

Once Digital Transformatiom platform has been established and declared its strategic plans, valuable supports have come from lots of organizations and companies. Two of them are Turkey's foremost technological companies Turkcell and STM. These two companies CEO's Mr.Yılmaz and Mr.Terzioğlu gave information about the details of the support. They told that they have made an aggrement with the Digital Transformation Platform, and acccording to the aggrement; Turkcell communication infrastructure will be used for collecting raw data from every business sector including automotive, energy, transportattion an these will be processed at STM's optimization and data analysis platform (OVERA). Then this processed and converted information will be used at the IoT platform in order to support all sectors from the perspective of maintaning process, estimation and other issues.With this study, it is estimated to percent 10 to percent 15 productivity gain from the manafacture costs and percent3 expansion at industry sector (Terzioğlu K, Yilmaz D. 2017)[8].

[8] Terzioğlu K., Yılmaz D.,2017, İki Şirket Dönüşüm Platformuna eşlik edecek. http://www.kokpit.aero/stm-turkcell-digital-donusum-platformu[accessed 04-08-2018]

To understand Turkey's Industry 4.0 journey comprehensively, it is also important to know sector leading companies point of views to the Industry 4.0. In this context, it will be fruitful to take a look to the approaches of Turkish businesmen.

Turkish Vehicle Delivery equipment Association Chief (TAYSAD) Alper KANCA highlights the importance of Industry 4.0 and says 'It ıs very important to accompany the World Industry 4.0 efforts. It looks everybody knows something has to be done but there is no clear vision what to do. Turkey should participate in these efforts and go on in order not to be late. Because if we wait until everything will be clear, at this time even we run too fast we can't catch the Industry 4.0 train. So R&D investments are very critical and we shouldn't ignore this.'

Siemens Turkish Execution Board member Ali Rıza ERSOY states that Industry 4.0 has brought 3 percentage growths to the Germany since 2014, and if we adapt Industry 4.0 to the sectors Turkey will gain at least 1-2 percentage growth even other parameters stay stable. So Industry 4.0 is 'must' for Turkey not only for competence but also to reach Turkey's 2023 economic targets. Additionaly convert our industry to the Industry 4.0 will prevent Turkey from the median income trap. It is also expected to born 16 new busines area due to Industry 4.0. If we want to lessen unemployement rate we must evaluate this opportunity and train especially our young population for the forthcoming new business areas.

Bosch Turkiye CEO Steven Young states that as a Bosch Turkey they are using Industry 4.0 at all the assembly line. Since 2014. Industry 4.0 ensures savings from costs in a large scale at the same time they have more control at all production process. Industry 4.0 will provide lot of opportunity, but to use them first requirement is definetely trained personnel. So preparation for Industry 4.0 starts with personnel training. Since Turkey has young population, manning is not a big issue but point is direct them to the Industry 4.0 business areas.

Schneider Electric Vise Manager Mehmet OZALP indicates that in order to Turkey convert Industry 4.0 to the advantage and take the leadership, it should invest at least 10 billion dollar every year to the Industry 4.0. While making these investments, most important thing is to invest the 'human 4.0'. So human 4.0 is essential for Industry 4.0. Journey (Şahin 2017).

Lastly, TÜSİAD has announced the expected impact of the digital transformation on Turkish economy is listed below;

i. Productivity gains from 4 to 7 percent on annual basis.

ii. Allthough low skilled work loss will seen, it is estimated that percent5 absolute employment increase will seen.

iii. High skilled work force structure will be chance for preparing stronger know how enviranment for Turkey.

iv. Additional manufacturing totaly will grow up to 3 percent per year; it means that 1 percent growth impact on Turkish national GDP. To accomplish this goal prerequest is to invest roughly between 3 and 5 billion Euro each year for the next 10 years.

According to all these studies and opinions of the foremost industrial companies' high level managers, Turkey has really strong sides for this transformation. Most important one is the Turkey's private sector. Since it is very dynamic and ready to say welcome style for every change, it looks except the self confidience, there is no rational reason to stay behind or fail at this Industry 4.0 competition. On the other hand it is also remarkable that using and depending on technology as a means to achieve Industry 4.0 objectives will be the humorous reality of this transformation journey.

When looked at the Turkey's business sectors at the below Figure 3.5, four of them have an advantage position for digital transformation, which are machinery, automotive,

chemicals, and white appliances (TÜSİAD 2016)[9]. Starting with these sectors will led to the leverage effect for the other sectors, and this will also give chance to measure readiness of Turkey and her industry for the upcoming new digital transformation.

Figure 3.5: Industry 4.0 applications in pilot sectors

Industry 4.0 Level	Company	Examples
Integrated automated and optimized production flow	Home Aplliances	Integrated Quality Management
	Machinery	Integrated Design Data
	Home Applications	Horizonal Data Integration
Viritual Product Design	Automotive	Virtal Factory and Product Design
Flexible Manufacturing	Home Applications	Flexible Manufacturing Robots
Automated logistics	Automotive	Laser guided automated guided vehicle
Learning and self optimizing	Chemicals	Self Optimizing process flow

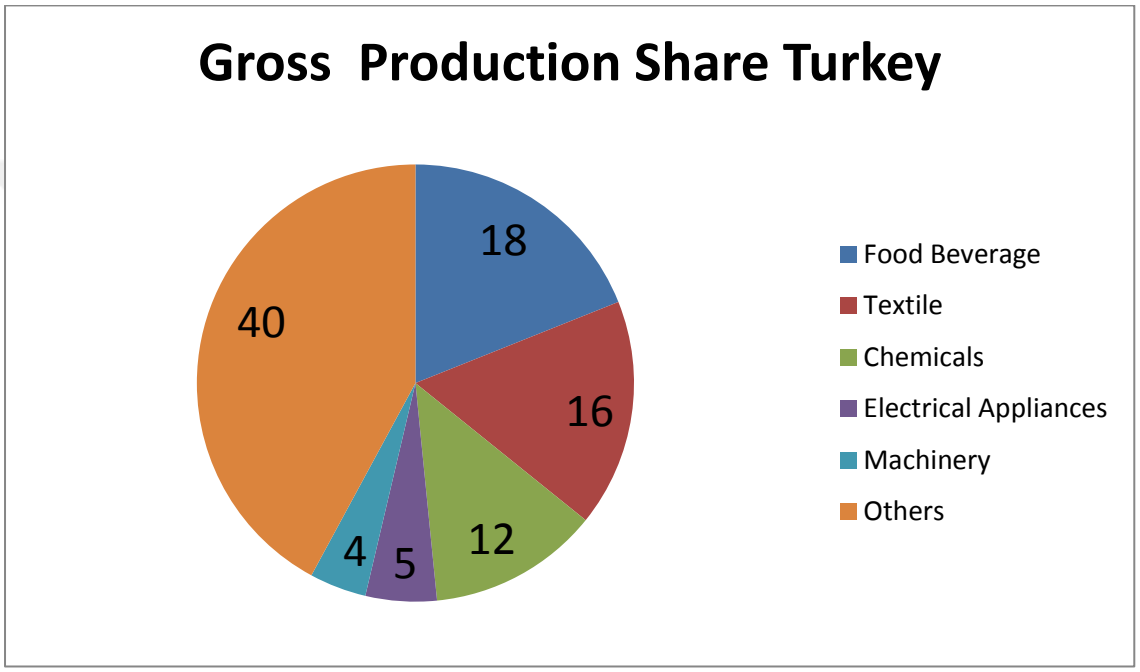
Source:http://tehad.org/wp-content/uploads/2017/05/TUSIAD-END-40-_-RAPOR

