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

INTEGRATION OF LOGISTICS TO INDUSTRY 4.0: A LOGISTICS FIRM CASE

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IZMIR- 2018

THESIS APPROVAL PAGE

DECLARATION

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

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ABSTRACT

Master Thesis

Integration of Logistics to Industry 4.0: A Logistics Firm Case

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Industry 4.0 is the new industrial revolution and it takes its roots from a new initiative instead of an invention. Industry 4.0 aims to improve usage areas of technology in every aspect of business and benefits from the technological improvements. Therefore, like other sectors, changes in logistics sector are also expected. Logistics is a sector that is not only effected by internal factors but also external factors in order to comply with the customer needs and wants. Considering the increasing effects of Industry 4.0, the studies about the topic rise in importance. Hereby, the main objective of this study is to examine the effects of Industry 4.0 on logistics. In according with this purpose, a single case study on a logistics company in Istanbul is conducted. Data is collected via in-depth interviews and document analysis. Findings reveal the applications of Industry 4.0 in the field of logistics, the implementation processes, the obstacles in front of the applications and the fields that can be developed. By analysing the firm's situation in the sector, deficiencies and advantageous areas are determined. Fields where the company had problems were identified and recommendations are presented and suggestions are made to the logistics firms which want to implement the applications of Industry 4.0.

Keywords: Industry 4.0, Logistics, Logistics 4.0

ÖZET

Yüksek Lisans Tezi

Endüstri 4.0'ın Lojistik Sektörüne Entegrasyonu: Lojistik Firması Örneği

Melis Gizem ÖZTÜRK

Dokuz Eylül Üniversitesi

Sosyal Bilimler Enstitüsü

İngilizce İşletme Anabilim Dalı

İngilizce İşletme Programı

Endüstri 4.0 köklerini bir buluş yerine yeni bir inisiyatiften alan yeni sanayi devrimidir. Endüstri 4.0, iş dünyasının her alanında teknolojinin kullanımını ve teknolojik gelişmelerin kullanımını geliştirmeyi amaçlamaktadır. Bu nedenle her sektörde beklendiği gibi lojistik sektöründe değişiklikler beklenmektedir. Lojistik, müşteri ihtiyaçlarını ve isteklerini yerine getirmek için sadece içsel faktörlerden değil, dışsal faktörlerden de etkilenen bir sektördür. Endüstri 4.0'ın artan etkilerini dikkate alındığında konuyla ilgili çalışmaların önem kazandığı görülmektir. Çalışmanın temel amacı, Endüstri 4.0'ın lojistik sektörüne etkilerini incelemektir. Bu amaç doğrultusunda, İstanbul'da bir lojistik firması ile bir vaka çalışması yapılmıştır. Şirket yöneticileri ve çalışanları ile derinlemesine görüşmeler, odak grup çalışması ve doküman analizleri yapılarak veri toplanmıştır. Bulgular, Endüstri 4.0'ın lojistik alanındaki uygulamalarını, uygulama süreçlerini, uygulamaların önündeki engelleri ve geliştirilebilecek alanları ortaya koymaktadır. Firmanın sektördeki durumu analiz edilerek, eksiklikleri ve avantajlı olduğu alanlar ortaya konulmuştur. Firmanın sorun yaşadığı alanlar tespit edilerek çözüm önerileri sunulmuş ve Endüstri 4.0 uygulamaları yapmak isteyen firmalara önerilerde bulunulmuştur.

Anahtar Kelimeler: Endüstri 4.0, Lojistik, Lojistik 4.0

INTEGRATION OF LOGISTICS TO INDUSTRY 4.0: A LOGISTICS FIRM CASE

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ABBREVIATIONS

I4.0	Industry 4.0
GDP	Gross Domestic Product
ACATECH	Germany Federal Science and Research Academy
IoT	Internet of Things
CPS	Cyber Physical Systems
RFID	Radio Frequency Identification
MES	Manufacturing Execution System
NCPDM	National Council of Physical Distribution Management
CLM	Council of Logistics Management

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INTRODUCTION

Through the history, arising technological developments changed the businesses. Technological developments such as mechanization, mass production, and automation lead the arise of industrial revolutions. Industry 4.0 is a relatively new concept and expectances about the Industry 4.0 is related with capability of affect every sector vastly. With Industry 4.0 new enabler technologies for the new industrial revolution are rising. With the new industrial revolution, like every other aspect of business, logistics will change too. The change possibly will be regarding how services are running and what customers are expecting from the logistics companies. Especially with the new technological developments components of logistics systems such as transportation, material handling, and inventory management may go through a change.

Industry 4.0 is a concept that is still in the development phase. With this concept, new technological developments will arise and effects of these new developments are still relatively unknown. Impacts of Industry 4.0 on logistics are still an area that is open to exploration. There are no certain facts and data, besides, there is a limited research on the effects of Industry 4.0 on logistics. Therefore, overall objective of this study is to uncover possible effects, application methods and barriers related to Industry 4.0 integration to logistics.

This study consists of three chapters. In the first chapter, Industry 4.0 will be discussed with its main lines. General overview of Industry 4.0 is made to give a broader perspective about the concept. In order to understand Industry 4.0 other industrial revolutions are examined. Industry 4.0 is still a concept that is not has an absolute definition, therefore definitions and changes of Industry 4.0 is examined. Main features of Industry 4.0 is discussed and determined. Implementation methods, barriers of implementations, advantages and disadvantages of these implementations are also discussed in this chapter. Future prospects of Industry 4.0 phenomenon and current situation of the world and Turkey examined at the end of the chapter.

In chapter two, general overview of logistics is made. In order to examine logistics concepts, first definitions of logistics are examined. After the definition examination basic concepts and principles of logistics discussed and this part acts as a base for examining the impacts of Industry 4.0 on logistics. Historical development of logistics examined to pinpoint changes that comes with industrial revolutions and others changes trough out time. The chapter finishes with the current situation of logistics in the world and Turkey.

In chapter three, the methodology and the findings are presented. Case study method is selected for this study to explore effects of Industry 4.0 on a logistics firm and in-depth interview and document examinations are applied for data collection. Finally, the conclusion of the study is introduced.

CHAPTER ONE
INDUSTRY 4.0

1.1. GENERAL OVERVIEW OF INDUSTRY 4.0

1.1.1. Historical Developments of Industrial Revolutions

The industrial revolution, which regarded as a transition from production based on the human power to output based on machine power, is divided into various phases depending on the developments since the 18th century. It is possible to examine industrial revolutions under four main headings as the first, second, third and fourth industrial revolution. Some sources have added industry zero to industry revolutions and studied them under five main titles.

Industry 0 is considered the starting level of industrial revolutions. It started with the use of simple hand tools in production and ended with the start of the use of steam machines. The industrial revolutions that began with the invention of the steamer have been scattered over the last two hundred years. Industry 1.0 is the starting point of industrialisation, in the United Kingdom at the 19th century. The revolution fully established on the middle of the century. The first industrial revolution spread in Europe, America and Japan after the United Kingdom. In this process, water and steam-powered machines have been used to provide maximum benefit from water and steam power. In this respect, as the workforce in production, the transition from human to machine power has been experienced, and production has started in the factories. Production has been facilitated, and quality of life has increased with the mechanisation processes. With industry 1.0 introducing new opportunities, mass production has been passed, and as a result, profits have increased in production. Besides, the working class was born, the supply of production increased, and income differences between the worker and the employer increased. Thus, social class problems have also started to occur. Also, the development of railways has been accelerated by the use of machines in this period. Events also made it easier to access new raw material sources.

The industry 2.0, recognised as a revolution by industrial engineers, is considered to have begun with the period defined as the Fordist era in which Henry

Ford adopts mass production for car production. Raw material and energy source changes, steam, coal and iron, as well as steel, petroleum and chemical materials in manufacturing began to use electricity. (EKO-IQ Magazine, 2014) With the use of power in production lines, Henry Ford has also been the pioneer in industry 2.0, so series production has begun. This revolution, in which the foundations of the underlying logic of production were introduced, produced the automobiles needed in a standardised way. (Alçin, 2016). After 1970, automation became widespread in manufacturing, information technology gained importance, and human power took its place in machines. The railway network became prevalent with the irony taking place in the irony place of the first processes of the industrial revolution so that the trade was accelerated. Communication and communication facilities have begun to take place more and more in our lives in parallel to these developments and to increase the welfare level of the society. Although the central executive countries of this period generally do not look like England, Germany, USA, Japan; the effects of the revolution have in time influenced many nations of the world. (Gabaçlı and Uzunöz, 2017)

With the Industry 3.0, which has been recognised as the post-Fordist era since the second half of the 20th century, programmable machines have been designed and incorporated into production systems using electronic, information and communication technologies. The emergence of the Internet has accelerated the development of this industrial revolution. Developments in the field of transportation and communication have been experienced. The concept of globalisation has begun to take place in the industry.

Despite being a very new concept, the industry 4.0 is one of the first efforts made by the German Ministry of Education and Research to sustain and develop a continuous development strategy. The Ministry has identified different areas and themes in the sustainable development program, and one of them has been named "Industry 4.0" in Germany, which is called "Industrie 4.0". These studies were published at the 2011 Hannover Messe fair, one of the most important fairs of the industry 4.0 strategy documentary industry, which was carried out by Germany Federal Science and Research Academy (ACATECH). (Management Information Systems Review, 2017)

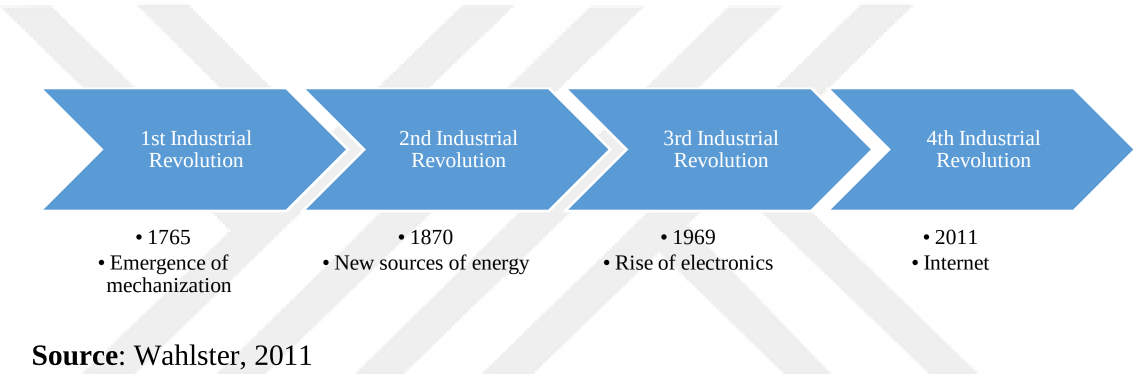
Today, the modern production plays an important role, especially in European countries. In recent years, European nations have faced many challenges, such as ageing populations and competition from developing countries. According to the Economic Policy Committee and the European Commission, the working age population will be reduced by about 48 million (16%) and by the year 2050 will be 58 million seniors. In 2011, the industrial share of developing countries (such as China, India and Brazil) increased by 179% in 1990. On the other hand, industrial value share in Western European countries; Germany, France and the United Kingdom. The reduced workforce causes these problems. These problems have led to the development of industrial technologies such as reduction of workforce, shortening of product development time, efficient use of resources, the cyber-physical system (CPS) and the internet of objects (IOT).

Since its first publication, many European manufacturing research organisations and companies have created a study that underlines the fact that manufacturing under industry 4.0 will consist of autonomous and intelligently moving production units capable of working with information-clearing and controlled machines. (Qina et al., 2016) With the rapid progress of technology, the production stages of products have begun to change. Due to this change, intelligent products have been planned according to customer needs, which has led to the completion of the life cycles of the products together with competition in the industry. This sophisticated layout unveils the idea of combining the internet, mobile devices, sensors and other intelligent devices with the main elements involved in the production. As a result of this idea, the concept of industry 4.0 emerged. (Bozkurt and Durdu, 2016)

Moreover, the present production paradigm is not sustainable. On the one hand, industrial production leads to a great deal of environmental deterioration such as global climate warming and environmental pollution, but on the other hand, it is consumed too much from non-renewable sources such as oil and coal. Besides, labour supply is decreasing due to the ageing of the population. For this reason, the industry needs a radical change, and this change is addressed by Industry 4.0. (Wang et al., 2015) When the developmental stages of the industrial revolution are examined, the industry is regarded as 1.0; production is done with machines, industry

2.0 in the process; we see that serial output has been achieved due to the increasing needs, and digital technology is used in the industry 3.0 process. We cannot recognize these processes briefly as the transition from human power to machine power. Compared to other industry revolutions, the industry has seen the metamorphosis of 4.0 aimed at intelligent production based on Internet technologies of cyber-physical systems and objects. (Economic Forum Magazine, 2016) With the start of the industry 4.0 process, the production phase has begun to digitize using the internet, which plays an active role not only regarding machine power but also in the development of production technology.

Figure 1 Industrial Revolutions



Source: Wahlster, 2011

However, like it would be explained in more detail in the future chapters, fourth industrial revolution is different than others. Because every other industrial revolution emerged with a new invention, however, this time fourth industrial revolution is arising from the vision of German government instead of a new invention.

1.1.2. Industry 4.0 Development and Definitions

German government started to build the foundations of Industry 4.0 innovation in 2006 with High Tech Strategy report. Other features of industry 4.0 is defined with the German governments reports related with technological road maps in 2010 and 2012. German government formed a group of academicians, industry representatives, and scientists in order to determine keystones for industry 4.0 applications. This group formed eight main steps for German government to establish Industry 4.0 vision. These eight main steps are ranging from standardization to continued learning.

German government aimed to increase their competitiveness level and make them one step ahead from their current and future competitors. Their aim is to transfer current and new technological prospects to the industry level in both corporate level and SME level. Aim is to increase the German companies' global competitiveness levels both in scope of SME's and corporates. German government also supports Industry 4.0 applications with government bodies. As an example of this, German government established a platform that connects academicians with real world and Ministry of Economics and Research are responsible from this connection.

The term is founded by German Government and it mainly covers how technological changes will impact the manufacturing and creates legal frameworks for to reach required technological changes. Main point in this change is to protect and enhance Germany's competitiveness level. It is conceptual in that it sets out a way of understanding an observed phenomenon and institutional in that it provides the framework for a range of policy initiatives identified and supported by government and business representatives that drive a research and development programme. (Industry 4.0, 2016)

1.1.3. Industry 4.0 Main Features

Industry 4.0 generally covers four directions:

a.Factory: One of the main structures of Industry 4.0, the factory is connected to all production systems such as machines, sensors, actuators, conveyors, robots and not only automatically exchanges information but also consciously and intelligently to control the production process and manage the factory system. With the changes of industry 4.0 smart factories will emerge. Besides the production process; other processes such as production planning and engineering, product design, services, etc., will become integrated systems with each other. This means that production processes are not only governed by a decentralised system but also controlled independently. Such factories will be known in future as Smart Factory (Qina et al., 2016).

In the changing and uncertainty of the modern business environment, businesses are forced to identify and develop different production capabilities and to introduce new products to the market accordingly. High flexibility, low volumes and short delivery times are key factors in meeting business demands. Three types of factories are described according to demand and business specifications: (McKinsey Digital, 2015)

Intelligent auto factory: the first new type to be identified with full automation and mass production at low cost. These facilities are digitised. It produces high price and large volumes. As an example of this, the soap facility is the first demonstration of intelligent factories that produce any number of personalised coloured liquid soap bottles. Customers can choose any amount of different liquid soap, and this production facility can produce soap without human control. This production facility is designed as an integration of various communication systems controlled by decentralised systems (Zuehlke, 2010).

Customer-focused factory: It is defined as facilities that produce highly customised goods at reasonable cost, depending on the data-driven demand forecast. The machines will become extremely flexible and will quickly adapt to changing quantities, specifications, and other parameters in the demands. Once customers have placed their order online, the request will be sent directly to the most appropriate plant. Despite the need for adaptation of the machines, factories can achieve high efficiency through process automation. Also, the use of different technologies and 3D printers will impact the range of products to be manufactured and offer customers comprehensive product options without increasing inventories.

E-factory: mobile, agile, small-scale, prefabricated facility that addresses foreign markets and is installed in a convenient place. The E-factory concept includes standard modules that can be installed in containers and easily transported. When the factory is set up, it will be able to produce a limited number of products in a new place without being fully automated. Besides, customers will be able to use their simulation tools with the help of specialists, who will be able to stop and design their products on sites, select structures and materials. Robotic and end-to-end information flow, 3D printing, highly skilled central teams will support production in an e-shop container and will help operators make their work easier. For this reason, the e-plant in a container does not have to have an industrial field and is highly adaptable to local trends and fully integrated into the ecosystem.

In the main idea of the Industry 4.0 revolution, production systems in businesses will be built on computers, machines, sensors and other systems integrated with each other. By exchanging information with each other, these systems will be able to coordinate and decide themselves independently of humans. This will increase production quantity and quality while production time, costs, amount of energy needed is reduced. Also, products produced in new systems, unlike today's, will have a unique serial number, in other words, an identity, which will keep some information in memory (Ege, 2014).

RFID technology can be used to read and identify IDs defined in products. RFID, known as the abbreviation of the English name, is called Radio Frequency Identification as the Turkish counterpart. It is aimed to create and collect information without human factor in RFID systems. All businesses want to follow the car, product, carrier, people and so on. By mapping objects to the appropriate object, and this information can be read at specific distances.

The components in the structure of the RFID communicate with the radio frequency. Reader, tag and antenna are the three basic parts of RFID. The task of the readers; read the information of the product with the help of the labels placed on the products and take it as a digital code by radio waves. The task of the tags is to keep the information. Communication between the reader and the tag takes place via antennas and this event is called binding. The reading distance can be extended with extra antennas (Maraşlı and Çıbuk, 2015).

RFID identification systems have become widespread in the Automated Recognition and Data Acquisition (OT / VT) sector. This aims to automatically read and record material information in all activities in the supply chain. Passive RF systems from RFID systems have begun to be widely used in our country because of decreasing tag costs (Çiftçibaşı, 2009).

b. Work: Industry 4.0; various companies, factories, suppliers, logistics, resources, customers and so on. It means a complete communication network that will exist between. Horizontal and vertical integration between each department and real-time information flow is provided depending on the demands and status of the relevant sections of the network. Depending on this situation, costs and pollution, raw materials, CO_2 emissions, etc. is expected to decrease. In other words, the future business network will be a structure that is influenced by each business unit department, which can be self-organizing and deliver real-time answers (Qina et al., 2016).

Industry 4.0 technology plants, suppliers, logistics and so on. problems in the workflow process can be solved instantaneously. This situation is expected to save time and effort for the staff working.

c. Products: In the production of intelligent products; industry 4.0 technologies will be used, and a new product type will be created as a result. These products are; an information-bearing processor, identifiable components and embedded detectors, can be monitored during production and post-production processes. In this way; feedback from products will be available. As the final result of the production process, more information about machine conditions can be provided via the backward reasoning algorithms of product quality. Today, such a feedback loop is not available and needs further research (Lee et al., 2014).

There may also be benefits, such as guidance from customers. Due to the identities that will be defined in intelligent products, it is possible to measure user conditions and accordingly to estimate the demand for the product and to monitor the product life.

d. Customers: The intelligent production of products will give customers many advantages. Perhaps in the future, a new purchasing model will emerge with a completely smart production. Once a customer has submitted their order, they can change their order or add or remove additional features at any stage of production. This will bring many benefits. Especially; the customers will also have the product knowledge of the product. Thanks to customer-made changes, manufacturers will have information about the use of products. Most important part is possibility for producers will be able to provide customer satisfaction close to one hundred per cent.

