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# Contemporary Challenges and Practices in Logistics and Supply Chain Management

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İSTANBUL UNIVERSITY PRESS

# CONTEMPORARY CHALLE PRACTICES IN LOGISTICS AND dolphin choir MANAGEMENT


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## PREFACE

In recent years, extraordinary developments such as global epidemics, war and other humanitarian crises that the world has experienced have caused some recessions and difficulties in logistics and supply chains as well as in all sectors. While the world is making calculations of returning to its old order, new concepts and issues in logistics and supply chain management are on the agenda of both researchers and practical industry environments. For this reason, the idea of this book has emerged in order to bring these new concepts, models, and good practice examples that are new and candidate to application in these two subjects, such as logistics and supply chain management, which require an interdisciplinary view. With this book, contemporary challenges and applications in logistics and supply chain have been discussed from the perspective of different disciplines such as marketing, management science, social sciences, engineering and law.

Many issues such as supply chain analytics, new developments in logistics and human resources in the supply chain, new concepts in sustainable and reverse logistics (such as sustainable supplier selection, risk management, resilience, service quality), integration of the internet of things into logistics and supply chain, evaluation of sustainable practices and company profitability of transportation and logistics businesses, and the situation of freight forwarders in logistics and transportation law have been discussed through this book, and a guide has emerged that will benefit both the academia and industry.

We are very thankful to the Istanbul University Press team for making this book publication smooth and successful.

We thank all the authors, who are the true architects of the success of our book project, and the reviewers for their valuable comments, contributions, patience and cooperation.

Finally, we, as the three editors of this book, are grateful to our families for their constant love, patience and support. Without their unique support, we would not have been able to complete this book. With the best wishes that the book will be useful to all concerned.

Abdullah OKUMUŞ, Ebru DEMİRCİ, Muhammet GÜL

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## CONTENTS

# CHAPTER 1

# SUPPLY CHAIN MANAGEMENT: CHALLENGES AND SOLUTIONS

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**ABSTRACT**

A supply chain is a network that businesses use to manufacture and distribute goods and services. This system begins with the raw material and ends with the final product or service delivery to the customers. The supply chain comprises suppliers, manufacturers, freight forwarders, warehouses, distributors, and retailers, facilitating the worldwide movement of information and resources. Recently there has been a challenging era in the world in terms of supply chain due to reasons such as the global epidemic and the Russia-Ukraine War. Product supply sources, and product and transportation routes are undergoing profound changes. At this point, the latest developments and regulations regarding the environment and climate also come to the fore. In countries, where production inputs are dependent on imports, supply chain difficulties and management become more important for production, employment and exports. Countries and companies need to plan a strategy for these developments, and current plans must be updated according to the latest developments. This chapter explores the contemporary supply chain management challenges and how to address them. In this way, it is aimed to provide a road map for strategic plans of countries and companies. The main headings will arrange the chapter as supply chain management, supply chain challenges, and how to overcome supply chain challenges. After defining the supply chain management in the first section, the most critical supply chain challenges are determined and explained in the literature review section. After defining and explaining the challenges, solutions depending on the related literature and practice to help strategic decisions of countries and companies are given in the third section. As a result of the study digitalization can be seen also aa a challenge and an important solution to the challenges in the supply chain. In the new world, where everything is changing very rapidly globally, supply chains are becoming more costly, risky, and complex. Thus, traditional supply chain strategies and methods can be insufficient. The condition of successful supply chain management is to be positioned around digitalization, technology, and integration.

**Keywords:** Supply Chain Challenges, Supply Chain Management, Supply Chain Solutions, Transportation Management

## 1. Supply Chain Management

Supply chain encompass the activities of products and/or services from a supplier to an end consumer. The whole of the people, studies, resources, technology, activities and organizations involved in this process is called the supply chain. It is a series of tasks ranging from making orders and providing raw materials to produce finished outcomes and also delivering them to the customer. The supply chain begins with purchasing and acquiring the goods and commodities to be sold. Then it is needed to warehouse and inventory management. It generally finalizes with the distribution of the goods to the customer. The supply chain is a system of tools and delivering choices that perform the functions of obtaining materials, transforming the materials into the final product, and delivering the final product to customers.