These sectors mainly constitute the large portion of the national gross production in Turkey, and knowing their contribitions for Turkish economy is really important as a

[9] TÜSİAD, 2016, Industry 4.0 in Turkes as an imperative for global competitiveness an emerging market perspective. *Boston Consolting Group.*

whole. Allthough aformentioned sectors are the leading and locomotive sectors for digital transformation of Turkey, there are other sectors such as Food&Beverage and Textile which constitute the biggest portion in GDP value of Turkey. So it is cruical to know their share rate in Turkish economy in order to pay attention them according to their size. At the below figure 3.6 share of all sectors are shown.

Figure 3.6: Gross Production Share Turkey



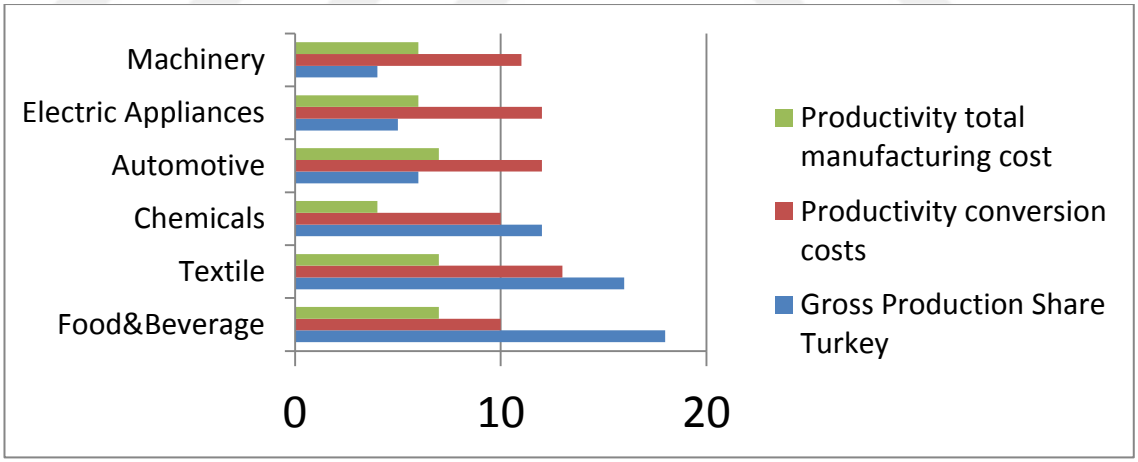
Source:https://www.ceicdata.com/en/turkey/gross-domestic-product-share-of gdp

When these valuers are scrutinized, in addition to machinery, automotive, chemicals, and white appliances, textile and food&beverage sectors are very important due to their contribution the GDP of Turkey. So if Turkey wants to manage digital transformation, she doesn't have luxury to ignore them. Considering all sectors as a whole and making a good investment plan on Industry 4.0 will bring considerable technological advancement and this will show its benefits in four areas.

i. Productivity

Turkish manufacturing companies and whole sectors have opportunity to increase productivity over 50 billion TL, if industry 4.0 is adapted successfully. This means to gain 4 to 7 percent productivity gain for each year. At the below figure 3.7 give the values of productivity conversion cost for main sectors which rang form 5 to 15 percent. So according to this table, chemicals and food&beverage sectors have lower productivity conversion costs when compares the other sectors. This means that these sectors will benefit from productivity improvements more than others. But even machinery and electric appliances have opportunities and will gain from this transformation, allthough both consists the small portion of the GDP. So despite each sector has its own dynamics as normal and has different starting points, it is certain that digital transformation and industry 4.0 will bring substantial benefits to their sectors productivity both as a quality and value.

Figure 3.7: Potential Benefits of Turkey's Industry 4.0 Transformation



Source: Boston Consulting Group

ii. Revenue Growth

Revenue growth is indirect result of increase of productivity. Once Turkey's production both as a quantity and quality, revenues from these increased production will definetely be higher. This revenue growth will be provided via global integration. And as stated if the increased products are cost efective and in a good quality then itis inevitable to get

higher share from the global value chain. This aim wil be managed not only just implementing industry 4.0 but also it requires detailly planned transformation and strategy plan.

iii. Investment

It is predicted that Turkish industrial producers are to invest roughly 10 to 15 billion TL each year for the next 10 years, which consists of about 1,5 percent of their production revenues, for the purpose of Industry 4.0 adaption process. At first yerars these investments wil mostly consists of R&D and innovation lines, but later, reuirements will change and, cost lines will start to convert to new equipment procurement and education of labour force.