1.1.4. Key Terms of Industry 4.0

With industry 4.0, many technologies are mentioned. These technologies are listed as follows:

a. Cyber-Physical Systems: Systems that connect to the Internet, the cyberspace, and the physical world are called cyber-physical systems. Through the sensors they possess, these systems transfer the movements in the physical environment to the internet environment and generally involve the interaction of objects (Global Industry 4.0 Survey, 2016). The National Science Foundation describes cyber-physical systems as cyber-physical systems; systems that are governed by mixed technology, consisting of the main principles of production processes such as coordination, monitoring and control, communication and computation. Mixed technology, in other words, makes physical machines smarter by integrating with cyber technology. Acting on this, the process is referred to as a whole as cyber-physical systems (Aegean Region Chamber of Industry Report, 2015).

The Cyber-Physical Systems, heading towards lifting the boundary between real and virtual worlds, creates an extensive network of communication with the use of the Internet of Objects and thus constitutes the basic structure of the Industry 4.0.

Cyber-Physical systems coordination; logistics and production processes carried out in the process of value creation such as monitoring and control are the systems that can operate at the highest level. In this system; With the help of actuators and sensors, the virtual computing world is connected to the physical world. With this system, global behaviours composed of different basic structures are created. These structures often include software systems, communication technologies, sensors/actuators such as embedded technologies to interact with the real world (Öz and Topaloglu, 2013).

With Cyber-physical systems, each physical component and machine will have a twin model consisting of data generated from cyberspace, sensor networks, and manual inputs. Intelligent algorithms will process the data in the cyberspace so that information about the health conditions, performance and risks of the physical components will be calculated and synchronised in real time. In this environment, the production system can also program customised manufacturing criteria for individual machines according to their performance. As a result, the production system can be configured to personalise each product's production according to the current status of all devices in the production line to provide a high guarantee. Quality production with optimal operating costs In such an intelligent factory, the manufacturer can meet customer specifications by supporting last minute changes in manufacturing and other flexibility not available in traditional factories (Lee, 2015).

In cyber-physical systems, pre-programmed systems can communicate with the machine through machine-embedded software and sensors embedded in built-in manufacturing factors and work without any intervention. One of the most important features of cyber-physical systems is that the processes that are extremely difficult to solve with human intelligence and power can be realised in a concise time. Since Cyber-physical systems are connected to the internet, they can reach the data very quickly and can incorporate the data obtained into the production process. Also, since it is connected with the outside world, it can also adapt to external conditions.

b. Learning Robots: Robots are evolving and becoming more autonomous, flexible, and cooperative each day to provide more benefits. With Industry 4.0, these robots will be produced today at a lower cost and will have a wider range of capabilities than those used in production. For example, Kuka, a European robot maker, offers autonomous robots that interact with each other. These robots are integrated with each other so they can work together and automatically adjust their actions according to a product that is waiting for them. Control units and high-level sensors allow close working with people (Rüßmann et al., 2015).

c. The Internet of Objects: The concept of the Internet of objects emerges as the industrial internet of opposing objects in the industrial field. The industrial web of objects includes the use of machine-to-machine (M2M) information flows and industrial automation technologies within large data technologies. In this context, it is possible to think that intelligent devices are more efficient than humans and transmit data consistently and correctly. This information flow between the machines can ensure that the companies keep their resources safe and support their business intelligence work. The industrial internet of objects is especially important in terms of quality control in the production environment, the continuity of the activities, the traceability of the supply chain and the productivity.

d. Cloud Computing: Services that provide common information sharing among computing devices are called cloud computing or online information distribution by functional name. Cloud computing is not a product in this direction, it is service. By providing the basic information and software sharing, computers and other devices are often used in a similar way to electrical distributors over the information network where the internet is used (Aegean Region Chamber of Industry Report, 2015).

Cloud computing systems are established and shared by many organisations. This technology, provided by the cloud server, is used to reduce the load on personal computers. With cloud technology, applications that users do not want to download and install on their computers can be stored. On this page, it is possible to easily access these information, programs and data with the device connected to the internet.

d. Big Data Analysis: Large data is the number given to complex and large data sets that information systems cannot handle. In other words, software tools and known database management systems are referred to as "large data" over the ability to store, collect, manage and analyse data (Göksen, 2018).

Big data will provide essential values in the future. The use of big data is now possible with cloud computing, which offers scalable storage and computing capabilities. Questions about which data to gather, how to collect these data, how to formulate it, what its meaning is, and how to analyse it needs to be answered first. Instead of thinking about how to collect various data and how to use them, practical considerations should be taken into account which information may lead to quality and efficiency-related factors. For example, machine tools and work history should be monitored and analysed to predict problems so that people can respond in advance, as breakdown machines, product quality, and finished product rate are reduced. In order to increase productivity, the production (processing) time of each process and the working time of each machine must be known. The performance in these processes helps to identify the bottleneck and load the imbalance of the devices (Wang et al., 2015).

e. Horizontal and Vertical Integration: The end-to-end integration of the engineering process can be explained. The reason for the end-to-end integration of the engineering process is that the product life cycle consists of several steps that must be performed by different companies. A company must compete with other related companies at the same time as a business association. Due to the horizontal integration between institutions, associated companies can create a productive environment. Finance, information and materials can efficiently circulate among these companies. This can contribute to the emergence of new value networks and business models (Wang et al., 2015).

f. Layered Manufacturing: More and more companies are beginning to apply additional manufacturing methods, such as 3D printing, which they often use to prototype and produce individual components. With Industry 4.0, these mass production methods are widely used to create small-scale speciality products that offer construction advantages, such as intricate and lightweight designs. High performance, centrally independent mass production systems will reduce shipping distances and stocks available. In the engineering phase, 3D simulations of the products and production processes of materials are already in use, but future simulations will be used extensively. These simulations can apply leverage to project real-world data in a virtual model to include the physical world, machines, products, and people. This aims to improve quality by allowing operators to optimise the machine settings of the product in the virtual world before physical exchange to maximise and thus reduce machine set-up times. Today, manufacturers have developed a virtual machine that can mimic the processing of parts using data from the physical device. In this case, the actual processing time is estimated to reduce the installation time to 80 percent (Rüßmann et al., 2015).

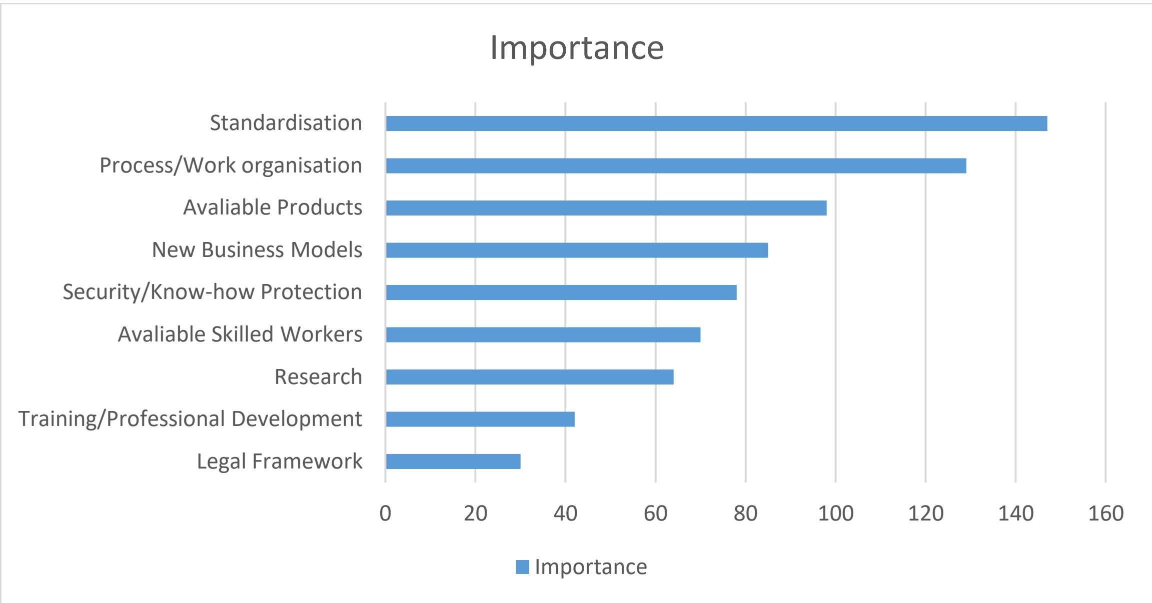
g. Increased Reality: Increased Reality (AG) technology is the technology that has been in the field of information technology in recent years. The increased reality in which many field work is done is a technology that has begun to enter our life more and more from day to day. In the simplest sense, reality technology can be divided into two as enhanced reality and virtual reality. Increased reality; it keeps its connection with the real world, allows data and images to be added to real-world images, and allows real and virtual objects to be perceived together in the same environment. Virtual reality is; it is expressed as an environment in which the relationship with the world is completely lost when the user enters this atmosphere.

1.2. IMPLEMENTATION OF INDUSTRY 4.0

1.2.1. Preconditions for Industry 4.0 Implementations

Preconditions for industry 4.0 applications are defined based on the survey conducted by European Parliament in 2013. The study made from by the member states of EU and determined which precondition is important than others. According to the study, preconditions for Industry 4.0 implementations are; standardisation, process/work organization, available products, new business models, security/know-how protection, available skilled workers, research, training/professional development, and legal framework. Preconditions of Industry 4.0 applications shown at the Figure 2.

Figure 2 Preconditions of Industry 4.0



Source: BITKOM, VDMA, ZVEI 2013.

As depicted in the Figure 2 above standardisation stands for one type of every aspect of business. Basically, for most efficient industry 4.0 applications companies should create one system for everything and every aspect of business should flow through these systems such as platforms etc.

Process/work organization will change according to new conditions of business that will come with Industry 4.0. Real-time information flow and real-time data follows are getting more important with new industrial revolution therefore process and work organizations will reflect to that. As a result of this new business models will also emerge and according to this new models' requirements for blue-collar workers and white-collar workers will change too. Therefore, we can say that process/work organization, new business models, available skilled workers, and training/professional development are interconnected.

Because of this it can conclude that, to apply Industry 4.0 projects in the companies, company systems, workers from top to bottom, and legal frameworks should be ready in both countries and factories.

According to another study conducted by German consulting firm Scheer (2018), there are eight main strategies for implementing Industry 4.0 applications. These are, blue-ocean strategy, solving problems with new technologies, I4.0 factory islands via CPS, PLM and open innovation, transparent logistics islands (RFID), I4.0 consultancy services, product related services, build, own operate (BOO).

Strategy 1: Blue Ocean Strategy: In the Blue Ocean Strategy, destructive innovation can be mentioned (Kim & Mauborgne, 2005). This, leaving the existing; Following the Green Field strategy is the creation of a new company with a new business model. An example of this is the Google Car. Today, cars are 95% stable and 5% active. The Google Car is designed to reverse this relationship, so the car must be 95% mobile and 5% stable. This has led to the emergence of a shared vehicle and driverless service concept. The car is delivered to the new user when the destination is reached. Rather than having a car, the principle of reaching mobility has come to the forefront. With this concept, Google can radically improve car traffic by making it accessible as a mobility service. This means that innovation is not a gradual improvement, but rather a tenfold improvement over the current situation.

The Tesla tool is an example of the Blue Ocean Strategy, with its uncompromising electronic approach.

The character of the Blue Ocean strategy is not to optimise the existing business model, but rather to break/remove all possible principles. The mobility concept of UBER-POP differs from commercial taxi service and removes marginal costs. The MyTaxi system be an advanced dimension of innovation by fully digitising the central taxi office.

Strategy 2: Solution of Conventional Problems with New Technologies: It is possible to review complex or unsuccessful solutions for problems encountered to date with I4.0 techniques. Many examples can be given to this. For example, a machine manufacturer can reduce the number of shipments to minimal levels by planning a flexible transport (depending on the needs) that the manufacturer has configured in the plant to accommodate stock status in production or assembly stations, rather than a fixed number of fixed shipments. A manufacturer of agricultural machines, thanks to the 3D scanners, can prevent time loss by providing better accuracy and quality in the connection between chassis and chassis. A screw maker can improve the Kanban system by inserting sensors and cameras in the Kanban boxes, controlling their stock without visual inspection. With a car manufacturer, RFID technology, auto-counting controls and storage, the parts in the process can, therefore, improve efficiency. In the Figure 3, these approaches are characterized by excessive capital requirements, but with limited potential for the I4.0 vision.

Strategy 3: I4.0 - Factory Islands: A car manufacturer is commissioning a new production line following the I4.0 principles. All workstations are connected to the internet and meet the CPS criteria. Material flow can be self-controlled by RFID techniques. In case of anomalies, changes can be made between production systems. Materials and equipment are monitored through sensors and preventive maintenance is carried out (Lepratti et al., 2014). The example is striking, but when the whole company is thought of, it just emerges as a pilot work. A medium-sized foundry installs a Manufacturing Execution System (MES) to link data retrieval systems

(Borland Database Engine or BDE) to the control layer and to create a data filter for planning systems.

This example demonstrates the correct approach to the production process towards real-time production, but lacks the use of CPS. The MES approach is in conflict with individual control, but it can be seen as a transitional stage in terms of architectural and procedural standardization on the way to I4.0. Even if minimums of I4.0 have been applied, these examples may require high capital and may be regarded as a starting point for further steps. Nevertheless, in these examples, new business models, focused only on the factory, have not been discussed.

Strategy 4: PLM and Open Innovation Islands: An engine builder creates a product memory database that is compatible with Product Life Cycle Management (PLM). At the same time, it reorganizes the product development department. In addition to the production data, production part lists and work plans are also extracted from the ERP system and transferred to a new product database. All these developments point to the architecture of a new information system for the company. Focused on the generation and management of product-related data, so I4.0's high product variety and product singularity orientation are treated accordingly. Logistics activities in sales, procurement and production planning functions have become business applications that access the product database and do not need the management of ERP systems.

A toy maker pays for excellent product ideas by including customers in the product development process. Ideas can be created and sent over the internet using a simple CAD system. This creates end-to-end flexibility in product design and leads to new business models. Nevertheless, re-engineering of the development process requires high capital.

Strategy 5: Logistic Islands: An end-to-end reorganisation of supply chain management, like the RAN project mentioned above, requires that customers and suppliers be included in the chain in many cases. From a single company's point of view; enhanced flexibility and reduced costs can be achieved through the integration of customers, suppliers and even transportation systems. Early notifications of anticipated arrival times, content, measurements and customs can be obtained thanks to the real-time display of RFID technologies and end-to-end use of the transport statistics.

Sensors on the transport route can collect information on specific topics, such as unusual heat or vibrations. This information can be used to control a delivery that may be needed. Field management of RFID controlled materials regulates transport from the transport entrance to the warehouse. The transportation system and settlement information in the warehouse belong to the system itself.

The use of multiple channels by the customer in ordering and monitoring processes creates significant integration problems. A technical material supplier creates a direct sales channel through commercial distribution channels as well as e-shop. This technique requires that the inventory control for the material supplier be accurate on an instant basis rather than on a day-to-day basis. The distribution is now broken down into smaller subsections and should be managed by a new service provider.

The first example relates to the improvement of internal logistics processes, while the second example introduces new business models. In Figure 3, the required capital as a whole for the Logistic Islands is shown at a moderate level and the strategy reaching average is due to the selective approach of the strategy.

Intelligent Services is as emphasized earlier, I4.0 opens up new types of services to bring industrial companies to their strategic potential. Thanks to such terms as "Shared Economy", this potential is expressed strikingly and represents the relevant standards of the system. It is now the customer's access to services that are more closely related to the customer's wishes, products and resources. This means that industrial organizations are transforming into service provider characteristics for functions related to their products. Automobile companies are now providing mobility service providers, compressor manufacturers are also offering air energy, and so on.

Such a development is not new. In the 19th century almost all producers provided their own water and energy requirements from their wells, or with energy sources such as wind, water or steam. Their property belonged to them, and they had to be built and maintained by them. Today, water and energy are provided by independent companies and paid as much as they are used: they are no longer considered services.

Industrial companies can only build additional services related to their own expertise and competencies and complement their product range. The prominence of this development is also recognized in the I4.0 study. The Federal Ministry of Research (BMFT) and the Federal Ministry of Economic Affairs and Energy (BMWi) have therefore approved the addition of intelligent services to existing I4.0 research.

Strategy 6: I4.0 – Consulting: As I4.0 predecessors, industrial companies that have gained experience with new technologies and forms of organization can convey this to other companies. For this purpose, they can establish their own consulting companies. For example; The company's Information Systems department can offer the bazaar service. This is due to the enrichment of expert competencies. Information Systems, the cost centre, become a profit centre. Another benefit is that the company benefits from the parent company by increasing the speed of innovation and addressing the needs of the new client. This development can already be seen clearly. On a smaller scale, such enterprises may be experts in RFID technology or material flow control, for example. On a large scale, the market leaders worldwide in the automotive industry, or the machinery manufacturing industry, including hundreds or even thousands of Information Systems and manufacturing specialists, can be created by primary service providers to design comprehensive I4.0 solutions. Even if the return is higher than the investment cost, the privatisation of a department is more of an organisation problem than an investment problem.

Strategy 7: Product Related Services: The Internet connection of complex products such as tooling machines or printing presses enables them to gain valuable knowledge about the performance of these products in different working conditions around the world. Companies have thousands, even tens of thousands of products running instantly. This information can be used by industrial companies to offer maintenance contracts to customers, especially at competitive prices.

However, there are still essential obstacles to come from above. If the client receives the machine data, the manufacturer must adapt it to the customer's format for use by the customer and reformat the data when using it with his systems. (Conversely, when an industrial company receives data from a supplier for its production processes, it must format it in its data structure.)

It is essential to have a wide range of data, a range of data standards with different customers and suppliers. The first initiatives were undertaken by the UCM (Universal Machine Link for MES) and the OPCUA Foundation from MES union associations. However, further work at the international level is necessary, as in the case of the IIC example. Most likely, industry standards driven by international market leaders in information technology will eventually dominate the market.

Data security issues can also be resolved. If the machines offer open interfaces in their controls, in principle, it can be used in both ways. Sophisticated security measures must be taken to prevent misuse and sabotage (remember that the remote control security mechanisms of the cars of the famous German car manufacturer have been hacked).

For this reason, the concept of data management and the services built on it must be built per the complex infrastructure. Therefore, in the Figure 3, a modest investment requirement is estimated. This strategy has a good potential for development, such as information generated in a wide range of performances of the machines, for example on the level of use or improvement of the facilities.

Strategy 8: BOO: BOO describes the transition of an industrial company to a full-service provider. Now it means to sell the functionality of the product, not the product, to the customers as a service. Hilti in Liechtenstein has become the leading company in hiring more than just selling its products. The rental offer, prepared by machine makers working with banks, showed an early change in the status of service providers. Thus, the creation of bills based on the sale and use of functionality is a logical development.

It is clear that an agricultural equipment manufacturer has become a harvesting service provider. The basic competence lies in the linkage of information technology to agricultural machinery and the means of transport used for harvesting fruit, for example.

Automation in the field of intelligent agriculture is more advanced than the traditional sectors. The reason for this is; because there are no traffic control areas. So it is easier to use driverless satellite control systems for Smart Agriculture.