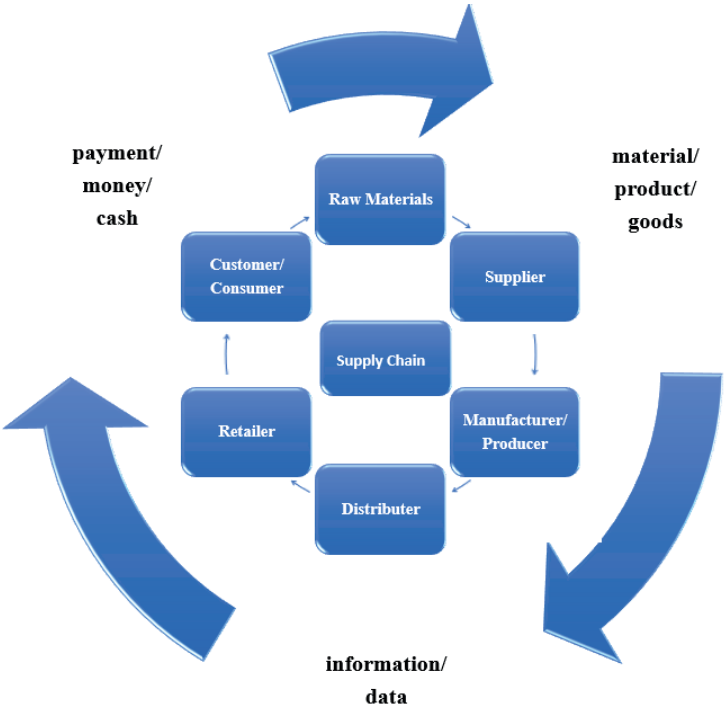


**Figure 1:** Supply Chain Components and Activities
*Created by the authors*

The activities among suppliers, manufacturers, wholesalers, distributors, retailers and consumers are illustrated in Figure 1. In the chain, raw materials are getting from suppliers, transformed into a final product, and then delivered to huge distribution centers and then delivered to final customers. In real life, a supply chain consists of a lot of final goods and

outcomes with familiar parts, means of production, and capacities. Supply chain managers should optimize all parts of the supply chain components.

Supply chain management (SCM) aims to ensure the well-functioning of all stages of the supply chain. In addition, it is to increase efficiency by reducing operational costs. Supply chain management ensures that appropriate materials, services, and technology are bought from the accurate source, at the accurate schedule, and with the suitable standards in a business. Therefore, there are four essential elements of supply chain management. In today's environment, supply chains are of great importance for businesses to provide a competitive advantage in international markets. Supply chain management term refers to organize continuous and rapid product/service flows and to see companies' business processes as a whole. With i e e tive supply chain management, delivering performance is improved, inventories are kept at an optimum level, cycle time is shortened, forecast accuracy increases, efficiency increases and costs decrease throughout the chain, and capacity utilization rate increases. In this regard, a number of activities are in constant interaction, from relations with domestic and international suppliers to the factory environment, from warehouse management to distribution planning. Therefore, supply chain management deals with the business as a whole, including forecasting, purchasing, procurement, production planning, flow and process management, marketing, after-sales support, customer service, logistics, and indirectly finance and human resource management. Figure 2 illustrates the business operations in the supply chain management.

