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BARRIERS TO INNOVATIONS IN E-LOGISTICS IN THE DIGITAL AGE

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ABSTRACT

BARRIERS TO INNOVATIONS IN E-LOGISTICS IN THE DIGITAL AGE

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In this study, the effects of technological developments, which have entered our lives in recent years and have influenced a large part of them, on the industry and logistics sectors and the barriers in front of businesses that want to switch to new systems by applying these developments have been studied. First of all, detailed information about logistics and industry areas was shared, and all the developments in these areas from the past to the present, especially the systems developed in recent years, were mentioned. Later, when companies want to adapt to these technological developments, a literature review was made about the challanges that appear in front of them, and 9 barriers were determined and these were grouped under 3 main dimensions. In the last part, the priorities of the barriers in front of the companies in order to move on to new applications were determined by interviewing 6 experienced people in the sector and using the best worst method.

Keywords: logistics, industrial developments, industry 4.0, logistics 4.0, e-logistics, best worst method

ÖZ

DİJİTAL ÇAĞDA E-LOJİSTİKTE YENİLİKLERİN ENGELLERİ

Eryılmaz Taşdemir, Sanem
Yüksek Lisans Tezi, Uluslararası Lojistik Yönetimi
Danışman: Dr.Öğr.Üyesi Aylin ÇALIŞKAN
Mayıs 2022

Bu çalışmada, özellikle son yıllarda hayatımıza giren ve büyük bir kısmını etkisi altına alan teknolojik gelişmelerin endüstri ve lojistik sektörlerine olan etkisi ve bu gelişmeleri uygulayarak yeni sistemlere geçmek isteyen firmaların önlerine çıkan bariyerler üzerinde çalışılmıştır. Öncelikle lojistik ve endüstri alanları hakkında detaylı bilgiler paylaşılmış bu alanlardaki geçmişten günümüze olan tüm gelişmelerden özellikle son yıllarda geliştirilen sistemlerden bahsedilmiştir. Daha sonra firmaların bu teknolojik gelişmelere uyum sağlamak istediklerinde önlerine çıkan engeller ile ilgili literatür taraması yapılarak 9 adet bariyer belirlenmiş ve bunlar 3 ana başlık altında toplanmıştır. Son kısımda ise sektörde tecrübeli 6 kişi ile görüşülüp en iyi en kötü methodu kullanılarak firmaların yeni uygulamalara geçmek için önlerindeki bariyerlerin öncelikleri belirlenmiştir.

Anahtar Kelimeler: lojistik, endüstriyel devrimler, endüstri 4.0, lojistik 4.0, e-lojistik, en iyi en kötü methodu

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Sanem Eryılmaz Taşdemir

İzmir, 2022

TEXT OF OATH

I declare and honestly confirm that my study, titled "BARRIERS TO INNOVATIONS IN E-LOGISTICS IN THE DIGITAL AGE" and presented as a Master's Thesis, has been written without applying to any assistance inconsistent with scientific ethics and traditions. I declare, to the best of my knowledge and belief, that all content and ideas drawn directly or indirectly from external sources are indicated in the text and listed in the list of references.

Sanem Eryılmaz Taşdemir

23.05.2022

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SYMBOLS AND ABBREVIATIONS

ABBREVIATIONS:

MRP Materials Requirements Planning

DRP Distribution Resource Planning

SCM Supply Chain Management

QR Quick Response

EDI Electronic Data Interchange

ERP Enterprise Resource Planning

RFID Radio Frequency Identification

MRP Material Requirements Planning

JIT Just-In-Time

3PL 3rd Party Logistics

4PL 4th Party Logistics

PRM Product Recycling Management

IT Information Technologies

APS Advanced Planning Systems

WMS Warehouse Management Systems

TMS Transport Management Systems

ABC Activity Based Costing

CPS Cyber-Physical Systems

IOT Internet of Things

3D Three-Dimensional

ISO International Standards Organization

ITS Intelligent Transportation System

ISMS Information Security Management System

UAV Unmanned Aerial Vehicles

MCDM Multi Criteria Decision-Making

CR Consistency Ratio

BWM Best-Worst Method

SYMBOLS:

c_b The most desired

c_w The least desired

A_B Best-to-others

A_W Others-to-Worst

CHAPTER 1
INTRODUCTION

Throughout history, there have been four different industrial revolutions. The revolutions that started with the invention of mechanical workbenches that enable more efficient use of water and steam power went into the second phase with Henry Ford's production line design and the use of electricity in mass production and the development of the production line. The third period was with the introduction of programmable machines in production, which caused the replacement of mechanical and electronic technologies with digital technology in the 1970s.

Finally, with the beginning of the industry 4.0 revolution, industries have developed hardware and software which activates these hardware that consume less energy, therefore less costly and can operate with higher efficiency and reliability.

These developments in the industry have affected many other sectors and has given a great acceleration to the logistics sector. As the developments in the industry progressed, some revolutions were experienced in logistics as well.

Considering that logistics covers all the processes of transportation, inventory, storage, material management and packaging, it has become inevitable to develop logistics activities in order to meet both the diversity in production and the increasing human needs with the developing technology.

As a result of these developments, with the continuous increase in production and consumption and also increasing globalization day by day, allowing to reach even a product on the other side of the world; traditional methods have begun to be insufficient in the face of increasing workload. It has become inevitable for companies to start using new systems such as cyber-physical systems, big data, cloud systems and autonomus robots in warehouses.

These systems have many advantages such as cost reduction, fast, error-free and instantaneous workflow, customer satisfaction, etc. However, as with all innovations, these systems have many advantages as well as disadvantages. Even though

companies are aware of these advantages, they feel uneasy about switching to new systems due to some barriers. Some of these barriers are technical challanges, managerial and economic challanges, and regulatory and social challanges.

In this study, the barriers that logistics companies encounter when they want to use new systems that have entered our lives with technological developments have been studied, some of the barriers have been determined as main headings and sub-headings, and the weight ratios of the barriers determined by interviewing experts in the field, using the best worst method. The specific area of research is the barriers to innovations in e-logistics in the digital age.

1.1. Logistics Management and Supply Chain Management

In these days, businesses have to give importance to speed, cost and quality in products and services in order to provide competitive advantage and make it sustainable, especially in global markets. One of the most important way to achieve this is to adapt the supply chain and logistics systems to advanced technology. Logistics is an effective and efficient management of the movement of all kinds of products, services and information flows in the supply chain from the starting point of the source to the point of consumption in order to meet the needs of customers. Logistics; "…the right amount of the right products represents an activities that enable it to reach the right customer at the right time." (Kasilingam, 1998: 1) The logistics management process consists of the planning, implementation, transportation, storage and control of the entire logistics related process. Supply chain management is defined as the sum of the activities in the delivery of a product from the initial raw material to the consumer and also post delivery activities. Supply chain management cover all activities including suppliers and companies that perform all services such as procurement, manufacturing, transportation, warehouse, sales and after-sales.(Özen,2013:98) In this context, there is a close relationship between logistics management and supply chain. Logistics management is needed to manage supply chain activities.

1.2. Definiton of Logistics

Logistics has a wide application area and different perspectives. Because of that there are many definitons.

To give an example from our daily life; all kinds of products that we use to meet our needs like all the food and drinks in our fridge, our clothes, our household items that come to our house thanks to logistics activities. Activities such as packaging, transportation, storage, distribution, and planning all these stages of the products we buy from the manufacturer until they come to us are logistics activities. Logistics is one of the basic activities and the most important one in almost every part of our life and necessary for our living.

In terms of businesses; logistics is the management of processes such as planning and controlling efficiency, reducing costs, stocking raw materials, semi-finished products which according to the needs of the customers and it is a business planning framework for the management of all.

In its most general definition, it is defined as all the activities necessary to deliver a product from its source to its customer or consumer.

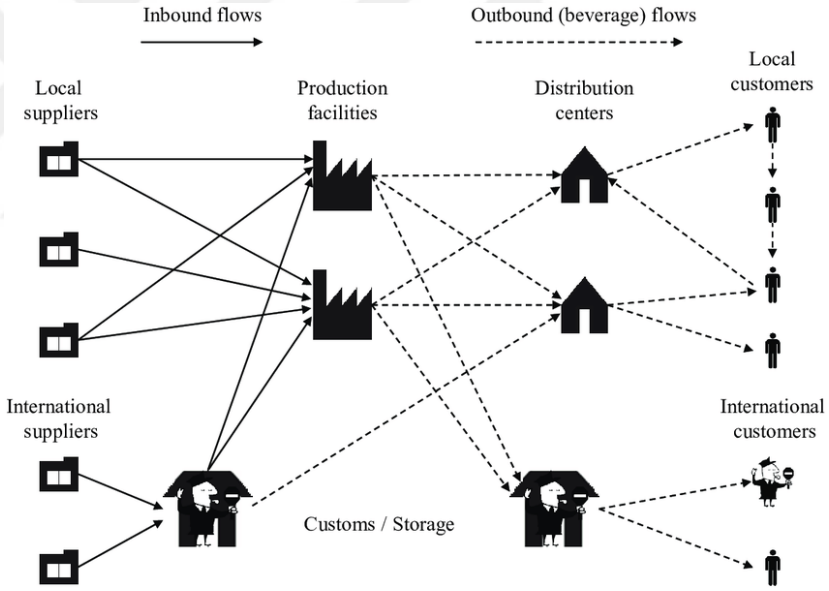


Figure 1.1. Logistics Network

Logistics network (Figure 1.1), in addition to providing the flow of raw materials, semi-finished products and finished products between facilities; suppliers, production centers, warehouses, customers, distribution centers and retail outlets.

Another general definition is the "Seven Right"; which in the literature: It is to ensure that the right product is available under the right conditions, in the right quantity, in the right place, at the right time, at the right cost, for the right customer.

In this context, an important value for products or services is considered as a creative activity.

According to Logitics Management Council logitics is the process of planning implementation and control in order to reach the raw material, in-process inventory, final product or related information from the point of origin to the point of final consumption in an efficient and cost effective manner to satisfy consumer needs. (http://www.logisticsworld.com/logistics.htm(20.09.2012)

Definition of the Society of Logistics Engineers (SOLE), which is an important group related to logistics; it is the management support area used throughout the entire life of the product or system, created to ensure the efficient use of resources and to ensure the timely impact of resource inputs on the system with an effective approach throughout all phases of the product life cycle, by considering each logistics element appropriately. (Definition of Logistics, http://www.sole.org(20/09/2012))

The technical definition of logistics is; from the simplest device to the most complex systems; It is a science that ensures that all necessary processes and procedures are operated so that they are ready for duty, obtainable, supportable and have a high level of operational capability. (Lojistiğe Farklı Bakış: Entegre Lojistik Destek, http://lojistikkulubu.org/
modules.php?name=News&file=article&sid=155(01.05.2013)).

Another definition covers "the process of planning, executing and controlling products/services and their related information and inventory to ensure an efficient and sufficient flow from the production place to the consumption place in order to meet customer requirements" (Gürdal, 2006, p.11).

When the concept of logistics is used for foreign trade, the meaning of the concept is limited. In this situation, logistics is expressed as all activities and their management that ensure that a final product is delivered from the production place in the exporting country to the consumption point in the importing country in order to meet the needs of customers in return for a certain price (Koban and Keser, 2008, p.43).

1.3. History of Logistics

The history of logistics, which is defined as a concept of military origin, is as old as the history of humanity. When the settled order was settled, there were processes such as drying and storing the hunted animals and the food obtained for later use, and transporting them again. Different production techniques were created in order to process the requirement, and efforts were made to transport and store. It is ideal from prehistory to start these processes (Baki, 2004:7).

The following developments have both heralded the new century and brought along new tasks, tools and opportunities for logistics.

- In the Construction of the Egyptian Pyramids Constructing the 146 meters high and 6 million tons of Giza Pyramids by moving the blocks of tons of weight to the construction site
- The supply and logistics system used for the construction of the columns in the Islamic structures in the Cordoba Mosque, which was built by the Andalusian Umayyads in Spain in 756 as the largest mosque in Europe.
- In the city of Hamburg in Germany in 1188, for those who want to travel more safely in the North Sea and do business abroad the Hanseatic union known as the International Network - the transport of over 200 thousand fur skins by Hanseatic ships in the association of package transport and international maritime transport.
- Sending the first letters to Paris, Belgium, Spain and the Vienna Empire with the Postal service, in Europe
- Thanks to new technologies in transportation, finding new ways, building railways, using steam engines, inventing vehicles, using steam power in railroads and ships, discovering crude oil

The emergence of logistics as a science began in the early 1900s with the distribution of agricultural products in terms of strategy, time utility and place utility. (Douglas, Stock and Ellram, 1998: 5).

It was used as a military term for the first time in the second World war, and it expressed the whole of services that connect and implement multifaceted services such as road, communication, health, food - beverage and weapon provision in the

most rational, effective and rapid manner in a plan and program in war or military operation.

During World War II, armies started to use new forms of logistics and analyzed their systems in order to ensure that the materials they needed were at the desired place. After the war, marketing managers turned their attention to the post-war demands and due to the decrease in profits, a period in which more effective cost control system researches were started in business circles. Many companies have realized that there is neither careful study nor coordination in their logistics and distribution activities.

The recent Körfez War has demonstrated how important logistics is in the military field. In this war, the American Armed Forces daily; it consumed 5,000 tons of ammunition, 555,000 gallons of fuel oil, 300,000 gallons of water, and 80,000 kg of meat. An officer in charge of transporting everything from toilet paper to letter organized 100,000 trucks and 50,000 employees in an open-air warehouse to distribute the army's food and other supplies.

Table 1.1. Historical Development of Logistics

Years	Stages	Headquarters	Organizational Design
1960’s	Storage and Transportation	Sales and marketing, Storage, Stock management, transportation activity	Dispersed logistics activities, Weak connection between logistics activities, Low logistics management authority supports business success
1980’s	Total Cost Management	Centralization of logistics, Total cost management, Process optimization, Logistics as a competitive advantage	Centralized logistics activities, Growing logistics management authority, Computer applications
1990’s	Integrated Logistics Management	Logistics planning, Supply chain strategies, Integration with business activities, Integration with process channels	Expansion in logistics activities, Supply chain planning, Support for total quality management, Logistics management activities
2000’s	Supply Chain	Strategic supply chain view, technology use,	Commercial partnership,

	Management	Collaborating on supply chain TQM indicators	Virtual organization, Changes in demand, Benchmarking and restructuring
2000 and after	E-Supply Chain Management	Using the internet in the concept of SCM, Low cost instant database sharing, Electronic information, SCM synchronization	Making a trade partnership with the supply chain network, E-Commerce, Organizational agility and measurability

Source: David F. Ross, Introduction to E-Supply Chain Management, CRC Pres LLC, 2002, s.6.

Before 1950: Until the 1950s, businesses around the world did not recognize the concept of logistics and continued their logistics activities in separate departments and under different responsibilities. Often, the objectives of these departments conflicted with each other, making it difficult to act together. With the emergence of the marketing approach in this period, logistics increased its importance.

1950-1960: In this period, distribution systems were unplanned and irregular. Manufacturers would produce, retailers would sell, and somehow the goods would reach the shops. Distribution was generally done by the transporters and manufacturers' own vehicles. There was no real connection between the current controls and the various distribution-related functions. (Alan Rushton-Phil Croucher-Peter Baker, The Handbook of Logistics and Distribution Management, Kogan Page, 2006, s.8.) In the 1950s, terms such as physical distribution, material management, supply management and distribution management began to be used as reference in business periodicals for the first time. (John Joseph Coyle-Edward J. Bardi, The Management of Business Logistics, West Publication Coperation, 1980, s.4.) In addition, due to the economic stagnation of the USA in the 1950s, the emphasis on the circulation of industrial goods in foreign resources also led to the development in these years.

With the discovery of Sea Containers in 1956, the structural revolution in world trade and the increase in the international circulation of goods, the situation of production in almost all industries in the world has changed. This also means that people's consumption habits change. Container transport due to the importance of maritime transport in international trade has had a significant impact on globalization.

1960-1970: Companies began to focus on developing detailed marketing strategies to create and capture customer loyalty. The emergence of the concept of business logistics coincides with the 1960s. What triggers this change is the transition from mass production to large-scale and small-scale production. In this period, there was no standardization of logistics or a generally accepted form of expression. CLM, which makes the most valid definition of logistics today, was established in 1963.

1970-1980: This process is an important decade in the development of the concept of distribution. One major change was the determination by some firms that the functional management structure of an organization should include distribution. This decade has seen an increase in the strength of manufacturers and suppliers, as well as a surplus of large retailers. There was a conceptual change in the regional and local distribution warehouse to initially supply their own shops and larger retail chains developed in their own distribution networks.

In addition, due to the increase in oil prices in 1973, the effects of logistics activities on businesses increased. The slow growth of the market, high inflation pressure during the economic recession, the release of transportation control and the discovery of the product diversity of third world countries in foreign markets have increased the importance of the logistics system in planning and business (Tseng, 2005: 1659-1660).

In the 1970s, materials requirements planning (MRP), inventory management systems and distribution resource planning (DRP) and billing systems were developed to integrate production, purchasing and inventory management functions. These systems are generally function-based and therefore developed independently of each other (Wang and Pettit, 2016: 6).

1980-1990: The concept of logistics began to be used by large masses in 1985. The next phase of the concept is the transition from logistics to Supply Chain Management (SCM). The main reason behind this transition is the rapid development in information systems and communication technology after the 1980s. With the deregulation of the telecommunications sector in the USA in 1981, the speed of use of information and communication technologies increased. The deregulation of the transport sector also coincides with the same period. With the deregulation of transport, price flexibility has emerged and the services that transport companies

provide to their customers have increased significantly. In 1985, the concept of QR (Quick Response) emerged in the clothing industry, followed by movements in other sectors. With the development of inter-institutional information networks and EDI (Electronic Data Interchange), the transition process to SCM has begun.

In the 1980s, a new logistics system, MRPII, was developed due to the inadequacy of MRP information technology for financial and workforce plans in logistics activities carried out to reduce costs (Wang and Petit, 2016: 6).