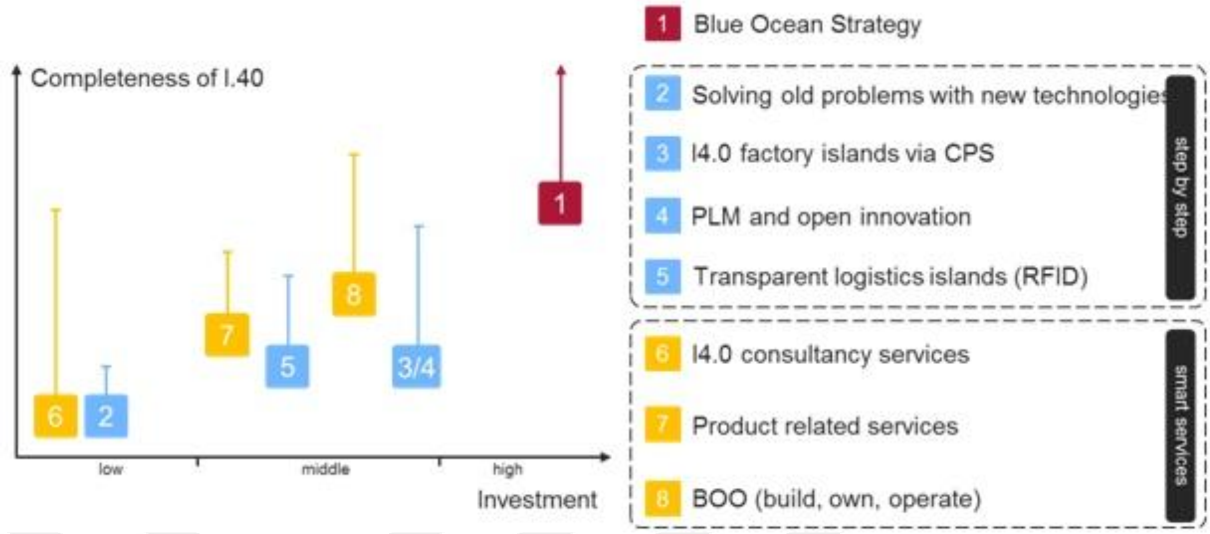
The result for agricultural machinery manufacturers using all technical and organisational means is a profitable business model. Independently, combiners can decide how and when to distribute in a customer's field. In addition to the optimisation of this service, they can even market agricultural products themselves by renting land in the basic knowledge of their machines and their working conditions. The information provided by the machines of the affiliated machines concerning the seasonal situation, adjectives and qualities, such as product anticipation; will support how to determine the price policy. Thus, there is no limit to the creativity that can develop new business models.

There are also new possibilities in medical technology. In recognition of disease symptoms, new assessment possibilities arise as a result of research work done by doctors, but not by medical equipment manufacturers. Sophisticated data analysis techniques are changing, and data analysis with Big Data shows results beyond hypotheses. This allows non-specialist analysts such as informatics scientists to produce interesting medical relationships and results.

In the Figure 3, due to the constant change in business models and the shift from sales profits to service-dependent rental income, BOO strategies have been assigned greater investment capital needs. However, this leads to the development of greater development perspectives.

Positions of the strategies in terms of required investment rates and adjustment to Industry 4.0 is shown at the Figure 3. The figure represents costs and benefits of strategies in terms of Industry 4.0 compability.

Figure 3 Application Methods



Source: Scheer GmbH, 2018

Overall, there are several preconditions and strategies to adopt Industry 4.0. Preconditions have different impacts and importance on companies however they have main points in preconditions. On the other hand, implementation strategies have different advantages and advantages therefore it depends on company preferences related to I4.0.

1.2.2. Advantages and Disadvantages of Industry 4.0

According to Boston Consultancy Groups study, possible impacts of Industry 4.0 are; productivity, revenue growth, employment, and investment. BCG conducted that study in German environment and measured how Industry 4.0 will impact Germany.

For the productivity, conversion costs that do not involve the cost of materials, the efficiency increase will vary from 15 to 25 per cent. When material costs included in the account, efficiency gains of 5 to 8 per cent will. These developments will vary by industry. Industrial-component manufacturers, for example, stand to get some of the most significant productivity improvements (20 to 30 per cent), and automotive companies can expect a 10 to 20 per cent increase.

Industry 4.0 will also increase revenue growth. Consumer demand for producers' increased demand for equipment and new data applications and increasingly privatised products will generate additional revenue growth of about € 30 billion per year or about 1 per cent of Germany's GDP. BCG expecting adaptation process will require investment of €250 billion in next decade and this will be around 1 per cent of businesses revenues.

When BCG examined the impact of Industry 4.0 on German production, they have seen growth stimulus to lead to a 6 per cent increase in employment over the next decade. Demand for workers in the mechanical engineering sector can rise to 10 per cent in the same period. However, different skills will be necessary. In the short span, the trend toward greater automation will displace some of the generally low-skilled workers who perform simple, repetitive tasks. At the same time, the increasing use of software, links and analytics will increase the demand for competencies in software development and IT technologies, such as mechatronics specialists with software development skills. (Mechatronics is an engineering field with many engineering disciplines.) This transformation of expertise is one of the most critical challenges ahead.

Advantageous practices that manufacturers can implement cost-effectively to ensure a good return on investment can be:

a. Reduce maintenance costs: Increasing interaction between machines and progress in intelligent estimation algorithms make predictive strength and high maintenance possible. Maintenance costs are declining over long-term periods.
b. Reduce operational costs: The development of sensors allows more devices to participate in the internet of objects. Unfinished products can join the network in genius embedded systems. While efficiency increases, it allows better results in workforce planning.
c. Decision-making activity: Today's industrial software tools provide an environment where production, purchasing and marketing departments can work together. Future platforms supplier; the manufacturer will provide a

holistic environment in which the customer can communicate and influence the entire supply chain. It will allow for more effective and faster decisions.

d. High customer satisfaction: With the data set in the collection, the benefits of large data technology can effectively reflect in orders in line with customer preferences. According to this behaviour, producers can reprogram production processes and provide the customer with the most appropriate personalised production.

e. Continuous improvement: It is a fact that most competitive producers are continually improving. They improve their production by increasing safety, quality and productivity in business processes. Today, operational work is mostly manual. Using digital technologies as a tool for continuous improvement will provide both efficiency and efficiency gains at all levels of management.

Considering the difficulties in adapting the Industry 4.0 model, the following main points as disadvantages;

Data security will be of considerable importance with the integration of more devices. Production information should be considered as a cybersecurity problem again. Reliability and stability in cigar physical interaction need to provide with high performance. The emergence of the production process from human supervision stands out as another factor to consider maintaining the quality in the same way. Employment is one of the most prominent predictions that will decrease in parallel with the need for humanity. New automation processes should take into consideration in considering this factor. It should take into account that avoiding technical problems can lead to high costs in the long run.

In emerging markets, it is clear that all producers will be affected by these problematic processes, which are difficult to avoid from a competitive standpoint. With the acquisition of production by the robots, the need for human power will reduce, and robots will take their jobs in a sense. It affects not only the blue collar but also the white collar with artificial intelligence that can encode the robots. People who work in the production process need to understand this transformation process well, regardless of whether they are at the management and employee level.

According to another study conducted by Snasell (2016), advantages and disadvantages of Industry 4.0 is stated in Table 1.

Table 1 Advantages and Disadvantages of Industry 4.0

Advantages	**Disadvantages**
Individual customer requirements	Lack of data protection
Flexible production	Easy manipulation of remote manufacturing systems
Relief to employees – work-life balance	A disadvantage for rural areas is the lack of broadband connections
New value: new B2B services	Continuous provision and maintenance of necessary infrastructures
Increased competiveness	High and expensive technical standards
Identifying and developing productivity and Resource efficiency	Additional requirement for employees (IT know-how)
Handling new national and global challenges	

Source: Snasel, 2016

1.2.3. Future Prospects of Industry 4.0

While the concept of Industry 4.0 today is often associated with goals and expectations for increasing productivity in production, the innovations that Industry 4.0 will bring changes to the world of technology and social life and these changes will not stay in the limits of that. Because of the legal and legal regulations needed, new opportunities for the development of new products and processes will come into the agenda. Therefore, the expectations for Industry 4.0 are broad and high.

Industry 4.0 defines the Fourth Industry Revolution, a new level in the organisation and management of the entire value chain in the life cycle of products and production systems. This cycle focuses on ever-increasing individual customer needs and includes all-in-one services that include product development and production orders, beginning with an intellectual phase, including a product end-user distribution and recycling.

In the new level to be reached with Digital Conversion and Industry 4.0, people, objects, and systems will be connected to each other commonly and effectively. Thanks to this infrastructure, dynamic, real-time optimised, selforganising, spread across the entire organisation and inter-organisational value-added chain networks. These networks can optimise themselves according to various criteria such as cost, availability and resource utilisation.

a. Growth: The transition to Industry 4.0, of course, requires significant investments, radical changes and technological advancement. The high level of automation of the industrial processes and the investments required to build intelligent factories promise substantial growth. Because those investing in new technologies in the new technologies are investing to meet the most basic customer expectations. The provision of these investments also means economic and industrial growth for both businesses and countries. According to forecasts, industrial sales with Industry 4.0 will increase by 2-3 per cent annually in the first place. Looking ahead to Germany, which is the pioneer of Industry 4.0, it is estimated that annual turnover increase of 30 billion Euros and the Euro-wide increase of 100 billion Euros. In other words, Industry 4.0 promises to cover up the investment made quickly.
b. Employment: One of the concerns about Industry 4.0 is security, while the other is the loss of work as a result of the widespread use of robotic systems. In fact, it would be enough to look at the period of the Third Industrial Revolution to see if this loss is not realistic. During this revolution, especially automotive automation increased while unemployment did not increase. On the contrary, economic growth with the Third Industrial Revolution led to the emergence of new and innovative business areas, the emergence of new professions (such as the maintenance and repair of automation robots and machines), and increased job opportunities.

   Therefore, it would be sensible to enter the same expectation for Industry 4.0. Every development recorded around the world brings with it a change process. However, in this process of change always new opportunities arise. It is envisaged that Industry 4.0 investments will increase employment in the short term by 6 per cent and in the long run, demand for the qualified workforce, especially in IT and mechatronics, will increase significantly. These expectations are likely to change the expectations of the states or the individual's education system.

c. Investments: According to the results of the research of the PwC research company with 235 companies in Germany, the enterprises plan to allocate 3.3% of their annual production in the next five years to the Industry 4.0 focused projects. It expected that the state support that these projects will receive would contribute to the acceleration of the process. It estimated that the annual amount of investments for Industry 4.0 in Europe would reach 140 billion euros. Of course, the most critical factor in such a complete revolution and transformation process is stated contribution and support.

   The government of Germany is also investing heavily in the industry for Industry 4.0, which is shaped by the contribution of non-profit organisations in the United States, with government support in Finland and China. By 2020, the government promises 40 billion euros every year to the projects of Industry 4.0, creating an attractive innovation environment for private sector enterprises.

d. State: As seen in the German example, one of the most significant tasks in the Industry 4.0 process falls on the states. It is of utmost importance that such great transformations are realized with state support. Governments are accelerating the development of Industry 4.0 strategies and processes through collaborations they have made with universities, industry representatives, non-governmental organisations and think tanks.

   The integration of the identified strategies into various points of the school, especially vocational and technical education, is one of the responsibilities of the states. In particular, the identification of strategies with intense support for R & D work and infrastructure support are highlighted as a responsibility that governments must undertake in the industry's transformation.

e. Universities and Research Organizations: No transformation with social, economic, administrative effects will occur with the incentive of a single group or institution. Universities and research institutes have enormous responsibilities for the transformation of the industry in the context of official strategies.

Industry 4.0 needs to update the training programs of universities in line with the new employment opportunities that they will bring with them. Especially the adoption of multi-disciplinary approaches in the field of science; it is essential to establish new educational programs in the field of mechatronics that bring together electrical, electronic, mechanical engineering and computer science.

At the same time, universities are expected to take an active role in every field, especially in R & D, by following the standards of universities worldwide. In other words, since Industry 4.0 is not only possible to achieve success as an academic or just a commercial venture, the academy-business world-politics triangle must be drawn firmly.

f. Technology Providers: At the heart of Industry 4.0 are advanced technologies, including robotics and mechatronics. Hence, among the steering committees of this revolution are also technology providers in the private and public sectors. Technology providers, who know the technology most closely, are in a very advantageous position to see the future industrial systems. It is therefore vital that they share their views on investment in products and services that will add value to the focus of their R & D work.

Execution of joint projects, business models and awareness-raising activities by technology providers, private sector businesses and industrial plants promises a great future regarding the development of Industry 4.0.

When we take into account the definition and vision of the industry 4.0, we see that the following technological areas have gained importance in the implementation phase;

- Cyber-Physical Systems
- Learning Robots
- The Internet of objects
- Cloud Informatics
- Big Data and Data Analysis
- State and Vertical Integration
- Layered Production
- Virtual Reality

- Cyber Security

Industry

It is, of course, impossible to exclude the industry when talking about an Industrial Revolution. As a stakeholder influencing and influencing the industry 4.0 process, industry organisations need first to analyse customer expectations and advise government agencies, universities and technology providers. In this regard, expectations and targets from Industry 4.0 can be clarified and strategies can be determined in this direction.

It is important to note that one of the essential tasks of the industry is to inform the ecosystems. Revolutions are joint movements. For this reason, the progress of all the stakeholders for Industry 4.0 and the different units or enterprises within the stakeholders will benefit the industry, the countries, and the world in the final analysis.

1.3. INDUSTRY 4.0 IN THE WORLD AND TURKEY

1.3.1. Leader Markets in the World

Many countries that want to have a say in production technology of the future are upgrading their infrastructure and strategies according to Industry 4.0. Countries are preparing the necessary legislation for the smooth process of the integration by using public, academia and the private sector to establish a business partnership between stakeholders to step forward in this process to move forward. Countries that predict that Industry 4.0 will increase productivity on a global scale are also developing collaborations with each other.

Some countries have begun to make pioneering moves and clarify their strategies and create roadmaps. Looking at the current situation of a few countries that make visible breakthroughs in industry 4.0 and analyse the process well can be helpful in seeing the practical implications of Industry 4.0.

a. Germany

Industry 4.0 was first used at the Hannover Fair in 2011. Germany, the name of the process, has been positioned among the leading countries of Industry 4.0 with the contributions of engineering tradition. Plattform Industrie 4.0 was established to coordinate the development of Germany's Industry 4.0 vision. The platform operates under the chairmanship of the German Federal Ministry of Economics and Energy and the German Federal Ministry for Education and Research Senior representatives from the business world, academia and trade unions are involved in the platform's management mechanisms (platform-i40.de, 2018).

Platform developed under the leadership of important associations such as VDMA (German Machinery and Plant Manufacturers Association), ZVEI (German Electricity and Electronics Manufacturers Association) and BITKOM (Federal Information Technology Association) have joined in many later institutes and private organisations of Germany (Duran,2018). Various working groups have been established under the platform which is among the projects accepted by "High Technology Action Plan 2020” These groups are; standardisation, network security, research, education and legal framework.

The platform, which coordinates the formation process of legal legislation, R&D work, sectoral training and reference architects to be developed, enables Germany's Industry 4.0 vision to become evident. Innovative production models are also being investigated in the interdisciplinary environment created by the combination of technology clusters and industry, trade chambers and associations. The results of these studies are transferred to other elements of the platform.

b. United States

It can be safely said that America, which is fed by the potential that the Silicon Valley has, is one of the critical global actors of Industry 4.0. According to McKinsey's "Industry 4.0 Global Expertise Survey 2015", the share of R&D spending on Industry 4.0 is 15% in Germany and 29% in the United States. The share of revenue related to Industry 4.0 in total income also appears to be 19% in Germany while it is 30% in the US.

The NNMI (National Production Innovation Network) program is one of the critical structures that will give life to America's production strategies in the industry 4.0 process. The program, which includes academics, government agencies and the private sector, has been officially misinterpreted in 2014. The functioning of this network; (National Advanced Manufacturing Program Office), which is headquartered within the National Institute of Standards and Technology (NIST) within the US Department of Commerce.

As it stated in Manufacturing USA Annual Report 2016, It is aimed to develop new generation technologies that will make a difference in the production sector in the frame of this roadmap. The program, which aims to facilitate technology transfer between universities and sectoral stakeholders, is working on advanced production models to increase America's competitive power in the global dimension.

c. Japan

Japan, Industry 4.0 deals with the process differently and sets a new vision that emphasises the human factor. This concept, called Society 5.0 (Society 5.0), aims to create a healthy relationship between society and technology. Japan, which wants to contribute to the meaning of Industry 4.0 in the human dimension, Within the framework of the "smart society" strategy, it seems appropriate to comment on the Community 5.0 label.

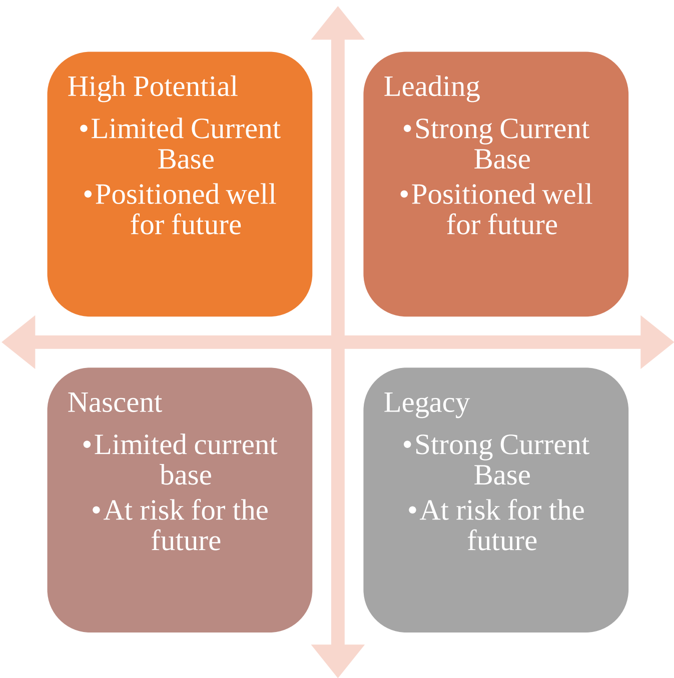
The study by Keidanren, the Japanese Economic Federation, made in 2016 will be a good source for examining Japan's innovative approach. In this work, the efficient integration of digital technologies into the real world and its use for the benefit of society has been particularly emphasised by focusing on environmental sensitivity. The obstacles to be overcome in the name of reaching the aim are also explained under the headings of social prejudices and legal processes.

This strategy, which aims to enable people to live in harmony with technology, will make it easier for them to imagine their future societies. Looking at Industry 4.0 and beyond from a broad perspective, Japan is trying to move its pioneering position in electronics to the next level with Community 5.0.

Even if these three countries act as pioneers, they are not the only ones interested in Industry 4.0. According to the World Economic Forum's Readiness for the Future of Production Report published in 2018 countries have four main approaches to Industry 4.0. That approaches based on drivers of production and structure of production. Drivers of production divided as favourable and unfavourable while the structure of production examined in terms of complexity and simplicity.

In this study made by the World Economic Forum, countries divided into four categories. The categories are; leading, high potential, nascent and legacy. The countries have more advantages regarding drivers, and the structure of production accepted as the leading countries. Countries that have favourable drivers of production but have a simple structure of production are high-potential countries. Nascent countries have a simple structure of production and unfavourable drivers of production, and they accepted in risk categories. Countries that have a large structure of production but have unfavourable drivers of production categorised as legacy countries. Country archetypes shown at the Figure 4.