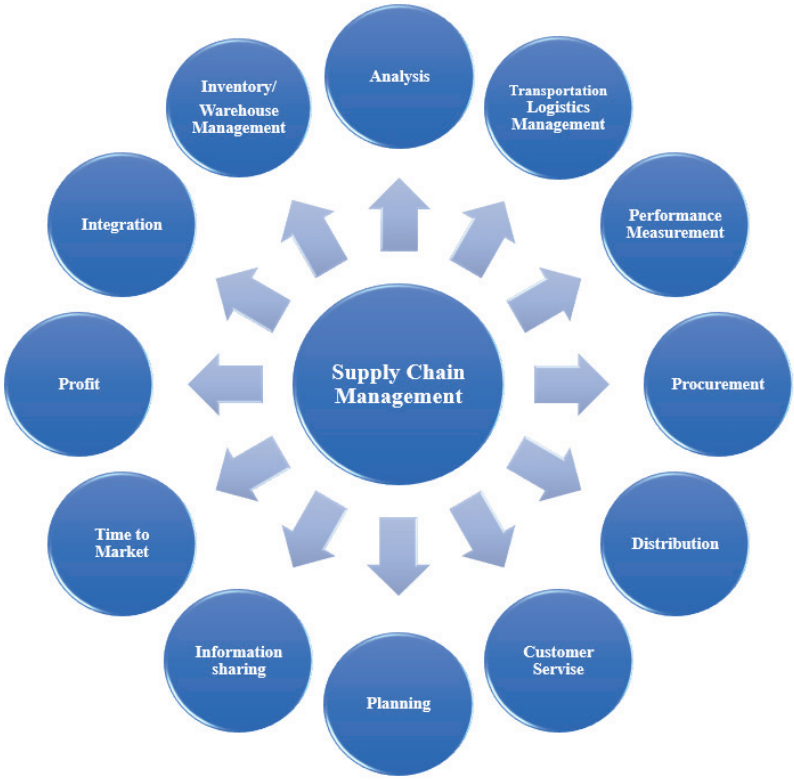


**Figure 2.** Supply Chain Management
*Created by the authors*

There are many challenges that managers face in this whole and complex supply chain management process. Supply chain challenges generally consist of increasing costs, planning and control deficiencies, sustainability, managerial challenges, transportation inadequacy, machine failures, technological change, supplier selection, supplier problem, supplier error, buyers flexibility, information technology failure, changes in customer demand, following customer preferences, and increases in raw material prices, all negative results of accidents, strikes, wartime, natural disasters, restrictions on imports, oil shocks, terrorist attack, and high customs duty, and so on. In the new era, suitable solutions are required to overcome supply chain challenges. Adaptation is needed to be updated to changing business environment. Today, with the fourth industrial revolution, solutions all over the world have become more technology-oriented and more digital. In this final step of mechanization, developments in industrial science such as artificial intelligence, machine learning, Internet of Things, automation and sensors are transforming the way companies create, maintain and distribute new products and services. In the new technology-oriented and digital world, the way businesses

apply technology to the supply chain differs from the method they used in the past. Today, SCM is concerning with the usage of technology in order to make the supply chain and business more intelligent.

This chapter is organized in four sections. The supply chain management is briefly defined in this section, the most critical supply chain challenges are determined and explained in the second section. After defining and explaining the challenges, solutions depending on the related literature and practice to help strategic decisions of countries and companies are given in the third section. Finally, conclusions are stated in the fourth section.

## 2. Supply Chain Overview in Literature

The literature is searched in the lights of the challenges in the supply chain for the last twenty years. According to the Gartner survey (1), 76% of supply chain executives showed that compared to three years ago, their company today faces more frequent supply chain disruptions (1). A combined systems of amenities and transportation options for producing, distributing, and storing materials and goods can be referred to as a supply chain. The supply chain is found in service and manufacturing businesses, although its intricacy varies by industry or business. From industry to industry, they differ significantly in size, intricacy, and scale (2). The supply chain is a broad, intricate network of facilities for manufacturing, distribution, and storage (3). In order to connect these businesses and build an integrated network, various transportation alternatives with various lead times and ways (truck, barge, air, etc.) will be available. The supply chain would also be vulnerable to several unknowns, including major disruptions in supply, changes in the price of essential commodities globally, etc. (4).

Increasing customer demands, globalization, stricter competition, shorter product lifecycles and quicker clock speed, technical advancements, and economic business cycles are just a few of the issues facing manufacturing organizations today (5), (6). In order to tackle these problems, manufacturing organizations are focusing more on their core skills, but outsourcing has also become more popular. As a result, firms' dependency on suppliers increased (7).

According to estimates, about 75% of goods' content comes from sources other than the original equipment manufacturer (8). So, it comes as no surprise that the supply chain is considered to be the primary role of the Contemporary corporation (9). Additionally, it has been asserted that supply networks now compete with businesses instead of individual ones (10), driven by rising consumer choices, decreasing product lifecycles, and cost pressures. Therefore, for a modern company to thrive in the current environment, it is essential to modify procedures within the supply chain function, the way the function interacts with other functions internally, and the way it interacts with other actors externally (11).

As a result of high demand and yet limited logistics capacity, global supply networks are unable to meet demand. Since 2019, global container transportation costs have been increasing and there have been delays in plans. Especially in important trade routes such as Asia-Europe and Asia-North America, cost increases and delays are more common. It is discussed how businesses operate an environment of persistent unpredictability, three key challenges in global supply chain (labor shortages, equipment unavailability and global bottlenecks results) and what public sector decision-makers can do to strengthen the resilience of supply chains (12).

In some ways, after a very turbulent 2020 year with the COVID-19 pandemic, global supply chains have been able to get back on track. However, a number of supply chain issues persisted into 2021 and made things more difficult for both large and small e-commerce companies. In 2021, significant weather events, port congestion, and industrial delays were among the most frequent supply chain problems (including hurricanes, tornadoes, wildfires, and more). Additionally, there were many outliers to deal with, such as new COVID variants and closures of manufacturing factories (13).

## 3. Supply Chain Challenges and Solutions

Digitalization, managerial challenges, planning and control, logistics challenges, sustainability and food waste, environmental sustainability, political factors such as delays in import process, raw material scarcity, automation and reverse logistics and supplier selection are some of the main challenges listed in the literature up to date from the year 2000. A thorough analysis of the literature revealed some of the most significant challenges in supply chain management are summarized in Table 1.