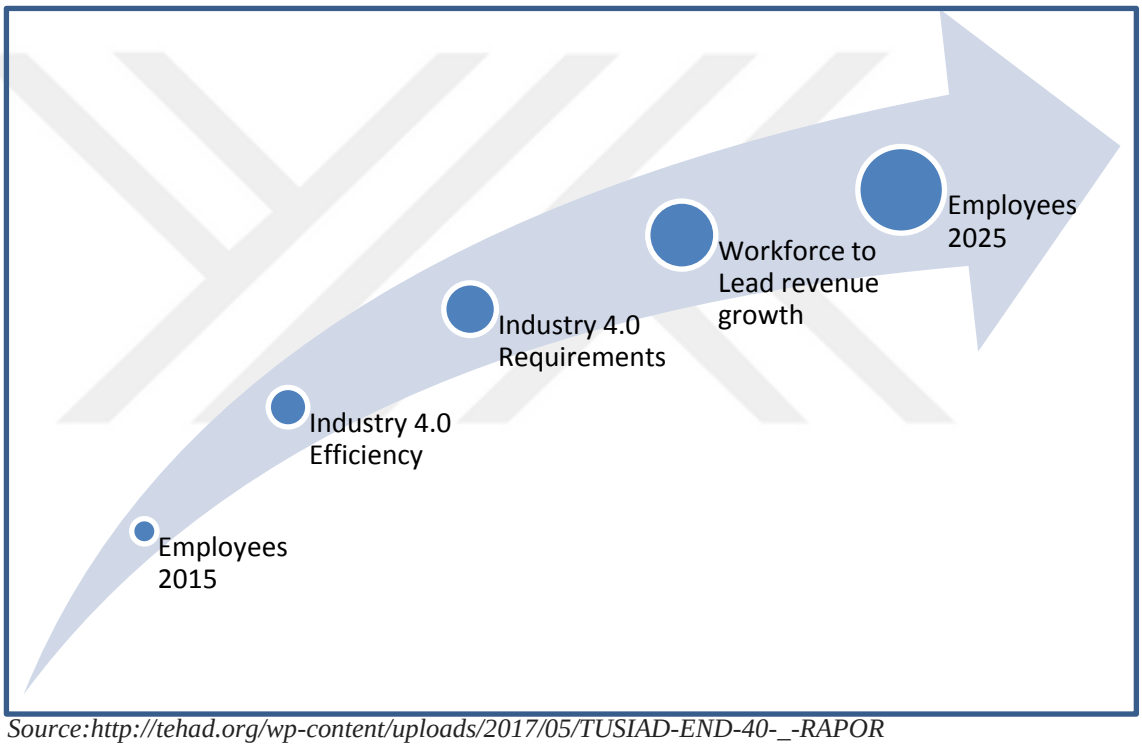
iv. Employment

The adoption of Industry 4.0 will initially lead to partial substitution of manual labor with automated systems, particularly of low-skilled employees concentrated in production, quality, and maintenance functions. A 20 to 30 percent effect at some value chain steps could be expected in the long-run. Automated systems will assist workers by providing ergonomic improvements to physically demanding tasks. Assembly line tasks that require physical labor, such as heavy lifting or precise positioning of parts, will be partially or completely executed by robotics. This will free up workers' capacity for more value-added tasks, as well as improve help and safety standards overall. Remote and predictive maintenance will allow technicians to use the extra time on different tasks. Machines, parts, and equipment will be monitored continuously with the help of real time data collected from operations. This will eliminate the need for physical presence on the shop floor for inspection and diagnoses of issues. With the assistance of augmented reality, a technician can receive remote instructions from an expert, repair the machine, and document the tasks automatically without the need for paperwork. If spare parts have to be ordered for troubleshooting, the technician will not have to wait to get to the site and will be able to focus on more productive tasks. All these are the expected results of the digital transformation and Industry 4.0 not only in Turkey but also throughout the world. But in addition to these benefits, the best side is, Industry 4.0

will mostly prevent the industrial injurances which are really widespread in our country unfortunately.

While mentioning about the impacts of digital transformation and Industry 4.0 on employement, it is important to say that the significantly higher skilled labor force structure is expected to raise the income pyramid and prepare a stronger know how base for Turkey which is depicted at the below figure 3.8.

Figure 3.8: Employment Projection for Turkey



Source:http://tehad.org/wp-content/uploads/2017/05/TUSIAD-END-40-_-RAPOR

Vision for Turkey: In the long run a better skilled labour force with increasing absolute employement.

The last issue for the employement part. Turkey has advantage as the labor costs are low when compared to the other develop countries. So if the same rate productivity occurs and assuming that other costs are same, then Turkey will have the competitve advantage due to her low labor costs. But it should be taken into consideration that while labor force getting more skilled, their costs will also increase. This will increase

the production and quality but at the same time it will increase the production costs to some level. After these four areas are inspected detailly it is time to deeper look to the 6 major sectors which contribute much value creation via Industry 4.0;

i. Automotive (figure 3.9)

An increase in flexibility and automation of assembly lines will develop small-batch capabilities of producers. Advanced automation of assembly lines through cooperative and autonomous robots will develop flexible production lines where multiple models with different parts and designs can be produced using the same line. In shortly it is called ‘customizaton to Customer’.

Figure 3.9: Potential Productivity Increase in Automotive Sector

Automotive: Potential productivity increase of percent10-15

Autonomoıus Robots	**Automation of assembly lines** **Measure: Advanced automation of assembly lines and vertical integration of process and systems** **Result: Improved tracebly,is real time perfomance monitoring, preventive quality control and efficient trend management**
Big Data Analytics	Horizontal Data Integration with design suppliers Measure: Advanced analytics of big data collected from production lines Result: Error precision in production design, Less wastage and less dependance on control units
Simulation	Smart warehouse and intralogistics solutions Measure: Architectural layout simulation and automated simulation systems. Result: Stronger working capital due to reduced inventory cycles

Source: Boston Consulting Group

Vertical integration of production systems and process will allow engineering of multiple product models and life cycles. Big data collected from these vertically integrated systems will significantly improve traceability, and advanced analytics will increase both accuracy and complexity of real time performance monitoring, preventive quality control, and efficient trend management units.

Horizontal data and system integration with suppliers will create co-working spaces.Timely collaboration through standardized processes will generate errorproof precision in product design, which means less wastage for the car makers.

Suppliers will also benefit from this integration, as they will be able to maximize their potential in just-in-time logistics by streamlining their operations on the basis of new orders from the producers. This change will reduce the costs of logistics and operations. All these processes including vertical and horizantal will come up with savings cost and time. Additionally this will also led to customer satisfaction.

ii. White Appliances (figure 3.10)

Sensors embedded in parts, lines and equipment will enable Machine to Machine (M2M) and Machine to Human (M2H) communication systems. Advanced automation and connection of end to end methods and processes will raise agility of whole production lines. This will let companies to manage the complexity and integrity more effectively and enlarged their engineering for multiple product lines and cycles. With the increased use of production cycles and lines will make mass quantities customizations possible.

Vertical integration of internal systems will allow to more efficient production. This will expand reporting and monitoring capabilities of companies and allow them to take quicker actions via utilizing detailed data and information which are collected from all these systems.

Figure 3.10: Potential Productivity Increase in White Appliances Sector

White appliances: Potential productivity increase of percent9-14

Industrial Internet	**Advanced connectivity of lines** **Measure: Full automation of production lines, M2M and M2H communication via sensors** **Result: Agile and integrated operations to manage to production. Adaptive and flexible manafacturing**
Software Integration	**Vertical Integration of enterpirse and production** **Measure:** System Integration, to achieve more efficient assembly lines. **Result:** Enhanced monitoring and reporting of operations
Simulation	**Optimized logistics and inventory solutions** **Measure:** Simulation and augmented reality used **Result:** Shorter lead time via higher labor efficiency.

Source: http://tehad.org/wp-content/uploads/2017/05/TUSIAD-END-40-_-RAPOR

iii. Textile (figure 3.11)

Further utilization of improved simulation for vertical data integration and prototyping of R&D with internal product development units will elevate the level of collaboration and help companies to discover new products faster. Companies will not only gain a high value added products but they will also decline waste and defected products ratio because of enlarged accuracy and precision in product cycles and designs. At the below Figure 3.12, productivity increase in textile sector is depicted from the perspective of industrial internet, software integration and simulation perspectives.