Figure 4 Country Archetypes

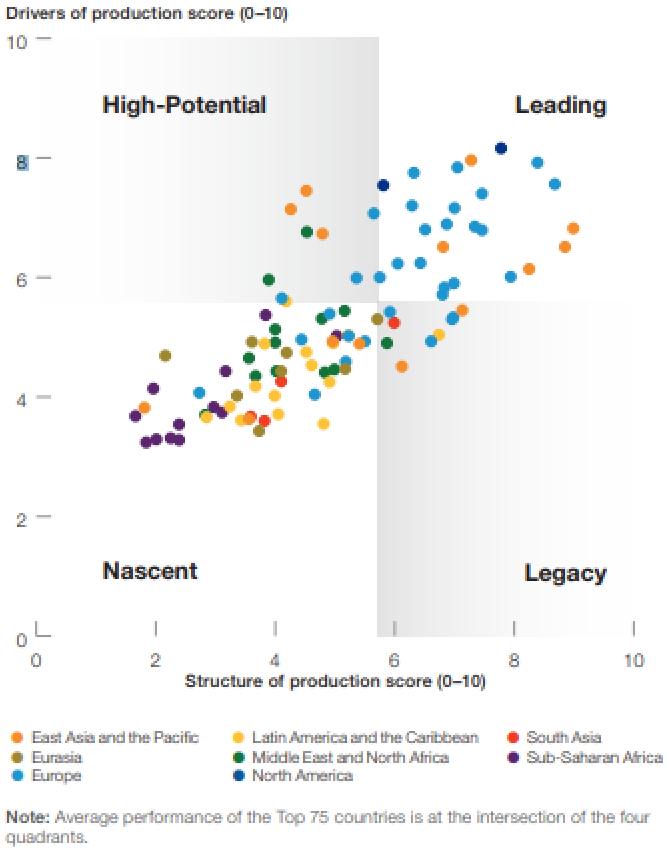


Source: World Economic Forum, 2018

According to Figure 4, the most advantageous countries are leading countries, and they will get most of the benefit from Industry 4.0 in the future. Nascent countries are least benefit getters in this situation, and they must change both their production structures and drivers of production.

In the current situation, nascent countries are representing majority while high potential countries have lowest amount. Results and distribution of study is shown at the Figure 5.

Figure 5 Global Map of Readiness Assessment Results 2018



Source: World Economic Forum, 2018

World Economic Forum's Readiness for the Future of Production Report study made on 100 countries all around the world, and as a result, 58 of the participant countries are nascent, 25 of them are leading, 10 of them are legacy, and 7 of them are high-potential. The most flourishing country regarding criteria of the study which includes several different aspects is the United States of America while Cameroon comes last. According to study first and last countries are shown Table 2.

Table 2 Readiness to Industry 4.0 Country List

Leading	High Potential	Legacy	Nascent
Austria	Australia	Hungary	Albania
Belgium	Hong Kong SAR	India	Algeria
Canada	New Zealand	Lithuania	Argentina
China	Norway	Mexico	Armenia
Czech Republic	Portugal	Philippines	Azerbaijan
Denmark	Qatar	Romania	Bahrain
Estonia	United Arab Emirates	Russian Federation	Bangladesh
Finland		Slovak Republic	Bosnia and Herzegovina
France		Thailand	Botswana
Germany		Turkey	Brazil
Ireland			Bulgaria
Israel			Cambodia
Italy			Cameroon
Japan			Chile
Korea, Rep.			Colombia
Malaysia			Costa Rica
Netherlands			Croatia
Poland			Cyprus
Singapore			Dominican Republic
Slovenia			Ecuador
Spain			Egypt
Sweden			El Salvador
Switzerland			Ethiopia
United Kingdom			Georgia
United States			Ghana
			Greece
			Guatemala
			Honduras
			Indonesia
			Jordan
			Kazakhstan
			Kenya
			Kuwait
			Kyrgyz Republic
			Latvia
			Lebanon
			Mauritius
			Moldova
			Mongolia
			Morocco
			Nigeria
			Oman
			Pakistan
			Panama
			Paraguay
			Peru
			Saudi Arabia
			Senegal
			Serbia
			South Africa
			Sri Lanka
			Tanzania
			Tunisia
			Uganda
			Ukraine
			Uruguay
			Vietnam
			Zambia

Source: World Economic Forum, 2018

1.3.2. Turkey and Industry 4.0

In the study made by World Economic Forum to pinpoint readiness levels of countries to Industry 4.0, there are two main criteria for Industry 4.0 readiness. One of the criteria is drivers of production that consists of technology and innovation, human capital, global trade and investment, institutional framework, sustainable resources, and demand environment. Another one is the structure of production, and it includes complexity and scale. Turkey's scores about these criteria shown at the Table 3.

Table 3 Turkey's Ratings (1-10)

Drivers of Production	**4.9**
Technology & Innovation	4.2
Human Capital	4.5
Global Trade & Investment	5.1
Institutional Framework	4.8
Sustainable Resources	6.3
Demand Environment	5.8
Structure of Production	**5.9**
Complexity	5.9
Scale	5.8

Source: World Economic Forum,2018

According to table 3 in terms of drivers of production Turkey's rankings are 54th, 72nd, 57th, 64th, 51st, and 26th respectively. That shows Turkey is relatively strong in demand environment, mediocre in drivers of production, human capital, and sustainable resources, while performs lousily in technology and innovation, and institutional framework.

On the other hand, Turkey ranked as 42nd and 18th regarding complexity and scale. It shows that Turkey has the capability of producing at a larger scale and in the right place in the world while the range of product types are limited.

Turkey's Industry 4.0 approach focused on increasing competitiveness in production with sustainability, regarding added value it refers to products and services that generate higher revenue. When industry 4.0 established, an efficiency increase of will be provided in the manufacturing sector in Turkey and it is estimated around 4% to 7%. Again, if adapting to the industry 4.0, the livelihoods and increased competition in the economy are expected to provide about 3% growth in industrial production. Similarly, to achieve the transition to industry 4.0, producers in the next ten years need to invest 10-15 billion TL, equivalent to 1-1.5% of their income (Şuman, 2017).

In order to inform the public about Industry 4.0, Turkey established Industry 4.0 platform that includes some pioneer firms such as Scheer, Atos, İnci Holding, Arçelik etc. Siemens is the sponsor of the mentioned platform. The platform explores, discusses, brings to the country agenda the following topics, and shares the readers with their supporters:

- Latest manufacturing technologies, and industrial R&D activities, 4.0 concepts to be integrated with the industry and analyses Turkey's situation
- Industry 4.0 vision and roadmap
- Recognize difficulties in implementing Industry 4.0, managerial, technological / IT and organizational problems
- Recent developments in manufacturing technology
- Identification of strategic focus of firms and redesign of business models
- Different events about Industry 4.0 such as seminars, fairs and conferences, and training programs
- Identification of problems and solutions for transition to industry 4.0
- Separate and specific application recommendations for each production sector
- Integration of training systems in the Industry 4.0 concept
- Industry 4.0 in the written, visual and digital media (industry40.com)

Ali Rıza Ersoy from Siemens stated in an interview he made with industry40.com, Turkey was already interested with technological advancements before Industry 4.0. As an example of this, Vestel established group of engineers that specifically focuses on R&D processes in their company. Another point Ersoy emphasizes is Turkey is only four years behind of Germany in terms of collectivistic

Industry 4.0 efforts. However, in order to reach or maybe surpass Germany in this topic, raising awareness is a must.

Some of the applications are started to give results or on their way to increase awareness. For example, Burdur Chamber of Commerce started to give pieces of training related to Industry 4.0, the first autonomous truck was produced with 1500 R & D employees in Ford Otosan in Gebze, the Industry 4.0 laboratory was established in Kocaeli Municipality, the start of robot production in Arçelik developments are proof that we are not too far behind Industry 4.0 (Yüzak, 2016).

Turkey in the last 20 years, the world's manufacturing base its strategy of leading companies, industry 4.0 path is one of the major threats facing Turkish economy. With Industry 4.0, people's participation in the production process will be reduced and it will provide an advantage for Turkey because Turkish population shifts from young dominated population to elder dominated population. Producing goods in Turkey for developed countries, it will become costlier to produce than their own country if Turkey did not participate Industry 4.0. Therefore, Turkey is required to capture the industry trend in absolute terms. Specifically, technology breakthroughs will be made in Turkey will increase the growth rate.

CHAPTER TWO

GENERAL OVERVIEW OF LOGISTICS

2. GENERAL OVERVIEW OF LOGISTICS

2.1. DEFINITION OF LOGISTICS

The history of the logistics based on many rumours, so it has been defined in many ways by some organisations and individuals. According to Collin's dictionary this word comes from the word "logistikos", which means an arithmetic association for any reason capable of doing calculations in Greek sources. Later on, this word began to use as a Latin "logisticus" in languages spoken in Europe. In 1840, the word "logistique" came to mean the uniting and coordination of transport modes by the French Academy.

Logistics definition evolved throughout time. As cited in Lummus (2001) one of the earliest definitions of logistics is made by Simpson and Weiner in 1898 as "Strategy is the art of handling troops in the theatre of war; tactics that of handling them on the battle field of the battle … The French have a third process, which they call logistics, the art of moving and quartering troops." From this definition it can be concluded that logistics first aim was transportation. Again Lummus (2001) stated that in another study of same authors in 1947 It was stated that "The Americans use the word logistics to describe the technique of packing stores … It is derived from the French maitre du logie." From this definition adding warehouse feature to logistics is happened. Logistics was focus point at the both World Wars and it was an important asset for military.

In 1971 Luttwak defined logistics as "… all the activities and methods connected with the supply of armed force organization including storage requirements, transport and distribution. Since in modern conditions a wide range of equipment and supplies are employed in widely varied "mixes", logistics involves a great deal of planning and calculation as well as physical activities. The aim is to provide each echelon of the armed force organization with the optimum quantity of each supply item, in order to both minimize stocking (which restricts mobility and causes diseconomies) and shortage of essential equipment." Luttwak's definition signals that the modern logistics has its roots from those times

With the improvements in the logistics, there was a need for the council. In 1957, American Production and Inventory Control society is formed by 20 American companies. This council now known as APICS (The Association for Operations Management) and according to their website registrations now has more than 45,000 members and shows activity over100 countries in the world. The establishment of the council has contributed to the enrichment of the logistics knowledge and has led to a progress in the sector.

One of the definitions of council is made by Cox et al. in 1998 and the definition is "In industrial context, the art and science of obtaining, producing, and distributing material and product in the proper place and proper quantities. In a military sense (where it has greater usage), its meaning can also include movement of personnel."

The APICS Dictionary, 13th edition defining supply chain management instead of logistics and their definition is "the design, planning, execution, control, and monitoring of supply chain activities with the objective of creating net value, building a competitive infrastructure, leveraging worldwide logistics, synchronizing supply with demand, and measuring performance globally".

2.1.1. Principles and Functions of Logistics

In logistics activities, some principles are generally the same in the military field and the production sector. These principles are used as a guide in the realisation and planning of logistics services. The logistics principles are examined by MEB (2011) under eight headings. These are;

I. Standardization: Logistics services to be used in supported systems should be standard. It is essential to catch international standards in standard services, materials, procedures and applications. Containers, handling elements, railways, information technology, etc. standardisation of necessary logistics elements helps firms to capture competition in the globalisation process. The targets such as standardisation, joint work, manageability should be primary targets.

ii. Being Affordable: In today's global economy, resources are diminishing, and demand is increasing and need are becoming more diversified. The economic principle is that the cost-resource balance should be well-adjusted with the least expenditure. Firms will save both time and money when they are sensitive to priorities and allocation of resources.

iii. Sufficiency: In the principle of sufficiency, non-plan costs should be avoided from affordability and sustainability instead of the excess value of the excess stock.

iv. Elasticity: Logistics organisations should be structured in such a way as to fit well with today's consumer behaviour, tasks, concepts and concepts.

v. Simplicity: Firms should avoid complicated occurrences in both practice and planning and should be based on sustainability in all departments. Simplicity improves the efficiency and makes it easier to access information.

vi. Traceability: It is necessary for the early detection and resolution of possible problems that can be monitored in real time by real-time monitoring of the amounts, situations, production times and locations of products used in all departments with the help of information technology and electronic systems.

vii. Coordination: The provision of logistic support activities depends on the coordination of all the units in the logistics. The coordination between logistics performers and planners and customers must.

viii. Planning: The aim in logistics is to determine the difference between the plans and applications in the processes and make improvements in the process.

The information given in the definition of logistics indicates that logistics is a multitude of functions. There are two different functions of the logistics as primary and auxiliary functions:

- **Basic function**
    - Production Planning
    - Material and inventory management,
    - Purchasing,
    - Customer service,
    - Storage and handling,
    - Distribution and transportation
- **Auxiliary functions**
    - Packaging
    - Order processing, handling
    - Knowledge management
    - Demand forecasting/planning
    - After-sales service
    - Factory/warehouse location selection
    - Purchasing, customs clearance
    - Waste parts management

2.1.2. Logistics from Historical Perspective

As it is defined before, logistics started to gain its importance with military, but this does not mean logistics started with military. In ancient times, there were a requirement for containing and transporting local food supply, tools that are both used for harvesting, collecting food and for other purposes. Therefore, it can be concluded that logistics is a necessity that comes with human being.

Logistics as an absolutely necessary component in the development of human society has been fully proven since ancient times and as an example is the period of

2700 BC which can be considered a turning point in the development of logistics, handling technologies for materials and last but not least the building systems that were used to build pyramids. Shaped stone blocks well thought and weighing tens of tonnes they were prepared on several sites, then transported and assembled on the site dedicated to construction (Cuturela, 2013). A small example related to pyramids supports that logistics was always in the picture for humans and has its own importance through time whether it's called logistics or not.

Before the 1950s, logistics was thought of in military terms. It had to do with procurement, maintenance, and transportation of military facilities, materiel, and personnel (Ballou, 2007). All these military aspects of logistics caused emergence of business logistics. The reason lies behind the examining military first is earliest work concerning logistics originated in military writings. Tzu (1983) specifically identifies various types of supply and/or logistics depending on specific translation in approximately 500 BC.

In military, logistics was a base for planning before the beginning of war times. It basically took relevant decisions regarding supplies, support factors, and speed based on aim of operations and capacities. Logistics was important because it was perceived as a source of power for armies and Taylor (2008) quoted that Frederick II of Prussia write in 1747 at Instruction for his General "Without supplies, no army is brave".

Military examples are crucial to understand roots of business logistics because business logistics is spin-off from military logistics. Examples from Alexander the Great, Romans, World War I and II are examined. According to Shutherland (2008) Logistics especially before the heavily technologized wars were a decision mechanism about winners of the war.

Alexander the Great and his father recognized importance of logistics in winning a war in terms of providing solutions to limited mobility of their sources and used logistics to exploit enemies' weaknesses to have the upper hand in the war. Alexander the Great noticed how using additional tools to carry supplies of soldier such as weapons and armours slowed down the army and made soldiers to carry their own supplies. Alexander also made extensive use of shipping, with a reasonable sized merchant ship able to carry around 400 tons, while a horse could carry 200 Lbs (but needed to eat 20 Lbs of fodder a day, thus consuming its own load every 10 days) (Sutherland, 2008).

World War I was an exceptional situation for the world and it was something no one ever faced before. There were two major problems about logistics in the World War I one of them was the underestimated supply numbers and other one was the size of the war area. World War I was a milestone for military logistics. It was no longer true to say that supply was easier when armies kept on the move due to the fact that when they stopped they consumed the food, fuel, and fodder needed by the army (Sutherland, 2008). However, with the scope of war the situation was reversed and it became harder and harder to supply troops in the move. Before the world shake of the effects of World War I, World War II has started. It was a testing stage for the world in terms of logistics. Petroleum access was one of the main factors that shaped the war because every supply transportation based on petroleum usage such as railroad, motorized components etc.

In this environment business logistics also started to improve. Logistics, then known as physical distribution, first appeared in the academic literature in the early 1900s. Only a few articles discuss the history of logistics thought and/or practice. At the beginning business logistics were only based on transportation and it was not perceived as an important part of business because of the abundant resources and demand that came after the WWII. During the 1950s, transportation was the emphasis. Several university programs offered transportation majors. However, the topics of logistics, physical distribution, physical supply, and supply chain management were not included in these programs (Southern, 2011). In this era, calculation required in logistics were especially difficult because there was no electronic equipment that is useful in logistics. Another obstacle in improvement of logistics was the influence of governmental constitutions. For example, in USA federal government only decided to promulgate Federal-Aid Highway system in 1956. One of the improvements logistics business was the book of “Economics of Transportation” written by D. Philip Locklin in 1954 and it was one of the first textbooks for academic literature of logistics.

In 1960s, demand slowed, competition increased and companies realized that have to cut costs. Logistics cost were high in that time and heavily regulated in countries like USA. For example, in USA logistics cost approximately accounted for %15 of GDP, in UK it was around %16, in Japan %26.5, in China %24, and in Australia around %24. On an individual firm level, they could be as high as 32 percent of sales (LaLonde and Zinzer, 1976). With the understanding of how highly logistics cost can, companies started to focus on physical distribution processes from outbound logistics activities. Physical distribution was already a part of marketing which is an essential business activity at that time and it was the main cost generator for the firms. Almost two of third of costs generated by physical distribution. After the focus on outbound activities, companies realized their inbound activities are almost as important as outbound activities. In that time one of the definitions of logistics were made by Smykay in 1961 as "Physical distribution can be broadly defined as that area of business management responsible for the movement of raw materials and finished products and the development of movement systems."

In 1970s, emphasis was on physical supply and deregulation of logistics. Inbound side of logistics started to gain importance in this era and physical distribution (outbound logistics) and physical supply (inbound logistics) were combined. In 1970s, governments were also started to support logistics activities. For example, in USA government established railroad transportation firm (AMRAK) to improve transportation and other deregulatory rules were applied.

The term physical distribution began to be phased out during the 1980s, and the term logistics emphasized. As an example, James C. Johnson and Donald F. Wood changed the name of their textbook Contemporary Physical Distribution to Contemporary Physical Distribution and Logistics (Johnson and Wood 1982). The NCPDM changed its name to the Council of Logistics Management (CLM) in 1985 (Southern, 2011).

1990s was a game changer era for business including logistics due to emergence of electronics and internet systems. With the electronics and internet systems globalization is also increased which affects demand for logistics. Another important change for the 90s was the increase in third part logistics companies. After the middle of 90s, supply chain emphasized more and more.

Supply chain was the main concept for 2000s, medium and small enterprises also started to focus on supply chain. The CSCMP defines supply chain management as follows: “Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities” (CSCMP 2010).

2.2. LOGISTICS SECTOR IN WORLD

Logistics sector is expressed as a locomotive in the development of countries. Since it is difficult to calculate the size of the sector because it covers many activities, it is thought that the world logistics market reached 5 trillion dollars in 2006. The logistics sector is among the fastest growing sectors with annual growth rates of 7-9% in Europe, 15% in North America and 20% in Asia. Leading countries in the logistics sector are USA, UK, Japan, Netherlands, Germany, France, Hungary and Bulgaria. More than 50% of the world's logistics market, outside of the US and Europe, cities such as Hong Kong and Dubai have recently been trying to become logistics bases. Asia-Pacific, Eastern Europe, Russia and the Middle East will be the regions to be increased in the future (PricewaterhouseCoopers, 2010).

Developments in the logistics sector and global scale transportation are gaining more importance in the rapidly developing world as it is in our country. When examined by industry, the logistics sector contains many areas closely related to each other, and real and clear statistical information cannot be obtained because it is in the service sector structure.

MÜSİAD report states that since 2011 the transportation sector in the world has grown by 7% every year. It is also stated that the same report logistics sector created 1.1 million new jobs between 2013 and 2016. MÜSİAD's information based on the World Bank on modes of transport includes the following statements: "The global value of today's air transport industry is measured at 70 billion dollars. Between 2008 and 2013, the air transport sector created an additional value of 4.6%. Asian air transport increased by 6.5%. 42% of transportation is between Europe and

North America. The global value of sea transport is $ 54 billion. Maritime transport operations do 80% of the world's trade. According to the economic crisis, shipbuilding companies in the top 20 between 2008 and 2013 lost $ 6.5 billion. The global value of the road transport industry is $ 2 trillion. Land transports carry 8 billion tons/year of material transport every year. Modern economies prefer 85% of land transportation at distances less than 150 km. Land transport in Eastern Europe is steadily rising. The size of the world logistics market is over $ 5 trillion in 2016, and at least 25 percent of the value of every $ 1 produced on earth is devoted to logistics activities. The size of the EU market is about 627 billion euros. Changes in these rates are summarized at the Table 4.