**Table 1.** Challenges in Supply Chain Management

| No. | SCM Challenges | Industry | Study |
|---|---|---|---|
| 1. | **Digitalization** | - | Ageron et al. (2020) |
| 2. | **Managerial challenges** | - | Ballou et al. (2000) |
| 3. | **Planning and control** | Norwegian SMEs | Vaaland and Heide (2007) |
| 4. | **Logistical challenges** | Petroleum | Hussain et al. (2006) |
| 5. | **Sustainability and Food waste** | Agriculture | Yadav et al. (2022) |
| 6. | **Environmental sustainability** | Agriculture | Wu and Huang (2018) |
| 7. | **Political Factors, Delay in import process** | Pharmaceutical | Kumar et al. (2022) |
| 8. | **Raw material scarcity, production and transportation disruption** | Textile | Paul et al. (2021) |
| 9. | **Automation and reverse logistics** | Automobile | Yadav et al. (2020) |
| 10. | **Supplier selection, supplier and buyer relations, supplier and buyer flexibility** | - | Jain et al. (2009) |

With the spread of **digitalization** in the world, digitalization has also become very common in supply chain management. Companies and organizations need to follow current developments in digital supply chain management. It is needed to keep up with innovative technologies such as big data analytics, blockchain, augmented reality, cloud computing, IoT, etc. Digital supply chains integrate innovative technologies, improve customer service, and increase the organization's performance. Thereby, effective digital supply chain management also solves other supply chain problems (14). In fact, digitalization appears as both a challenge and a solution. Because companies that have successfully adapted to digitalization can solve many supply chain problems. However, companies that fail to achieve this will not be able to stand with the traditional methods they used in the past.

**Blockchain** is a cryptographically saved distributed ledger that cannot be altered. This technology ensures the record- keeping, and settlements. Thus, blockchain can allow traceability and confirm the origin of manufacture. Blockchain technologies in the supply chain is a technology that creates trust between parties. By using this technology, supply chain managers can realize a secure communication paradigm where data integrity and stability can be guaranteed. As mentioned before, supply chains are a structure with many physical flows involving multiple actors and stakeholders, and information sharing that supports this flow. Within this structure, many activities take place, starting from the receipt of the order to the delivery of the right product, in the right quantity, under the right conditions, at the right location, and at the right time. The application logic of blockchain and supply chains bears great similarities in this respect.

As mentioned before, supply chains are a system with many flows involving multiple actors and stakeholders, and information sharing. Within the system, many activities take place, starting from the getting of the orders to the delivery of the "right product", in the "right quantity", under "the right conditions", at "the right place", and "at the right time".

**Internet of Things (IoT)** states that it is set into with software and other technologies to collect and exchange data with devices connected to each other over the internet. Thus, IoT has many practices in supply chain management, such as tracing flow, and smart and precision production.

**Cloud Computing** ensures to reserve the data on many different hosts without direct active management and provides Software as a Service on Demand of customers. It is an internet-based computer system. It supports to the management for dealing with the big data analytics.

**Big data analytics** is identified as next-generation technologies that are designed to financially get value from large amounts of a broad variety of data by allowing high-speed capture, detection, and analysis. Big data analytics supports other technologies like cloud computing, and IoT. **Information and Communication Technologies** also provide information and data to supply chain management. Information and Communication Technologies help to decision making by acting as an information system for many supply chain stakeholders.

Ballou et al. (2000) suggest that supply chain management has to balance and coordinate three dimensions of the system; in a function, between different functions, and between different organizations. However, since cooperations are generally among members with different reward systems or may be legally separate, members need to realize gains from their cooperation. There becomes a challenging situation when the gains pool with some members at the harm of others. Balancing these gains essential challenge for all members to be efficient in their cooperation, which is an essential challenge for the supply chain management. The solution to the challenge is to find a way to calculate and report incomes and expenditures, and other data, such as demand level, and customer service quality; give information related to the gain level, and reallocate the gains that put some members in a worse position as a result of their cooperation, thereby balance the gains (15). Information Technologies in Supply Chain Management ensure effective coordination between the processes of the chain, reduces the required costs and time, provide the requested information to be analyzed instantly, create long-term business relationships by providing value-added IT (information technologies) based services to the customers. For this reason, many businesses in the sector are investing in information technologies for managerial problems. With supply chain management software, accurate information is collected, analyzed and shared with business partners in the chain.

Although this type of software brings together all business functions and enables businesses to be managed more effectively, within the scope of optimization; it cannot fully answer questions such as what should be done when, where and by whom. At this point, managers need Decision Support Systems (DSS) tools to optimize critical elements such as production characteristics, transportation costs, and inventory costs. For example, if transportation costs are the highest cost of a business, the first DSS application will be fleet routing systems or network design.