Figure 3.11: Potential Productivity Increase in Textile Sector

Textile: Potential productivity increase of percent10-16

Industrial Internet	**Advanced connectivity of lines** **Measure: Adaptive manufacturing via machine to machine communicaiton** **Result: Reduced Operating costs, Predictive maintenance, improved health and safety**
Software Integration	**Horizontal system integration with suppliers** **Measure:** Advanced IT and ERP solituons, Horizontal Integration with suppliers and clients. Result: Reduced Inventory costs due to predictive procurement
Simulation	**Advanced simulation and vertical integration** **Measure:** Advanced simulation for prototyping and testing and vertical integration of R&D and design unit suppliers. **Result:** High value add product portfolio,reduced wastage increased capacity utilization.

Source: Boston Consolting Group

Horizontal integration of Enterprise Resource Planning (ERP) solutions with clients and suppliers will turn back as a better relationship with the customers. The integration and transformation will allow companies and organizations to predict their procurement time and cycles more precisely and decrease inventory costs.

iv. Chemicals (figure 3.12)

Vertical and horizontal data integration of manufacturing, accounting, and inventory procuderes and systems will assist small size manufacturing and agile operations. Advanced planning methods and real time or near real time monitoring of the production cycles and lines will decrease the overtime and out of standard work.

Figure 3.12: Potential Productivity Increase in Chemicals Sector

Chemicals: Potential productivity increase of percent8-12

Software Integration	**End to End vertical integration of intra systems** **Measure: Vertical data integration of manufacturing, ,accounting and inventory systems** **Result: Small manufactoring and agile operastions, Real time monitoring,minimized overtime**
Big Data Analytics	**Big Data and advanced analytics used in R&D** **Measure:** Advanced analytics of big data collected from production lines, used in R&D **Result:** Shorter development times
Augmented Reality	**Smart warehouse and intralogistics solutions** **Measure:** Advanced production with augmented reality **Result:** Shorter lead times. Efficient inventory management through optimized procurement.

Source:http://tehad.org/wp-content/uploads/2017/05/TUSIAD-END-40-_-RAPOR.

Advanced big data gathered from production lines and cycles utilized mainly for R&D targets will endorse innovation for new products and development of manufacturing processes and systems. More precise R&D results will cause to minimum waste and less development times.

v. Food & Beverage (figure 3.13)

Advanced and improved big data gathered from inventory, production, and sales systems will assist companies and organizations to estimate demand coming from market with more accuracy. This will allow companies and organizations to dedicate the right product to the right place at the right time. Geographical improvements in demand projections will enable the optimization of logistics planning and thus will reduce the transportation costs of lightweight food products.

Figure 3.13: Potential Productivity Increase in Food and Beverage Sector

Food&Bvg: Potential productivity increase of percent9-12

Cloud/Cyber Security	**Data Integration, cloud storage and cyber security** **Measure: Vertical integration of production and logistics systems** **Result: Better capacity utilization, Real time performance monitoring and reporting.**
Big Data Analytics	**Advanced analytics of Big data collected** Measure: Analytics of big data collected from inventory and sales Result: Preventive maintenance, allocation of right place at right time.
Software Integration	**Horizontal integration with suppliers** **Measure:** RFID and sensors used to monitor food stock, in order to produce customized diet programs and reduce total cost of feeding **Result:** Improved suplier efficiency.

Source: Boston Consulting Group

Horizontal integration especially with suppliers via RFID and other sensors will be mainly used to monitor food stock for the purpose of producing indiviually or organizaitonal level customized diet plans and programs to reduce costs. This will not only reduce cost but also customer as an individual and organizational satisfactory level will be very high.

Vertical integration of sales, production, and including logistics systems will all produce big data, which will be stored in remote cloud structures with advanced security protocols. Analytics of this data will improve capacity utilization and allow real time performance monitoring and reporting.

vi. Machinery (figure 3.14)

For machinery sector especially advanced simulation methods are used in testing systems and prototyping. Also design is very important for machinery sector, both while designing products and equipments that are used for production. Transformation will shorten the development period and reduce to relying on quality mechanisms because of nearly zero defect rates.

Figure 3.14: Potential Productivity Increase in Machinery Sector

Productivity Increase of 4-8percent possible in total costs

Software Integration	**Superior mould design and development** **Measure:** Advanced simulation for protoyping and testing. **Result:** Less development times.
Automation	**Automated production and consigment systems** **Measure:** Automation of melting moulds and production lines with installation **Result:** Less setup and lead lasting
Big Data Analytics	**Improved CRM and postsales services** **Measure:** Big data andanalytics integrated with CRM systems. **Result:** Reduced post sale services.

Source: http://tehad.org/wp-content/uploads/2017/05/TUSIAD-END-40-_-RAPOR

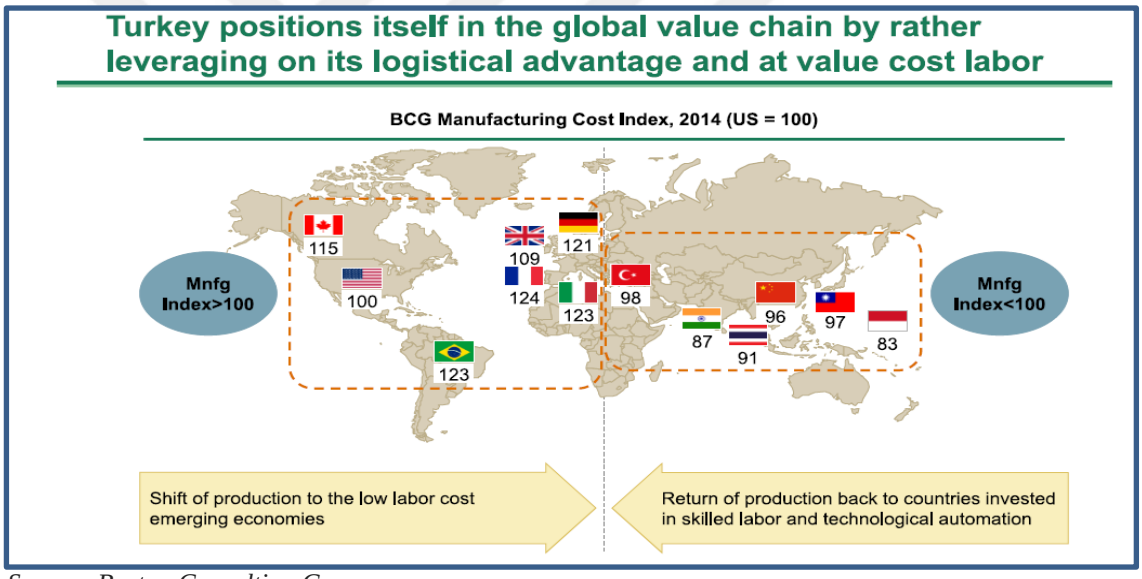
Big data analytics integrated and cooperated with Customer Relationship Management systems will increase both pre and post sales services. Also remote troubleshooting methods econducted via sensors will reduce the warranty costs and also post sales operations cost. Extended service for the all lifecycle of product will influx customer satisfaction.