Table 4 World Transportation Rates

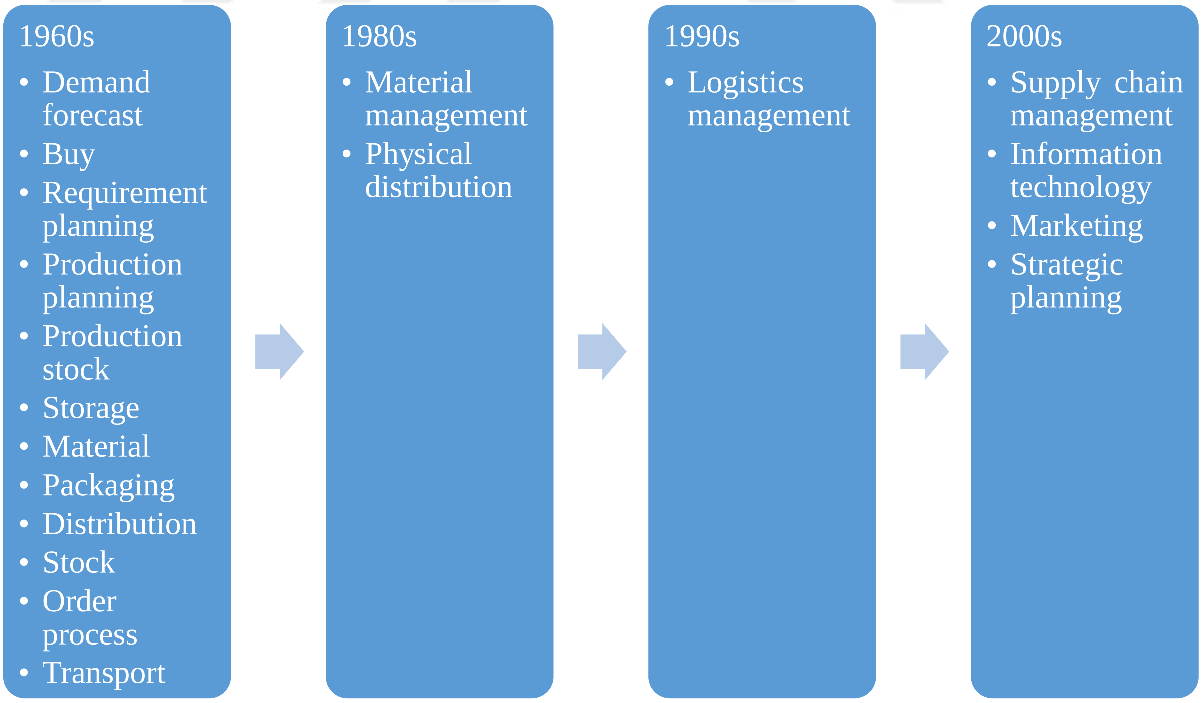
Years	**World Transportation Rates (Every type of transportation)**	**Change**
2008	10,86	-
2009	9,56	-12%
2010	10,82	13%
2011	11,54	7%
2012	11,83	3%
2013	12,19	3%
2014	12,58	3%
2015	12,88	3%
2016	13,18	4%
2017(*)	13,55	3%
* Expected value		

Source: Clarkson Research Jan,2017

World freight transport was 10.86 billion tons in 2008, compared to 13.18 billion tons in 2016. The forecast for 2017 is 13.55 billion tons. 3.7% of the freight transport in the EU is made up of inland waterways, 11.2% by rail, 37.8% from ships and 47.3% from trucks. It is estimated that by 2050 these costs will increase by around 50%. Within the EU it is generally estimated that freight transport will increase slightly by 4% in 2030 and 80% in 2050 compared to 2005. In addition, it is stated that the passenger traffic will grow slightly less than the load traffic (34% by 2030, 51% by 2050). It is predicted that this situation will cause clogging, especially in cities. The estimated cost of congestion in 2050 is 200 billion euros. The infrastructure requirement of the EU for 2010-2030 is 1.5 trillion Euros.

The geographical regions that are rising in the logistics market and will grow in the years to come to the forefront are; Asia-Pacific, Latin America, Africa-Middle East and Eastern Europe. From the perspective of our country is the fact that Turkey is located at the intersection of three continents due to present its strategic location, the logistics industry in the future of our shows will have a significant share in the market of this region. Historical changes seen in the logistics sector is summarized at the Figure 6.

Figure 6 Evolution of Logistics



Source: Hesse, Rodrigue, 2004

2.2.1. Logistics Sector in Turkey

Improvement in logistics depends on countries capabilities and opportunities. While some countries have more advantages than others about things that are crucial for logistics improvement. In logistics, area examination is based on geographical, physical, and institutional infrastructures.

Logistics is a relatively new concept for Turkey. Improvements in logistics started with import and exports, then continue to improve with large scaled wholesaling (super and hyper markets) and e-commerce. Like all around the world Turkish logistics sector going through three main phases. These phases are military term, business logistics, and modern logistics. Modern logistics includes;

1. Managerial logistics: Supply management, logistics management
2. Operational logistics: Material management, production and operation management, distribution management (Erkan, 2014; Tutar,2009)

Turkey has aim for 500 billion dollars export goal for 2023 and logistics is important aspect to reach this goal. Turkey's logistics potential comes from its geographical place because the country is a connector between Europe and Asia as well as close location to Black Sea.

Turkey started to integrate the logistics sector in 1980s and 1990s. In this era, investments are made for air, railroad, road, sea and intermodal transportation and these investments created infrastructure for Turkey. In 1990s investments are increased and in 2000s Turkey's logistics sector become a dynamic sector that shows activity globally.

Turkish companies started to create their own logistics departments and the departments are more active in warehousing and transportation. Information technology applications for logistics are still weak in Turkey therefore other aspects of logistics did not improved as much as warehousing and transportation. Turkish logistics sector is heterogeneous and differ from each other in terms of capital, revenue, turnover, perspective, work values, principles and organizational culture. Most basic categorization for Turkish logistics companies can be done like that:

1. More specialized small firms that are working traditionally and away from modern work values. These companies earn their revenues from more daily and spontaneous works and their main focus on turnover and revenue. They do not have permanent policies, values, and marketing strategies.
2. SME’s are also showing activity in logistics. SME’s characteristics in logistics are their domestic capital, takes its roots from market information, while being local they also try to act like a global company. Organizational values of SME’s are based on company growth. While they are working for their company growth they are also working for the market growth.
3. Big firms that are showing activity under holdings which has a chance for growth and improvement. They can either have a national or international partner. These firms are more modern in terms of organizational values and their aim is being a well-known brand in the sector.
4. Turkey Branch of international companies are also in the Turkish logistics sector. They are using advantage of being a global firm in order to establish trust and service quality. Their motivation is to use local market advantages while improving conditions of local market by using their experience.
5. There are also companies that originated from cargo companies and establish a logistics company with the same name. They are using the advantage of their already created cargo transportation lines. Their aim is to become a market leader, help the market growth with the new projects, gain interest with new projects and products, create a sustainable differentiation by using new investments and trainings. These types of firms are important for Turkish market because they even earn global rewards in their sectors.

Even though Turkish originated companies are showing activity there is also an increasing trend for branches of global companies. Turkish logistics market takes its power from academics, fairs and global trainings. Human force of logistics is improved with the logistics education in universities. Software is also important for logistics and Turkish companies tend to create their own software to offer information of their customers. Focus of software is on RF and satellite information lines. By using them companies offering information about drivers, transportation, distance and cost. Customers and suppliers of customers are using online places to get information from logistics companies.

To see Turkey as a bridge between East and West because of its geographical position causes play a critical role in the logistics sector in Turkey. When we consider the industry as storage and freight-passenger transportation to be able to examine the logistics sector, according to TURKSTAT data, it is seen that the industry was 101.7 billion dollars in 2013 and this figure is 12.3% in national income. In 2014, this ratio increased to 12% (TL 210 billion). When the development of the sector between 1998 and 2014 examined, it is seen that it constitutes 11.3% of the average share in GDP (MÜSİAD, 2015). In 2016, the logistics and warehousing segment was realized at TL 250 billion (İş Bank, 2017).

Today, in developed countries GDP logistics activities while spending approximately equivalent to 1,5-2's% in developing countries, this ratio ranged between 0.2-0.5% In Turkey, this ratio is around 0.3 %. The logistics investment share of the country's stock in total annual investment in developed countries in developing countries realised that this ratio between 15-40% 2-5%, and 3% in Turkey (MUSIAD, 2015).

Analysing data transport in Turkey "Tonne-Km value between 2003 and 2015, 61% Vehicle-Km value of 116%, while the value Passenger Kilometres increased by 77%. In 2014, roads and passengers transported 103 billion vehicles x km, 234 billion tons x km and 276 billion passengers x km; In the year 2015, 113 billion vehicles, which are used by highways, reached 244 billion tons x km and 291 billion passengers x km in cargo and passenger transportation. These values are expected to reach 365 billion tons x km and 378 billion passengers x km in 2023. Moreover, when the year 2016 goods export (2015-2016) data is examined, the total number of international and domestic transportation companies is 489,206, and the total number of vehicles is 1,209,170 "(UDH, 2016).

Turkey's import data from 2010-2017 in August by the route are given in the Table 5.

Table 5 Turkey's Import Data (Thousand USD)

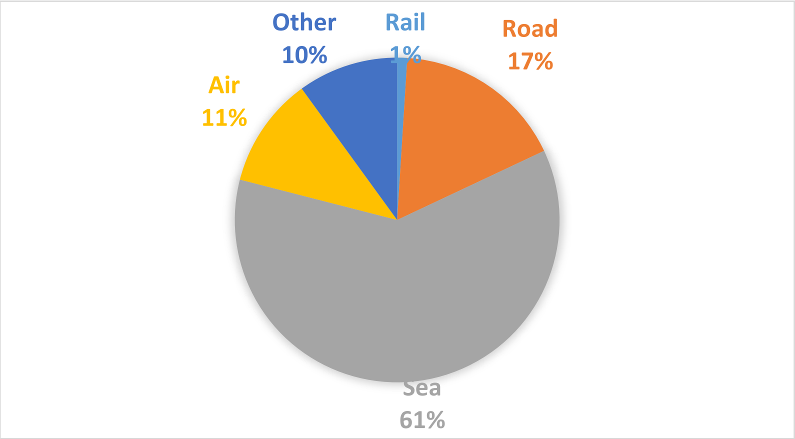
Year	Total	Sea	Rail	Road	Air	Other
2010	185 544 332	98 629 933	2 454 604	42 442 194	15 131 613	26 885 987
2011	240 841 676	133 440 206	3 185 525	44 516 802	21 514 596	38 184 548
2012	236 545 141	129 029 330	2 346 113	39 414 333	23 797 146	41 958 219
2013	251 661 250	139 927 201	1 773 400	40 058 217	32 602 866	37 299 565
2014	242 177 117	141 381 287	1 206 626	37 300 980	24 696 997	37 591 227
2015	207 234 359	124 439 886	1 169 581	34 364 154	20 002 844	27 257 894
2016	198 618 235	120 376 825	1 428 154	34 306 874	22 969 452	19 536 930
2017*	148 979 421	86 193 944	758 825	23 726 227	22 679 333	15 621 092

Source: Tuik,2017

*January – August

According to this, while the import value of all roads was 185 544 332 thousand dollars in August 2010, this figure was 251 661 250 thousand dollars in 2013, 198 61 618 235 thousand dollars in 2016 and 148 979 421 thousand dollars in the first eight months of 2017. The distribution of the year 2016 according to the roads is more clearly shown in the Figure 7.

Figure 7 Import Distributions



Source: Tuik, 2017

When the graph is analysed it is seen that sea made 61% of the imports in 1986 618 235 thousand dollars in 2016, 17% highway, 11% airway, 10% other and 1% railway.

Turkey’s exports values and chances in time are shown on Table 6.

Table 6 Turkey's Export Values

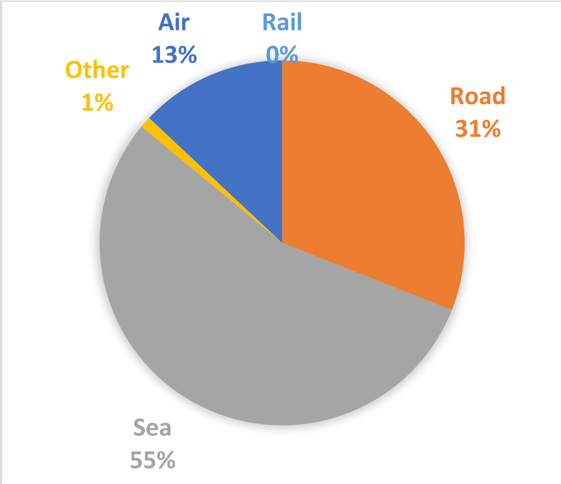
Year	Total	Sea	Rail	Road	Air	Other
2010	113 883 219	57 784 065	990 802	45 948 708	7 684 769	1 474 875
2011	134 906 869	73 576 384	1 242 610	50 257 713	8 577 891	1 252 272
2012	152 461 737	77 983 403	1 017 753	50 440 156	21 781 595	1 238 830
2013	151 802 637	82 930 885	956 521	53 674 535	12 960 697	1 279 999
2014	157 610 158	86 304 496	922 776	55 270 960	14 103 312	1 008 613
2015	143 838 871	78 036 876	806 721	46 708 755	17 275 523	1 010 997
2016	142 529 584	78 400 026	641 121	44 754 542	17 747 063	986 832
2017*	103 323 340	58 799 501	459 681	30 072 624	12 295 747	1 695 787

*January – August

Source: Tuik,2017

When the 2010-2017 August export data according to Turkey's road surveyed in 2010 113 883 219, while a thousand dollars in the year 2014 157 610 158 thousand dollars in 2016 is 142 529 584 thousand dollars in 2017 in the first eight months of the 103 has been shown to 323 340 thousand dollars. The distribution of exports according to the routes of the year 2016 is more clearly seen in the Figure 8 below.

Figure 8 Export Distributions



Source: Tuik, 2017

According to Figure 8, it is seen that sea makes 55% of the exports in 1426 529 584 thousand dollars realized in 2016, 31% by road, 13% by air, 1% by other and 0,45% rail.

The Logistic Performance Index is ranks 160 countries on the world in terms of logistics services quality. KPI's for the research are;

- The efficiency of customs and border management clearance ("Customs").
- The quality of trade and transport infrastructure (Infrastructure").
- The ease of arranging competitively priced shipments ("Ease of arranging shipments").
- The competence and quality of logistics services—trucking, forwarding, and customs brokerage ("Quality of logistics services").
- The ability to track and trace consignments ("Tracking and tracing").
- The frequency with which shipments reach consignees within scheduled or expected delivery times ("Timeliness"). (lpi.worlbank.org, 2016).

The Logistic Performance Index (LPI) table for the years 2010, 2012, 2014 and 2016 according to the Logistics Performance Index (LPI) made in 2007 by the World Bank to measure countries' performance in the logistics field is given at Table 7.

Table 7 LPI Index

2010 LPI			2012 LPI			2014 LPI			2016 LPI		
Rank	**Country**	**Point**	**Rank**	**Country**	**Point**	**Rank**	**Country**	**Point**	**Rank**	**Country**	**Point**
1	Singapore	4,13	1	Germany	4,11	1	Germany	4,12	1	Germany	4,23
2	Hong Kong	4,12	2	Singapore	4,09	2	The Netherlands	4,05	2	Luxembourg	4,22
3	Finland	4,05	3	Sweden	4,08	3	Belgium	4,04	3	Sweden	4,2
4	Germany	4,03	4	The Netherlands	4,07	4	England	4,01	4	The Netherlands	4,19
5	The Netherlands	4,02	5	Luxembourg	3,98	5	Singapore	4	5	Singapore	4,14
6	Denmark	4,02	6	Sweden	3,97	6	Sweden	3,96	6	Belgium	4,11
7	Belgium	3,98	7	Japan	3,97	7	Norway	3,96	7	Austria	4,11
8	Japan	3,93	8	England	3,95	8	Luxembourg	3,95	8	England	4,07
9	USA	3,93	9	Belgium	3,94	9	USA	3,92	9	Hong Kong	4,07
10	England	3,9	10	Norway	3,93	10	Japan	3,91	10	USA	3,99
39	Turkey	3,22	27	Turkey	3,51	30	Turkey	3,5	34	Turkey	3,42
155	Burundi	1,61	155	Somalia	1,34	160	Somalia	1,77	160	Syria	1,6

Source: lpi.worldbank.com, 2016

Turkey, meanwhile, # 39 in 2010 (3.22 points) while the # 27 in 2012 (3.51 points), in #30 in 2014 (3.50 points) and # 34 in the 2016 (3.42 points) found its place. The scores of the sub-criteria that make up our LPI score for our 2014 and 2016 countries are given in the Table

Table 8 Turkey's LPI Performance

	2014		2016	
Indicator	Ranking	Point	Ranking	Point
Customs	34	3,23	36	3,18
Infrastructure	27	3,53	31	3,49
Ease of arranging shipments	48	3,18	35	3,41
Quality of logistics services	22	3,64	36	3,31
Tracking and tracing	19	3,77	43	3,39
Timeliness	41	3,68	40	3,75

Source: lpi.worldbank.com, 2016

2.3. LOGISTICS AND INDUSTRY 4.0

Industry 4.0 will change almost every aspect of business including logistics activities. In logistics main changes will be on resource planning, warehouse management systems, transportation management systems, intelligent transportation systems, information security.

Resource planning will be based on CPS because CPS's features are based on improving flexibility, productivity and agility. Therefore, simulations based on showing how to plan resources will be changed trough more clear estimations about people, sources, and equipment.

Especially, the introduction of 'smart' management throughout the proper adoption and implementation of Warehouse Management Systems (WMS) which will transform the warehouse activities into the future requirements of the inbound logistics according to the Industry 4.0 paradigm. Especially, the introduction of 'smart' management throughout the proper adoption and implementation of Warehouse Management Systems (WMS) which will transform the warehouse activities into the future requirements of the inbound logistics according to the Industry 4.0 paradigm (Barreto, Amaral, Pereira, 2017). WMS will be more autonomous and less dependent on human factor. It will increase efficiency of warehouse activities because in current systems WMS is based on humans and it increases possibility of mistake.

Transportation management system controls communication between order management systems and distribution centre. Therefore, it is a crucial part of logistic activities. With industry 4.0, real time information flow will be more important, and it will lead to intelligent transportation systems. Intelligent Transportation System (ITS) is a novel field that interoperates in different fields of transportation systems such as transportation management, control, infrastructure, operations, policies and control methods. ITS adopts new technologies like computing hardware, positioning system, sensor technologies, telecommunications, data processing, virtual operation and planning techniques (Barreto, Amaral, Pereira, 2017).

Basically, with Logistics 4.0 blue-collar workers and some of the white-collar workers will change with the automation such as automated warehouses, packaging, material handling, loading of vehicles. One of the most important possibilities for the logistics is the automated drivers. Road transportation still is one of the most common ways for the transport. However, problems that come with drivers is still an important issue for current logistics environment. There are several vital limiters for the driver both legally and humanistic. For example, drivers cannot drive more than legally limited hours and they also have basic needs such as sleeping, eating, etc. This causes a downward trend for the lead time. With the Industry 4.0, automated drivers will have the ability to drive non-stop, and this will reduce transportation time.