1990-2000: In the early 1990s, businesses began to radically expand their integrated logistics management activities that would broadly change their production capability in order to respond to new market challenges, and tended to have all subsidiary companies in a string along the supply chain. The main reason for this development is the increasing need for logistics integration, both internally and externally, in the late 1980s and early 1990s. For this reason, communication and integration tools developed rapidly between those years. In logistics processes, restructuring and time-oriented management were captured and the infrastructure of information technologies in logistics was created (Ericsson, 2007: 135). Towards the middle of the 1990s, with the merger of logistics and information technologies, there was a significant increase in the frequency of use of technology in logistics activities. In particular, information technologies, which are increasingly applied to the distribution function, have significantly reduced the amount of storage in inventory in high-efficiency facilities. Today, logistics service functions such as wholesale and retail, where stocks are kept to a minimum in stores and offered for sale, were realized in these periods (Hesse and Rodrigue: 2004: 174).

In the 1990s, when logistics integration began to be used at a high rate, the inadequacy of the logistics systems used in the previous years led to the creation of enterprise resource planning (ERP). With the activation of ERP, all integrated logistics activities could be combined under a single organization (Wang and Pettit, 2016: 6).

Year 2000 and After: Logistics, which adds new services to its services day by day, has now become an important component of business strategies and a general requirement to provide competitive advantage. Logistics activities started to be divided into production logistics, supply logistics and distribution logistics.

After 2000, businesses faced many difficulties in terms of competitive advantage, gaining profit, and launching new products. These are specifically for redefining business goals and for improvements that need to be made.

It gave rise to many new ideas. Logistics and supply chain has finally been recognized as a key to business success, and for many organizations, changes in logistics have brought about significant improvements in their business. Leading organizations have realized the added value that logistics can offer to businesses. For this reason, the role and importance of logistics has continued to be recognized as an important aid for business development (Rushton, 2010: 9).

As can be seen from its historical process, logistics has undertaken important tasks that facilitate life over the years. Today's understanding of modern logistics is also gaining importance rapidly, and considering that logistics is a fundamental factor for gaining competitive advantage, it is obvious that its importance will increase even more (Gümüş, 2009: 100).

Finally, we have met the concept of e-logistics with the development of technology, increase in business opportunities, globalization, web-based information communication, that is, communication over the internet.

1.4. Basic Logistics Activities

Logistics, a tool of supply chain management, consists of a series of activities. Each logistics activity has an effect that will affect each other and change their costs and efficiency. Therefore, logistics management requires a systematic approach, which constitutes the main philosophy of logistics management.

1.4.1. Transportation

The duty of the transport; it is to send the raw materials from the point of supply to the point of production, and the products from the point of production to the points of consumption in desired quantities, within the planned time and at a reasonable cost. (Zeyyat Sabuncuoglu-Tuncer Tokol, Enterprise I-II, Ornek Bookstore, 1987, p.200.) The role of transportation in logistics management has changed significantly over the past three decades. A wide range of transportation alternatives exist today to support product or raw material logistics. For example, logistics managers can implement

special integrated transports to reduce overall logistics costs. (Bowersox-Closs-Cooper, a.g.e., s.328.)

The use of the right transportation method, which is one of the seven lines of logistics, is one of the most important logistics activities. Each product is transported with different transportation methods according to its type, weight, volume, quantity, shelf life, price and degree of need. Logistics means the system to determine the most suitable one among these options and put it into practice. The method by which the product will be transported forms the basis of the process planning.

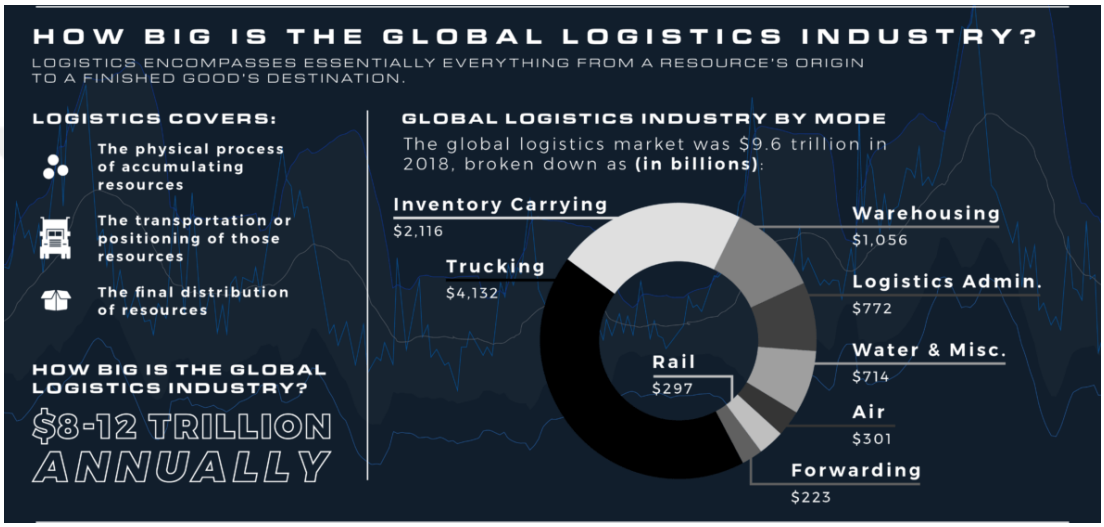


Figure 1.2. How Big is the Global Logistics Industry?

Source: Ricks, E.

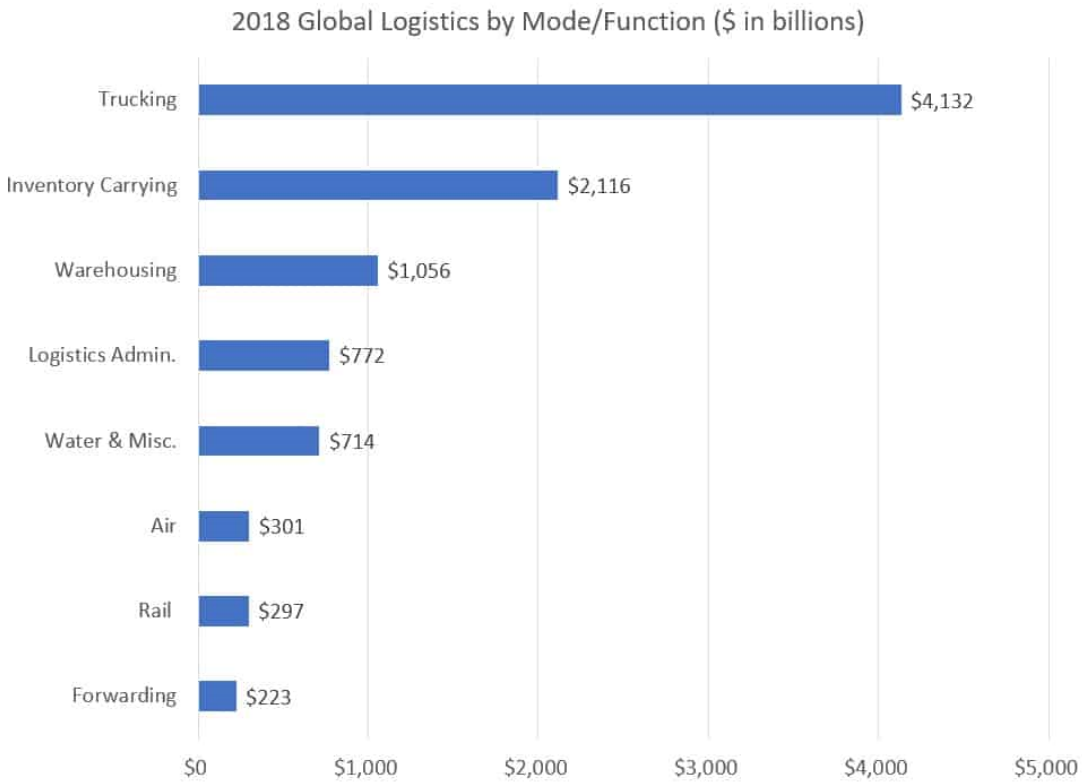


Figure 1.3. Global Logistics by Mode/Function

Source: Armstrong & Associates Inc. https://www.3plogistics.com/

Transport modes are divided into the following subgroups according to the types of vehicles used.

- Road Transport,
- Maritime Transport,
- Air Transport,
- Railway Transport,
- Pipeline Transportation,
- Inland Waterway Transportation,
- Combined Transport.

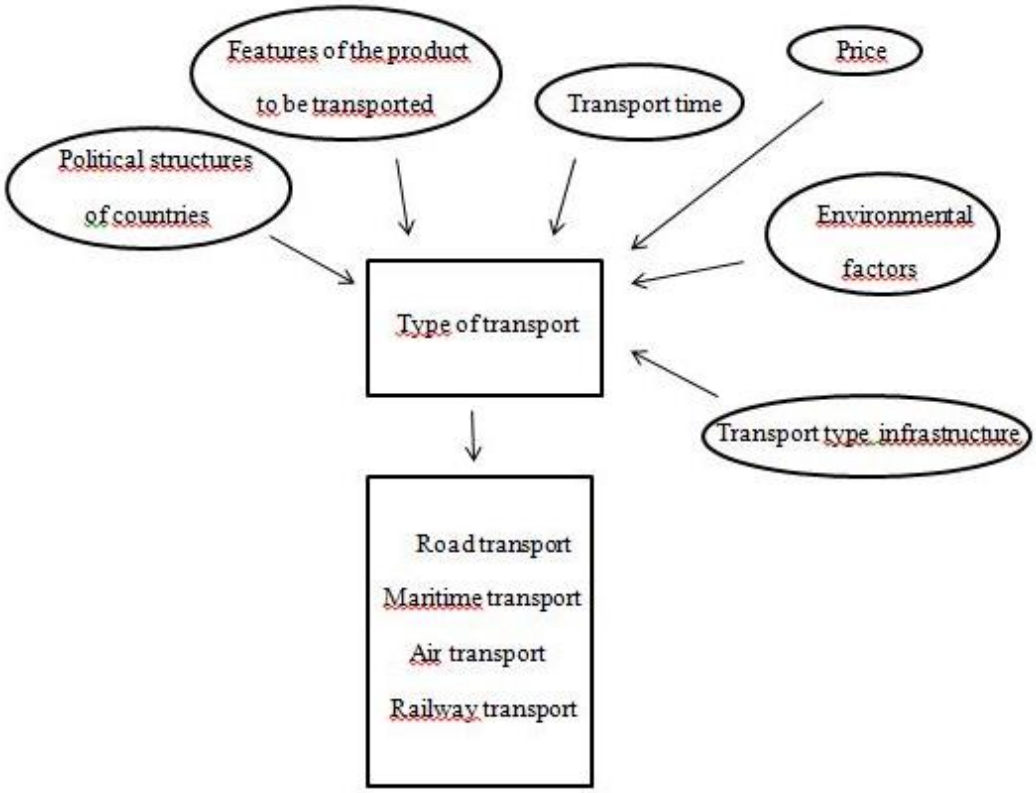


Figure 1.4. Factors Influencing the Selection of Transport Type

Source: Emine Koban and Hilal Yıldırır Keser. Logistics in Foreign Trade. 2nd Edition, Bursa: Ekin Publishing, 2000, p.109.

The factors that are effective in deciding which of these transportation groups will be selected are shown in Figure 1.4.

The decisions made by the transport can be listed as follows:

1. Transportation type decision

Table 1.2. Characteristics of Transport Types

Business features	Railway	Road Transport	Maritime Transport	Pipe line	Air Transport
Speed	3	2	4	5	1
Talent	2	1	4	5	3
Reliability	3	2	4	1	5
Capacity	2	3	1	5	4
Frequency	4	2	5	1	3
Composite Result	**11**	**10**	**18**	**17**	**16**

Source: Bowersox-Closs-Cooper, ibid, p.346.

The lowest of the values in the table indicates the best. If these are briefly explained:

Railway; It is a convenient mode of transport for economical and heavy-volume loads.

Roadway; It is a very flexible, relatively fast and inexpensive mode of transportation.

Seaway; It is the slowest and most economical mode of transport, and it is the most suitable method for transporting large volumes of goods.

Airline; It is the most expensive but fastest mode of transport.

Pipe Line; It is mainly used for transporting gas and oils.

River Road; It is a form of transportation limited to the places where the river passes.

Electronic Transportation; is the newest form of transport. Goods such as music, which used to be sent only in physical forms, can be sent electronically via the internet with this form of transport. (Sunil Chopra-Peter Meindl, Supply Chain Management Strategy Planning and Operation, Prentice Hall, 2000, s.55.)

2. Carrier selection (decision to determine the carrier or carriers to carry out the transportation)

3. Selection of transportation vehicles (decision of whether transportation will be carried out with own goods, rental or purchasing)

4. Determination of the traffic line (decision of which route to follow for the delivery of products)

5. The carriage contract and the decision to determine its scope

6. Preparation of transport documents

Air transportation is the least used of the five known main transportation methods (road transportation, rail transportation, seaway transportation, air transportation and pipelines) in terms of ton-km. In global transportation, 29% of the road, 28% of the railways, 22% of the seaway is used, while the pipelines are used at the rate of 19%, the rate of air transport is only 0.2%. While air transportation occupies a very small place in world transportation, the rate of income from this operation is also increasing. While the land transportation turnover provides 69% of the total transportation market, seaway transportation is 19% railway 5% pipeline 4% and air transport is 3%. In general terms, transportation is product transportation. This

activity consists of transport vehicles. While selecting this field of activity, it is selected in accordance with the transportation styles of unprocessed and processed materials. (YILDIZTEKİN, Atilla, Air Cargo Transportation, http://www.atillayildiztekin.com/ p=318(5.5.2013)).

1.4.1.1. Road Transportation

Road transport has a very important position in logistics activities. Delivery services from airports and ports for air and sea transportation can be expanded by road transportation. While door-to-door delivery cannot be made in any other mode of transportation, it can be done in road transportation only.

The advantages of road transport are its accessibility to land areas and relatively inexpensive short-distance transport. Its disadvantages are low capacity, low security and low speed compared to other transportation modes. It also causes environmental pollution due to the type of energy it uses. The excessive use of land transport brings along many problems such as traffic congestion, pollution and traffic accidents. Another disadvantage is the increased cost expenses due to rising oil prices. Despite this, the rate of orientation to the roadway is gradually increasing, both in western countries and in our country, compared to iron and airways.

Turkey is one of the countries with the largest and youngest fleet among the European Union countries. However, this vehicle cannot use its fleet efficiently due to the problems experienced at border crossings, passport quota and visa applications. Even though the transition quotas have been increased in recent years as a result of the intense work of the state institutions, this increase does not meet the rate of increase in Turkey's foreign trade. Considering the export target of 500 billion dollars within the framework of the 2023 vision, it has become vital to eliminate these and similar restrictions. Companies that prefer road transportation in their foreign trade transactions generally state that the density at the border gates negatively affects costs and times. Successful improvement projects were carried out with the build-operate-transfer model at the border gates.

Nevertheless, road transport has been the most used mode of transport in our industry since the beginning of the logistics service. This is why; Its share in the logistics sector of our country is around 40%. The biggest reasons why companies have mostly adopted this mode are; door-to-door transportation can be counted as speed,

flexibility and reliability (İPEKÇİ, Emre, Karayolu Taşımacılık, http://www.emreipekci.com/karayolu-tasimaciligi.html/(5.5.2013)).

1.4.1.2. Maritime Transport

The transportation of an item from the loading port to the unloading port by sea vehicles is maritime transportation. The oldest known use in maritime transport, which has been used since the first periods of history, was in the Aegean Sea by the civilizations and city states established in Anatolia and the Greek basin.

Maritime transport plays an important role both in international transport and for Turkey. Turkey has a great advantage in maritime transport due to its geopolitical position. It is known that approximately 90% of the activities subject to international trade in the world and in our country are carried out by sea. It can provide cheap and high carrying capacity for consumers. Therefore, it has a vital position in the transport of certain goods such as crude oil and grains.

The disadvantage of maritime transport is that it requires longer transport times and the program is highly affected by weather conditions. In order to reduce costs and increase competitiveness, existing ogistics firms tend to use large-scale vessels and cooperative operation techniques. In addition, customers using maritime transport care more about service quality than delivery price. Therefore, in order to increase service satisfaction, it is necessary to create new logistics concepts such as real-time information, accurate time windows and goods tracking systems.

Transportation by sea is 3.5 times cheaper than railway, 7 times cheaper than road and 22 times cheaper than airway. For this reason, transportation is carried out in different ways on the seaway. The first of these is Tramp Transport. In this transportation, which is carried out between two cargo ports and does not have a specific date or time, the main thing is the presence of the cargo. It is a form of transportation used for the transportation of materials that fill all or a large part of the ship, such as underground mines, crude oil, timber, coal, in one go. It is not easy to talk about a certain freight in Tramp Transport since the realization of the transport depends on the presence of the cargo. For this reason, shipowners want to direct their ships to areas where there is a higher probability of cargo. Another is Layner Transport. In contrast to tramp transportation, the departure, destination and transfer ports of this type of ships are predetermined, in which the service is the basis, not the

load. Ships stop by these ports on predetermined dates and perform loading and unloading operations. Since this transportation is based on tariffs, those who will transport their goods make their plans in advance according to this situation and ensure that the goods reach the destination by giving their cargo to the carrier company on the date the ship arrives at the port. The best example of liner transportation is container and Ro-Ro transportation (İPEKÇİ, Emre, Denizyolu Transportation, http://lojistikkulubu.org/modules.php?name=News&file=article&sid=144 (5.5.2013)).

Figure 1.5. Maritime Transport Routes and Strategic Crossing Points

Source: http://www.utikad.org.tr/pdf/Lojistikuskavrami.pdf(6.5.2013)

The routes and strategic transit points used in global maritime transport are shown in the figure 1.5 below.

According to CNBC-E Business, maritime transport and economies of scale will increase greatly in the future. This will also lead to company mergers. In this environment where competition is heating up, any investment to be made in Sea Freight from today will always take both countries and companies located in these countries one step ahead in global trade (İPEKÇİ, Emre, Denizyolu Taşımacılık, http://lojistikkulubu.org/modules.php?name =News&file=article&sid=144 (5.5.2013)).