After Turkey Industry 4.0 implemantations at major sectors are inspected it is time to look at Turkey's location for Industry 4.0.

Turkey has competitively positioned itself along the global value chain by leveraging its geographical location for logistics advantages and providing low at-value labor costs for flexible and cost-efficient production.

According to BCG's Global Manufacturing Cost Competitiveness Index, which calculate competitiveness scores for countries based on energy costs, manufacturing wages and productivity, scored Turkey with 98 point. The same organization gave U.S. 100 and gave Germany 123 points (figure 3.15). This means that manufacturing costs in Turkey is, 2 points lower than U.S., and 23 points lower than Germany.This also give competitive advantage to Turkey.

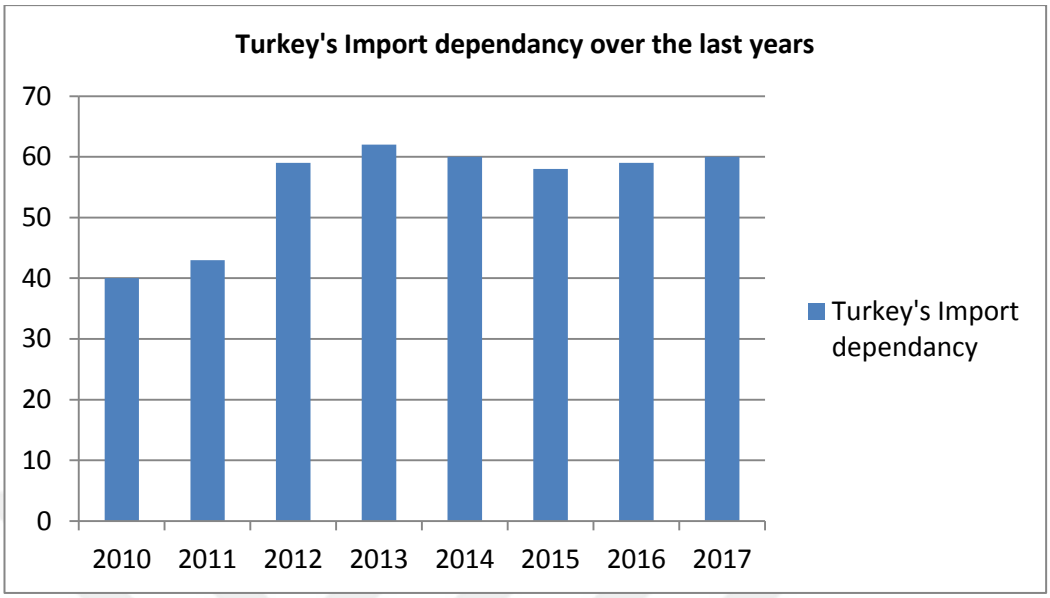
Figure 3.15: Turkey's Position in the Global Value Chain



Source: Boston Consulting Group

As it seen from the table, Turkey has cost advantage when compared the all western countries and jst four points below the China. Nevertheless,Turkey in order to maintain this advantage have to deal with the some structural challanges such as, high import dependency for exports, limited workforce skills, high employee turnover. But especially import dependency is critical and it is showed at figure 3.16.

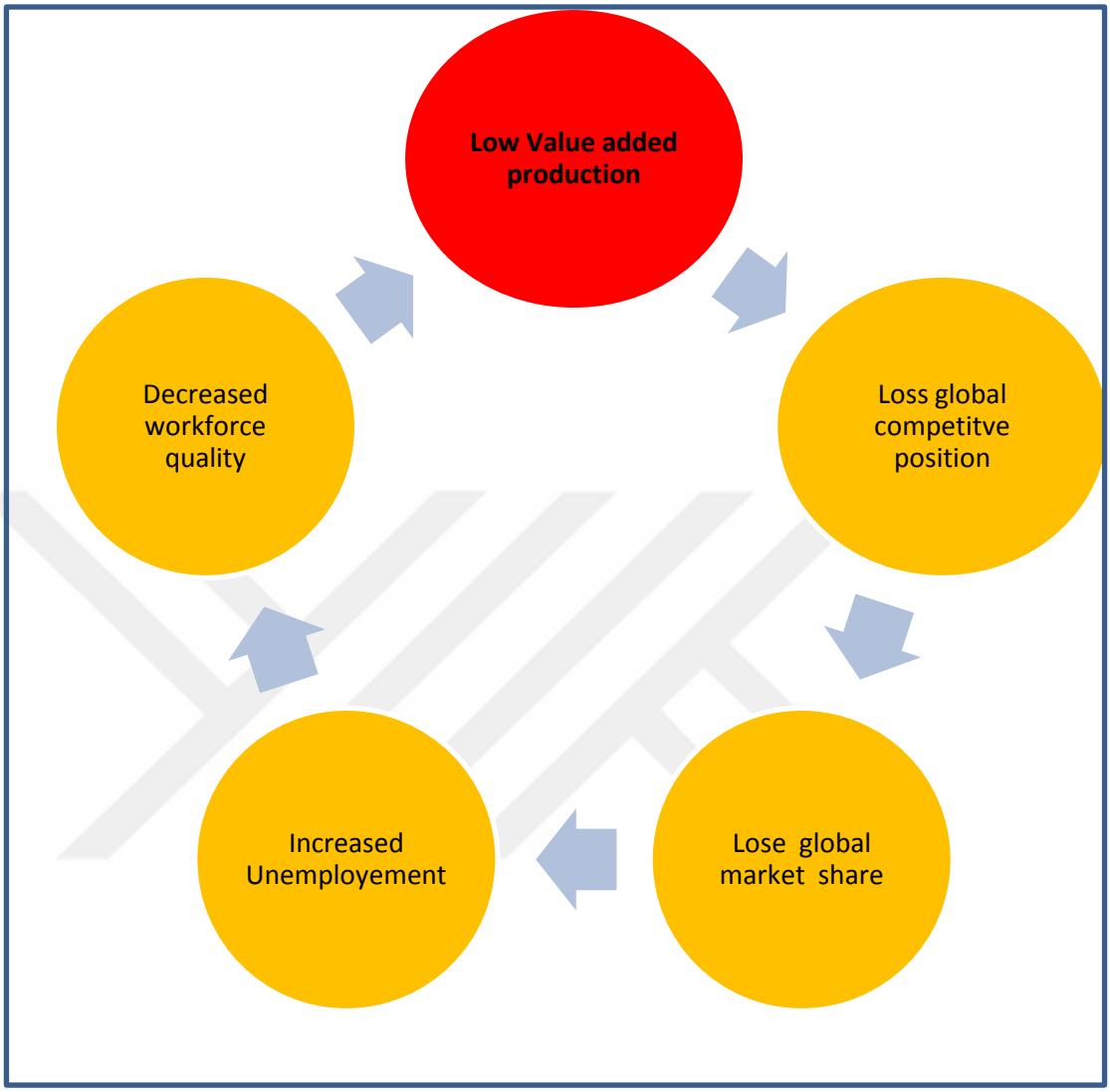
Figure 3.16: Turkey's Import dependancy over the last years.