CHAPTER THREE

METHODOLOGY AND FINDINGS

3. METHODOLOGY AND FINDINGS

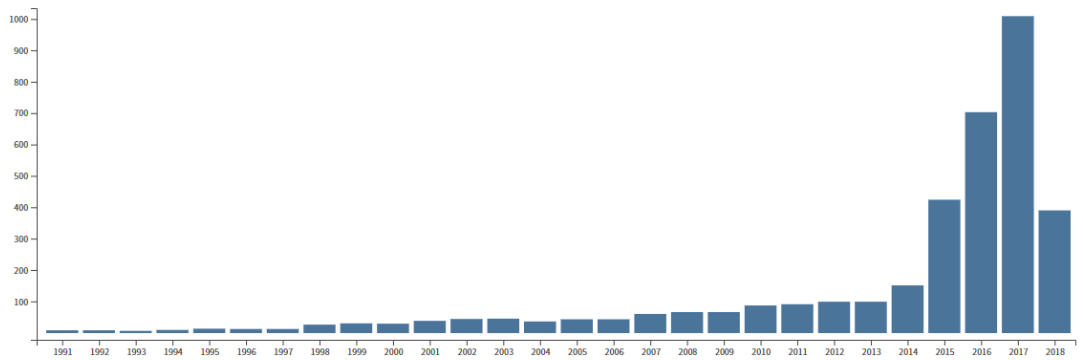
This study is an exploratory research that aims to shed light into industry 4.0 application areas and methods in the logistics sector.

3.1. DESIGN OF STUDY

3.1.1. Purpose of the Study

Industry 4.0 is a relatively new concept that is still in the development phase. Therefore, effects of Industry 4.0 are unknown and will be uncovered through time. Studies about Industry 4.0 is also limited in number but has an increasing trend. Total publications with the keyword of Industry 4.0 shows 3647 results in the web of science. Year distribution of the publications are shown at Figure 9.

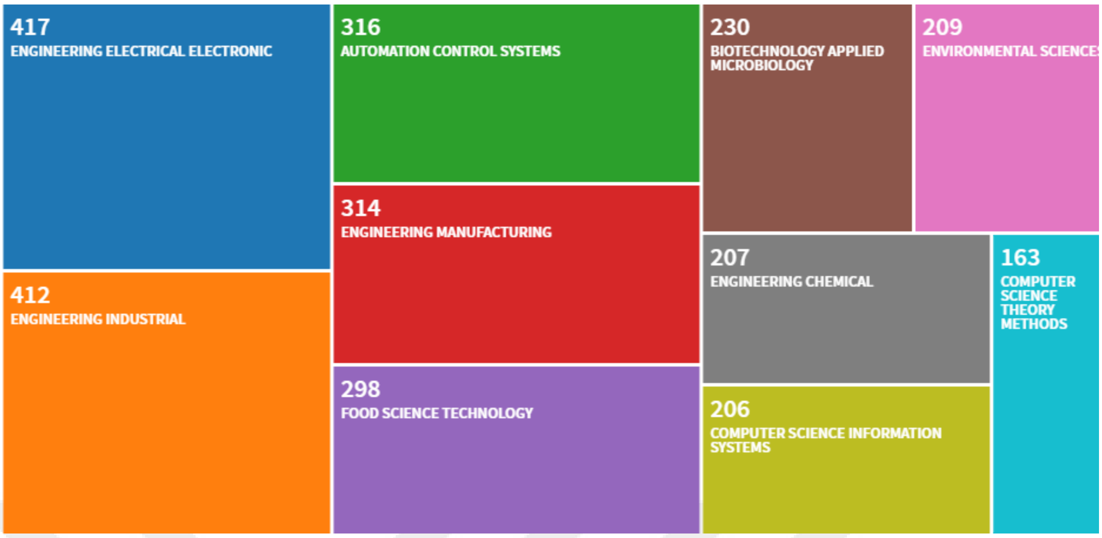
Figure 9 Total Publications by Year



Source: Web of Science, 2018

As it can be derived from the Figure 9, even though Industry 4.0 was first mentioned in 2011, academic studies about it peaked at 2017. It explains the lack of studies about the topic. Studies are mainly focused on engineering fields and distribution of studies according to their field is shown Figure 10.

Figure 10 Distribution of Studies



Source: Web of Science, 2018

As it can be concluded from Figure 10, Industry 4.0 is a new area that still has portions that need to be uncovered. A substantial amount of studies related to Industry 4.0 is about engineering and the studies on business are generally focused on production and process management. Therefore, the relationship between industry 4.0 and logistics still is an area that is open to exploration. The exit point of the research is the lack of studies about the logistics sector in industry 4.0, contributing to the logistics industry in the field of industry 4.0 applications and improving the literature in the subject field. In this regard, the main research objective is to identify and evaluate the possible effects of industry 4.0 on the logistics sector. Based on the main objective, research questions of this study are stated as follows:

- What are the implementation areas of Industry 4.0 in logistics sector?
- Which methods are being embraced in Implementation process?
- What are the barriers and problems in implementation processes?
- What are the benefits sought by implementing industry 4.0 practices?
- Is there a gap between the areas that Industry 4.0 practices are applied and can be applied?

3.2. RESEARCH STRATEGY

3.2.1. Case Study

Yin (1984) defines the case study research method “as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used.” The case study is efficient for rare cases and is advantageous when studying dynamic populations in which follow-up is difficult. Case study method is advantageous when exposure data is expensive or hard to obtain. Case studies are beneficial for answering how and why questions due to their exploratory nature. In this case, Industry 4.0 is a new concept in the business; therefore, features and benefits are not apparent. Therefore, it is beneficial to use case study methodology in this research.

The term 'case study' is strongly associated with qualitative research although it is used in a variety of ways. Indeed, it sometimes appears to be used as a synonym for qualitative research. The particular features associated with case studies are variously seen as:

- The fact that only one case is selected, although it is also accepted that several may be (Lewis, 2003; Bryman, 2001; Stake, 2000)
- The fact that the study is detailed and intensive (Lewis,2003; Bryman, 2001; Piatt, 1988)
- The fact that the phenomenon is studied in context (Lewis,2003; Cresswell, 1998; Holloway and Wheeler, 1996; Robson, 2002; Yin, 1993,1994)
- The use of multiple data collection methods (Lewis,2003; Creswell, 1998; Hakim, 2000; Holloway and Wheeler, 1996; Robson, 2002; Yin, 1993,1994).

3.2.2. Scope of the Study

It is unclear how many of logistics companies are currently focusing on Industry 4.0 applications. To find how many logistics firms are making investments to Industry 4.0, logistics firm that gets funding from TÜBİTAK - Technology and

Innovation Support Programs Presidency (TEYDEB) is examined. The reason for this examination is that companies tend to get support to implement their projects due to its costly nature. As a result of this examination, 12 logistics companies are determined. Another factor which acts as an indicator of possible relation with Industry 4.0 is R&D centres. According to the Ministry of Industry and Technology, only nine logistics firms have R&D centres. Companies that are collected from TEYDEB and Ministry of Industry and Technology are compared and according to this comparison, Ekol Logistics is determined as the unit of analysis. There are two specific reasons for the selection of this company. First one is the fact that they are embracing Industry 4.0 applications utterly such as starting from changing their company name to establish one of the largest R&D departments in the logistics sector. Another reason is the fact that they are the earliest logistics company focused on Industry 4.0.

3.2.3. Methodology and Steps of the Study

In this study, Yin's case study methodology accepted as base. According to Yin (2003), for a successful case study design there are five main components, these are; a study's questions, its propositions, if any, its unit(s) of analysis, the logic linking the data to the propositions, the criteria for interpreting the findings.

In this regard, first step is the deciding the research problems and they are stated in part 3.1.1.

For study propositions, instead to offering certain propositions, due to the exploratory nature of this study, impacts of Industry 4.0 on core logistics applications are selected and examined. Impacts of Industry 4.0 on firm profile such as demographic changes to changes from customers perspectives studied.

Although the unit of analysis s determined as Ekol Logistics, the scope of the study is limited to R&D department, Automation Department and Key Account Department. Features of each department selected and the rationale behind the selection reasons can be stated as:

a. R&D Department: Ekol's R&D department is the first one launched in the sector at 2012 with the approval of related ministry. This department is accepted as the centre of Industry 4.0 activities in the company.
b. Automation Department: Automation is one of the key concepts of Industry 4.0 therefore a dedicated department to that provides insights about research questions.
c. Key Account Department: This department is selected to pinpoint benefits of Industry 4.0 from the customers perspectives and how projects are used in order to satisfy most important customers of the company.

Last two steps that are advised by Yin (2003) which are the logic linking the data to the findings, the criteria for interpreting the findings are used in findings and data analysis part of this study.

3.3. DATA COLLECTION

In this study, primary and secondary data collection methods are used. Data is collected with in-depth interviews and document review.

3.3.1 In-Depth Interviews

There are several advantages of using individual in-depth interviews. As Barriball and While (1993) stated, Austin (1981) said it supresses the low answer rates of questionnaires, it is suited to exploration (Richardson et. Al., 1965), it provides ability to observe non-verbal clues (Gordon, 1975), capability of comparability and unable to get help from others to formulate an answer (Bailey, 1987).

The research topic is not detailed enough to use questionnaires, by using semi-structured questions it is possible to determine new aspects of the study area and the study is exploratory study therefore in-depth interview is the most suitable data collection method for this study.

In order to select interviewees and determine the questions, an interview with R&D director is conducted and these questions were asked to select interviewees;

- Which departments/groups are primarily responsible from Industry 4.0 projects?
- Who are the employees that are directly working about Industry 4.0 projects in the stated departments?
- How long these employees are working on Industry 4.0 projects?

Eleven semi-structured questions are determined, and interviews shown at the Table 9 are conducted.

Table 9 Interview Dates and Durations

Name	Department	Type of Interview	Date	Duration	Context
Erdem Özsalih	R&D Director	Individual	22.11.2017	Not recorded Approx..1.30 hours	Industry 4.0 is discussed in general terms to get information about company's situation
Erdem Özsalih	R&D Director	Individual	26.01.2018	00:45:29	Individual in-depth interview is made.
Ebru Al *Erdem Özsalih*	R&D Director R&D employee	Individual	26.01.2018	00:28:34	Interview is made with the same semi-structured questions.
Ebru Al	R&D Employee	Individual	03.07.2018	00:36:29	Individual in-depth interview is made.
Ebru Al *Erkut Usta*	R&D Employee Software Development Expert	Individual	03.07.2018	00:44:44	Interview is made with the same semi-structured questions.
Erkut Usta	Software Development Expert	Individual	03.07.2018	00:26:06	Individual in-depth interview is made.

The interviews are recorded with the permission of interviewees and for the not recorded interviews, notes are taken. The reason for conducting interviews with the same people at different times to enable easier tracking for the changes related to

Industry 4.0 in the company. First interview is conducted to get information that is used to form interview questions.

3.3.2. Document Examination

Document examination process is divided into two parts. In first part, online resources about the company are searched and related documents are collected. In the second part, documents that are provided by the company are collected.

Internal documents are accessed by company employee's permission and they include interviews of the company employees about Industry 4.0, projects that are currently in progress and already completed about Industry 4.0, articles that are written by the company employees. Internal documents that are collected shown in the Table 10.

Table 10 Internal Documents

Name of Document	Date	Authors	Type of Document
Uygulama Örnekleri ile Neden Lojistik 4.0	26-27 October 2017	Ebru Al Erdem Özsalih Bengi Müge Yenipazarlı	Presentation for congress
Erdem Özsalih Interview	October 2016	Transmedya.com	Magazine Interview
Internet of Things Project	2018	Ekol Employees	Project File
Big Data Project	2018	Ekol Employees	Project File
Image Processing Project	2018	Ekol Employees	Project File
Ekol Company Presentations	2018	Selin Üstün	Presentation

Another part of internal document collection was the lectures of Selin Üstün given in a private university in İstanbul. These lessons were held for 16 weeks around 1.50 hours every week. In these lessons, logistics applications of the company is examined and explained in detail as real life examples of logistics applications. Two of the lectures were directly about Industry 4.0 applications of the company and others were about logistics topics such as intermodal transportation, warehousing. With the approval of the Selin Üstün, company presentations are examined.

For the external document collection, the company's website, news searches from online search engines are made.

3.3. RESEARCH DESIGN QUALITY

In order to create construct validity and reliability in case studies there are several methods to follow. One of the methods that is created by COSMOS Corp. (2001) and improved by Yin (2003) is shown in Table 11.

Table 11 Case Study Tactics for Four Design Tests

Tests	**Case Study Tactic**	**Phase of Research Which Tactic Occurs**
Construct Validity	Use multiple sources of evidence Establish chain of evidence Have key informants review draft case study report	Data collection Data collection Composition
Internal Validity	Do pattern-matching Do explanation-building Address rival explanations Use logic models	Data analysis Data analysis Data analysis Data analysis
External Validity	Use theory in single-case studies Use replication in multiple-case studies	Research design Research design
Reliability	Use case study protocol Develop case study database	Data collection Data collection

Source: (Yin,2003; COSMOS Copr.,2001)

Another and more improved study of Riege's study is adapted according to the study and this adaptation is shown in Table 12. In this study, qualitative techniques to improve validity and reliability is determined.

Table 12 Techniques to Establish Validity and Reliability in Case Studies

Case Study Design Tests	Qualitative Techniques
Construct Validity	Confirmability audit (examine data, findings, interpretations, and recommendations)
Internal Validity	Triangulation (sources, investigators, and method) Peer debriefing Member checks Researcher's assumptions, worldview, theoretical orientation Researcher self-monitoring
External Validity	Predetermined questions Thick description Cross-case analysis Specific procedures for coding and analysis
Reliability	Dependability audit (examine document and the process of inquiry) Clarify researcher's theoretical position and biases

Source: Adapted from Riege, 2003

3.3.1. Construct Validity

According to these two studies steps (Yin, 2003; Riege, 2003) are taken to improve validity and reliability. For enabling the construct validity, an extensive literature search is made about Industry 4.0, its components, Industry 4.0 reports from industry and governments. Aim for searching reports was to pinpoint the legislative point of view and how legal points are perceived from the industry side. It was important because Industry 4.0 is started as an initiative of the German government and business owners can change its aspects. Then literature research about logistics is done. In that part, the primary focus is on how historical changes affected the logistics and what are the main components of logistics. By deciding main components of logistics, research area narrowed, and specific examination areas are determined.

3.3.2. Internal Validity

Yin (1993), stated that for exploratory studies explanation building is used to increase internal validity and in this study explanation building is not to conclude studies but to further study suggestions. In single-case studies, elements of explanation are used. To answer research questions, casual links are established between concepts.

In order to create causal links, the theoretical base of Industry 4.0 and company data is compared. As an example of creating a causal link in the study is to connect the aim of the company to why they are using the Industry 4.0.

For internal validity, triangulation is applied. According to Denzin (2001), there are four methods of triangulation and one of them is data triangulation. According to Flick (2002) data triangulation is using different sources of data. This includes different times for data collection, difference places from which to collect the data, and different people who could be involved in the research study. For establishing data triangulation, in-depth interviews document examination are conducted, and lessons of a manager from the company are attended for 16 weeks in a private university at İstanbul. Details of source of information are provided in Data Collection part.

3.3.3. Reliability

For reliability, main point of reliability in case studies is to reach same result repeatedly with the same case. In this study, to increase reliability, a case study protocol is developed, and it makes it possible to repeat same study steps again. Case study protocol is developed by formulating a definition of concept in literature review, determining object of measurement by forming research questions that are stated in chapter 3.1.1, for location of measurement primary and secondary data collection methods are used, evidence is collected by company employees, company documents and external sources such as online websites. Sources of evidence is decided with the guidance of the managers in the company, and evidence collected with note-taking and voice recording. Evidence that is taken by voice recording transformed to data by transcription. By using these steps case study protocol is formed.

By using the same steps again, researchers may reach the same answers unless the company changes its vision about Industry 4.0. According to Yin (2003) another method to increase reliability was in-depth interview method, interviews are made until the correspondents started to give same answers.

According to Weber (1990), content analysis is a systematic process that is compressing texts to meaningful content categories. As a part of this, coding is used in this study and in order to improve the reliability of coding inter-coder method is used. Campbell (2013) stated that intercoder reliability is the ability of different coders to code the data in the same way. In order to use coder reliability in this study, the first two interviews coded by two researchers. Free-coding approach is used for the not recorded interview with Erdem Özsalih. Both researchers were present during the interview and took notes. After the interview, researchers compared the notes and recognised the same themes in the interview. After the recognising same themes, researchers coded the second interview with Erdem Özsalih which is recorded with a tape recorder. Again, the same researchers encoded the interview and again reached the same themes.

3.4. LIMITATIONS OF THE STUDY

Overall limitations of single case studies also apply to this study. The study is limited to the analysis of one logistics company in Turkey. Generalizability is hard for the study. Because every company has its own dynamics and capabilities. Ekol is a company that heavily focused on technological development and integrating their systems to Industry 4.0. Their applications are different from other companies in the same industry. Therefore, it is hard to say that their steps will be similar with other companies. However, there is also a possibility that Ekol's steps will act as a guide to other companies that will integrate their systems to Industry 4.0.

Another limitation of the study is that data are based on one company therefore the data only represent an excerpt of Industry 4.0's integration to logistics. Future research might uncover other areas that are covered due to the not used by the selected company. In the study, a theory cannot be established because the academic studies on Industry 4.0 still is not broad enough to theory creation.

One possible limitation of this study is related with interviewees, every interviewee works closely and in the same working environment as a part of the company. In order to avoid biases, individual and more confidential interviews are conducted.

3.5. DATA ANALYSIS

To conduct data analysis, all data collected including in-depth interviews and document analysis recorded into an excel sheet. A database is created in excel and includes every component of data collected in the scope of study.

In order to determine patterns, open and axial coding which also referred as pattern coding are used. By using open coding, interview records are compared, and certain patterns are recognized after the examinations. These themes shown at the Table 13.

Table 13 Open Coding of Research Questions

Open Codes for Research Questions	Open Code	Properties	Examples of Participants Words
Research Question 1: What are the implementation areas of Industry 4.0 in logistics sector?	Suitable to implement every function of logistics Project creation	Application area is vast Implemented to every function of logistics	Every area can benefit Suitable to implement all of the company Every employee in the company including will fit to it
Research Question 2: Which methods are being embraced in Implementation process?	Creativity of employees Company enablers	No top-down management Ideas of employees Company initiatives	I can do every project I want as long as I took results in a meaningful time period
Research Question 3: What are the barriers and problems in implementation processes?	Financial burdens of the projects Cost maintain problems	Costly applications Partnerships are not desired by the company	Cost of one project is around 1 million TL. Other than financial problems there is nothing stops us Financial aspect of Industry 4.0 is problematic for everybody in the world.
Research Question 4: What are the benefits sought by implementing industry 4.0 practices?	Long-term survival and growth Advantage in the industry	Advantages like agility, flexibility, customer satisfaction, competitive advantage	It differentiates us in from the competitors. Innovative approach satisfies customers
Research Question 5: Is there a gap between the areas that Industry 4.0 practices are applied and can be applied?	Costs of technological advancements Technological Limitations	High cost Long return of investment times Create new programmes	Every project is feasible unless there is a financial problem Some programmes designed for Industry 4.0 is almost impossible to use in this conditions

According to Ellram (1996), there is an iterative relationship between open and axial coding. In axial coding, themes relate to each other and matched with research questions. These matchings are shown on Table 14.