Vaaland and Heide (2007) show that small and medium-sized enterprises give less importance to planning and control methods than large-sized enterprises. Ineffective management components in small and medium-sized enterprises cause severe problems in the supply chain system. If they do not improve efficient planning and control methods, they will face a decre-

ase in competitive power. To solve this problem, Small and Medium Enterprises must adopt the technology and system considered vital to keep supply chain management applications. Especially in the plans of large companies, more technology-oriented supply chain management is included. In addition, "horizontal collaboration" or "vertical integration" might decrease the information technology gap by sharing planning and control systems. Support systems suppliers should think of offering whole "turnkey" solutions to encourage supply chain functions explicitly targeting small and medium-sized enterprises (16).

Some industries have their own supply chain challenges. For instance, according to Hussain et al. (2006), the petroleum industry has crucial supply chain management problems, especially in the logistics components, which do not exist in many other industries. The logistical challenges significantly affect the cost of oil and its derivatives. One of the solutions to these kinds of challenges is to use financial hedging instruments. For instance, a "swap contract" may be undertaken, saving a huge amount of logistics costs. Although the petroleum industry has been considered in Hussain's (2006) study, the outputs of this study can also be applied to other industries. Financial derivatives are an instrument that can be used in other industries with high logistics costs to avoid the risk of costs (17).

Yadav et al. (2022) state that the agriculture food supply chain faces many challenges regarding the growing demand for foodstuffs and consumer choice for food safety. Increasing concerns about sustainability, information asymmetry, food safety, food waste, and traceability issues are some of the most important challenges in the industry (18). Thus, supply chain managers should adopt industry 4.0 technology new tools, techniques, and methodologies to model and solve the present food supply chain challenges and design the food logistics network accordingly. Digitization and effective design of the agriculture food supply chain are inevitable solutions to address the problems. There are many effective design approaches to the agriculture food supply chain, such as blockchain, digital twin, IoT, big data analytics, information and communication technologies, cloud computing, and cyber-physical system. For instance, Blockchain can be traceable and confirm the origin of products. By using Blockchain the loss and waste of food can be suppressed. Further, IoT can have several implementations ranging from sensitive agriculture to smart agriculture. Smart agriculture technologies also has a vital role in the trackability of the agriculture food supply chain. According to Juma et al (2019) blockchain technology is a suitable technology for optimizing the processing model adopted the fields of healthcare, commercial supply chain, and food safety depending on the features of the Blockchain (19).

Wu and Huang (2018) suggest that food supply chains may threaten the environment in

some ways. Stakeholders aiming to be environmentally friendly in their food chains have two main problems with limited resources and facing too many eco-options (20). The study emphasizes that these problems can be solved with business analytics tools. It can be successfully narrowed down to many options by evaluating of past accomplished selections. By using business analytics to sense the environmental sustainability of food supply chains from massive data sources and turns the complicated information into meaningful managerial knowledge of sustainable food supply chains, and managers can formulate effective strategies with this meaningful knowledge. It states that the two most important elements of successful sustainability applications are eco-innovation and food loss/waste.

Kumar et al (2022) identify a pharmaceutical company's most important supply chain challenges. They find that the top three key challenges are political factors, delays in the import process, and weak internet connection. In addition, during the COVID-19 era, the top three managerial opportunities are inventory management, transport method choice, and operational cost. Thus, companies can be added value to its product through a supply chain system, efficient management members, and skillful decision-making toward satisfying the demand on time and observing supplier performance (21). Advanced and Planning Systems (APS) provide real-time information from the chain across the entire supply chain, providing customers with a fast and reliable, feasible schedule. With the APS implementation, better throughput times, shorter delivery times, effectively managed inventory levels, and high customer satisfaction are achieved. The most important reason for the adoption of advanced planning systems by many businesses is that they ensure that processes in complex supply chain networks can be planned easily and in a short time. In addition, vehicle routing systems are used in supply chain management. Aiming to ensure that the products are delivered to the right locations with the available resources as soon as possible, vehicle routes are determined statically and dynamically by using technologies such as GPS, and database management systems. Vehicle Routing Systems (VRS) that integrate these technologies are used to effectively manage and dynamically route vehicles.

Paul et al (2021) state that Covid crisis does not have many results as there are many results for financial, environmental, and political crises. The uniqueness of the Covid crisis makes it difficult to guess outcomes and potential challenges for recovery. Thus, the study tries to identify the challenges rather than finding solutions. When firms anticipate the challenges, they can develop suitable solutions to ensure the sustainability of their supply chains during the recovery. According to the study, raw material shortage, manufacturing and transportation breakdowns, and social distancing cause the fragility of global supply chains. Supply chain management must evolve strategies (22).

Yadav et al. (2020) emphasize the importance of sustainability in supply chain management. According to the study, the primarily culpability for failures in adopting sustainable supply chain management is seemed to be the managerial and organizational challenges. The secondary challenges are related to the lack of financial, technical, and human resources constraining the adoption of sustainability. Adopting the 6 River System (6 R's) within the organization and environmental product design and lifecycle analysis is the most effective solution for sustainable supply chain management challenges (23).