Turkey has a significant maritime potential with its 8,333 kilometers of coastline which is advantageous in terms of maritime and its position as a natural bridge between Europe, Central Asia and the Middle East. At the same time, it is a maritime transportation center extending from the Strait of Gibraltar to the Atlantic Ocean, the

Suez Canal to the Arabian Peninsula and the Indian Ocean, and the Black Sea-Aegean and Mediterranean connections of the Turkish Straits to Eurasia. In our foreign trade, maritime transport is more preferred than other modes of transport due to the excess amount of cargo transported at one time and lower costs. The Turkish maritime merchant fleet, consisting of 1561 ships, ranks 28th in the world rankings.

1.4.1.3. Air Transport

Being the fastest transportation method is the most distinctive feature of air transportation. Its advantages are fast delivery, low risk of damage, safety, accessibility and unaffected by landforms. In cases where time is a critical factor, this mode of transport is preferred when transporting small and expensive products. The biggest increase in the last 20 years has been seen in air transport. Acceleration of globalization, liberalization of world trade, medicine, electronics, cosmetics etc. The reasons such as the development of the sectors have increased the amount of freight transported by air by more than 7% on average annually since 1980. According to the European Union, an increase of nearly three times is expected in the air transport sector in the next 20 years.

The biggest disadvantage is the high delivery fee. Another is that cargo planes cannot carry more than a certain size due to their carrying capacity.

A fraction of the total product costs allocated to shipping is a major consideration for most shipping. High air freight prices consume a large portion of the total costs of low value products, so air freight is not economically viable for these items. For this reason, airline transportation generally provides services for high-value products (Sadjady, 2011: 15).

Given the trend of global markets, air transport has to change the services it provides. Future trends in air transport development are related to other modes of transport and merging between air transport companies. The future goal of air transport logistics is to provide just-in-time and door-to-door service in cooperation with other modes of transport such as sea and land transport (Reynolds, 2001: 431).

1.4.1.4. Railway Transport

The advantages of transportation by train are that it is the best public transportation option based on various criteria such as the number of passengers carried, congestion-free traffic, the reduced amount of fuel and therefore the reduction of

emissions per passenger, the reduction of costs, the reduction of road accidents, increased safety, and especially long-distance movements. It is seen that it is cheaper than other modes of transportation (Dincer, Hogerwaard, & Zamfirescu, 2016: 40).

The disadvantages are slowness and low reliability. Although rail service is available in almost all major cities, the rail network is not as extensive as the road network in most countries. Therefore, the rail system lacks the flexibility and versatility of road transport. Another reason why the rail system is not as common as road transport is that it provides terminal-to-terminal service instead of door-to-door service. Effective and efficient use of the rail system can be achieved by integrating it with trucks to provide door-to-door service, like other modes of transport (Farahani, Rezapour and Kardar, 2011: 14).

It is generally used for the transport of materials that need to be transported slowly such as chemicals and low-value goods such as wood, canned food, and raw materials. It is an infrequently used type of transport because railway networks are not very common, they are used more in passenger transport instead of commercial cargo, and a large amount of cargo must be transported.

The first entry of the railway into our country was in the last period of the 19th century, and states such as Germany, England, France, Italy and Russia pioneered the development of railways in our country for different reasons. The length of the railways, which were created by the Ottoman Empire by giving a profit guarantee to foreign partnerships and giving the right to operate for many years, exceeded 4000 km, which corresponds to about half of the railways in our country at the moment.(Akgüngör and Demirel, 2004, p.423). As of the end of 2010, the total length of the railways operated by TCDD is 11940 km. 5% of the 550 million tons of transportation carried out annually in Turkey is made by rail. Between 2001 and 2009, the amount of international transportation by railways increased by 154% on a ton basis.

1.4.1.5. Pipeline Transportation

Pipeline transportation sub-sector covers the activities of planners, investors and operating organizations in the transportation of crude oil, petroleum products and natural gas by pipelines. It has a unique importance among the types of transport. This type of transportation is not affected by the conditions that may occur in air and

traffic and allows the transportation of large quantities of cargo. The highest fixed and smallest variable costs among all modes of transport are in this mode of transport (Baki, 2004: 54). Although the investment cost of pipeline transportation is higher than road and sea transportation, it also covers the investment in a short time since it is faster, more economical and safer than other transportation modes.

The longest gas transmission line in the world extends from Alaska to Canada with a total length of 7700 km. In the Americas, the countries where natural gas transportation is carried out most intensively by pipelines are the USA and Canada. The longest crude oil transportation line in the world is the one in Canada, with a diameter of 34" and a length of 3220 km, reaching from Manitabo to Ontario.

As in the whole world, importance has been given to transportation by pipelines in our country in recent years. In addition to the general characteristics of the pipelines, international crude oil and natural gas pipelines that will pass through Turkey are expected to increase rapidly, especially due to the geographical location of our country.

1.4.1.6. Inland Waterway Transportation

It is a form of transportation in rivers, lakes, canals and underground waters. Although it is widely and frequently used in Europe, it is still among the developing sectors in our country. Special transportation vehicles are needed for the development of this mode of transportation. Vehicle capacities generally vary according to the depth of the water.

It is not possible to benefit efficiently in our country because the rivers of our country have a high flow rate and do not have the ability to carry them due to geographical reasons (Ateş, 2009, http://www.hilalyildirirkeser.com/hilal/ vocationaluygulama/230730007.pdf(6.5. 2013)).

1.4.1.7. Combined Transport

Combined transportation is a transportation system that uses more than one type of transportation. Technological, organizational, price policy and legal integration should be considered as a whole during the realization of combined transportation. Here, transportation operations are carried out in coordination with each other. A single mode of transport has no place in combined transport. If there are various vehicles to carry out the transportation in combined transportation, the fact that the

transportation is carried out at low cost and by experts is among the reasons why combined transportation is preferred. For example; It is possible to transport directly from Central Europe to Iran by train, truck or ship. However, combined transportation should be preferred to save time and cost (Ateş, 2009, http://www.hilalyildirikeser.com/hilal/meslekiuygulama/230 30007.pdf(6.5.2013)).

"Intermodal transportation", which is the most common and contemporary transportation method today, is the transportation of the cargo to its final destination by using at least two transportation types in the door-to-door transportation chain. "Multimodal transportation", which is a different version of this, is transportation using more than one transportation type with different transportation units and vehicles. "Combined transportation", which is another different form of these, is the transportation of the goods in a single transportation unit using at least two transportation methods without the need for reloading (Altuntaş, Mehmet, Transportation Modes and Integrated Transportation in Logistics, http://www.ekodialog.com/ Articles/logistics_modlari_ Entegre_tasimacilik_makale.html (6.5.2013)).

Table 1.3. Comparison of Transport Types by Characteristics

Type of transport	Cost	Transport speed	Number of places served	Ability to use various goods	Frequency of scheduled shipments	Reliability of tariff implementation
Road transport	High	Fast	Wide	High	High	High
Maritime transport	Very low	Slow	Limited	Very high	Very high	Medium
Air transport	Very high	Very fast	Wide	Limited	High	High
Railway	Low	Slow	Limited	High	Low	High
Inland waterway transportation	Low	Slow	Limited	High	Low	Medium
Pipe Line	Low	Slow	Limited	Limited	Medium	High

Source: Metin Çancı and Murat Erdal, Logistics Management, 3rd Edition, Istanbul: Utikad Publications, 2009, p. 25.

In all these types of transportation, it means the transportation of goods by more than one transportation method without slowing the speed of product movement and

without changing its scale. In this system, the loads loaded on containers or trailers from one point reach the place where they will be transported and delivered in the most appropriate way without opening the cargo covers of the sea vehicles with Ro-Ro, railway and road vehicles with Ro-La vehicles and the containers or trailers.

It requires a management where there is always online control over the shipped goods. The documents, documentation, customs procedures if necessary, information flow related to this mode of transportation should be simplified and standardized for all countries.

1.4.2. Demand Forecasting and Management

It is the function of predicting the amount of goods and services that consumers will demand in the future. This estimation forms the basis for determining the production level of the enterprise. Which product will be produced, what quantity consumers will demand from this product, and when this demand is most likely to be realized are interpreted with demand forecasts. In demand planning, it is aimed to meet the customer needs at the maximum level, but to reduce the delay time, expenses, costs and stocks.

The estimation techniques used in the decision process are classified as qualitative and quantitative. Decision makers should first determine the most appropriate estimation technique for the structure of the problem to be estimated. Forecasting activities; the type of estimation is a function of the time covered by the estimation, accessible information sources and the estimation technique used (Coşkun, 2010, p.6).

Economic factors are one of the main reasons that make it difficult to determine demand. Although estimations are made based on past demands, the fact that retailers are making more promotions as a result of bad economic conditions and increased competition and promotions made by competitors make it even more difficult to forecast the demand correctly. In particular, it is difficult to forecast the sales of promotional products and related products. On the other hand, the disappearance of the usual seasonal trends in products makes demand forecasting difficult too. Especially fashion retailers have difficulty keeping up with the changes in seasonal periods and planning according to the weather conditions (Dal, 2011,

http://www.retailturkiye.com/bulent dal/yavas-ve-hizli-urunler-talep-tahmini-ve-stok-yonetimi (6.5.2013)).

However, on the other hand, good management of information, communication and relations enables demand forecasting in an effective and efficient manner (MEB, 2011: 36). With the development of technology, it is easier to determine customer requests and needs in the internet environment, customer profiling can be realized faster and it is easier for businesses to forecast demand. In this way, logistics enterprises can make more efficient decisions (Yaylacı, 2005: 15).

1.4.3. Order Management

The process of the order processing procedure refers to the time elapsed between the time the customer places the order and the time the product is received. Since this system is directly related to the order or performance cycle time, it is one of the main logistics activities (Sople, 2007: 8-9).

The general purpose of order processing is to deliver the right product to the right customer on time, cost-effectively, and profitably with a result that satisfies the customer (Turban et al., 2018: 504).

Correct management of information is required in logistics services. Logistics information system basically consists of order management processes.

The following are priorities for the correct management of information:

- Producing the service (taking the order, questioning its adequacy, scheduling the delivery and providing convenience in invoicing)
- Ensuring effective supply chain management
- Ensuring flexibility of time, place and form, etc. issues play an important role.

1.4.4. Inventory Management

Logistics businesses need inventory management in order to more easily respond to the requests and needs of their customers. Inventory management briefly; it is possible to define it as keeping the raw materials or processed products needed in line with the orders of the customers ready within the business. In the flow of goods to the market with inventory management, it is an important problem at which points and in what quantity to keep the product (Koban and Keser, 2008, p.96).

Inventory management is the function of material management that has a fundamental role in achieving its basic objectives, one of which is economic and the other is functional. These purposes are; it is to establish and operate systems that will ensure that all kinds of materials required for production are available at the point of need when needed, and to contribute to the business objectives by saving on all costs related to these activities. All businesses want to reduce their costs and therefore increase their profits. The inventory control system is also applied by the managers within the enterprise to serve this purpose. Because there are many cost elements that are affected by inventory control in businesses. These are (http://erp.karmabilgi.net/envanter management/(5.5.2013));

- Quantity discounts
- Preparation costs
- Direct material costs
- Direct labor costs
- Overtime and shift costs
- Costs of recruiting, training and firing new workers
- Excess capacity costs
- Cost of kidnapping
- Wear and tear costs
- Taxes and interest charges
- Storage costs
- Transportation costs
- Price changes

Inventory types according to the reasons for holding inventory are as follows (Tek, 1999: 667):

- Period Stock,
- Stock in Transit,
- Bumper Stock,

- Speculative Stock,

- Seasonal Stock,

- Dead Stock,

The rapid development of information and communication technologies has also positively affected inventory management. In the past, stock counting, which was done with traditional methods, is now done more quickly with the help of radio frequency identification (RFID) technologies and barcode systems. In addition, thanks to these systems, errors in inventory counting are minimized. Some applications that contribute positively to inventory management; enterprise resource planning (ERP), radio frequency identification (RFID), material requirements planning (MRP), just-in-time production (JIT) and barcode reading systems. With the help of these systems, inventory management has taken its place as an important department for the logistics business (Koban and Keser, 2007: 95).

Inventory management has many positive aspects for logistics businesses. However, inventory management is a process that needs to be done very carefully. If the logistics company has excess stock, the warehouse and so on. It can harm the business as it increases costs. In addition, low stock or less stock than customer demand is an important problem for the enterprise (Kayabaşı, 2007: 63).

1.4.5. Warehouse Management

Storage and warehouse operations constitute one of the most important links of the supply chain. Warehouses; raw materials, semi-finished and finished products are the places where they are kept. Logistics system is one of the important points of activity types in terms of physical distribution of products and time benefit. Because, thanks to storage, businesses have the opportunity to respond to customer demand in an unexpected time in a desired way. For this reason, companies need storage systems in order to ensure that factors such as customer retention programs, which are one of the most important efforts of businesses today, are healthy and beneficial, and businesses do not lose customers. One of the most important functions that determines success in terms of service level is storage. As the flow rates of the product and other moving elements decrease, an increase in total costs is observed. For this reason, storage processes are low value-added operations at the same time that cause high costs for supply chain management (Görçün, 2010: 374). The

purpose of warehousing is, on the one hand, to facilitate the movement of all the input sources necessary for production to the production sites, and on the other hand, to the market of finished products in large quantities and arranged according to customer orders. In addition, it is to reduce transportation costs, coordinate supply and demand, assist the production process and the marketing process. Warehouses, on the other hand, are places established in bonded areas where the quantity, quality and characteristics of goods and goods are examined, their value is determined and they are protected under appropriate conditions. Warehouses, as places with the characteristics specified in the relevant articles of the Customs Law and Customs Regulation in our country, constitute intermediate points in the international logistics workflow.

According to the traditional management approach, warehouses are considered only as the place where products are stored, but today, within the framework of a different understanding, it is seen as a process that helps marketing within the supply chain, with the direction of consumer/customer demands (ITO, 2006:16-17).

In addition, from the point of view of the supply chain, the warehouses provide stocks against the demands that may come from the market, thus protecting the supply chain process at the point of the disappearance of the demands and providing the opportunity to respond quickly to the customer in case of demand changes. The fact that the warehouse locations are geographically close to the distribution centers creates a separate advantage for the enterprises. Because in places where the transportation infrastructure is underdeveloped and congested, there will be problems with product delivery times. For this reason, the location of product storage centers close to distribution points according to the transportation type will provide faster shipping and better customer satisfaction (Hackman and Bartholdi, 2011: 5).

While developing technology has changed a large part of the traditional business processes, warehouses have become a business center that can perform many functions such as order taking-processing, sending, stock control and invoicing.

In addition, one of the main reasons for the success of marketing is choosing the right distribution channel and delivering the product to the customers. At this point, distribution channels have a special importance. In this context, distribution channels can be listed as follows (Tekin, 2006:150):

- Direct distribution: It is a form of distribution from the producer to the customer and does not involve intermediaries.

- Indirect distribution: It is the involvement of one or more institutions and persons who are intermediaries in delivering the products to the consumer.

- Mixed distribution: It is the form of both direct and indirect distribution in the delivery of products from the producer to the consumer.

Warehousing has a strategic role for logistics. If these are to be explained in items:

- Providing local stock,
- To perform value-added services for customers,
- To serve as a control center for incoming materials by working closely with important suppliers.
- To be the meeting point of orders,
- Combining orders for more economical transports,
- To protect against variable production times,
- To provide quality controls,
- Managing reverse logistics,
- To provide production economy,
- To ensure effective purchasing.

The warehouse management function is one of the functions that both manufacturing and service businesses have problems in executing due to the increased performance expectations from this function. Although its own warehouses and other physical facilities are sufficient, it is counted among the main 3PL services due to the need for specialized support from outside in terms of management. Within the scope of this service, there are elements such as inventory management, cross-docking, measurement and collection, and the following are analyzed (Gülen, 2011, p.40).

• Inventory Analysis: In warehouses, most of the analysis can be done through inventory. These analyzes, in accordance with the purpose, are inventory based on suppliers, inventory based on material classes, etc. in a time period or a time section. Includes calculations and classifications.

• Warehouse Performance Analysis: Various warehouse performances are compared over performance indicators such as picking accuracy, transportation accuracy, error analysis, overtime hours percentages and on-time shipping percentages.

• Warehouse Cost Analysis: Warehouse costs depend on product dimensions and transportation requirements.

• Aggregation Analysis: It is also a suitable way to analyze products based on the total demand amount.

• Warehouse Space Utilization Analysis: These analyzes can be used to evaluate empty warehouse spaces. It is also looked at how effectively the occupied areas are used, and the cost per unit space of the empty spaces or volumes in the warehouses is analyzed within the said time period.

The number, size, geographic locations of the warehouse are directly related to the ability to serve customers. Therefore, storage processes must be done very carefully. In the event of a possible disruption in the storage processes, it affects many parts of the logistics business, including the production and marketing processes. All the problems arising from the minimum implementation of the storage processes can cause financial loss of the logistics enterprise and also shake the image of the enterprise (Tek, 1999: 663).

1.4.6. Packaging

One of the goals of logistics is to prevent products from being damaged to an economically unacceptable level. A wrap made of materials such as plastic, paper, cardboard and glass, which protects the products against external factors, facilitates distribution and marketing activities by keeping the materials inside together, and informs the consumer about the goods inside and containers. Well-designed packages for the protection of the products ensure that the product movements are carried out without damage. Apart from this, suitable packaging sizes also allow efficient stocking and handling (Coşkun, https://dosya.sakarya.edu.tr/ .../581802000_2._hafta_temel_lojistik_akti... (5.5.2013). Packaging should ensure that the product is protected, controlled, sheltered, presented, promoted and transported in an economical and environmentally friendly manner throughout its entire life cycle. It is also important to pack in accordance with the weather conditions and geographical conditions in which the transportation

will be made. Because, depending on the sensitive nature of the packaged product, additional packaging methods must be applied.

Packaging is the silent selling element of marketing and is valuable for logistics containment and storage activities. It contains important information to inform the consumer. The packaging can be designed appropriately for warehouse configuration and material handling equipment, facilitating movement and storage. Especially by providing protection during transportation, it is of great importance for long distances compared to multiple modes of transportation such as international transportation (Lambert, Stock and Ellram, 1998: 19).

Different packaging types are given below (Tek and Özgül, 2008: 332):

- Primary packaging; It is the inner packaging in which the product is placed directly.