Source: http://bilingumruk.com/turkiyenin-dis-ticaret-rakamlari-2005-2017/

Turkey's structural challenges particularly rely on to the import; can reduce her manufacturing global competitiveness. Staying behind at this competiton will trigger the unemployement rate and it'll be accompanied by low workforce quality. In this case, Turkey would eventually slide into a vicious cycle of underinvested, low value-added production. On the other hand, investing in Industry 4.0 enablers would provide a tectonic shift for Turkey's global competitiveness for Industry 4.0 and lead to a higher share in the global value chain, creating more jobs with a highly skilled workforce. Consequently Turkey has two option and these are depicted at the below which are depicted at Figure 3.17 and 3.18.

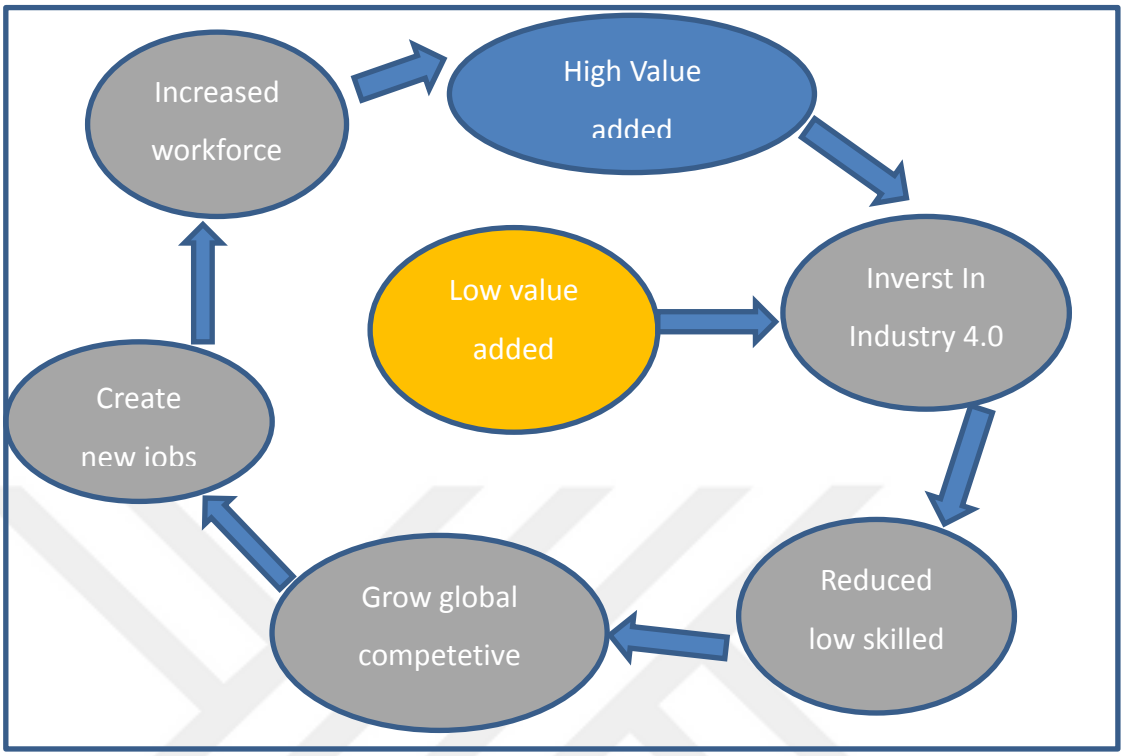
Figure 3.17: Do nothing and enter into a vicious destruction



Or Turkey has another option to choose; and actually Turkey either voluntarily or inevitably has to choose if really want to reach the target of ATATÜRK, as he said in NUTUK 'To surpass the contemparary civilizations' Turkey has to go on with the latter option (ATATÜRK 1933).[10]

[10] It is written at the second page of the original hand writing version of NUTUK, which is at at the http://www.isteataturk.com/g/icerik/Cumhuriyetin-10-Yil-Nutku-29101933/750 adresss.

Figure 3.18: Investing to benefit from a vicious circle of value creation



All these indicators clearly show that Turkey is fork in road. Turkey will invest to digital transformaiton and Industry 4.0 for smart manufacturing or delay investing and her low value manufacturing will stay at same level. The result of second option is falling behind of the global competitvenes and global quality. But with the first option Turkey will have chance to produce high value added products and in a global level quality.

Last but not least, as did the comparison of GDP and Expert values and world range position for other Europen countries, The same investigation is done also for Turkey and table is 3.8 is at the below.

Table 3.8: Turkey GDP and Export Values

		2012	2017	Percentage	World Range
Turkey	GDP	760 Billion $	850 Billion $	%12	18
	Export	152 Billion $	157 Billion $	% 3	32

Source:https://www.cia.gov/library/publications/the-world-factbook/rankorder/2078 rank.html

When looked at the values of Turkey, it is very clearly seen that Turkey is just crawling and located in a position not matching with her potential. Another issue is there is no consistency between GDP and Export values for the world range. Allthough Turkey is located in a much advantaged place and have young population compared to western countries, it seems Turkey haven't used its advantage up to now. It is not too late but Turkey really has to hurry up.

4. COMPARISON

After general looking to the EU biggest countries (England, France and Germany) Industry 4.0 implemantations and deeper diving to Turkey Industry 4.0 implementations, it is time to compare these countries with each other. While making comparison, in addition to objective criterias, stiuational awarenes of the countries will be evaluated as subjective criteria.

According to survey which is conducted by Infosys and the Institute for Industrial Management (FIR) at the RWTH Aachen University, which would contribute to the creation of an Industrie 4.0 Maturity Index, the UK get 26 point, Germany get 21 and France get 14 point (I-scoop 2017)[11] . Although Industry 4.0 concept was born in Germany, UK has passed the Germany.This result can be looked surprising since Germany has implemeted and get the revenue of Industry 4.0 more than England, but this survey focused on maturity and since UK has the Industry experience nearly for three centuries UK has got this score. The same global search gave Chian 57 point and gave US 32 points. This means that China has already positioned herself as number one, in the World. This search unfortunately didn't include Turkey, but we have some other measurments to compare us with especially Germany and EU countries.