Jain et al. (2009) focus on supplier-related issues. They examined issues such as supplier selection, supplier-supplier relations, and supplier-buyer flexibility in relations in a dynamic supply chain. The study tries to present a dynamic model of the supply chain, taking into account some current and ongoing developments and research activities. This study analyses how various modelling techniques such as agent technology, Petri nets, fuzzy logic, and data mining can be applied to support dynamic supply chain models by taking into account of supplier-related challenges (24)

The requirements for making logistics activities more flexible and perfect require the creation of new approaches and practices for logistics and supply chain processes. Optimization and intensive technology are at the forefront of these approaches. The approaches both increase the ability of supply chains to make more accurate and faster decisions regarding the solution of emerging or potential problems and significantly reduce the level of complexity in the system.


**Figure 3.** Supply Chain Solutions
*Created by the authors*

One of the most effective ways for businesses to survive is to integrate technology and optimization applications into their supply chain systems in a way that will obtain the highest possible benefit. With supply chain management software, accurate information is collected, analyzed and shared with business partners in the chain. In addition to technological software, Decision Support Systems are also used, which optimize critical elements such as production features, transportation costs, inventory costs to answer questions such as what should be done when, where and by whom. The supply chain solutions are illustrated in Figure 3.

In the past, businesses thought of information operating systems and related software as costliness in order to carry out their logistics activities and demanded a mid-range system, today many companies invest in these technologies. One of these technologies is Blockchain technology. It also finds its place in supply chain applications. According to Irak and Topcu (2020), although the initial investment and energy consumption of blockchain technology are high, the gains it provides in the supply chain are well above these costs in the medium and long term (25).

Especially with globalization, supply chains have become quite long and complex, making it difficult to control and trace, creating opportunities for malicious people, intensifying competition, etc. cause. With the traceability feature, blockchain technology is beneficial for the applications in the supply chain for the tracking of products such as food, medicine, dangerous goods, and sensitive electronic devices that carry the risk of deterioration, theft or counterfeiting in the supply process.

## 4. Conclusion

In 2019 people all around the world faced to a pandemic named COVID-19. This pandemic thrived instantaneously and affected all kind of business and the way of many things are done. However, companies had not a chance to prepare for such a pandemic, which thrived instantaneously. In addition, rapid digitalization causes conditions to change very quickly in the world. In brief, wars, pandemics, and rapid digitalization have created a world system that is much more difficult to predict. These demonstrate to companies that they must be ready for bad scenarios. Although we demonstrate the supply chain problems specific to different sectors and supply chain components in this chapter, it is understood that the solutions always focused on digitalization, technology-oriented approaches, and optimization. In the new world, digitalization has become inevitable. Digitization is both a solution and a challenge for companies that can lead to their extinction. Companies that can keep up with the fourth industrial revolution and digitalization will be able to survive. In the new world, where everything is changing very rapidly globally, supply chains are becoming more costly, risky, and complex. Thus, traditional supply chain strategies and methods can be insufficient. According to our literature survey, the condition of successful supply chain management is to be positioned around digitalization, technology, and integration.

The business environment needs to be even more intertwined with the concept of a sustainable supply chain to be ready for the new digitalized world and the worst situation and remain resilient in the competitive environment. This requires agility and digitization.

In order to develop a potential solution in economic terms, blockchain can be used effectively. Many studies suggest blockchain technologies for solving supply chain problems. With blockchain technology, all the activities can be kept in the digital system from the suppliers to the end customers. By retaining the whole information about the process in the digital environment, the information of the process becomes visible, accurate and reliable and also can be accessed more efficiently. The flexibility of the process provides to cope with the of crisis. Lean supply chain practices can include sustainable and flexibility parameters.

In addition, with the covid19 pandemic and the Industry 4.0 revolution, the number of factories that do their work with machines rather than human labor has increased. It is expected that as the machine usage rates increase in the factories, the error rate will decrease and therefore the quality and the productivity will increase.

Blockchain technologies, digitalized factories, IoT technology is among the tools that can be used to solve supply chain management. Today, supply chain management is about using technology to make the supply chain and business smarter. Businesses now store very long supply chain data, not with the human factor, but with blockchain technology, and process it with big data analytics. Businesses no longer wait for machine breakdowns; with smart technologies They can now predict a failure before breakdowns happen and take steps to prevent it so that the supply chain can continue uninterrupted. It is also certain that companies that be unsuccessful to achieve these will fail.

The literature review and the solutions proposed showed that the supply chain managers can no longer escape from digitalization and technology. The solution at the focal point of all kinds of problems is digitalization and technology. As digitalization has become prerequisite for the supply chain, companies are expected to make their investments in the line with digitalization and technological developments in order to provide sustainability and competitive advantage.