- Secondary packaging: It is the packaging that protects the primary packaging and is discarded when the product is used.

- Loading or shipping packaging: It is the packaging used for the storage, transportation and identification of the product.

While making the protective packaging decision, the following points should be considered:

- The selected packaging handling vehicles and systems must be compatible with storage specifications.

- There must be consistency between the cost of the packaging and the cost of damage that may result.

- The packaging should be suitable for the protection, transportation, storage, purchase and storage requirements of retail outlets and consumers.

- Market test should not be neglected while choosing the packaging.

Table 1.4. Benefits of Packaging Activities

Transportation	Increased packaging knowledge	It reduces the delays of the shipments and facilitates the tracking of lost shipments.
	Increased packaging protection	It reduces damage and theft during shipping, but increases packaging weight and shipping cost.

	Increasing standardization	It reduces transportation costs, reduces waiting time for loading and unloading vehicles, and reduces the need for specialized transportation equipment.
Material management	Increased product protection	Reduces theft, damage, insurance costs; increases product availability; Increases product value and transportation cost.
Warehouse and storage system	Increased packaging knowledge	Increases order filling time and labor cost.
	Increased packaging protection	It expands the storage area by increasing the product dimensions.
	Increasing standardization	Material handling reduces equipment costs.
Communication	Increased packaging knowledge	Reduces product-related communications such as phone calls to track lost shipments

The balance between factors depends on the importance a firm places on each factor. Table 1.4 shows how packaging costs can be balanced with other logistics activities.

1.4.7. Handling

Handling includes operations such as storing, transporting, storing, classifying the products and dividing and combining them according to customer demands.

Handling operations; aeration of goods, mixing, repair or consolidation of containers, refurbishment of containers, sifting, discharging from large to small containers or combining containers, making new types of containers, sampling or sampling from containers.

Handling can be done with manpower, automatic systems and semi-automatic systems. Which handling system will be used in the warehouse may vary depending on the financial strength of the company, the physical structure of the warehouse, and the characteristics of the products.

Especially the recent technological developments in handling equipment have played an important role in reducing labor, equipment and operation costs and increasing performance.

1.4.8. Customs Clearance Services

Customs clearance services are a supporting activity for logistics enterprises, which are out of basic production activities. It is the service of conducting the relations and transactions with the state during the foreign trade activities carried out in the sale and purchase of all kinds of goods and services to or from the national borders, during the transit of the products or services through the bonded areas.

In particular, it is necessary to follow the legal regulations that differ and change frequently according to the product imported and exported and the country with which the commercial relationship is made, and there should be no mistakes in the documents that need to be prepared.

The customs sector is one of the areas that interact the most with the logistics sector. The fact that the first applications of outsourcing were used in the customs area supports this approach. Although national borders are no longer an obstacle in the globalization process, customs procedures are too important to be ignored for logisticians. In the global logistics approach, when choosing one of the road, air, rail, sea or other modes of transport or combined modes, the type of organization to be processed should also be taken into account. A neglected customs operation can cause not only a loss of time, but also a loss of prestige as a result of a legal proceeding.

Many large-scale, multinational enterprises prefer to have such services done by experts in order to avoid being called a customs smuggler or tax evader due to an amateur mistake (http://www.mikro-pc.com/modern-lojistikte- customs-processes.html(5.5.2013)).

1.4.9. Customer Relationship Management Services

Customer service is a comprehensive concept that can include many elements from service support, evaluation of returned goods, goods recovery, returning customer complaints and requests, product availability to after-sales services. The aim of customer service in logistics management is to do everything right the first time. Customer satisfaction is the basis of logistics management. Accordingly, "Increasing Logistics Performance" is included within the scope of total quality understanding in the entire system, which is assumed to be very well defined by the customer,

marketing philosophy, process and materials. For this, the management's perspective on the customer is very important. Transactions, behaviors and documentation made during the period from the receipt of the order to the delivery of the order position the company in the mind of the customer as a part of the service. Being successful in logistics (ITO, 2006, p.13);

• Understanding customer needs and expectations,

• Concretization of the service,

• Complete and correct transactions,

• Ability to make the desired changes in a timely manner,

• It is directly proportional to the knowledge and skills of the human power that will provide this.

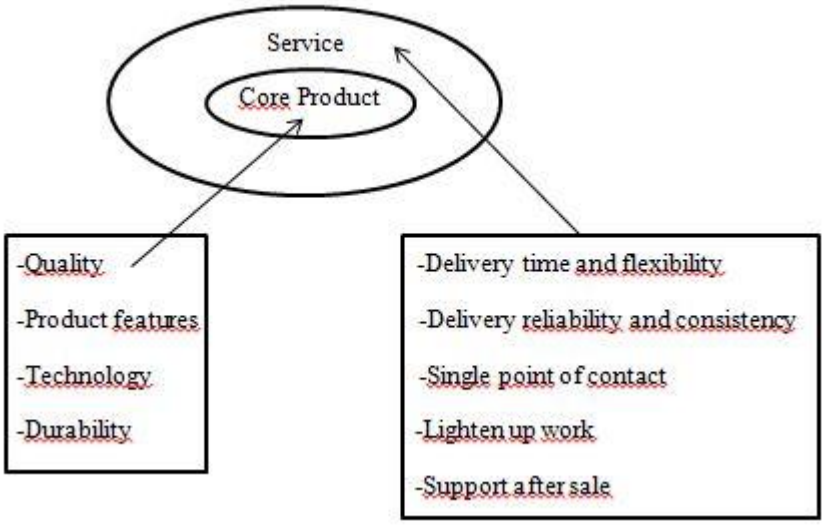


Figure 1.6. Use of the Service in the Development of Core Product

Source: Martin Christopher, Logistics and Supply Chain Management, FT Prentice Hall Financial Times, 1998, p.44.

Figure 1.6 develops this idea with the “service siege” approach. The core product, which is the main product in the center, is the form in which it leaves the factory. The outer circle represents all the value added by the customer service and logistics services. The logistics business builds and develops the features of both the main service and the additional service elements surrounding it on the benefits demanded by the customers.

Businesses that set specific, measurable, achievable and consistent goals in order to achieve their goals should be able to use some measures to provide effective customer service during the sales process. The most important of these measures are listed below (Uğurlu, 2007: 26-27):

- Order Period / Cycle: The time between placing an order for a product and its delivery.

- Service Level: It is the percentage of customer demands that can be met correctly within a certain period of time, without running out of stock.

- Order Fulfillment Rate: It is the rate at which customer orders can be prepared and sent correctly.

1.4.10. Facility Selection

The choice of factory and warehouse location, which is one of the important links of the logistics processes that companies have to manage, is a strategic decision. It affects not only the inbound shipping of raw materials and the outbound shipment of finished goods, but also customer service levels and response speed. The result of a very comprehensive study with the analysis of long-term strategic goals, affects the structure of the entire logistics system of the companies. (Lambert Stock-Ellram, ibid., p.19.)

The fact that the factory and warehouse are in a central location and close to the customer, but the rental cost is high, or the rental cost is low but far from the customer outside the city, is a decision that varies according to the product produced by the business and its strategy. For example, perishable or durable products are the main reasons for making this decision.

Some companies may also prefer to use their warehouses as sales centers. For example IKEA

1.4.11. Insurance

Logistics companies insure the products to prevent possible damages and losses during the transportation of the products. The insurance process, which is made depending on the agreement of the parties, is carried out under certain

responsibilities in order to prevent damages and losses that may arise during the transportation of the product.

1.4.12. Purchasing

The sole purpose of the purchasing activity in the enterprises was to purchase the materials required for production at the lowest price for many years. However, in the last two decades, the understanding of procurement supply chain management has left its place to an understanding based on the relationship between the manufacturer and the supplier, and the activity has taken a more strategic and higher level position within the organization. Today, purchasing is at the beginning of the main inputs of an enterprise producing in developed countries.

Each manufacturing business may have different production strategies, and therefore each of them's purchasing approach may differ to meet the specific requirements of the production strategy they have chosen. Undoubtedly; performance must meet customers' product quality requirements and expectations. Maintaining the production at the desired quality and speed necessitates the management of the supplier and manufacturer, in other words, the seller-buyer relationship in a healthy, systematic and strategic framework. (Serdar Aydıntug, I.Ü Ulastırma ve Lojistik Y.O. Yayımlanmamıs Ders Notları, Istanbul, 2001.)

It is possible to list the activities carried out during the purchasing process as follows (Uğurlu, 2007: 24):

- Determination of needs,

- Determination of making or purchasing needs,

- Determining the type of purchase,

- Conducting market research,

- Identifying and evaluating potential suppliers,

- Realization of the purchase,

- Performance evaluation, can be listed as.

1.5. Basic Consepts of Logistics

1.5.1. Supply Chain Management

The supply chain starts with supply raw material and covers all processes, including supplier, manufacturer, transportation, storage, sales and also after-sales service, in which a product moves from the point where the raw material starts to the final consumer. Also it is the management of products, money and information between suppliers, manufacturers, distributors, retailers and customers.

With the increase in the competition of enterprises as a result of globalization, better quality and more affordable products have been expected from suppliers in a shorter time. For this purpose, supply chain management provides effective and efficient work by creating a network based on the manufacturer-supplier relationship between businesses.

Although logistics and supply chain are compared, they are actually different concepts. Logistics related activities, in a way, are included in supply chain activities and have a complementary feature to these activities. Logistics covers all the works necessary to fulfill the purposes in the supply chain, the management of information and risk that flow with the product throughout the process.

1.5.2. 3PL (3rd Party Logistics)

Outsourcing is an agreement with companies that are experts in the field in activities other than the core competencies of the enterprises. Businesses generally prefer outsourcing in activities such as transportation, storage, customs clearance, dining hall, personnel transportation, cleaning, repair and security services. The party requesting these services does not take any responsibility for the processes, does not spend time on how to do it, only deals with the quality of the work and the costs. Businesses that prefer outsourcing can focus on their own competencies and allocate more time. For example, Yaşar University's area of competence is education, it prevents time wasted on these areas by agreeing with companies that are experts in their fields regarding the cafeteria, security, cleaning and repair activities that should be in the university.

3rd Party Logistics is the outsourcing of logistics. Number 3 is the expert logistics company that acts as a bridge between the first sender, the second receiver and the

third two companies. The fact that the enterprises agree with a company with a high logistics service quality in the fields of logistics activities such as transportation, storage and leave the job to the specialist also increases the overall performance of the enterprise. Because in this way, they do not have problems in the field of logistics activities and they can allocate more time to the field of competence.

1.5.3. 4PL (4th Party Logistics)

The limitation of 3pl companies to transportation and storage activities has started to be insufficient after technological developments. As a result, 4pl activities emerged. Companies that provide 4pl logistics services have an integrative role by bringing together their own resources, technology, work quality, resources of third party logistics (3PL) companies and by undertaking the management of the entire chain with the help of information technologies in order to offer their customers a comprehensive supply and distribution chain. The aim of 4pl activities is to have the ability to offer different solutions to its customers in all business processes and add value to processes throughout the entire supply chain.

1.5.4. Reverse Logistics

Logistics activities do not end with the delivery of the products to the final customer, but also include their return. Reverse logistics is the movement, storage and handling of goods returned from the end customer to the vendor or service provider in the manufacturing industry. In addition to reverse logistics, goods, containers or boxes, packaging materials that are damaged, seasonal stock, retrieved, returned by the manufacturer, expired and returned due to overstock; it also includes recycling programs, hazardous materials programs, obsolete materials training and asset recovery. In this way, products that have lost their function and damaged can find life again in different products. (Deborah L. Bayles, E-Commerce Logistics&Fulfillment Delivering the Goods, Prentice Hall PTR, 2001, p.258.)

Reverse logistics helps recycle unwanted materials (like cans, bottles) and returns or defects to other stores (like factory outlets, flea markets). This helps save on the costs of compacting, transporting and storing garbage. The management of these processes can be done according to the Product Recycling Management (PRM). PRM is about the importance of the products and materials used. Reverse logistics is the recycling

of used products, product parts and/or materials for all logistics activities to provide a stronger and more environmentally friendly recycling. For this reason, it is also called "Environmental Logistics". The main reasons for reverse logistics to become effective: (REVLOG- The European Working Group on Reverse Logisitcs, http://www.fbk.eur.nl/OZ/REVLOG/, 07.11.2006.)

1. Increasing the environmental awareness of consumers,

2. Environmental laws oblige businesses to take back their products and take additional measures in this regard,

3. Saving the high costs of using recycled products in the production phase. The purpose of all these reverse logistics processes; minimizing process costs while maximizing the value of goods or the level of proper use.

1.5.5. Green Logistics

As in many areas where people work, the term "greening" in the transportation industry began to be used as an important word towards the end of the 1980s and the beginning of the 1990s. In recent years, within the scope of increasing awareness about environmental problems such as acid rain and global warming and the policies developed as a result, many international companies develop their processes in accordance with these policies and determine new strategies and policies. The logistics sector has also taken its share from this and the term green logistics has emerged as the general definition of the implementation of all these policies. The concept of green logistics, which has become increasingly important especially in recent years, has shown its effect at every stage in the logistics sector, and has brought important gains with it.

Green logistics is about producing and distributing goods sustainably, taking into account environmental and social factors. The aim of green logistics includes impacts of public interest, such as the effects of pollution on the environment. Green Logistics activities include measuring the environmental impact of distribution strategies, reducing energy use and waste in logistics activities, reducing the amount of CO2 released into the air from transportation vehicles, optimizing transportation routes and keeping environmental threats under control (Sbihi and Eglese, 2007: 99).

1.5.6. Lean Logistics

Lean thinking is the practice of eliminating waste in production and other processes. The aim of Lean is to reduce losses and stocks of semi-finished products, and to prevent waste by minimizing process and production times. In this context, companies that implement the 'lean' system do not focus on single cost elements such as transportation and storage, but focus on the total cost and organize the process by making a general analysis.

1.6. Importance of Logistics

The logistics sector, which is a service sector, has direct and indirect relations with all other sectors. Logistics is such an important element in the total business structure of an enterprise.

1.6.1. Logistics and Marketing

Marketing is defined as "management philosophy aimed at satisfying the needs and wants of target markets more effectively and efficiently than competitors". While the aim of marketing is to maximize the long-term profit of the business, the aim of logistics is to minimize the total logistics costs by adhering to the customer service level determined by marketing. At this point, the systems approach is important. Accordingly, businesses should reduce the total cost of the system by making some cost concessions among alternatives in order to achieve long-term profitability.

The physical distribution part of a business's logistics system is responsible for the storage and physical movement of goods for customers and plays an important role in selling products. Therefore, logistics is often perceived as the other half of marketing.

Marketing unit; identifying target consumers, understanding their lifestyles, thinking, and profitably satisfying consumer needs must determine strategies to direct all business resources. However, while doing these, it should work in coordination and cooperation with other business functions and logistics.

1.6.2. Logistics and Production

Logistics and production functions are operations that complement each other. The basis of this function is the movement, storage and transportation of goods from

warehouses to factories and sales centers to be produced and sent to markets. Logistics and production management activities complement each other. For example; for production, raw materials and semi-products must be brought to the enterprise from suppliers by logistics processes and then production must be carried out.

While the joint and coordinated work of the logistics and production function causes a high business performance, the objectives they have separately cause incompatibility and conflicts between them. For example; while the logistics department has the aim of working with less stock and reducing the stock cost, the production department tends to keep stocks by taking into account the increase in costs in order to be cautious against demand fluctuations. These differences in purpose that may arise between the units can be minimized by deciding together on the common issues that concern both units. The synergy that will emerge with the harmonization of logistics and production processes in enterprises and starting to function as an organic function will increase the profitability of enterprises. In this context, enterprises with an effective production strategy are determined as enterprises that can integrate their logistics processes into this production strategy.

1.6.3. Logistics and Finance

Effective and efficient use of working capital is possible with a strong financial management. Enterprises with strong financial management are considered as enterprises that have the necessary equipment to compete in global markets. Evaluation of the financial burden of the existing stocks in the enterprises and the effect and necessity of these stocks on the operating costs are possible as a result of the work of the existing logistics and finance functions in the enterprise within the framework of a common mission. The logistics manager should discuss with the finance manager about the logistics processes of the enterprise, such as the monetary amount to be spent, stock management, warehouse rental, purchase of a new transportation vehicle such as forklift or a machine that should be used in the packaging process, and discuss the logistics expenses in question. Also reports to the finance manager. Logistics manager has to check stocks frequently with finance manager. This is because; money that is over-tapped in stock is considered an

opportunity cost. As a result, a well-designed logistics system makes a direct and enormous contribution to the financial control of the enterprise.

1.7. Logistics in Turkey

As a result of the development of world trade day by day and Turkey's adoption of export-based growth policies after 1980, the increase and development of foreign trade volume directly affected the Turkish logistics industry, causing the industry to go further and the number of enterprises to increase.

Our country has a natural logistics base location. In the context of the logistics sector, Turkey has an important strategic advantage geographically for its logistics base establishment location, as it is located in the center of the continents of Europe, Asia and Africa and is close to all three continents. In terms of transportation, which is the most important function of logistics, Turkey's geographical and technical infrastructure that allows the passage of all transportation modes, including air, land, sea and railways, offers an important advantage for this sector. In addition, the possibility of integrated transportation between these transportation modes makes our country stand out as a logistics base.

With the new airports, high-speed trains, highways built in recent years, and also natural harbors the value of our geographical location in terms of logistics services is increasing.

Although only transportation and distribution are considered when it comes to logistics in Turkey, thanks to the developing technology and globalization, the importance given to all other logistics activities is increasing and it is starting to take a bigger place in our lives.

1.8. Globalization and Development in the Logistics Sector

As a result of developments such as the acceleration of globalization, the transformation of the world into a single market, and the use of the advantages of scale size, those who successfully use information technologies and communication will rise, those who can train their own staff will gain cheap labor, automation and robots will gain importance with the increase in the amount handled, and distribution will become dealers and sales centers in the future. It is expected that combined

transport, in which maritime transport will be combined with rail, will gain more importance instead of to the end user.