To make the comparison it is essential to take in consideriton mainly fielded implementations and when we look at fielded implemantations in Turkey, Her manufacturing industry is numerically dominated by SMBs, and looks it will be much more difficult for this group to adapt the digital transformation process than large corporations. For example, according to 2016 data from the Turkish Statistical Institute, only 16 percent of SMBs, which employes 10 to 249 personnel, order products or services via computer networks. In 2017, our manufacturing enterprises created an added value averaging 220,000 euros. This is less than one fourth of the average in the EU. Our manufacturing businesses create less than one tenth of the added value created

[11] I-SCOOP, 2017, Industry 4.0: the fourth industrial revolution –guide to industrie 4.0 https://www.i-scoop.eu/industry-4-0/ [accessed 20-10-2017]

by German manufacturing. When addressing the issue in terms of workforce efficiency, seen nearly same picture. The added value created by our employees in manufacturing is one third the EU average, and one fourth that of Germany. As a result, the efficiency of our industry is much lower than that of EU countries. So it seems the fourth Industrial Revolution could not only preserve this gap, but also make the gap wider if Turkey doesn't take timely measures. It is certain that sustainable growth can't be achieved without manufacturing.

On the orther hand approximately 30 percent of Turkey's manufacturing and 37 percent of her exports consist of medium and high-tech products, while medium and high-tech products comprise 63 percent of EU exports. So one of Turkey's priorities should be increase to exports of medium and high-tech products and achieve the EU average. 10 percent of the difference is in medium-tech and 16 percent is in high-tech products. High tech sectors are those most affected by digitalization. Therefore, it is absolutely essential for Turkey to digitize her industry in order to increase high tech manufacturing and exports (Özlü 2017).

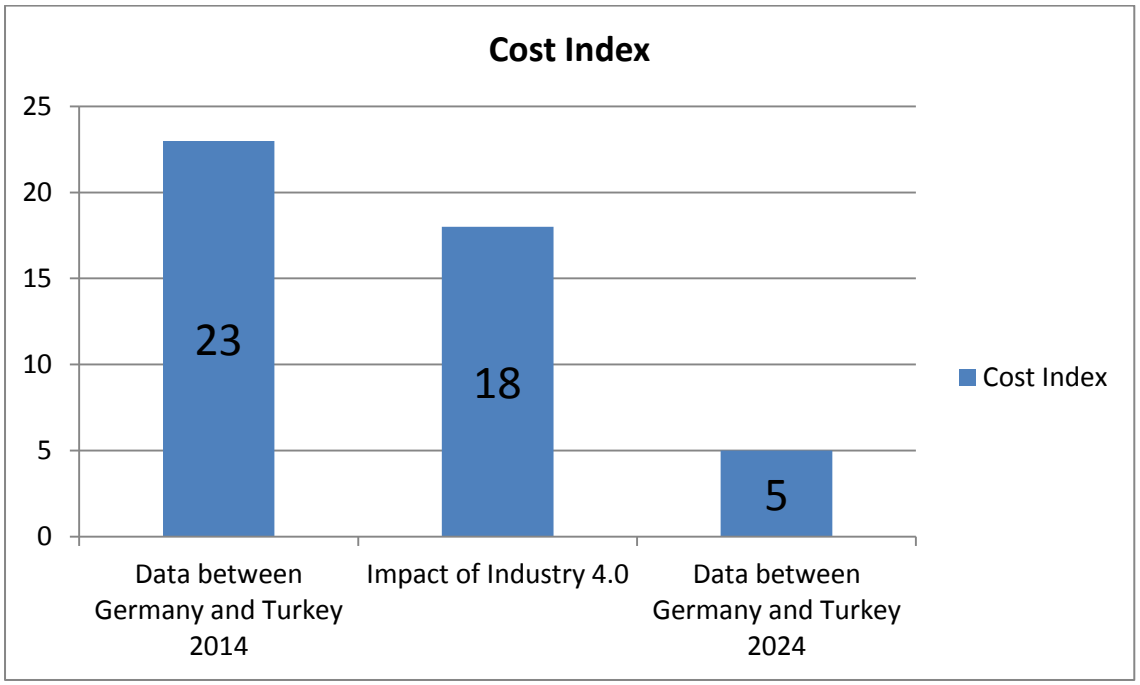
As stated several times, Industry 4.0 is full of advantages and one of them will be seen on the cost compettivenes. The global balance of cost competitiveness will shift toward industrialized countries adopting the enabling technologies of Industry 4.0. In this context, for instance, if Germany were to reduce its transformation costs by 20 percent via successful implementation of Industry 4.0 initiatives, and Turkey would maintain its current competitiveness level, would lose nearly the total of its current cost advantage against Germany, which is depicted at figure 4.1.

This example illustrates that a natural development of further penetration of Industry 4.0 concepts and the evolution of the manufacturing systems in other countries will further intensify the competitive pressures on Turkey in the long term. Consequently, Turkey will face cost pressure from an increasing number of competitors. High cost production countries will improve their productivity by leveraging the scale of their advanced manufacturing establishments, while low cost production countries will have the opportunity to further reinforce their position via easier access to new technologies.

Furthermore, if Turkey fails to realize Industry 4.0 investments, playing catch up will be much more challenging as entry barriers to participate in the ever-increasing integration of the global value chain will inevitably rise, due to the high entry barriers of technology and human resources developing in the global marketplace.

Turkey must use the advantage of young population properly and prepare for this competitive challange. Now that, lots of Europe countries' factories is installed to Turkey, just because of relatively cheap laborорce when compared to Europe Union. But in near future this stiuation can be turned to reverse. In order to prevent this Turkey should take the necessary preventions both as a goverment and private sector side. Only by this way, Turkey can companste the skilled workforce deficiancy which will be occur by Industry 4.0 implemantations. This is very critical point and never should be neglected by Turkey in the forthcoming years.As it showed at the below figure 4.1, Potential effect of the Germany Industry 4.0 potential into reality, Turkey coluld lose its cost advantage against Germany in just a five years.

Figure 4.1: Potential Effect of the German Industry 4.0 Transformation on Turkey



Source: http://tehad.org/wp-content/uploads/2017/05/TUSIAD-END-40-_-RAPOR

As seen in this figure 4.1 when this gap closed, our production cost advantage will be losed and it looks this will show domino effect nearly all industrial areas to employment rates.

Allthough Industry concept is nearly fully understood by EU countries and Turkey, and all of them are aware of challange and advantages of Industry 4.0, it is hard to say any country is fully ready for Industry 4.0. There are various reasons for that but most important one is in all countries private sector need the support of goverments. This stiuation makes pressure on the goverments heavily since investments results wiil be turn in a mid and long terms. So Industry 4.0 is coming like a snowball and it is seen by everybody but to stand is require courage steps firstly from goverments, then private sectors will follow them.