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# CHAPTER 2

# SUPPLY CHAIN ANALYTICS IN THE CURRENT NEW WORLD

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**ABSTRACT**

Disruption and volatility are very common in the new world. In light of this, the supply chain community needs mechanisms to increase resilience, agility, better risk management, design methods, decision-making capabilities, by leveraging technologies like IoT, Blockchain, and Analytics. Prerequisites are not limited to the availability of good quality data, sharing of such data, factoring in the human element, and the need for increased collaboration across supplier levels and Original Equipment Manufacturers. Supply chain analytics consists of processes that companies use to gain insight and get value from the huge data associated with the procurement, processing, and distribution of goods. In today's new world supply chain analytics is an indispensable component of supply chain management. With the above context, this work surveys analytics efforts spanning sourcing, manufacturing, inventory, demand, warehousing, transportation, and customer relationship management with the aim of detection, response, simulation, and prediction of events. In the new era, the supply chain challenges and thus solutions are too many and very complex. In this chapter, the focus has been mostly on Transportation Analytics. Authors in this chapter have dealt with the challenges of carrier selection, shipment modality selection, shipment consolidation, shipment type, route analysis, and the formation of new routes. The intent has been to present to the reader some introductory examples from the industry where such analytics could be useful. The theoretical bases for the examples stated are not treated in this chapter, but the focus has been to mainly draw out the problem, the typical inputs & outcomes with some hints on future work.

**Keywords:** Supply chain analytics, transportation analytics, logistics management, transportation management

# 1. Introduction

## *1.1. Supply Chain Analytics*

Supply chain analytics means using technology and data to eliminate barriers in complicated, multi-pronged processes and logistics. Systematizing these aspects of an entity simplifies processes, improves accuracy, and saves time. It can also help entities decrease their costs and balance their budget. Supply chain management deals with four main and interrelated areas: i. Goods and Products, ii. Manufacturing/production, storage, and distribution, iii. Transportation and iv. Shipping, logistics, routes (See Figure 1.). Supply chain analytics tries to make solutions in these areas. Therefore, Supply chain simulations model these components and sub-components and movements. While being modeled it gathers data on these components and uses the data to improve some areas. Supplier, Transportation, Inventory, warehouse management systems, customer relationship management systems, data process automation and robotic process automation are some of the important supply chain analytics solutions. IoT and Blockchain technologies are also used for solutions. In this way, supply chain risks decrease while productivity increases, it helps to enhance supply chain planning, increase the ability to meet demand, and decrease inventory costs. The focus of this chapter is on transportation management with some treatment on the inter-related areas of shipping, logistics, and routes.

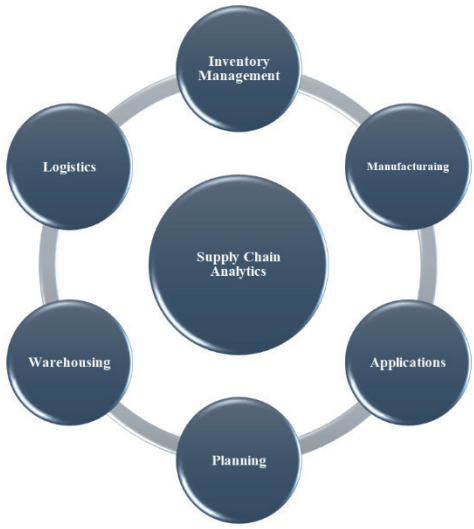


***Figure 1.*** Areas of Supply Chain Analytics

### *1.2. Transportation Problem and Analytics*

Large organizations spend millions of dollars in transporting their goods from their warehouses to customers while hopping through various nodes in between. This problem can be daunting as the nodes increase. A broad class of optimization methods exists for this problem - called the 'Transportation problem'. Such methods deal with mechanisms to optimally transport items/goods (1).

**Transportation Problem** – It's broadly defined as the distribution of any commodity from any group of supply centers, called sources, to any group of receiving centers, called destinations, in such a way as to minimize the total distribution cost (1). This problem is a special case of the minimum cost flow problem. As the name suggests, it's to do with transporting the goods optimally. A more formal definition is the distribution of any commodity from any group of sources to any group of destinations in a manner to minimize the total cost.

As an extension, the assignment of resources to tasks in an optimal manner can also be a challenge, especially as the number of resources and tasks increases. The assignment problem is a subset of the transportation problem.