Table 14 Axial Coding

Theme	Research Question
Suitable to implement every function of logistics	What are the benefits sought by implementing industry 4.0 practices?
Company initiatives and creativity of employees	Which methods are being embraced in Implementation process?
Advantage in the sector through differentiation	What are the benefits sought by implementing industry 4.0 practices?
Financial burdens	What are the barriers and problems in implementation processes?
Cost of technological advancements	• What are the barriers and problems in implementation processes? • To find the gap between the areas that Industry 4.0 practices are applied and can be applied

3.5.1. Ekol Logistics

3.5.1.1. Company Profile

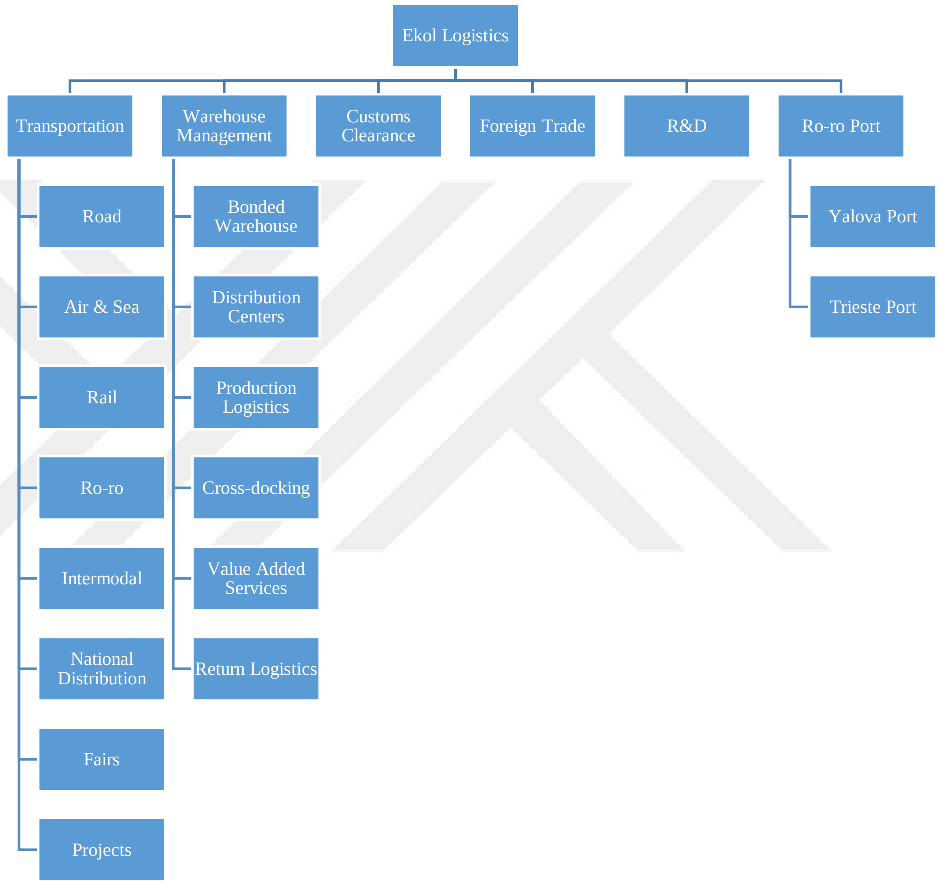
Taking its name from the Latin word école, which means school, Ekol seeks to embrace the pioneering role of developing human resources and new business models in the logistics sector. (Ekol.com)

Ekol, founded in 1990; is an integrated logistics company operating in 15 countries in the fields of transportation, contract logistics, foreign trade, customs and supply chain management. Supporting inspiration from technology, Ekol always offers integrated, flexible and cost-effective solutions to its customers.

In Turkey, Germany, Italy, Greece, France, Ukraine, Bosnia and Herzegovina, Romania, Hungary, Spain, Poland, Czech Republic, Bulgaria, Sweden and Slovenia, Ekol have indoor area of 1,000,000 m2 distribution center as well as intermodal transport enablers such as its 6 Ro-Ro ships, 48 weekly block trains and 5.500 vehicles. Ekol is one of the leading firms in Europe regarding the logistics sector. Mission of the company is “To inspire and create sustainable value together with our customers.”

Company’s main activity areas are: transportation (rail, road, sea, and air), warehouse management, customs clearance, foreign trade, ro-ro port, and ro-ro transportation. These activities and their sub branches are shown in Figure 11.

Figure 11 Ekol Logistics' Services



Source: Ekol.com

The company shows activity in more than eighty-five locations at fifteen countries via their facilities and reaching more than nine hundred locations in more than hundred and fifty countries via their contractors.

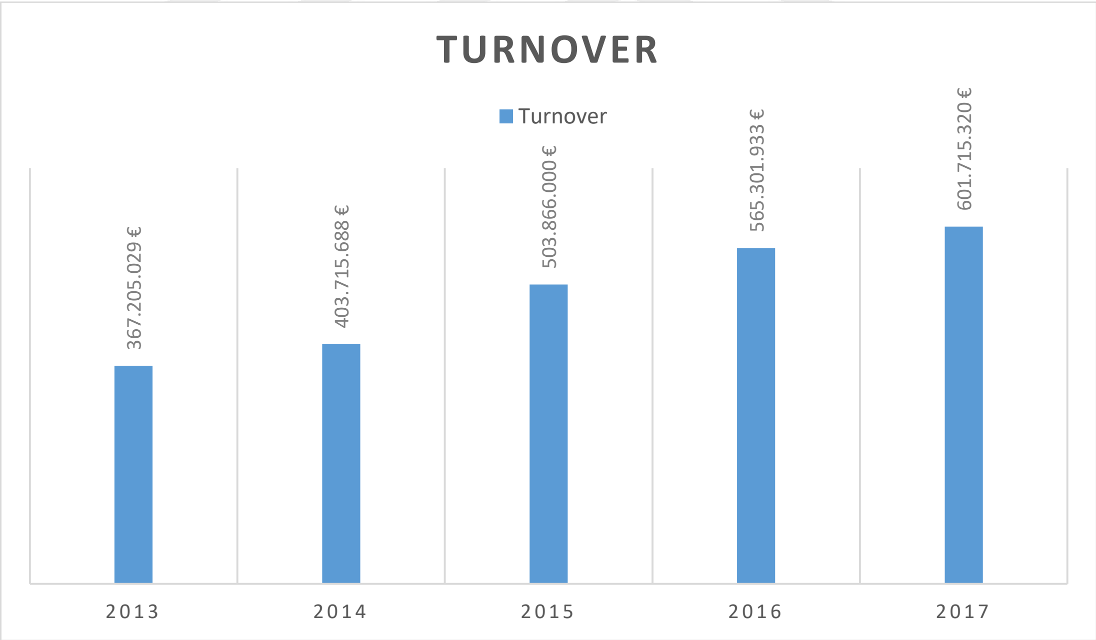
According to Erdem Özsalih, Ekol Logistics R&D director, Ekol's works like a production line because of the principle of separation of duties. Different people perform all steps such as order taking/entry. These types of businesses were choice before but nowadays its a must in the sector. Ekol's business mentality leads them to use systems such as Quadro and Quadro Light which is closer to Industry 4.0 applications. Quadro provides online real-time information to Ekol's customers and suppliers that based on Turkey about their orders status. Quadro Light provides this information worldwide. Ekol Logistics develops these two systems, and the systems are providing flexibility, agility, originality, the capability to meet customers expectations, competitive advantage, and productivity according to Özsalih.

Ekol has 93 warehouses and 7 bonded warehouses and 1,000,000 sqm facilities storage area. One of their investment area is about storages. For example, in 2016 they had 562,784 sqm facilities area and they increased it to almost double in only one year.

3.5.1.2. Ekol's Economical Profile

Company's one of the economical situation indicator is shown the Figure 12.

Figure 12 Ekol's Turnover Rates



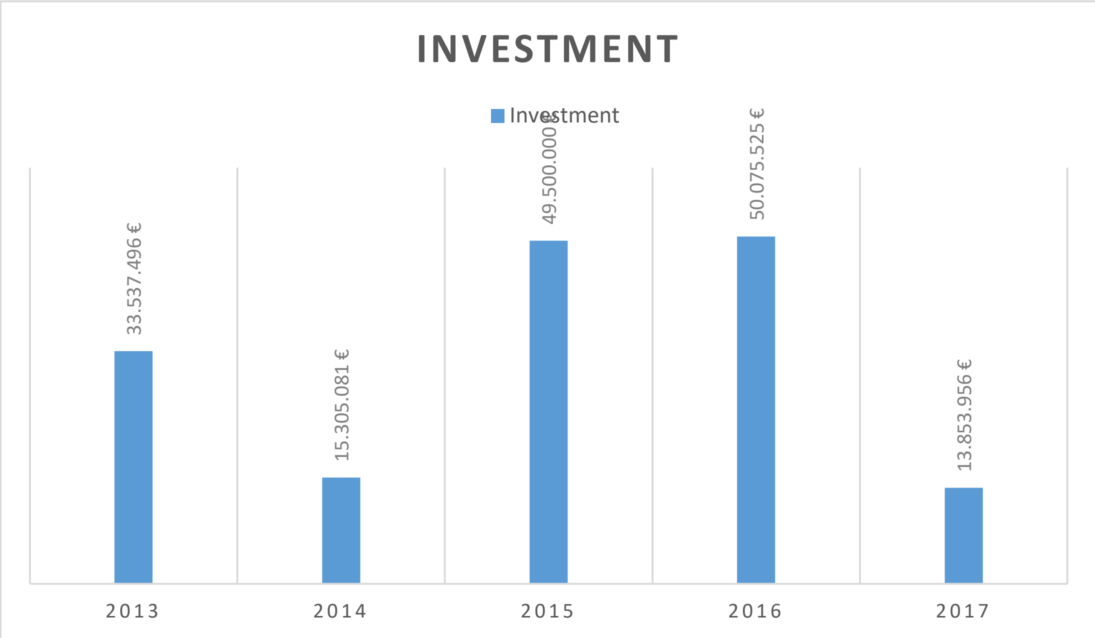
Source: Ekol.com

Industrial distribution of turnover is 26.81% automotive, 13.87% textile, 12.68% manufacturing, 18.68% service, 5.83% fast-moving consumer goods, 3.81% healthcare, 1.49% retail, and 16.84% others. (Ekol,2017)

Turnover per services is 57.01% road freight, 13.12% contract logistics, 18.14% international operations, 6.84% domestic distributions, 3.28% sea & air freight, and 0.78% customs clearance.

Another indicator about financial situation is investments made by the company and its details shown at the Figure 13.

Figure 13 Ekol's Investment Rates

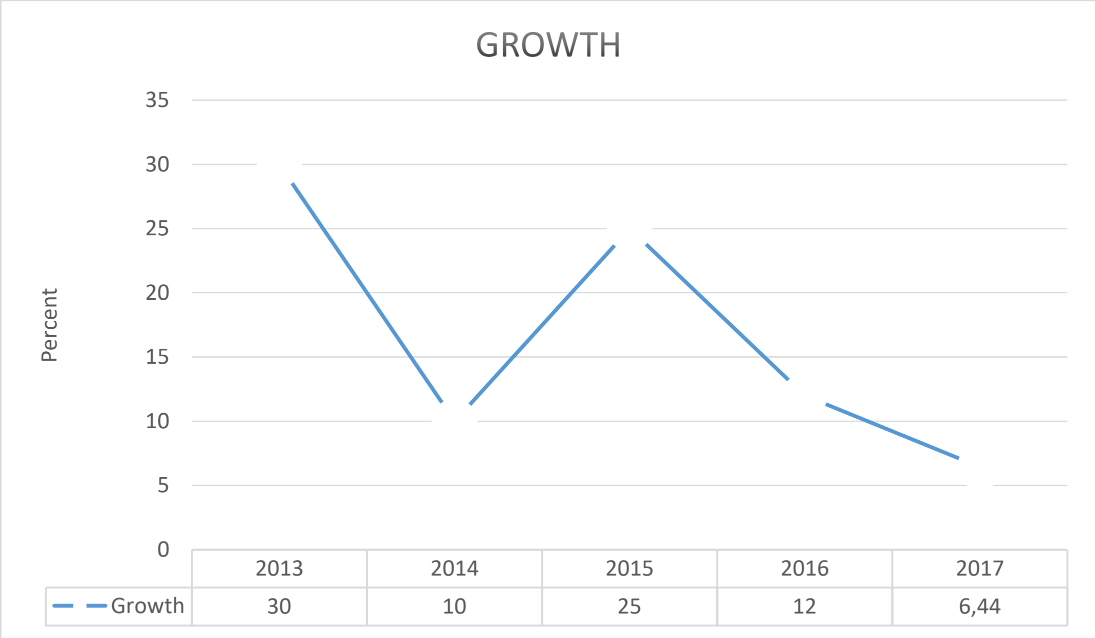


Source: Ekol.com

Company’s investments are mainly focused on their R&D activities and Ro-Ro ports investments. Company has a dedicated R&D department to provide Industry 4.0 applications and has two Ro-Ro ports one of them is in Yalova while the other one in Trieste with shared ownership.

Company’s growth showing differences through years however according to their key account director Selin Üstün they are one of the few companies that shows continuous growth for last several years in logistics sector. Growth pattern of the company shown at the Figure 14.

Figure 14 Ekol's Growth Rate



Source: Ekol.com

3.5.1.3. Ekol’s Demographics

Company has both blue-collar and white-collar workers. Majority of workers are blue-collar workers due to the nature of logistics field. However, with the Industry 4.0 company expects to lower the number of blue-collar workers and guide the remaining blue-collar workers jobs that they will not participate body work. Distribution of workers shown at the Table 15.

Table 15 Worker Distribution in Ekol

Year	Blue-Collar	White-Collar
2013	2,870	1,263
2014	3,417	1,486
2015	3,944	1,681
2016	4,587	2,151
2017	4,696	2,421

Source: Company files

Education levels of the workers are distributed as follows, 29.75% primary school, 38.21% high school, 9.02% associate degree, 20.14% bachelor's degree, 2.88% post-graduate.

Ekol is a man dominated company with 80.45% of male workers and 19.55% female workers. In age distribution, majority of company is between 26 and 35 years old with 37.24 percent. Other age distributions are like as follows, 17.92% between 18 and 25, 27.47% between 36 and 45, 17.37% older than 46 years old.

3.5.1.4. Ekol's Industry 4.0 Projects

R&D department of the company directs Ekol's Industry 4.0 projects. Distribution of employees according to their job descriptions are 84% researchers, 11% technician, and 5% support workers. Education levels of these employees are 34% masters/ doctorate, 56% graduate, and 10% associate degree (Ekol.com, 2018).

In the company interview, employees stated that they have three types of works in the company. The first type is simple works that include models created by Ekol for small problems. The second type is cooperation with universities to create solutions such as collaboration with Ege University to create the project related to the decision-making system for warehouse optimisation which takes support from TUBİTAK. The third type is projects with consulting and analysis companies around the world. Examples of these are studies on topics such as analysis, vehicle diagnosis, route planning with companies such as Ortech, Optim.

According to Ebru Al, an employee of Ekol Logistics R&D department, Ekol started to focus on Industry 4.0 applications at 2016. Therefore, projects that started in 2016 examined in this study. Details of projects that are examined in the study is shown at the Table 16.

Table 16 Ekol's Industry 4.0 Projects

Name	Type	Date	Details
Sealing Conveyor Belt for Medicines	Patent	November 28, 2016	Design a sealing conveyor belt which groups data matrices and labels the grouped medicines.
Product Collection and Distribution Cart	Utility Model	November 3, 2016	A modular collection cart design that facilitates product collection and/or distribution, particularly in storage areas
Height-adjusted, Moving-platform and Multi-deck Vehicle System	Patent	October 6, 2016	A moving vehicle transformation platform system to move vehicles and easily position them inside the container.
Height-adjusted and Multi-deck Vehicle System with a Ramp	Patent	October 6, 2016	A height-adjusted and multi-deck vehicle system with a ramp to move vehicles inside the container.
A Product Hanging Method	Patent	April 1, 2016	A database-driven product hanging method which speeds up distribution of multi-hanging products on shelf with the usage of multi-trolleys in storage area.
Multi-Depth Automatic Storage and Retrieval Systems Optimization with Smart Algorithms	Project	2016	To ensure optimal inventory area, to build a product placement algorithm with a mathematical model to minimize the need to move items and to maximize collection performance; and to minimize energy consumption with a modular shelf structure.
Design Automatic Warehouse and Field Management Processes in the FMCG Industry, and Develop a Commercializable Product through System Integration	Project	2016	A method which eliminates the need for new improvements to meet different needs by foreseeing all possible requirements in logistics operations, and merely altering parameters or making choices in the warehouse management system. Have the user interfaces built – not only by software developers but also by authorised and trained users.

Table 16 Cont. Ekol's Industry 4.0 Projects

Develop a Dynamic and Open-to-Improvement Tow Truck and Trailer Tracking System	Project	2016	Develop equipment and a system which instantly accesses the status of a vehicle such as location, speed, loading details, safety, fullness, and so on by taking into account industry requirements and the possibility to convert it into a commercializable product.
Future Cognitive Logistics Operations Through Social Internet Of Things (COG-LO)	Project	2017-2018	Reduce complexity, improve collaborative logistics and reduce costs coming from load sharing and merging transport needs, where possible.
The Use of Big Data Analytics for Process Modelling in Smart Logistics Operations-CHIST-ERA	Project	2017-2018	To address the challenge of redesigning the entire data produced from satellite-enabled (IoT) vehicle tracking technology
Development of Industry Based Integrated Image Verification and Analysis System in Dynamic Structure	Project	2017-2018	Realise the delivery of goods in logistics warehouse operations with barcoded labels with higher accuracy and efficient material flow management (MFS) by using integrated image verification and analysis system in the dynamic structure which will be developed within the company.

Source: Ekol.com, Company Interviews, Company Documents

In addition to Table 16, company R&D employees mentioned from other projects that are still in development phases. These projects designed as correspondents of Industry 4.0’s main components such as CPS. One of the projects that mentioned is related to warehouse management systems. In this project, material flow codes written and improved by R&D employees. The project brings automation capability and competitive advantage to the company due to the flexible nature of codes. The teams for data exchange & digitisation, which are the primary sources of Industry 4.0, have emerged to respond to the needs of warehouse customers and spread to the whole company.

At the moment mobile projects are open to the usage of drivers, port workers, transportation and warehouses workers. However, in the future (taking into account Industry 4.0 as a whole) there are some projects planned. For example, for vertical integration there are projects related to the in-house operation. As an example of this, there is an one order project ("One Ekol, One Order"). Tracking through a single order platform - e.g. faster completion of customs clearance by advising the Ekol authorities in Hungary of the goods going to Hungary in order to transfer to Spain. Advantage of this project is combining messy system and presenting feasible suggestions with pre-warning systems. This project is critical for contracted work and provide independence of individual systems.

For the security aspect of the projects, there are two security measurements taken by Ekol. First one is internal security that based on specific security permissions for the person - classification according to whom and whom authority should be reached. It is also contemplated to use new technology-oriented architecture such as micro-services for external security measures.

One of Ekol's projects is the Data Warehouse Project, which is involved in the current reporting activities for the future: Analysis, machine learning, in-depth learning projects planned. As an example of the future target situation, Fridays TOFAŞ Bursa loads are delayed to Yalova due to specific environmental conditions. The system will be arranged to learn this information and alerts to the threat. There are many acceptable parameters in optimisation applications and a critical study for the analysis of input parameters is the future goal of this project. Converting hypothesis to wisdom is essential for the company, and it aimed to bring this conversion. Moreover, it can create the right parameters for other decision support systems.

In the context of robot technologies, studies are being carried out to eliminate human-made processes. However, Ekol is not yet in that level, and as a future project, it is aimed to make pick & pack operations that can be done by with robotic systems. Within the scope of projects, it is aimed to create know-how with flowing or fixed images by image processing systems and to develop and use different purposes with barcode reading solutions. For example, for the future, it is aimed to measure goods from the storage, the unmanned counting using fixed cameras. To reach the goal, a barcode reading project is carried out in connection with universities within the scope of Tübitak. As a result of the project, it is aimed to create a product that will be a substitute for the readers, to use domestic production products instead of importing and to reduce foreign dependency on this number. Reducing external dependence Ekol is the business principle for logistics and for this purpose it is the sector to make customised solutions and adaptations. Ekol uses software components, not hardware, from the outside.