EU's advantage is they consist of 28 countries and this give them advantage of compansate the Industry 4.0 transformaton cost in a coherence. But to be consisting of 28 countries bring some challanges also. First of all every member of Europe Union is not at the same industrial level. This stiuation may burden the extra burden to the leading countries such as Germany and France. So allthough EU has decided to go on at the Industry 4.0 way, this road may be pathway rather than highway.

Lastly, it will be useful to see EU biggest countries' and Turkey's GDP and Export values and their World range at the same table. This table enables us to see all values in one table and also give us to make comparison over these values. As seen from the consolidated table, Turkey is at the last position when compared to the western countries. This is the natural result of first three industrial revoluotions. If Turkey wants to convert this table to the reverse, it looks there is no option to invest Industry 4.0 and digital transformation era. So this remarkebale table should be stimuli for Turkey to reverse the stiutaion.

Table 4.1: GDP and Export Values of England, Germany, France and Turkey

		2012	2017	Percentage	World Range
Germany	GDP	3.450 Billion $	4134 Billion $	%31	3
	Export	1.250 Billion $	1.480 Billion $	%18	3
England	GDP	2.470 Billion $	2.905 Billion $	%18	7
	Export	430 Billion $	458 Billion $	% 6	10
France	GDP	2.688 Billion $	2.833 Billion $	%5.5	6
	Export	510 Billion $	540 Billion $	% 6	6
Turkey	GDP	760 Billion $	850 Billion $	%12	18
	Export	152 Billion $	157 Billion $	% 3	32

5. CONCLUSIONS

In this thesis study, Industry 4.0 is tried to be explained not only from technological perspective but also from social and economic perspectives as much as possible. Since Industry 4.0 is very wide range concept, we have covered it generally and take the necessary part of the Industry 4.0 definitions. Then EU Biggest countries Germany, England and France are viewed generally. In this context our aim is not to give all detail what these countries have made about Industry 4.0. This is out of our subject; rather we have gathered information to detect these countries' stiuational awareness about Industry 4.0. Then we have continued with Turkey and as normal we have allocated biggest portion to the Turkey. Turkey's Industry 4.0 concept and implemantations are scrutinized detailly and given examples form various sectors. Also Digital Transformation Platform which is constitied by government and private sector cooperation is handled and inspected. Turkey as a developing country is compared with the EU's biggest countries from the Industry 4.0 concept and implemenatations. We have seen that all these countries are well aware of the Industry 4.0 and highly engaged with the latest developments. Additionally while they are in a competetion with each other they try to use the advantage of being a Union since Industry 4.0 requires collabaration and cohesion.

Industry 4.0, which is mainly risen due to the cost effective production, it is also one of the prestigious concern for especially U.S, China and EU leading countries. While these countries are trying to adopt their economies to the Industry 4.0, at the same time they are also sparing large amounts of funds to the Reseach and Development of Industry 4.0 and digital transformation.

Allthough Industry 4.0 is flourished in the Germany, other developed countries has rapidly realized the possible opportunities and participated in the race without losing any time.

One of the important issues that have seen in this study is Industry 4.0 implementations and convertion period can't be achieved without goverment support. So any country

who wants to get succesful results in a long term should provide close coordination within the goverment and private sector.

Since Industry 4.0 has started and this is irriversibale process, those who wants to not only catch this transformation but also manage and lead it, has to be couregous and patient until the Industry 4.0 big picture will be cleared. This is very critical because who success this first will be far ahead of the others both as a economic and technological sides.

Now, the main question, which has to be answered, is what should Turkey do on this Industry 4.0 journey? Before answering this question we can give an example from the Californian Gold Miners. When Gold miners were looking for gold, unfortunately they didn't be rich but the shovel sellers became rich (Çetin 2017). So if turkey wants to utilize Industry 4.0 as an opportunity, firstly invest, focus and give priorty to became a software, robot and technology producer and seller. Our vision should be based on this idea.

Turkey as fast developing country, who missed the first three Industry revolutions range from 30 to 100 years, now has a chance to catch this opportunity this time. Since Turkey's most of companies are positioned somewhere in between Industry 2 and 3 level it will not be so difficult to transform to the Industry 4.0 level. Also Turkey has a advantage of young population, by which transformation can be accomplished faster.

In order to be a leading country in Industry 4.0, Turkey has to do her homework well and address the key barriers which prevent the adoption of industrial 4.0 technologies. These can be about privacy, security, intellectual property and data on top of other barriers. So if the below items are fulfilled exactly, it is no doubt that Turkey can be one of the leading Industry 4.0 industry;

First; In order to increase stiuational awraness to Industry 4.0 in every sector, our policies including agriculture, health, education, the environment, energy, and transportation need to be updated and reshaped in light of the fourth industrial

revolution. This is only possible with a vision shared by all of the concerned segments because the impact of digital transformation will not be limited to our industry, industrialists, and industrial workforce, but will have a significant effect on every area of our lives and every individual. So common understanding is very critical.

Second; goverment and private sector coordination and cooperation should be enabled urgently. Allthough Digital Transformation Platform has been constituted, this is not enough to reflect and make prevail to all sectors. So in order to get satisfied results, digital transformation has to produce practical solutions and they have to be implemented insistly.

Third; allthough increased R&D expenditures look as a burden to Turkey budget at the beginning, it should be take in account that revenue of R&D will be much higher than what has spent so far. So R&D expenditures both in universities and practical area should be supported by government.

Fourth; It is no doubt that the most important capital in the future will be educated and qualified human resources. Therefore, it is critical that to create a qualified labor force that has the competencies required today and can design and manage their own systems as a contribution creating a competitive workforce in Turkey. This time first responsibilty belong to universities and academic area and second can be attributed to again government as a support mean.

Fively, Companies have the foresight and the road map that they need. It is essential that this new road map be drawn up by each company based on its own dynamics and those expectations as well as sectoral and global developments be analyzed properly. But while making these road maps, a control mechanism should be constitued in order to see ‘Big Picture’. Also this establishment can serve consultation point while companies preparing their roadmap. Since our private sector is very dynamic, open to change and act as a locomotive, if the road maps are prepared in a good plan, implementation will be definetely succesfull.

Last but not least item; Turkey should choose one pilot city for Industrial transformation and adoptioon. This city can be Bursa or İzmit, since they are highly industrilized and nearly all sector factories are installed to both these cities. Once the pilot implementations have tested and got the satisified results then can be reflect to rest of the Turkey.

Conclusionly, ‘Game is changing and time is faster too’. Turkey, who wants to be one of the ten biggest economies at her 100th anniversary, has to jump Industry 4.0 train and reserve her place not as a passanger instead as a conducter. Turkey should be quick, because ‘Society 5.0’ train (Granrath 2017) which has put the etichal and moral values to the Industry 4.0 depart the station from Japan is also approaching. So collaboration between government, industry and the academic world, Turkey should go on her way with ‘made smarter‘motto.

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