In order to increase efficiency and productivity in logistics activities, the following issues should be considered: (Karagöz, 2012: 16-17)

- Analysis and mapping of companies from a SCM perspective, determination of key competencies and qualifications in the chain, optimization, redesign and management,
- Establishing effective demand forecasting and systems for the best planning of supply and demand in the supply chain, preventing inefficiencies, and arranging safety stocks and other parameters in the best way,
- Warehouse design, implementation and management, planning of warehouse location, capacity, layout and operations, evaluation of outsourcing opportunities in warehouse rental and storage,
- Establishing an effective and efficient transportation planning and management system, cargo consolidation in transportation, combined (multi-model-multimodal) transportation organizations, vehicle-load monitoring, effective fleet management implementation,
- Establishment of the reverse logistics system (returns, empty containers, products to be repaired),
- Establishment of project management-based management forms for the best realization of integrated logistics, combined shipping, door-to-door logistics,
- Total quality management in the field of logistics, etc. tending to more external and internal customer-oriented studies with techniques,
- Realization of logistics services in accordance with the just-in-time production/distribution (JIT) approach in order to minimize stock and inefficiencies,
- Establishing supplier-managed and customer-managed stock-order systems,
- Establishment of quick response (QR) based systems to minimize the time from order to delivery,

- Providing the necessary logistical support to the Effective Consumer Response Systems, which allow customers to find the product they want, wherever they want, in any quantity,
- Ensuring traceability for the customer in cargo and services Determination, integration and selection of appropriate Information Technologies (IT), creation of IT infrastructure; Internet, Electronics, Electronic Commerce, EDI, Vehicle Tracking Systems, Radio Frequency (RF) Technology, Enterprise Resource Planning (ERP), Advanced Planning Systems (APS), Warehouse Management Systems (WMS), Transport Management Systems (TMS)), Barcode Systems, CRM, etc. Making use of e-logistics information systems and ensuring the integration of these systems with each other,
- Implementation of the Outsourcing approach, which envisages benefiting from the best in the business, based on the principle of "The one who does the job best knows", determining the logistics services to be exported, selecting 3PL companies with appropriate qualifications, determining Supply Chain Optimization opportunities with these companies, establishing an evaluation system for 3PL companies,
- Determining and researching strategic cooperation issues with external organizations in terms of logistics and establishing Strategic Business Partnerships with appropriate companies, based on the principle of “Strength comes from unity”,
- Having an understanding of Green Logistics in order to carry out logistics activities in a way that will cause the least damage to the circuit,
- Activity Based Costing (ABC): Determining and tracking logistics costs on the basis of activities,
- Establishing systems to reduce purchasing costs

CHAPTER 2

2.1. Industry 4.0

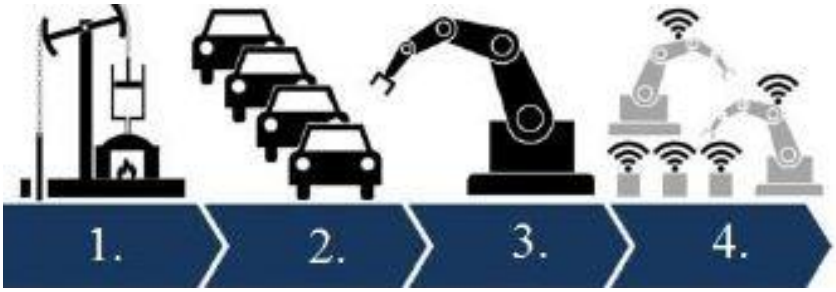
In production part the products may belong to the manufacturer as well as to the consumer. What belongs to the consumer is ultimately what is used by the consumer. For example, textiles and cosmetics. Manufacturer-owned are those used by manufacturers to produce other types of products. These can be machines, tool kits, equipment. The expansion of trade and trade processes varies depending on the growth of the industrial environment. This also represents the supply portion of the market size.

Industry 4.0 refers to the improvement of processes at all stages of the supply chain, starting from the purchase of raw materials, including the production, development, ordering, delivery and recycling of the product, by focusing on individual customer demands by utilizing the integration of traditional industry strengths and internet, information and communication technologies from advanced system. (Gilchrist, A., 2016: 197, Pamuk, N., Soysal, M., 2018)

In an increasingly competitive environment with globalization, businesses have to develop strategies that will reduce waste by consuming less resources and provide more efficiency in order to survive. With Industry 4.0, different strategies have begun to take shape, where human power is less needed and robots and different technologies are more involved in the production process.

The development of the Internet of Things (IoT) and cyber-physical systems (CPS) in Industry 4.0 are among the most decisive innovations of this period (Weyer et al., 2015). In addition to these two important concepts, big data (Witkowski, 2017), augmented reality, cloud computing system (Hofmann & Rüsch, 2017) and autonomous vehicles in Industry 4.0 are also changing traditional logistics processes. Fast adaptation of logistics processes to changing technologies, as in production processes, is important for companies both in terms of cost and competition (Barreto et al. 2017).

2.1.1. History of Industrial Developments



Water and steam power	Mass production, assembly line, electricity	Computer automation	Cyber physical systems

Figure 2.1. Industrial Revolutions

2.1.1.1. Industry 1.0

First Industrial Revolution that took place in the 18th century.

Before the 1st Industrial Revolution, there was a production based on human muscle power and animal energy. The 1st Industrial Revolution, which started in the 1760s, first emerged in England and influenced the world, for reasons such as the presence of rich mines and coal deposits, its strong economy, its being an island country, being away from political chaos and having a democratic management approach. It started to spread in Western European countries and America in a short time and continued until the 1830s.

The most important development in this process was the steam engine developed by James Watt, which was powerful enough to run a loom. Instead of mechanical devices working with air, water and wood, steam engines have been used. The use of fuels such as coal and steam made the use of machines in general more convenient, and the idea of machine production was widely spread. These steam powered machines have led to an increase in production quality, facilitated production, provided the production of more diverse products and increased the quality of life. Especially the textile sector has changed with industrialization. With the use of steam power in locomotives and the start of transoceanic steamship voyages, there have been great developments in transportation. Depending on the engine power, the load capacity in transportation increased, and the products weighing tons began to be transported to more distant trade regions in a shorter time. In this way, traders had the

opportunity to offer their goods and services to farther markets, thanks to improved and more comfortable transportation.

Towards the end of the industrial revolution, the use of coal has been widely used in almost all sectors that have entered into an industrialization effort.

With the change in production, the economy and social structure of the countries have changed, the welfare level has improved, diseases such as plague and malaria have decreased, and the average human lifespan has increased with the number of population. As welfare increased, more importance was given to scientific developments, and scientific inventions increased. For example, antibiotics were developed at this time. While industrial revolution was taking place in some countries, some countries could not keep up with this situation and the development gap between countries widened. European countries have turned their routes to the Middle East, Near East and Far East countries in order to reach raw material sources and market their products.

2.1.1.2. Industry 2.0

The Second Industrial Revolution (Industry 2.0) is the industrial revolution in which the transition to mass production with electrical energy is based on the division of labor seen at the beginning of the 20th century.

The 2nd Industrial Revolution (Industry 2.0) started with Henry Ford's development of the first movable production line in 1870. Since electricity is easier to use than water and steam, it has become the most important power source used in production systems. Mass production was started with the use of electricity and production line. However, a low-cost and much faster production process has begun.

In this period, logistics processes have passed to a very different dimension compared to the previous industrial revolution. Heavy industry developed with the use of steel, and along with it, a technological transformation began. Steel production, the use of oil and electricity led to the invention of automobiles and airplanes, the automotive industry developed. Steel has been used in construction projects, railways, ships, skyscraper and bridge construction. Steel production enabled the railways to be built at less cost, and thus the transportation network spread. The facilitation of transportation greatly facilitated the supply of raw

materials and enabled the products coming out of the production process to reach new and distant markets (Kolat et al. 2019, p.721).

Before electricity was used, candles and gas lamps were used to illuminate homes and factories. People were doing most of their work during the day. With the use of electricity, people's lives and working lives have changed.

Other developments in this period are as follows; In 1876, Alexander Graham Bell invented the telephone. In 1901, Guglielmo Marconi sent radio waves across the Atlantic Ocean for the first time. The bulb design was developed by Thomas Edison and Joseph Swan for use in homes during this period. With the development of the paper machine by Charles Fenerty and Friedrich Gottlob Keller, paper production became cheaper and books and newspapers could reach wider masses.

The increase in production led to a decrease in product prices, an increase in the level of welfare and an improvement in living conditions in developed countries. Hunger and malnutrition resulting from crop shortages in rural areas have largely disappeared as these places have been linked to large markets by means of transport infrastructure. With the industrialization, the number of people working in the fields decreased, people migrated to the places where the factories were, and the population engaged in agriculture decreased. Mechanization has not only good but also bad effects. Some of these are the decline in the health levels of the workers due to the poor working conditions in the factories, the loss of livelihoods of the artisans and tradesmen, and the fact that the workers who move there have to be separated from their families, as new workplaces become factories. The continent that was particularly affected by the second industrial revolution was the continent of America and after the oil crisis in 1973, the second industrial revolution in the world was over.

2.1.1.3. Industry 3.0

The Third Industrial Revolution (Industry 3.0) is the industrial revolution in the early 1970s, in which electronic and information technologies, which enable the automation of production processes to be carried to advanced stages, came into play.

At the end of the first two industrial revolutions, the world's resources were rapidly consumed and the sustainability of life throughout the world became difficult. Thus, the protection of the environment, the avoidance of polluting industrialization and the reduction of energy consumption through technological developments by

focusing on renewable energy sources led to the emergence of the Third Industrial Revolution (Wigand, Picot, Reichwald, 1997).

The prominent idea in the studies on the Third Industrial Revolution is that the development in information and communication technologies and the spread of the Internet started this period, and its foundations were formed with the communication tools using satellites and wireless technology. By adding information technologies to the production process, the automation process in manufacturing has come to the fore. With technological developments, many innovations have been made in the logistics sector. The transformation of product tracking systems, barcodes, handling tools into automation, and the increase in traceability with warehouse management systems have been important developments in logistics.

Issues such as solar, wind, underground and hydrogen energies, zero emission transportation, green economy, widespread inter-industry relations, globalization of industry and trade can be considered as the important factors of this period (http://www.2eylul.com.tr/ucuncu-sanayi revolutionimakale). , 157.html. Accessed: 04.09.2016.).

2.1.1.4. Indusrty 4.0

The concept of industry 4.0, which was carried forward by the German government, was used for the first time in Germany's Hannover fair in 2011 (Soylu, 2018:44). With the concept of Industry 4.0, it can be shown that the use of manpower in production and management is minimized as much as possible with machines that can both realize the requirements in the production processes and take the initiative in taking important decisions. In addition to these, among the targets of the concept of industry 4.0; to provide individual services to customers, to contact customers or customer groups thanks to developing telecommunications and to produce solutions by quickly responding to requests, demands and complaints, to implement and eliminate situations that are necessary or not in terms of competition in the management levels that emerged with modern management system approaches or to revise and to inform the manufacturer by transferring the collected information to digital media by creating machines and systems that have high sensing capacities and can intervene in positive or negative situations, thanks to the developed sensor technologies (Dengiz, 2017:39). Apart from the realization of production with robots, these sensors, which also communicate with each other, have the ability to detect the

environments they are in. In addition, these sensors aim to make a fast and high-quality production, most importantly less wasteful, that can instantly recognize the needs of the business by analyzing the data. (Sert, D., Hitit-Yılmazer, Z., Ertunç, S., ibid.)

It can be said that the first three industrial revolutions were shaped in line with the results of the developments in mechanization, electricity and communication technologies. It can be said that the fourth industrial revolution will be shaped in line with the creation of global networks that connect their machines, warehouse systems and production facilities in the future, including cyber-physical systems, as a result of the use of the concept of the internet of things and services in production areas. The industry 4.0 process, which will reconstruct the production and consumption processes, defines production systems that can quickly adapt to changing consumer needs and include automation systems that are in constant communication and work in coordination with each other (Alçın, 2016: 20).

Industry 4.0 and the developing digital transformation, information and communication technologies are there to serve today's needs. It is possible to define digital transformation as the process that enables life to reach a more livable point. This transformation concerns not only people but also all businesses. By following digital transformation, businesses using new technologies naturally gain an advantage in terms of competitive advantage.

2.1.2. Components of Industry 4.0

New applications that emerged with the development of technology have made our lives much easier both in terms of businesses and individually and have started to enable us to reach the necessary information faster. With these developments, new lines of business have emerged and have also become a big part of our whole lives.

Especially with the introduction of the concept of Industry 4.0 into our lives, we met many new technological concepts. Data collection and analysis between machines has become easier thanks to the new digital transformation technology. Because industry 4.0 has been a transformation that provides fast, flexible and efficient processes to obtain higher quality products at lower costs.

2.1.2.1. Internet of Things (IOT)

Figure 2.2. Internet of Things

The concept of the Internet of Things was first used in the literature in 1999 by Kevin Ashton in a presentation to P&G company on the benefits of identification with RFID technology. The first application of the concept of the Internet of Things was with the study of a group of academicians at Cambridge University on the coffee machine (Gökrem 2016:48).

Internet of Things is a system in which sensors embedded in objects can connect to the Internet via wireless or wired connections, interact with each other, and remotely control objects. The sensors in this system also collect data and represent a system that helps to improve industrial processes (Bai et al., 2020).

Thanks to the Internet of Things, data from different devices detected by connecting smart objects to the Internet, collecting and sending data to devices are performed, not only communication between objects, but also communication between objects and their users in a virtual environment. The Internet of Things allows the factory to be almost self-managed, contributes to the design of smarter, faster and less costly systems, and accordingly, reduces the need for workforce.

The use of IoT in logistics processes enables objects connected to the Internet to communicate both with each other and with control centers. They can be aware of each other in the stages of transportation, handling, production and packaging.

As an example of objects communicating with each other; By detecting that the refrigerator has run out of milk, directing the car to the nearest grocery store with GPS guidance, making the payment from a mobile device, and transferring the

information needed by the patient and doctor with health applications, it can be shown that the adverse conditions for the patient's health can be determined in advance (Gündüz and Daş, 2018: 328). The main application areas are; Smart homes, smart cities, scientific studies, IT sector, energy, daily use, security, manufacturing, agricultural production, public sector, construction, health, logistics and trade can be given as examples.

2.1.2.2. Cyber Physical Systems

It is to make it smarter by integrating physical machines and cyber technology through systems managed by a technology that blends basic principles such as monitoring, coordination and control in production processes (Soylu, 2018). Cyber-physical systems connect the physical world with the virtual computing world with the help of sensors and actuators. Cyber-physical systems, which consist of constituent components such as embedded technologies, software systems, communication systems, communication technologies and sensors, reveal a global behavior with the cooperation between these components. It can be said that cyber-physical systems combine two worlds thanks to two important elements: the network created by objects or systems that exchange information with each other via an assigned internet address, and the virtual environment in which objects and behavior sets in the real world are created by simulation models (Ghafory, 2016).

In order to gain a useful perspective to the factory management and to obtain the necessary information to reach the right content, the available data must be passed through processes consisting of tools with advanced (analytical and algorithmic) content (Lee, Lapira, Edzel; Bagheri, Behrad; Kao, Hung-an). , 2013). In addition to visible issues, some invisible issues, such as machine breakdowns, component compatibility, which are of great importance within the factory, need to be identified and resolved as soon as possible.

In logistics processes, internal logistics processes can be arranged by machines in line with needs, by communicating between Cyber-Physical Systems and machines. For example, finished semi-finished products in the production line can direct the machine used for handling to that production line in line with the signals coming from the machines, or in case of a decrease in the used material, the required material can be ordered automatically according to the data coming from the machine. (Çakılcı&Öztürkoğlu, 2020)

2.1.2.3. Artificial Intelligence

Artificial intelligence is a field of computer science that emphasizes the production of intelligent machines that can learn human-specific thinking power such as learning, perception, communication, and decision-making through certain algorithms and methods and work by improving themselves in this direction (Bai et al., 2020).

2.1.2.4. Augmented Reality

Augmented reality is a type of interactive and reality-based display that takes capabilities such as computer-generated screen, sound, and other effects to enhance the real-world experience. (Dalenogare et al., 2018; Lu, 2017; Wan et al., 2015; Posada et al., 2015). Thanks to augmented reality, images and perceptions that cannot be displayed in the physical environment are displayed in the virtual environment by means of sensors (ATSO, 2017). In this way, before the concrete establishment of the factories, they can be built in a virtual environment and enable the efficiency to be increased and the operating system of the enterprise to be analyzed (Dalenogare et al., 2018; Lu, 2017; Wan et al., 2015; Posada et al., 2015).

If we briefly explain a few of the usage areas of augmented reality technologies:

• Marketing: Companies enable their consumers to be more memorable.

• Education: Memorability can be increased with AR Technologies

• Decoration: An empty house can be decorated with AR technology without bringing things.

2.1.2.5. Big Data

Figure 2.3. Big Data

Big data and analytics refers to the strategy of analyzing large volumes of data used when traditional data mining and processing techniques cannot reveal the insights and meanings of the data. (Dalonegare et al., 2018, Withkowski, 2017, Rüffman et al., 2015). While performing big data analysis, large volumes and high diversity of rapidly incoming data from scientific tools are collected, stored, cleaned, visualized and analyzed.

Big data analysis provides high performance especially in the decision-making processes of enterprises, as well as rapid decision-making in various applications. Especially for businesses, it can reduce complexity, provide real-time services and support interaction with customers. Of course, there are risks and opportunities to be experienced in making decisions when businesses use big data. Trusting the data and algorithms used in decision making is very important for the development of the system. In terms of the use of personal data, important guiding principles will be needed in terms of accountability in legal structures. (Bulut, E., Akçacı, T., (2017), Turkey Analysis within the scope of Industry 4.0 and Innovation Indicators, ASSAM International Refereed Journal, 7, 50-72.)

Features of big data concept; It is briefly expressed as 3V as Volume, Variety and Velocity. By adding Veracity and Value to these three features, it has started to be expressed as 5V in the literature.

2.1.2.6. Cloud Computing System

Figure 2.4. Cloud Computing System

It is the general of internet-based IT services for all devices and computers that can be used at any time and provide resources shared among users.

With the use of cloud computing, companies' need for hard disks has decreased and high amounts of data have been shared quickly.