3.6. FINDINGS

3.6.1. Industry 4.0 Implementation Areas

Logistics has some core functions such as warehousing, transportation, material handling, packing. Ekol Logistics as a 3PL company shows function in these core areas. According to the company employees, its possible for Ekol to implement Industry 4.0 applications in every aspect of the company.

There are several components of Industry 4.0 such as cyber-physical systems, automation, robotics. With their projects, Ekol is combining these core areas. For optimisation studies, the company uses simulation-based methods which is a part of Industry 4.0. In that project, data transfer and digitalisation accepted as a base and warehouse optimisation studies made with using these two key terms.

In Table 17, projects and their correspondents in Industry 4.0 shown.

Table 17 Implementations and Industry 4.0 Relation

Project	Industry 4.0 Application
Quadro – Quadro Light	Automation
One Order	Vertical Integration
Personal Data Access Levels	Cybersecurity
Data Warehouse Project	Big Data – Machine Learning
One Order, Sales Force Applications	Cloud
Vehicle Tracking Systems, Trailer Tracking Unit	Sensors – Smart Cars
Trailer Tracking Unit	Autonomy
Barcode Reading Unit	Robotics

Source: Company Interviews

There are also smaller projects inside the regular projects to improve quality of services. Information on Delivery is one of them, and it provides real-time information about trailers by using navigation devices inside them. This project leads the company to work on in trailer monitoring systems which provide real-time information about the inside of the trailer. By using this, the company ensures the safety of goods transported in the trailer and providing this information to their customers. After that, a sensor trailer locking system is realised by using this system trailers doors are only unlock at the delivery place stated by GPS, or it unlocks with the approval of the company. Another step of the project was Geo-Fencing, in this part of project GPS tracks the trailer and gives warnings to the company if there is a problem with the route of the trailer or the trailer did not arrive at a designed place at the designed time. All these integrated projects are related to sensors and real-time information flow.

Warehouse Management Systems and Material Flow Control Systems are two integrated projects. With this two in-house developed software, material flow control system provides control over materials and information while warehouse management systems act as its superior and control every part of the warehouse while providing real-time information.

There are also projects related to automation. Some examples of the projects are automated storage and retrieval systems, automation systems for hangers, automated sorter systems, and voice guidance for picking. The aim of the automation projects to lower time and number of workers required.

As it can be concluded from these projects, Ekol selects projects that are suitable for the immediate needs of the company and its customers. As a part of "Logistics 4.0", the vision of the company's R&D Centre is conducting research and development focused on digitalisation and visualisation, process integration with internet and mobile applications. Stakeholder’s interaction and real-time information are essential for the projects.

3.6.2. Implementation Methods

Implementations of Industry 4.0 is based on Ekol’s R&D centre. Implementations of Ekol is divided into some sub-groups. These groups are cloud and cloud-based communication technologies, simulation and robotic systems, online and mobile applications, transporter – goods communication, communication between vehicles, vehicle – road communication, and digitalisation and visualising.

For each sub-group, R&D centre has different smaller working groups, and every group focuses on their projects about their topics. For example, Erkut Usta from Automation department stated that "*even if they create a new simulation programme they cannot try it without the authorisation from the IT group*."

Ekol divides the implementation phases into two. These are vertical and horizontal integrations. For the vertical integration, the aim is to connect every customer of Ekol. For the vertical integration, order management infrastructure, cost accounting & invoicing, planning, CRM, vehicle tracking systems and sensors, image processing infrastructure are using as implementation methods.

Horizontal integration aims to integrate every stakeholder of the company. For the horizontal integration, customers, open-source information sources, business partners, suppliers, ports and terminals, intermodal operations, government agencies, customs clearances, and weather and road conditions are using as implementation methods. With the horizontal integration company will provide the information about analysis from different sources, determination of measures to increase resource efficiency, determination of relations and interactions between data, determination of parameters, automation of repetitive and standardisable operations, real-time information to all stakeholders.

To reach this goal, the company's every department acts as an information supplier for the R&D department. An employee from the R&D department stated that "The main task that of the driver will be to give information that is not objective but subjective about process improvements".

Every company has its own dynamics therefore application methods vary from the company to company. In this case, Ekol prefers to create its own software systems in order to maintain their security. Their choice about the software answers one of the concerns about Industry 4.0 which is cybersecurity.

Implementation of Industry 4.0 was especially crucial for Ekol because the company not only using its products for its services but also outsourcing. It leads to complications over the control of Ekol; therefore, company creates a system that is usable in different products. Therefore, the company’s implementation processes are not only focused on internal aspects of the company but also to the external factors.

3.6.3. Barriers and Problems of Implementation

Consensus about main barrier about Industry 4.0 is financial deadweight of the projects. Industry 4.0 is based on technology and technological improvements costs are usually very high. An employee from R&D department stated that "we can do everything about Industry 4.0 with the same level in the worldwide, aside from monetary issues, as Ekol we have no problems with capabilities. We are issued to the same limitations about Industry 4.0 like any other company in the world."

Currently there are no legal bases for Industry 4.0. Therefore, even if companies reach to some certain levels the companies will not be able to use their projects such as autonomous driving cars. However, some employees believe that legal frameworks will be ready to that time.

An employee stated that “when we focused on Industry 4.0 applications, we noticed that our beliefs and habits make its difficult for us to change our processes”. Therefore, it can be concluded that companies may have some stereotypes about how business is done and can have hard times to break their habits.

3.6.4. Benefits of Implementations

Ebru Al from R&D department stated that “*Logistics is a human based concept and even if there are different systems human is the main concept of it. With these projects we are trying to control our processes more*”. Therefore, it can be concluded that Industry 4.0 applications are providing control over processes and it leads to lower the mistakes based on human.

Main benefits of Industry 4.0 are almost the same for every employee interviewed. These are; flexibility, agility, originality, ability to meet customer expectations, and productivity. Flexibility is not a novelty introduced by Industry 4.0, but because the company has implemented projects to create its systems, it can change according to the needs of customers and company employees. Agility is influenced by the ability of companies to take positions according to the circumstances, and Ekol aims to be agile by trying to adapt early to the vision of the industry 4.0. Industry 4.0 has emerged with the aim of preventing future economic problems and can contribute positively to the lifespan of companies as it stated from one of the automation department employees.

3.6.5. Gaps of Implementations

The difference between the currently applicable areas and the areas where Ekol can apply is due to the difficulty of technological investments. As stated by an employee from the automation department, the cost of line optimisation, which is an optimisation process made by Ekol, can be over 1 million Turkish liras. For this reason, the company cannot fulfil every vision. Besides, technological insufficiencies constitute a significant obstacle. For example, while Siemens can switch to an almost unmanned factory, Ekol is still in preparation for this infrastructure.

Another reason for implementation gap is the turnover rates in the company. Creating a know-how is not easy and with every new employee there is a learning time. One of the problems about Industry 4.0 is hardness to find employees with know-how and retain these employees in the company.

CONCLUSION

Industry 4.0, due to radical and incremental technological improvements, brings many changes in businesses. Therefore, the reflections of these changes on each sector have to be evaluated separately. Logistics is a sector that is not only affected by internal factors but also the external factors in order to comply with the customer needs and wants. Considering the increasing effects of Industry 4.0, the studies about the topic rise in importance. Hereby, the objective of this study is to examine effects of Industry 4.0 on logistics, determining implementation areas of Industry 4.0 to logistics, implementation methods, barriers and problems of implementation, benefits of these implementations, and finding the gap between applications areas.

A case study on a logistics firm which actively embraces industry 4.0 applications is conducted and data is collected via in-depth interviews and document reviews.

In the company interview and document reviews, every main component of Industry 4.0 like CPS, automation, and robotics are suitable for the usage of the logistics sector. However, from Ekol's projects, it can be derived that some components are more suitable from the others. As an example of this, Ekol's projects are more focused on systems integration and automation processes. The company focused on systems integration because company management believes that it will vastly improve customer satisfaction and create differentiation for the company. The second focus is on automation process because company's blue-collar workers are high in amount and it creates a cost for the company. With the automation processes, blue-collar workers can reduce. Therefore, from the study it can be derived that with Industry 4.0 companies have to pay cost for implementing projects but these projects have capability of lowering costs in the long term.

On the other hand, different departments show different importance to the aim of the projects. For example, Key Account department favours more customer-focused projects like “one order” because they are profoundly improving customer satisfaction levels. Automation department is more focused on optimisation processes because of their capability of lowering human mistakes. R&D department does not favour only one type of project. The department acts as a different entity in the company and creates projects to solve the company's problems.

For the implementation methods, as it can be derived from Ekol example, a dedicated R&D centre creates a significant advantage for the companies. R&D centre can observe and get real-time information about the problems of the companies and has the advantage of getting grants from governments. In this case, R&D centre works with different correspondents from both in industry and academics to create solutions to observed problems and improve the current status of the business.

As it stated from employees in in-depth interviews, the primary barrier in Industry 4.0 projects is about financial problems. Industry 4.0 projects are costly therefore it is beneficial for the companies to find government grants, university collaborations, and partnership with other companies from the industry. However, some projects should be only in control of the company, therefore, reducing costs is not highly available in short term.

The benefits of the industry 4.0 applications are determined by the employees as flexibility, agility, originality, ability to meet customer expectations, and productivity. These benefits lowers the costs, increases the resilience of the company and increases customers satisfaction levels. All these three overall increases the value of the company and increase its lifespan in the highly competitive sector.

Managerial implications of the study is, managers should be providers of the Industry 4.0 resources in order to provide knowledge to employees. In Ekol case, company follow top-to-down path to start Industry 4.0 initiative. After employees gained enough information about Industry 4.0, they gained drive to create their own projects.

Role of R&D departments is high in the adaptation process. Ekol's R&D department is the main provider for the Industry 4.0 adaptation process of the company. With the strong and driven R&D department, projects can be created but it is not enough to spread Industry 4.0 in all of the company. Every department of the company should act as an information source for the problems regarding the processes and customer satisfaction. With the information that comes from every aspect of the company, R&D department can pinpoint what is important to focus on in their projects. Another advantage of the company is closeness of R&D department to the main facility of the company. Their R&D department is in the same building with main operation centre of the Ekol therefore they are in connect with the rest of the company. This situation enhances capability of R&D department to observe the company.

The problems about Industry 4.0 applications are mainly related with the costs and other financial problems. However, in order to solve financial burdens of Industry 4.0 projects, the company can benefit from government supports related with Industry 4.0. Grants for Industry 4.0 projects are also providing by European Union. Another point about capability of return of investment of Industry 4.0 projects. They bring long-term benefit in terms of finance therefore their investments capability of lowering cost in the future.

Overall, this study examines Industry 4.0's implications on logistics and shed light to relatively uncovered area of Industry 4.0. By examining a single case, problems and barriers pinpointed and these areas are showing similarity with the Industry 4.0 literature. Solutions for these problems are advised. Managerial implications are examined and explained.

For the future research prospects, comparison of two logistics company can be made. By doing this comparison researchers will be reach to an better understandance of Industry 4.0 applications in the companies. Case study as a research strategy is being criticized as offering a poor basis for generalization of the findings due to external validity problem. Therefore, this study should be replicated in other supply chain settings (Atrek et. Al.,2014).

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APPENDICIES

Appendix 1: In-depth Interview Questions

Okulun Adı: Dokuz Eylül Üniversitesi

Öğrencinin Adı Soyadı: Melis Gizem Öztürk

Bölüm: İngilizce İşletme Yönetimi

Sınıf: Tez Dönemi

Görüşmenin Amacı: Endüstri 4.0 uygulamalarının lojistik üzerindeki etkilerini tartışmak

Görüşmenin Konu Başlıkları

1. Endüstri 4.0 sizin için ne ifade etmektedir? nedir?

2. Endüstri 4.0 hakkındaki neler biliyorsunuz? (nasıl uygulanmakta, ne gibi yatırım ve donanım ve teknoloji gerektirmekte?) Bu bilginin kaynakları nelerdir?

3. Endüstri 4.0'ın lojistik sektörünü genel olarak nasıl etkileyeceğini düşünüyorsunuz?

4. Firmanız endüstri 4.0 uygulamalarına hazır mı? Ne gibi eksiklikler var?

5. Türkiye'deki lojistik sektörünün tamamı düşünüldüğünde sektörel olarak endüstri 4.0 ın uygulamasına engel teşkil edeceğini düşündüğünüz şeyler nelerdir?

6. Firmanızın yaptığı ya da yapmayı düşündüğü Endüstri 4.0 uygulamaları nelerdir?

7. Bu uygulamaların önündeki engeller ve uygulamalara dair teşvikler (motivasyonunuz) nedir?

8. Hali hazırda yapılmış olan uygulamaların ve yapmayı planladığınız uygulamaların faydaları olarak neleri görüyorsunuz?

9. İleride tamamlanacak Endüstri 4.0 projeleriniz ile firmanızın nasıl bir değişimden geçeceğini düşünüyorsunuz?

10. Endüstri 4.0'ın dünyadaki lojistik sektöründe uygulanabilen fakat Türkiye'de uygulanamayan adımları var mıdır? Varsa nelerdir?

11. Firmanız Endüstri 4.0 ile ilgili inisiyatifler almasaydı da Endüstri 4.0 ilginizi çeker miydi? Neden?

Name of School: Dokuz Eylül University

Name and Surname: Melis Gizem Öztürk

Section: Business Management - English

Class: Thesis

Interview Purpose: To discuss the effects of logistics on the applications of Industry 4.0

Interview Topics

1. What does Industry 4.0 mean for you? What is Industry 4.0?
2. What do you know about Industry 4.0? (how is it applied, what kind of investment, equipment and technology do you require?) What are the sources of this information?
3. How do you think Industry 4.0 will affect the logistics industry in general?
4. Is your company ready for 4.0 applications? What are the shortcomings?
5. What are the things that you think would be an obstacle to the industrial sector as Industry 4.0 applications, when considered all of the logistics industry in Turkey?
6. What are your Industry 4.0 practices that your firm has made or is considering doing?
7. What are the incentives (motivations) for obstacles and practices in front of these practices?
8. What do you see as benefits of already existing applications and applications you are planning to do?
9. How do you think your company will change with your future Industry 4.0 projects?
10. 4.0 Industry can be applied in the logistics industry in the world is there but the steps that are implemented in Turkey? If so, what?
11. If your firm did not take initiatives related to Industry 4.0, would Industry 4.0 attract your interest? Why?

Appendix 2: In-depth Interview Sample Example

Ekol Lojistik Görüşme Notları
Erdem Özsalih - R&D Director
22.11.2017

Yazılım Geliştirme Faaliyetleri

- Daha verimli
- Farklılaştırma politikası

Ekol İş Modeli

- Üretim bandı mantığı / Görevlerin aykırılığı ilkesi
  - Siparişi alan/giren vs gibi tüm adımlar farklı kişiler tarafından gerçekleştiriliyor.
  - Eskiden "tercih" olan bu durum artık "zorunluluk"
  - Ekol iş modeli aynı zamanda Quadro ve Quadro Light kullanmalarının sebeplerinden biri

Ekol Lojistik ARGE'si

- Sipariş yönetim yazılımı
- Nakliye ve depomalar sistemlerini Ekol geliştiriyor
  - Tr – Quadro
  - World – Quadro Light

  Esneklik, hızlı değişiklik, özgünlük, müşteri beklentileri, comp. Adv., verimlilik

- Depo yönetim sistemi
  - WMS – Kod geliştirme ile özgünlük ve yetkinlik
- Material flow kodlarını kendileri geliştirdiler
  - Otomasyon yetkinliği
- Kod geliştirme çalışmaları
- Industry 4.0'nın temel kaynaklarından olan **veri alışverişi & dijitalleşme** için ekipleri ortaya depo müşterilerinin ihtiyaçlarına cevap vermek için ortaya çıkarak tüm şirkete yayıldı.

Optimizasyon Çalışmaları

1. Basit – Ekol tarafından kurulan modeller
2. Üniversiteler ile yapılan modeller (çözümlemeler)
   a. Depo optimizasyonu iyileştirmesi için karar verme sistemi – Ege Üniversitesi ile TÜBİTAK projesi
3. Dünyadaki danışmanlık ve çözümleme şirketleri
   a. Ortech, Optim gibi firmalar ile çözümleme, araç tanılama, rota planlama gibi konular hakkında

Mobil Çalışmalar

Mobil çalışmaları an itibariyle; sürücüler, liman çalışanları, nakliye ve depo ile ilgili alanlarda çalışanlar kullanıyor. Fakat gelecek için (Industry 4.0'nun tamamı göz önünde bulundurularak)

- Dikey Entegrasyon – Kurum içi işleyiş ile ilgili olan projeler
    - One order projesi ("One Ekol, One Order")
        - Tek sipariş platformu üzerinden izlenmesi – Örn: İspanya'ya gönderilen Macaristan'a gidecek malın Macaristan'daki Ekol yetkilisini önceden uyararak gümrük işlemlerinin daha hızlı tamamlanması
        - Avantaj: Dağınık sistemi birleştirmek + ön uyarı sistemleri ile uygulanabilir öneriler sunulması
        - Kontratlı işler için kritik
        - Kişiye bağlı olan sistemleri bağımsız hale getirmek

Güvenlik

- İç güvenlik önlemleri
    - Kişiye özel güvenlik izinleri – veriye kimin ve hangi yetkilinin ulaşması gerektiğine göre sınıflandırma (iç güvenlik önlemleri)
    - Dış: Yeni teknolojiye yönelik mimari (micro service gibi)

Data Warehouse Projesi

- Şu anlık raporlama ile ilgili projeler
- Gelecek için: Analizler, machine learning, deep learning ile ilgili projeler

  Örneğin: Cumaları TOFAŞ Bursa yüklemeleri x çevresel koşulundan dolayı Yalova gemisine gecikiyor. Sistem bu bilgiyi öğrenip tehdit için uyarı verebilecek şekilde düzenlenmiş olacak.

- Optimizasyon uygulamalarında çok fazla kabul edilen parametre var ve input parametrelerinin analizi için kritik bir çalışma
    - Amaç: Varsayımı bilgiye dönüştürmek
- Diğer karar destek sistemleri için doğru parametreler

Bulut Teknolojileri

Cloud based → one order, mail sistemi

Sales force → cloud tabanlı dışarıdan uygulama

Mobil çözümler her çalışana sürücüler bile CRM kullanıcısı olması amaçlanıyor

Araç Takip Sistemleri

Birbirleriyle haberleşme
Kontrol sese bağlı ve doğru
Araç takibi

Very toplama – yeni bileşenler ekleyerek geliştirme – esneklik burada fark yaratan faktör

Sensör verileri

Trailer takip ünitesi – Tübitak Proje
Önemi: Daha fazla bilgi ile tam kontrol
Örn: Araç yükleniyor mu bilgisi için şoföre güvenilmesi gerekir, bunun yerine gerçek ve doğru bilgiler
Otonom → Endüstri 4.0 için kritik
Sürücü bilgi veren olacak ana görevi objektif değil sübjektif bilgiler vermek olacak

Robot Teknolojileri

- İnsan tarafından yapılan işlemleri elimine etmek için yapılan çalışmalar
- Gelecekte olabilecek proje: İnsan elinin yapabileceği pick & pack işlemlerinin robotik sistemlerce yapılması
- Görüntü işleme – Akan veya sabit görüntülerle know-how oluşturma
- Barkod okuma çözümleri
- Farklı kullanım amaçları oluşturup geliştirmek
    - Örn: Gelecek için → Depolardan çıkan mal ölçümü, insansız sayım çalışmaları (sabit kameralar vs.)
- Barkod okunması projesi – Tübitak projesi – Üniversiteler ile bağlantı
    - Okuyucuların ikamesi olacak – ithal yerine yerli üretim
    - Dışa bağımlılığın azaltılması
    - Amaç: dışa bağımlılığı azaltmak – iş prensibi
        - Sektöre özel çözümler, uyarlamalar yapmak
        - Donanım değil yazılım bileşenleri dışarıdan kullanılabiliyor