Since the cloud computing system promises infrastructure services such as processing, storage and database in line with their needs, it is advantageous for them to implement the other components of Industry 4.0, such as the internet of things, machine learning, and big data more quickly. It provides the advantage of flexibility as it provides the opportunity to supply as much resources as needed for intensive commercial activities, and it provides resource savings because it eliminates costs such as data center or physical server costs. In addition, the possibility of global distribution within minutes by expanding to cover new geographical regions can be shown as another advantage of cloud computing systems (Amazon).

2.1.2.7. 3D Printers

3D manufacturing is a production technology that creates three-dimensional (3D) concrete objects using layered structures (Dalenogare et al., 2018; Lu, 2017; Wan et al., 2015; Posada et al., 2015).

3D printers are used in various sectors by enabling the use of many different materials, making it to reduce costs and more flexible production without stock.

Production with 3D printing also ensures that the raw material of the product to be made is processed, and the model is created before the product is produced. In this way, the enterprise can produce the requested products in the shortest time according to the demand received. In addition, the business can make design changes without incurring extra costs.

After the model is sliced into layers with special software, it is transformed into a physical object layer by layer, starting from the base, by means of a 3D printer. The production of parts that are impossible or difficult to produce can be done easily in a short time. Additive manufacturing systems; It has advantages such as working efficiency, ease of production of complex parts, acceleration of the design cycle and product optimization process, integration of design and manufacturing, use of fewer manufacturing machines, and reduction of production costs.

2.1.2.8. Intelligent – Autonomous Robots

Autonomous robots are used to repeat human movements during production (Dalenogare et al., 2018; Lu, 2017; Wan et al., 2015; Posada et al., 2015). The sensor technology in autonomous robots facilitates the tracking of the products on the production line by identifying the materials while they are moving on the production line and knowing which processes they will go through respectively, and ensures that the products are processed with zero errors and possible errors are detected faster (Soylu, 2018).

This does not mean that robots will replace humans, but future factory workers will have special abilities in their job characteristics, and the remaining workforce will be able to be evaluated in other areas. Only this system will make it possible for humans and robots to work connected to the system for a long period of time. In case of a disruption in production, the manager of the process or the technician will be able to automatically intervene in the problem with mobile communication tools.

Intelligent robots will be able to act independently under the control of an operator or independently with a computer program.

The most comprehensive definition of industrial robots has been expressed by the International Standards Organization (ISO) as "It is an automatic controlled, reprogrammable multi-purpose manipulator used in industrial applications, which can be fixed or mobile, with three or more programmable axes" (Dişlitaş, 2015: 3).

Some advantages in the use of industrial robots are as follows (Çengelci and Çimen, 2005:70):

• Reduction of labor cost

• Use instead of workers in dangerous and risky places

• Providing a more flexible production system

• Making quality control more consistent

• Increasing the amount of production output

• Meeting the shortage of qualified workforce

• Uninterrupted working capability

• Lifting more loads and reaching results faster than humans

• Suitable for use in tedious and repetitive jobs

• Ability to work in hazardous environments

After Amazon bought Kiva Systems in 2012, it started to use robots named "Kiva" in its warehouses. These robots, which can do the work of the workers autonomously, are used in every distribution center of Amazon in order to provide labor productivity (Çiçekli, 2018; Galindo, 2016: 32-33).

Figure 2.5. Amazon Kiva

Developed by Boston Dynamics for use in the logistics industry, it is 2 meters long and 105 kg. The robot named “Handle”, weighing in at a weight of 15, can easily and smoothly place the parcels to the desired location with its effective balancing system. 15 kg with fast and flexible working principles. It is expected that this robot with a camera and double wheels, which has a carrying capacity, will provide great convenience to people in transportation (Boston Dynamics, 2019).

Figure 2.6. Boston Handle

2.1.2.9. Simulation

Simulation is a computer simulation of a real-world process or system. (Dalenogare et al., 2018; Lu, 2017; Wan et al., 2015; Posada et al., 2015).

Simulation methods are used in fields such as education, health, service, manufacturing, business, management and marketing in terms of industrial use.

The use of simulation is especially important in high-risk and costly areas. For example, considering that flight experience involves high risk and there is no return, it can be said that simulation technologies are of great importance in terms of gaining flight experience for pilots (Özçelik and Onursal, 2020:991).

2.2. Logistics 4.0

As in previous revolutions, the 4th Industrial Revolution also affected the logistics sector. With the increase in personalized products and services, the logistics field has also adapted to this, and the process called Logistics 4.0 has started. The seven lines of logistics with the integration of logistics processes into technology; A good change will occur in all stages of providing the right product in the right quantity, in the right way, at the right time, from the right source, in the right way and at the right price, and the error rate will be minimized. With this development, manpower in the supply and logistics sector is replaced by operational systems, smart vehicles and robots. Due to the increase in complexity as a result of personalized products and services, traditional methods, ordinary planning and control practices in logistics processes have begun to be insufficient. The concept of Logistics 4.0 defines the innovation and technological applications provided by Cyber Physical Systems (CPS) for use in logistics processes.

Logistics 4.0 is a concept closely related to 'Smart Products' and 'Smart Services'. It would be appropriate to define the technology-oriented approach as 'Smart Logistics' to define smart products and smart services. Smart Logistics is a logistics system that will increase the flexibility of businesses, respond quickly to changes in the markets, and transform it into a structure that follows customer needs more closely. Thanks to this system, in addition to improving the customer service level and ensuring production optimization, a decrease in production and storage costs will also be achieved (Barreto et al., 2017: 1248). The technological transformation move, which is the biggest supporter of global production and distribution strategies that emerged

with the increasing capacity of global trade and the formation of market conditions that exceed the borders, has made the concept of logistics smart and embodied the concept of Logistics 4.0. Definitions related to Logistics 4.0 are shown below:

Logistics 4.0 is summarized in the broader term Industry 4.0 as logistics and supply chain processes. These processes are supported by RFID systems, embedded smart software, smart databases and smart sensors within Industry 4.0, and all product and service information related to the supply chain are shared and provided over the internet of things (Dutton, 2014: 3). Industry 4.0 not only changes the situation in logistics, but also brings with it new requirements to provide supply chain and transportation services covering different applications and technologies. Since it is known that there are many different types of logistics and many definitions of logistics, it is possible to define Logistics 4.0 as digitalizing supply chains by combining production with consumption using artificial intelligence, if it is derived from the basic logistics definition (Bukova et al., 2018: 19). Logistics 4.0 defines a broader concept of Industry 4.0 that applies across businesses to five functional areas, namely data collection and processing, assistance systems, distribution networking and integration, decentralization and service orientation, self-organization and autonomy (Prinz et al. , 2016: 114). Unlike the logistics concept in other industrial revolutions, the most important characteristic of Logistics 4.0 is that it has a great degree of automation as a network and a significant level of trust in logistics.

Logistics 4.0 is a necessary and important part of Industry 4.0. The Internet of Things, cyber-physical systems, autonomous devices, big data, cloud computing and other information technologies make great contributions to the realization of end-to-end logistics (Hofmann and Rüsch, 2017: 25). In order to be able to make well-informed decisions in the sourcing process, it is important that various big data-based information such as delivery time, stock level, production capacity and business investment support the logistics processes. Information sources such as ERP transaction data, GPS-enabled data, machine-generated data and RFID data are frequently used through the logistics system that requires big data processing methodology (Rozados Tjahjono, 2014: 4).

The new generation logistics system, which is placed in accordance with the structure of the institution and company, will provide significant savings on stock

costs, and it also offers great advantages in fuel and energy efficiency thanks to shorter and convenient routes to be followed by the carriers (www.magg4.com, 23.06.2019).

Logistics 4.0 further advances supply chain functions and inter-company coordination by utilizing information-processing and communication technologies. Thanks to intelligent and digitally networked systems, people, machines, plants, logistics and production communicate directly with each other. By integrating logistics into the supply chain as early as possible, timely production optimization is ensured (Timocom, 2019).

The success of Logistics 4.0, which enables businesses to meet their customers' needs more easily and quickly by providing flexibility, depends on the following digital technological applications:

1. Enterprise Resource Planning (ERP): ERP, which is a comprehensive software system that provides coordination between the activities of an enterprise such as purchasing, production, marketing and logistics, can be integrated with customers, production partners and suppliers by connecting with the information systems of other companies, and as a result, efficiency Increase in profit, flexibility, quality, cooperation, communication and customer satisfaction, decrease in costs, cycle times, stocks and error rates can be achieved. (Çakır and Bedük, 2013: 84).

2. Warehouse Management System (WMS): Businesses with an effective warehouse management system can reduce their logistics costs. In Logistics 4.0, there should be smart warehouses that are effectively managed with automation-based intensive technologies, that allow human-machine interaction with light and sound guidance systems, and that contain autonomous warehouses and storage vehicles (forklifts, robots, shelves, etc.). In these smart warehouses, where RFID technology is widely used, warehouse data should be monitored instantly through sensors and mobile software, and warehouse planning should be made automatically based on these data (Özdemir and Özgüner, 2018: 43).

3. Transportation Management System (TMS): The widespread use of Industry 4.0 applications requires the use of systems that provide integration between demand management, distribution center and warehouses in Logistics 4.0. Thanks to these systems with cloud and GPS technology, businesses can instantly track their vehicles

and obtain healthy information about their shipments (Özdemir and Özgüner, 2018: 43). Acting integrated with ERP and WMS software, TMS manages activities such as shipment management, vehicle loading and routing, fleet and area management with modern technology software (Loder, 2018).

4. Intelligent Transportation System (ITS): These systems, which offer reliable, efficient and effective solutions (road or vehicle data collection, traffic management, navigation, control, communication and information sharing, etc.) in the transportation sector, are used in road, airline, seaway and rail systems. It facilitates the decision-making of enterprises with the data it collects, especially by utilizing sensor networks, and enables logistics activities to be carried out more flexible and faster (Özdemir and Özgüner, 2018: 44).

5. Information Security Management System (ISMS): The internet of things in Industry 4.0, web-based applications such as big data and cloud computing provided a comprehensive and fast data and information flow, but the security of this information is also important for businesses. Access to this information and data only by authorized users and preventing access by uninvited and unauthorized persons is the main priority. In order to manage security risks, businesses need to invest more in information management systems. Because the key element of success in Logistics 4.0 is data security and a secure technological infrastructure (Özdemir and Özgüner, 2018: 44).

As in every development, besides having many advantages, the development of Logistics 4.0 also has some disadvantages for businesses. Although it will provide benefits in many areas, especially in terms of speed and cost, it may be difficult in some respects for companies to leave their systems that have been sitting for years and keep up with new developments. For example, the need for employees to adapt to the new system, the flow of work during the transition period, and the necessity of having managers who have command of the new system who can make the right decision when faced with a problem. Various advantages and disadvantages are compared in Table 2.1.

Table 2.1. Logistics 4.0 Advantages and Disadvantages

Logistics 4.0 Advantages	Logistics 4.0 Disadvantages
Integration of the real and virtual world	High implementation cost

Real-time communication between all systems	Requirements for advanced information technology equipment
Improving all processes in the supply chain, increasing visibility and flexibility	Rules for the application of the process-oriented management method
Possibility to shorten delivery times for customer satisfaction	The necessity of applying Industry 4.0 technologies
Availability of advanced technologies for analysis of unlimited amounts of data	Questions regarding the availability and processing of data
Reduction in the risk of structural or organizational errors in transactions	Low level of awareness among companies regarding this new approach
Possibility to increase the performance of machines and operators and reduce costs	Rules for the integration of companies' subsystems
Opportunity to make autonomous decisions by all system users	Rules for the integration of all stakeholders in the supply chain

Source: Szłapka & Stachowiak (2018: 4)

2.2.1. History of Logistics Developments

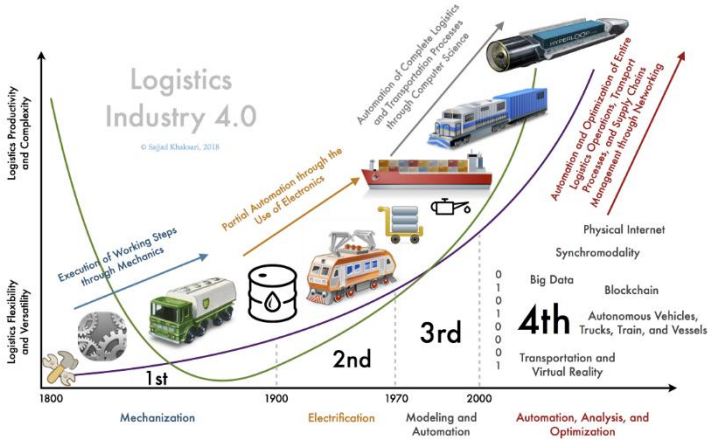


Figure 2.7. History of Logistics Developments

Source: Khaksari, 2018

2.1.1.1. Logistics 1.0

Logistics 1.0 starts from the second half of the 19th century, after the invention of the steam engine, with the development of steamships, steam trains and railways, a significant increase in carrying capacity, now using machines instead of animal power to transport people and goods. This period, which is also accepted as the

beginning of the mass transportation era, means the mechanization of transportation with the Turkish expression "mechanization of transport". Thanks to mechanization in agriculture, productivity in production has increased. Factories, which are new working areas for people, have begun to be established. Thanks to the use of animal power and the use of manual vehicles, transportation and production activities have gained a new dimension (Wang, 2016: 69).

In this period, businesses generally preferred to be spatially close to their local suppliers. The push delivery process (production to retailer) was used in the procurement and delivery processes. Therefore, it took a long time to adapt to changes in demand, which caused delays in the process and increased stocks. In this period, when warehouses started to be used, albeit in the form of a simple room, the transportation of goods in internal logistics was carried out manually by wheeled carts used by people, and external logistics was carried out by steam engine ships and trains (Çiçekli, 2018; Galindo, 2016: 25-27).

2.2.1.2. Logistics 2.0

The second period (Logistics 2.0) is based on the importance of steel, copper and aluminum in machine development with technological advances. In this period, the rapid development of electricity and oil resources also developed transportation. With these developments in logistics, "automation of cargo handling" has been used since 1960. With the help of electric power, rail and air transportation became widespread and the use of automatic warehouses began. In addition, the widespread use of the container ship is an important innovation in port freight transportation. In the supply chain that has begun to globalize, motorized forklifts have been used to transport goods within the factory (Çiçekli, 2018; Galindo, 2016: 27-28).

2.2.1.3. Logistics 3.0

In the Third Industrial Revolution, which started with the use of computers in manufacturing, the "system of logistics management", in other words, the logistics management system (Logistics 3.0) was developed. Warehouse management system (WMS), which is widely used today, is accepted as the beginning of transportation management system (TMS) and information technology system. In this period, when an important development was achieved in terms of controlling and managing logistics processes, there is a global supply chain management, and in addition to supply logistics, in production logistics, the process has become predictable before

production begins, thanks to automatic moving bands, and the management of warehouses is planned and controlled by a software. The transportation of goods within the factory is provided on automatic lines by forklifts used by people and robots with advanced technology and programmed routes. In this period, transportation and delivery processes are planned before starting production (Çiçekli, 2018; Galindo, 2016: 29-31).

2.2.1.4. Logistics 4.0

In addition to all technological advances, natural resources are decreasing day by day, access to energy resources becomes difficult as a result of natural disasters and wars, the workforce is aging, and competition difficulties in global markets are increasing. In order for businesses to survive, there has been a need for different structures and structuring in the life cycle from innovation to production and distribution. As a result of this need, Industry 4.0 has started with the synchronization of information technologies to production processes and product life cycle. With this revolution, computer and physical systems are intertwined, driverless vehicles, 3D production, unmanned aerial vehicles (UAV), drone use, smart objects, cloud computing, big data, cyber-physical systems, autonomous robots have emerged. These developments will deeply affect the supply chain operation and logistics operations as well as all industrial systems. The importance of logistics will increase with the increase in personal products and services.

Some of the developments in this period are as follows;

- Supply chains will expand in this process and communication between their actors will increase.
- It will be easier to control logistics operations.
- Labor savings will be achieved in terms of freight transport and on time.
- Storage costs will be greatly reduced.
- The flow of personalized services and products will intensify.
- The bulk quantity of the transported product will decrease, and less and frequent supply will be concentrated.
- Supply chain functions will become leaner.

- The level of integration between complex systems will increase and it will be easier to manage them together.
- Thanks to autonomous systems, it will be possible to operate without the need for human factors.
- Large-scale data will be transferred at a much higher rate.
- The data will also be a source for different needs.

2.2.2. Components of Logistics 4.0

Under this title, we will talk about the connections of industry 4.0 components, which we mentioned before, that entered our lives with technological developments, with logistics and their contributions to the logistics sector.

2.2.2.1. Logistics and Internet of Things

The Internet of Things has the potential to speed up logistics with a data-driven approach by connecting almost everything in production and distribution systems to the Internet.

With the internet of things, businesses can monitor and control all their products and services in real time and manage their logistics processes. The established network structure not only controls the circulation in the supply chain and shares information, but also analyzes the data obtained from each procedure and forecast. Thanks to the internet of things, business information can offer solutions by determining the possibilities that may arise by predicting from the current procedures of the products, future consumer trends or possibilities. In this way, the ability of businesses to respond to the market is developed (Galindo, 2016: 39).

Using the internet of things during the realization of logistics activities provides a high level of visibility to the logistics processes about all the information and locations of the objects and products themselves or their packages (Winkelhaus and Grosse, 2019: 8). In addition, the contributions of the internet of things to logistics processes and supply chain can be summarized as follows (Yıldız, 2018: 1225; Taha et al., 2017: 94):

- End users in the supply chain utilize these technologies to manage accurate and transparent shipment tracking of products and services.

- Business users and other partners of the supply chain can more easily achieve integrity checks for sensitive and valuable products.
- Logistics companies need transparency in their distribution networks, network utilization and shipment tracking for optimum efficiency.
- IoT technologies need to be used in SCM to create a highly transparent and integrated control system that will help identify the right product, at the right time, in the right place, in the right quantity, under the right conditions and at the right cost.
- The Internet of Things provides communication of any object with the systems of processes anytime, anywhere.
- Smart technologies of the internet of things enable businesses in the supply chain to reduce the costs arising from the process of obtaining information, and the processes in supply chain management are becoming smarter.
- The Internet of Things provides real-time visibility of inventory in the supply chain, making significant contributions to the optimization of inventory management.
- Thanks to the technologies of the Internet of Things RFID tags, it ensures that all kinds of information about products and services such as production information, expiry date and warranty period are recorded and shared with all business partners, so that the supply chain and logistics processes are managed effectively.
- With the Internet of Things, all processes of transportation operations (transport mode, transportation condition, destination, etc.) are carried out with the support of smart objects, increasing product traceability.

If we need to give an example of the internet of things from the field of logistics; In warehouses where circulation is high and millions of products of different types and characteristics are in flow; It is very important for profitability and flexibility to transfer the right product to the right area at the right time, completely and without errors. At this stage, errors and misuse of resources are provided by the barcoding system. Communication and integration between physical and digital elements in warehouses is provided by RFID. Unlike conventional labels, these barcodes have a

chip on them. Thanks to this microchip, the data to be used in the system are collected one by one and the location for the transfer is determined. When a product arrives at the warehouse, it is read and recorded by the smart tag, sensors and readers on it. This information is transferred to the system. Simultaneously, the system determines the shelf where the incoming product will be located, by analyzing the current situation, the conditions of the environment, and then the date when this product will be released, and many other data. While the barcode of the incoming material is read, the information that the product has arrived is transmitted to the supplier, again thanks to RFID technology. The environment analysis of the product, which is stacked on its own shelf, continues as long as it remains on the shelf. When suitable conditions deteriorate, the system automatically intervenes. When it is shipped, the product is taken from its current location in the light of similar analyzes. When the information that the current product will be released to the electronic system is received, the product sends a warning from its current location. When the product leaves the shelf, it also sends information to the system. The system compares this data with the shipping list. In this way, faulty product output is not allowed. If the shipping list and the product match, autonomous systems take the product from the shelf where they are placed and bring it to the exit door without the need for human beings. Before leaving the exit door, the reader reads the product again and it falls out of stock. If requested, a product output notification is sent to the unit to which the product will be sent. (See, Fourth Industrial Revolution Industry 4.0, p. 160.)

Thanks to the RFID system, the products can be separated according to their forms. For example, millions of shoes entering a warehouse; sorting them according to their numbers and colors can take a very long time with the human factor. However, smart stacking systems categorize products based on their barcodes and separate them into different areas according to their characteristics. As can be seen from this example, industry 4.0 elements actually work together. While the object is connected to the internet with the barcode and has an electronic tag with its features, in this example it is an autonomous robot that parses it.

In order to see the expected benefit from Logistics 4.0, it is essential that the technological infrastructure and elements have the necessary equipment. The most important of these equipment are; detection and identification systems, automatic

racking systems and conveyors for separating and combining (Görçin, Fourth Industrial Revolution Industry 4.0, p. 165.)

FedEx delivers more than 3 million materials to different parts of the world with more than 40,000 vehicles every day. FedEx couriers frequently lose their vehicle keys and it costs $200 to obtain new keys. FedEx, by attaching an RFID tag to the wrists of its couriers, got rid of both the cost of key replacement and the time loss caused by key searching (Saatçioğlu, 2019: 30-31).

Figure 2.8. FedEx RFID

2.2.2.2. Logistics and Cyber Physical Systems

Cyber Physical Systems; It is a smart state of machine and equipment-like elements that can develop attitudes according to variable conditions, equipped with technological capabilities. With a simpler definition; It serves to control the machines by means of intelligent software120. Therefore, it organizes operations related to industrial and logistics processes equipped with technology. These are the systems that process the information obtained by the Internet of Things and act within the framework of a specified command against this data.

Cyber-physical systems are systems that can instantaneously perform all operations within the production, logistics and value chain and provide coordination between them, increase the level of performance, create solutions for variable situations, implement the solution by itself, and perfect the operation. It is the technical infrastructure of Industry 4.0 and logistics 4.0.

2.2.2.3. Logistics and Augmented Reality

Augmented reality is used in logistics, especially in the field of warehouse management. The logistics or warehouse worker will wear specially designed augmented reality glasses. There will be a barcode system and it will scan the products in the employee list. By means of the markers on the products, the glasses will guide the employee to the material. These glasses consist of a frame and a screen. Thanks to this screen, you will be guided visually. (Miman, Küçük, Akırmak and Tatar, p. 1) At the same time, if the augmented reality system is integrated with the logistics ERP system, it can also send instant activity and stock reports to the manager. This system prevents all kinds of mistakes and confusion in logistics activities. In the picture below, you can see the virtual orientation that takes place through the glasses. (Fatih Bilici, "Using Augmented Reality in the Production Sector", 13 May 2016,

http://artirilmisdunya.blogspot.com/2016/05/uretim-sektorunde-artrlms-gerceklik.html, (2.04.2019).)

Figure 2.9. Example of Virtual Routing with Augmented Reality Glasses

Source: http://artirilmisdunya.blogspot.com/2016/05/uretim-sektorunde-artrlms-gerceklik.html

Augmented reality will also provide a lot of convenience for drivers. This application, which will replace the speed indicators in the vehicles, will be a real-time driving assistant. Drivers can benefit from all the features of augmented reality thanks to the projector named WayRay, in which Hyundai and JVC Kenwood are currently involved in investments under the leadership of Porsche. WayRay, which we can think of as an assistance service that warns the driver when to brake, speed

and direction, is located in Switzerland, USA, China, Russia and Germany. (Sami Eyidilli, “Porsche-led tour augmented reality startup WayRay $80 million received investment” 19 September 2018, https://webrazzi.com/2018/09/19/porschenin-basi-cektigi-turda-artirilmis-gerceklikgirisimi-wayray-80-million-dollar-investment-aldi/,(04.04.2019).) It is clear that this and similar applications that will make the driver's job easier and reduce the error rate will be of considerable benefit when spread to the transport sector.

Knapp logistics company has developed a product selection technology called “KiSoft Vision” using augmented reality technology (Knapp, 2018). “Selectors wear a headset that displays information on the screen that helps them locate the products more quickly and precisely, the integrated camera of the head captures the serial and lot identification numbers of the products, providing real-time stock tracking and reducing the error rates by up to 40%” (Çiçekli, 2018). ; Baur & Wee, 2015).

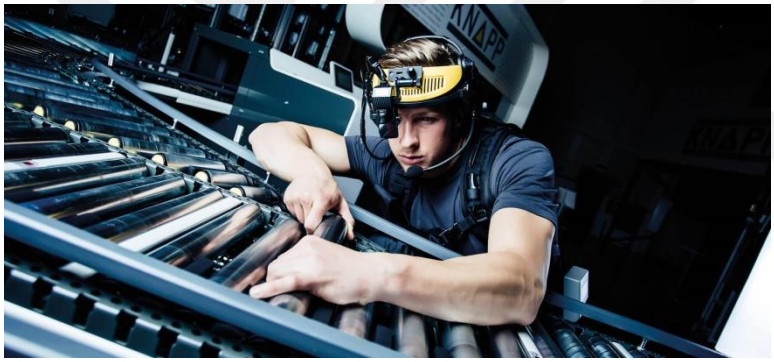


Figure 2.10. Knap KiSoft Vision

DHL achieved a 25% increase in performance in collecting customer orders, thanks to the Ricoh smart glasses it developed. The device connects to the warehouse management system in real time and significantly relieves the burden of employees thanks to its innovative user interface and hands-free operation (DHL, 2018: 38).

Figure 2.11. DHL Ricoh

2.2.2.4. Logistics and Big Data

Logistics is one of the fields where big data is used effectively. The variety of materials that are the subject of daily operations and the constant variation of the locations where they will be received or delivered increase the logistics business volume. Increasing productivity and efficiency and reducing workload and costs are directly proportional to the simultaneous and up-to-date data to be obtained. Thanks to big data, all data flowing to logistics can be provided simultaneously and up-to-date.

It enables real-time planning of routes in big data logistics operations. Route planning is done with traditional optimization applications. These applications are; linear program, traveling salesman method, transportation problem. However, these applications are made according to the data obtained at the beginning. Since there is no simultaneous data technique, it cannot always give effective and accurate results and does not allow any plan changes. While the operation continues with big data, conditions can be analyzed with the data received as a result of any demand, and a higher efficiency operation is possible.

For example; After the loaded vehicle is on the road, the effect of the vehicle's route change on efficiency can be calculated instantly as a result of information transmitted by means of big data (usually about shipment addition, traffic situation, delivery order, weather conditions), and the operation can be redesigned within the framework of this location if it does not cause loss of efficiency (Görçün). ,Fourth Industrial Revolution Industry 4.0, p. 166)

As a vivid example of this; We can show that UPS has saved 39 million gallons of fuel, 364 million miles and 10 million minutes since 2001 thanks to route optimization. (Exastax, “How Does the Logistics Industry Benefit From Big Data?”, November 9, 2017, https://www.exastax.com.tr/buyuk-veri/lojistik-buyuk-veriden-nasil/, (17.05.2019))

The increase in online sales from day to day has made the speed and quality of delivery the main competitive conditions. While these businesses dictate the need for trouble-free delivery, on the other hand, the intensive use of the internet by the customers and the online recording of the address information of the customers in the data provides the businesses with the ease of accessing the recorded data directly for the distribution operations. The fact that customers save their addresses via GPRS

eliminates address errors in shipments and prevents time loss. Businesses can access these databases from systems running on Google or GIS. In addition, apart from the delivery point, which is important in customer information, the customer profile, the age range of the profile, the type of taste, even what the customer profile will like in ten years, customer satisfaction and feedback can be easily accessed. This contributes to the instant or forward-looking strategy determination of the enterprises. In addition, businesses that can provide customer taste and expectation data can easily predict which products should keep their inventory.

2.2.2.5. Logistics and Cloud Computing System

Logistics sector; With the 4.0 transformation, it has turned to many technological innovations. Processes have been digitized and infrastructure has been renewed. Thanks to radio frequency identification systems (RFID), barcode and data matrix systems, which are the main systemic elements of the changing infrastructure, it recognizes the labels on the objects and provides all the necessary information in this way, the data is obtained automatically. Thanks to cloud computing, this data can be stored in the cloud system on the internet. The risk of loss is eliminated and data can be accessed from anywhere.

Another advantage of the logistics operation, in which many processes such as transportation, storage, operation, distribution, and finance are followed, is the opportunity to control all these from a single place. This provides a substantial cost advantage. In addition, since this system is equipped with 24/7 security measures, it is more reliable than a computer or hard disk.

The disadvantage of the system is that it is not possible to access the data without internet. (Zeynep Muzır, “Bulut Bilişim”, 20 July 2018, http://lojistikkulubu.ist/bulut-bilisim/, (05.04.2019).)

2.2.2.6. Logistics and 3D Printers

3D printers will make it possible to reduce the inventory cost, which has been intended since the past. Namely, since each product will be printed by 3D printers instantly and according to demand, the need to have products in stock will be eliminated. Thus, production, supply and storage costs will be directly reduced. Since the printers will not be located at points far from consumption such as factories, the producer-consumer distance will be shortened, thus saving time and money. At the

same time, there will be no delays due to carrier error or adverse weather conditions. In terms of the environment, it will be an important solution to the ecological footprint problem.

This change has advantages as well as disadvantages. Because not only will the distance be shortened, but because the delivered product will be personal, less in quantity and frequent operations will be required in time. In today's conditions, the decisive criterion for a profitable logistics operation is to load as much as possible at once. At this stage, it will become a necessity for the logistics industry to develop different methods. Transport with drones or fast courier network can be considered as a logical solution at this stage. (Seyhan 2019)

Amazon has developed a patented 3D printer delivery truck to deliver faster delivery to its customers. Thus, when a shopper orders a product from Amazon, the product can be printed on the 3D printer of the truck closest to the delivery location and delivered to the customer without storage (Çiçekli, 2018; DHL, 2016a: 34).

Airbus aircraft company uses more than 1000 parts made of 3D printers in its latest A350 model. Moreover, at the International Aviation Exhibition in 2016, it was 4 meters long and 21 kg. He exhibited a 3D-printed drone, which he named Thor, consisting of parts produced in only 4 weeks (DHL, 2016b: 13). Boeing produces most of the parts in its planes with 3D printers, so there is no need to stock airplane parts in different centers. It provides fuel savings and resource efficiency by producing a three-dimensional model of the part in need of spare parts, lighter than a 3D printer and with higher performance (Flightglobal, 2016).

Figure 2.12. 3D Printer

2.3. The impacts of Industry 4.0 on Logistics Industry

With the Industry 4.0, digital transformation in industries and developments in technologies make possible an individualized and sensitive logistics and supply chain management. The developments in Industry 4.0 affect logistics processes in a significant way, leading to Logistics 4.0. Emerging technologies not only facilitate important logistics aspects such as sustainability, efficiency, sensitivity in customer relations and better traceability, but also affect the basic elements of businesses and significantly change the business models they implement. (Strandhagen et al., 2017: 363).

Logistics plays an important central role in the integrative digitization of the economy and society. With the fourth industrial revolution, logistics is shifting towards “intelligent logistics”, where material flows are monitored in real time, better transport management and precision management committed to reducing risks. This evolution of logistics is also due to the integration of cyber-physical systems and the internet of things into logistics systems (Douaioui et al., 2018: 130).

2.4. Challenges in E-Logistics

With the rapid development of technology, the digitalization of all working structures and processes of institutions has become inevitable. In order to achieve digitalization in institutions, it is necessary to keep up with change and transformation. Although technological developments have many benefits in our lives, it is very difficult to adapt to these developments at the first stage. When businesses want to switch to different systems to keep up with developments, different challanges may arise. The challenges will be discussed under 3 headers and 9 sub-titles.

2.4.1. Technical Challenges

2.4.1.1. Technology

Industry 4.0 concepts require a strong infrastructure, as well as information technology-based facilities and technologies (Luthra and Mangla, 2018). One of the most important critical factors of Industry 4.0 adoption is to investing in the technology (Tay et al., 2021). Inadequate digital infrastructure (Pfohl et al., 2016), in other words lack of technological hardware and software infrastructure constitutes an important barrier to complete digitalization. Because industry 4.0 requires several

Technologies such as; internet of things, artificial intelligence, cloud computing, big data, virtualization, virtual reality, augmented reality, and additive manufacturing (Silva and Barriga, 2020).

2.4.1.2. Security Concerns

There is a huge amount of information and data flow within the Industry 4.0 platform. The lack of adequate systems on data privacy and protection and cyber security threats are obstacles for businesses to turn to digitalization (Alaba et al., 2017).

2.4.1.3. Internet Connectivity

Industry 4.0 initiatives are hampered by a lack of internet access. Inadequate internet-based networks and unreliable internet connectivity are critical barriers in front of the digitalization (Pfohl et al., 2017). Furthermore, internet-based technology is not equally acknowledged in urban and rural areas, which can stymie long-term business growth (Luthra and Mangla, 2018). In the production of the product with effective communication and service, signal attenuation due to weak signal coverage causes erroneous and incomplete solutions (Çalışkan, 2020).

2.4.2. Managerial and Economic Challenges

2.4.2.1. Financial Constraints

As with any technology adoption process, another obstacle to benefiting from the opportunities of the fourth industrial revolution is the high investment costs (Kamigaki, 2017). There is also the risk of making a loss and not being able to recoup the investment spent. Türkeş et al., (2019) examined the factors that motivate and hinder the use of industry 4.0 technologies by small and medium-sized companies operating in Romania. According to the opinions of the managers of the companies, one of the biggest obstacles to the transition to industry 4.0 applications is the high operation and investment costs. Briefly, high initial investment (Kagermann et al., 2013), budget restrictions (James et al., 2022; Tay et al., 2021), uncertainty in the economic interest of digital investments (Kiel et al., 2020), uncertainty about future profitability (Kagermann et al., 2013), and situation of customers are not always willing to pay (Kiel et al., 2020) can counted as financial constraints in digitalization.

2.4.2.2. Lack of Competency to Adopt/Implement New Business Models

One of the organization related difficulties in front of Industry 4.0 applications, there is the situation of not being ready and not ready for innovations and transformations. Because, thanks to automation, organizational structures and functions will change, a decentralized decision-making system will be formed, and even decision-making will go down to the workshop floor. These are recognized as major concerns for most businesses (Hussain, 2017).Poor understanding of I4.0 adoption pattern (Frank et al., 2019), meagre digital operations vision and strategy (Erol et al., 2016), absence of experts in I4.0 (Kiel et al., 2020), lack of digital culture (Simic and Nedelko, 2019), reluctant behaviour towards I4.0 (Luthra et al., 2019), implementation time (Sony et al., 2021) are the basic problems regarding lack of competency to adopt new business models in organizations.

2.4.2.3. Lack of Appropriate Management Practices

Businesses want to have clear information about the nuances of applications such as the Internet of Things, business models, value created and cost-benefit variances. In addition to this information, the lack of sample standards and references was also considered as a significant challenge (Mueller vd., 2017). Compliance with I4.0 needs effective learning, knowledge management and innovative capability. Lack of Industry 4.0 skills and know-how (Sony et al., 2021), lack of coherence in terms of implementation frameworks and reference architecture (Sony et al., 2021), lack of clear comprehension of I4.0 concepts (Hofmann and Rüsch, 2017) lead difficulty to adopt or implement I4.0 in management practices.

2.4.3. Regulatory and Social Challenges

2.4.3.1. Employees (Workforce)

When the literature is examined, it is seen that the most common view on the obstacles and difficulties in the adoption and implementation of Industry 4.0 in the production sector is the problems related to the workforce (Flynn vd., 2017; Kamble vd., 2018; Karadayı-Usta, 2019). These difficulties covers different dimensions related to workforce such as; the emergence of the need for more educated and qualified personnel, the need for continuing education, resistance of both white and blue collar workers to digital, organizational and process transformation, and workforce losses. Inadequate technical skills, training, confidence problems, talent

acquisition and retainment challenges, lack of awareness, demographic challenges, ethical behavioral challenges, resistance to change, education, culture, and employment disruptions (James et al., 2022) are the other challenges related with employees challenges.

2.4.3.2. Partners

In organizations, the implementation of Industry 4.0 will result in horizontal, vertical and end to end integration using modern ICT Technologies (Sony et al., 2021). Poor existing data quality (Simic and Nedelko, 2019), problem in integration of technology platforms (Zhou et al., 2016), problem of coordination and collaboration (Luthra et al., 2020) are the challenges under the heading of partners which prevents complete digitalization.

2.4.3.3. Legal Matters

One of the difficulties addressed in the literature is the uncertainty in the laws and responsibilities arising from the contracts that a business will be subject to when it implements industry 4.0 applications (Kamble et al., 2018). Unavailability of universal standards and protocols for data sharing (Rajput and Singh, 2019), lack of governmental policies and support (Raut et al., 2019) can also be counted under legal matters.

CHAPTER 3
METHODOLOGY: BEST-WORST METHOD

Among the multi criteria decision-making (MCDM) methods, the newest is the Best-Worst Method (BWM) developed by Rezaei (2015). Unlike other MCDM methods, the method focuses on choosing the best and worst alternatives among the alternatives to be decided. The biggest advantage of this method is that decision makers do not want pairwise comparisons between all determined criteria. The basic logic of the method is, first, the most and least desirable alternatives are determined, and then pairwise comparisons are made between the best and worst alternatives and other alternatives. The consistency ratio is calculated within the reliability of the BWM method. The method was developed in the following years and a minimum and maximum mathematical programming model was created to define the optimal weights of different criteria (Safarzadeh et al., 2018). Although this method based on pairwise comparison is new, it has applications in different subjects and sectors. The method consists of six separate steps; the order of operations is;

S1: A number of decision criteria are set.

One or several decision makers decide the *n* criteria about the problem.

$C = \{c_1, c_2, ..., c_n\}$

S2: The same decision makers are determined the best (c_b: the most desired) & worst (c_w: the least desired) criteria from the set of criteria.

S3: The preference ratio of the criterion that is the best (c_b) chosen according to all other criteria is determined for binary comparison.

The decision maker determines the preference rate. This ratio is as a number between one to nine (where one is equally significant & nine is extremely significant). Then a vector called best-to-others (A_B) is reached that goes from best to others. This vector is as follows.

$$A_B = (a_{B1}, a_{B2}, \ldots, a_{Bn})$$

Each a_{Bj} in the A_B vector shows the preference of B, which is the best criterion, according to criterion j. Value is an integer number between one to nine. In addition, $a_{BB} = 1$. This means that the most desired and most significant criterion will be compared with itself.

S4: The preference ratio of the criterion that is worst (c_w) chosen according to all other criteria is determined for binary comparison.

The same procedure that was done in the previous step is repeated for the worst criteria. As a result, the vector emerges which is the worst from the other criteria. Then a vector called 'Others-to-Worst' (A_W). This vector is as follows.

$$A_W = (a_{1W}, a_{2W}, \ldots, a_{nW})^T$$

Each a_{jW} in the A_W vector, shows the preference of criterion j over the worst criterion W. In addition, $a_{WW} = 1$. This means that the worst criterion will be compared to itself.

S5: Optimal weights are calculated for each criterion. $w^* = (w_1^*, w_2^*, \ldots, w_n^*)$.

The optimal weight for the criteria are; $w_B / w_j = a_{Bj}$ and $w_j / w_w = a_{jw}$ ($j = 1, 2, \ldots, n$). So, to provide these circumstances for whole j, necessary to obtain a solution where the maximum absolute differences

$|w_B/w_j - a_{Bj}|$ and $|w_j/w_W - a_{jW}|$ must become minimized.

Also, the weight vector must not be negative and the total condition must be 1. As a result, the following problem arises.

$$\min \max \{|w_B/w_j - a_{Bj}|, |w_j/w_W - a_{jW}|\}$$

$$\sum w_j = 1, \qquad w_j \geq 0, \text{ for whole } j = 1, 2, \ldots, n$$

The problem equation is transferred to the following linear programming problem.

$$\min \xi \qquad |w_B/w_j - a_{Bj}| \leq \xi, \quad \text{for whole } j$$

$$|w_j/w_W - a_{jW}| \leq \xi, \quad \text{for whole } j$$

$$\sum w_j = 1, \quad w_j \geq 0, \quad \text{for whole } j = 1, 2, \ldots, n$$

S6: With the completion and solving of all this model, optimum weights ($w_1^*, w_2^*, \ldots, w_n^*$) and ξ value are obtained.

The value of ξ expresses the maximum absolute difference and the Consistency Ratio

(CR) of the analyzes made. The CR is used to control the reliability of the optimal weights, it expresses the reliability among the got weights, and the binary comparison data ensured by the DM. CR is shown as follows.

$CR = \xi^{*} / CI$

CR is a number between zero and one ($CR \in [0, 1]$). Zero indicates complete consistency. ξ indicates the maximum absolute difference found from equation 4. According to the c_w criterion, determining the largest a_{BW} preference ratio of the c_b criterion (1,2, ..., 9), the maximum ξ value emerges. These maximum values are used as CI. It turned out that the higher the value, the weaker their consistency ratio and the less reliable the comparisons.

In the next section, the BWM method will be applied to determine the relationships and weights of the obstacles in front of innovations in e-logistics determined from the Industry 4.0 perspective. Thanks to this method, a strategic roadmap will be developed for decision makers who want to adopt Industry 4.0 in their work.

3.1. Implementation of the Study

The main purpose of this study is to identify and prioritize the barriers to innovations in e-logistics in the digital age we live in. Therefore, a two-stage methodology was used in this study. First, a detailed literature review was conducted to identify the barriers to innovations compatible with industry 4.0. As can be seen in Table 1, barriers have been identified, including 9 from the literature review. The BWM is then used to determine the weights and order of importance of these barriers. In order to implement BWM, two-stage e-surveys are applied to experts. In the first round, the experts are asked to identify the best and worst criteria for dimensions and for each dimension criterion. In the second round, the preference of the best criterion over the others and all criteria over the worst criterion is determined by expert opinions. Finally, the responses are used as input for the best worst method and to calculate the weights.

As stated in the previous section, a total of nine barriers were determined, including three main dimensions; technical challenges, managerial & economic challenges and regulatory & social challenges. The barriers were approved by taking the opinions of six experts who have at least seven years of experience in logistics and work in senior positions. The BWM matrix was then presented to the same experts for

weighting and ranking these barriers. The BWM application was completed by experts working in senior positions in different logistics companies. In this study, the experts whose opinions were taken are authorized persons working in the field of supply chain operations in Turkey's largest logistics companies. The ages of six people we interviewed, two female and four male, ranged between 39 and 52. A female and a male are directors and the rest are managers. The female and male directors are also the oldest of the six interviewees, aged 52 and 48, and have the longest experience with 16 and 17 years. The other interviewees are experiences of two people for 10 years and the other two for 13 years, mostly in direct proportion to their age.

Table 3.1. Information About Experts

Expert	Gender	Age	Position	Experience
1	Male	52	Director	17
2	Male	41	Manager	10
3	Male	45	Manager	13
4	Female	48	Director	16
5	Male	39	Manager	13
6	Female	40	Manager	10

The research methodology was explained in detail in the previous section. The proposed mathematical model is coded and solved by BWM-Solver in EXCEL. The answers from experts were put into the mathematical model and the model was run. By solving the BWM model, the weights of different criteria and sub-criteria were determined. The results are discussed in the next section.

3.2. Results and Discussion

Before analyzing the weights of the each barriers, we should check what extent the results are reliable. The Consistency Ratio (CR) of the pairwise comparison data provided by the decision makers must be looked at to check the reliability of the barrier weights obtained. As seen on Table 3.2., consistency values of the inside and outside vehicle are 0,303 and 0,213 respectively. This means that the closer the ξ^* to zero is the better, so there is not any problem about the reliability of the data and analysis.

Table 3.2. General Results of the BWM

Dimension	ξ*	Weight	Rank	Barriers	Local Weight	Rank	Global Weight	Global Rank
Technical Challenges	0,494	0,237	2	B1-Technology	0,6795	1	0,1038	4
				B2-Security concerns	0,2435	2	0,0591	7
				B3-Internet connectivity	0,0769	3	0,0223	9
				Total	**1.0000**		**0,1852**	
Managerial & Economic Challenges	0,616	0,208	1	B4-Financial constraints or capital	0,6164	1	0,2640	1
				B5-Lack of competency to adopt/implement new business models	0,2466	2	0,0837	5
				B6-Lack of appropriate management practices	0,1370	3	0,0519	8
				Total	**1.0000**		**0,3996**	
Regulatory and social challenges	0,329	0,169	3	B7- Employees or workforce	0,7143	1	0,2076	2
				B8- Partners	0,2086	2	0,1384	3
				B9- Legal matters	0,0771	3	0,0692	6
				Total	**1.0000**		**0,4152**	
						Total	**1,000**	

According to the results of the BWM, the "Managerial & Economic Challenges' dimension is the most important and "Regulatory and social challenges" is the least important dimension among main dimension. Moreover, financial constraints or capital (B4) is the most important barriers among the sub-barriers. If it is necessary to sort among all barriers; Employees or workforce (B7), Partners (B8) Technology (B1), Lack of competency to adopt/implement new business models (B5), Legal matters (B9), Security concerns (B2), Lack of appropriate management practices (B6) respectively. Surprisingly, Internet connectivity (B3) barrier came in at the bottom of the overall barrier ranking. From this, we understand that companies do not have a problem with connecting to the internet and they do not see this issue as a barrier since they have a strong infrastructure for this.

According to the results, the barriers with the least value after internet connectivity, Lack of appropriate management practices (B6) and security concerns (B2) do not create major problems as a barrier. From this, we understand that by choosing the appropriate management systems for their application areas, they manage their work flows correctly and that the companies minimize the problems by taking the necessary precautions regarding security.

Conversely, the fact that financial constraints or capital (B4) is one of the barriers

that companies have the most problems with shows that sufficient budget cannot be allocated for technological developments. From the Employees or workforce (B7) and Partners (B8) items that follow, we understand that employees have difficulty in adapting to new developments, they adopt the traditional systems they are used to, and their partners also think in this way.

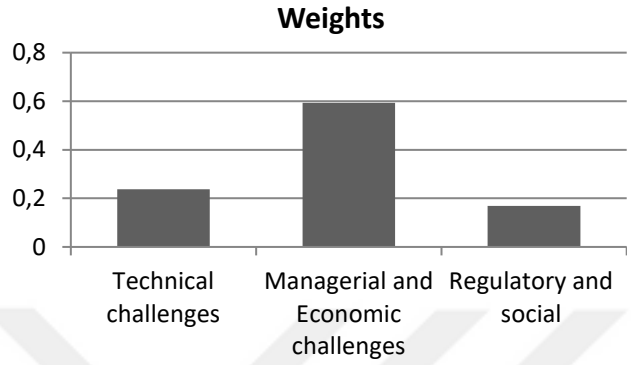


Figure 3.1. Weights of Main Barriers

As can be seen in Figure 3.1., the most important one with 0.616 value is the main title of barrier Managerial and Economic Challenges, which companies face the most. Technical Challenges follow with a value of 0.494. Finally, with a value of 0.329, it was the least important barrier Regulatory and Social Challenges title in the ranking.

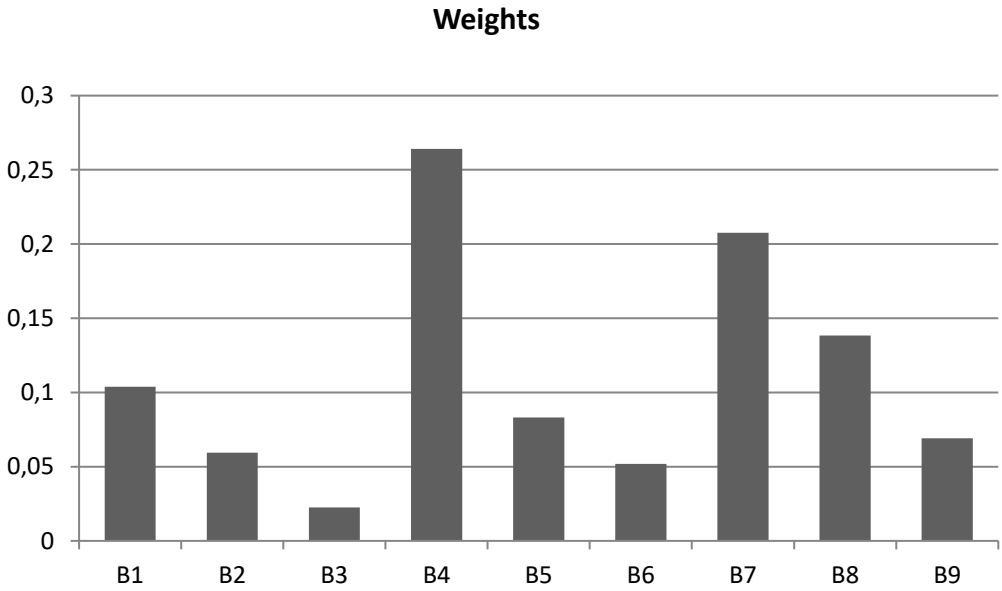


Figure 3.2. Weights of Each Barrier

It is clearly seen that Internet connectivity (B3) is the least important one with value of 0,0223. Lack of appropriate management practices (B6) and Security concerns

(B2) with the value of 0,0519 and 0,0591 were given the second & third lowest priority. Based on these results, this study gives the reader a comprehensive insight into how detected barriers affect digitalization performance. Therefore, this framework is a roadmap that is designed with a holistic view to guide manufacturer, logistics parties and even policy and decision makers.

CHAPTER 4
CONCLUSIONS AND FUTURE RESEARCH

In summary, when we examine the effects of technological developments in the fields of industry and logistics and the revolutions in these fields, we can see how effective the processes of starting to use new software with the development of the internet, from human power to steam power, to the widespread use of electricity, and to play an active role in the majority of our lives.

It affects all businesses to a great extent, because of the logistics industry develops within itself by being influenced by industry revolutions and covers many activities such as demand forecasting, raw material supply, material management, packaging, handling, transportation and storage.

Businesses should start using new systems instead of traditional methods to adapt to the new world, protect the competitive environment and get more profit.

In short, these new developments are to switch to cyber-physical systems, to use the internet of things, to use the cloud system to store the increased data more securely, to keep the processes running smoothly as a result of the machines being able to communicate with each other without the intervention of the employees, to monitor the whole process simultaneously from anywhere, to use artificial intelligence to reduce the error rate to zero and increase the speed, to avoid unnecessary costs without detecting and performing processes that will not be efficient by experiencing applications with augmented reality before they are implemented, to personalize products with materials that can be produced with 3D printers and to deliver instantly without the need for storage, and because it is a system that does not require large factories being close to the customer and shortening the transportation, saving labor and time by using intelligent - autonomous robots in the warehouses, improving the processes with simulation management and eliminating possible bottlenecks can be classified as preventing.

However, since these are activities that require radical changes, it is necessary to have the necessary infrastructure and information. Therefore, there are some challenges faced by businesses that want to change their systems. In this study, after the literature review, 9 barriers were determined and they were grouped under 3 main headings.

Main headings are technical challenges, managerial and economic challenges and regulatory and social challenges.

The 9 barriers that are the subject of the study are as follows; technology, security concerns, internet connectivity, financial constraints or capital, lack of competency to adopt/implement new business model, lack of appropriate management practices, employees or workforce, partners and legal matters.

Technology barrier is can be briefly explained as, industry 4.0 concepts require a several strong technologies such as internet of things, artificial intelligence, cloud computing, big data, virtualization, virtual reality, augmented reality, and additive manufacturing. infrastructure, as well as information technology-based facilities and technologies. If companies do not have a strong technological hardware and software infrastructure, they cannot take advantage of these innovations and fall behind their competitors.

As new technologies increase, the flow of information in the internet environment is constantly increasing. The lack of adequate systems on data privacy and protection and cyber security threats are obstacles for businesses to turn to digitalization. Therefore, another barrier is security concerns.

Because of all these technologies are internet-based, inadequate and unreliable internet connectivity are critical barriers in front of the digitalization for businesses. In the production of the product with effective communication and service, signal attenuation due to weak signal coverage causes erroneous and incomplete solutions. In this regard, the opportunities of urban and rural areas are not equal.

As in almost all businesses, finance is one of the most important issues. There is also the risk of making a loss and not being able to recoup the investment spent. High initial investment, budget restrictions, uncertainty in the economic interest of digital investments, uncertainty about future profitability, and situation of customers are not always willing to pay can counted as financial constraints in digitalization.

Thanks to automation, it is possible to experience the problem of being unprepared for radical changes such as organizational structures changing functions, creating a decentralized decision-making system and even going down to the decision-making workshop floor. The difficulties of the lack of competency to adopt/implement new business models barrier include the inability to understand the purpose of new technologies and therefore their reluctance to approach, the absence of experts in this regard, and the time it takes to learn and get used to new business models.

Businesses want to know about the details of new applications. However, since there are not many companies using these newly created systems yet, there are no examples that can be referenced in front of them. This situation presents us with the lack of appropriate management practices barrier.

Workforce difficulties can be listed as; the emergence of the need for more educated and qualified personnel, the need for continuing education, resistance of both white and blue collar workers to digital, organizational and process transformation, workforce losses, inadequate technical skills, training, confidence problems, talent acquisition and retainment challenges, lack of awareness, demographic challenges, ethical behavioral challenges, resistance to change, education, culture, and employment disruptions.

Poor existing data quality, problem in integration of technology platforms, problem of coordination and collaboration are the challenges under the heading of partners which prevents complete digitalization.

Uncertainty in the laws and responsibilities arising from the contracts that a business will be subject to when it implements industry 4.0 applications, unavailability of universal standards and protocols for data sharing, lack of governmental policies and support are legal matters barriers.

After the literature review in the methodology part, 6 people aged between 39 and 52 were interviewed, two women and four men. These people are experts in the field of logistics. The priorities of the 9 barriers, which were determined based on the data obtained in the literature review, were asked to the experts and their weights were determined using the best and worst method.

According to the results, financial constraint is the most important barrier in front of digitalization. It is followed by employees or workforce, partners, technology, lack of competency to adopt/implement new business models, legal matters, security concerns, lack of appropriate management practice, respectively. Finally, the internet connectivity barrier came in at the bottom of the overall barrier ranking.

We can interviewed only few experts. In future studies, challenges can be increased, more people can be interviewed and different methods can be used.

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