Macdonald (2007) stated that logistics activities spread all over the world, this spread increased logistics problems/challenges, and the solutions became more complex due to the effects of some factors such as globalization (2). Carrier selection, shipment modality selection, shipment consolidation, shipment type (normal, premium, expedited, weight, volume, etc.), route analysis, and formation of new routes are some of the most important challenges under the transportation problem and many optimization methods exist to solve these challenges [(7); (11); (10); (3); (4); (8); (13); (18)]

***Carrier selection*** and ***Shipment modality selection*** are part of the transportation decision-making process that includes defining relevant transportation performance variables, selecting shipment modality and carrier, negotiating fees and service levels, and evaluating carrier performance (3). According to Russell and Taylor (2003), transportation costs account for an average of 20 percent of total production costs and can be reached 6 percent of total revenue in some production companies (4). Thus, shipment modality selection and carrier selection decisions are all significant decisions for supply chain managers. Meixell and Norbis (2012) discuss the integration of carrier & supplier selection decisions for minimizing cost, and transit times, and enhancing supply chain security (5).

***Carrier selection*** is related to the decision on the choice of exactly one carrier to deliver freight on each route. In the supply chain, carrier selection plays an important role in

shipment. Especially, optimizing the carrier selection is more important in multi-commodity transportation (6). Lin and Yeh (2012) state that multi-commodity credibility can be identified as the probability that the logistics system can meet a customer's demand for various products and is a performance indicator for delivery (7). And they propose an optimization algorithm integrating a genetic algorithm, minimum paths, and a Recursive Sum of Discrete Products for the solution to the challenge.

Another important issue that supply chain managers face is ***shipment modality selection***. In logistics, the modalities can be divided into six different modes: road transport, rail transport, air transport, maritime transport, inland transport, and pipeline transport. If maritime transportation is considered separately as deep sea and short sea, this distinction increases to seven. It is necessary to choose the most appropriate shipment modality in the face of many parameters that may be conflicting with each other in some cases. Liao and Rittscher's (2007) approach to combining multiple attributes, some of which are contradictory, is the use of multi-objective mathematical programming formulations that optimize shipment modality selection (8).

Cooke (2006) stated that increasing transportation costs and services are important problems in the sector. In his survey of 1,100 carrier companies, he reported that the biggest problem of carriers' companies is **on-time delivery** (9). The study of Liao and Rittscher (2007) is also beneficial in this regard. Liao and Rittscher (2007) integrated not only modality selection but also dynamic supply lot size and carrier selection in their model. Its multi-purpose model minimized cost, the number of rejected products, and late deliveries due to demand satisfaction and capacity constraints. A genetic algorithm has been used to solve the problem and weigh the targets to obtain different Pareto optimal solutions (8).

***Shipment Consolidation*** is a system to combine similar products from different centers in the warehouse, the goods belonging to the same customer or same market region are collected in a special area. Thus, a larger portion can be distributed to the same customer/same market region (10). Significant savings can be realized when a consolidation program is undertaken in which several small deliveries are sent as one combined shipment, thereby realizing the economies of scale inherent in transportation. Çetinkaya, (2005) talks of the need for coordination of inventory & shipment consolidation decisions and calls out new initiatives of an inventory managed by vendors, and third-party warehousing among others (11). Çetinkaya (2004) argues that the Vendor Managed Inventory (VMI), Third Party Storage/Distribution (3PW/D), and Timed Delivery (TDD) applications can be used to enable the integration of inventory and shipping decisions, and thereby save costs (12).

In the freight transport system, ***the choice of shipment size*** is an important decision and challenge. Usable freight transport demand models include the shipment size variable and require specific strategies (13). Holguin-Veras (2002) and Johnson and de Jong (2011) studies demonstrate that various haul, carrier, and commodity characteristics are significant factors that impact the decision on the choice of shipment size (14,15). Abate and Hong (2014) indicate that trip distance and total freight demand have significant positive impacts on shipment size choice (16). They find these results based on de Jong and Ben-Akiva's (2007) shipment size optimization theory (17).

***Route Analysis and formation of new routes*** involve all analysis of existing routes and upcoming routes (delivery mechanisms, representation of routes, creation of possible routes, selection of the said routes). Kosicek et. al (2007) also discuss route planning & management. A natural extension is to optimize the entire routing system once the existing route structure is mature or once new routes emerge / old routes are sunset (18).

## 2. Transportation Analytics – some examples

Individual shipment vendors and corporate business use transportation data to monitor compliance with corporate carriers and view freight payment history. Transportation data comprises of region, freight forwarders, suppliers, global and local routes, shipments, weight, and revenue information collected from individual shipment sites. It allows businesses to verify that corporates are using approved carriers to transport freight and to look for productivity opportunities. It further allows them to have rate negotiations with vendors and suppliers based on the mode of transportation. Transportation data can have multiple use cases in statistics and optimization and benefit the supply chain business. The transportation data is spread across multiple systems and obtained through various steps. The data is housed in different formats and structures, which limits the visibility to the big picture and hence limits the use of data science techniques to the fullest.

Data from shipper sites, consignee sites, suppliers, and freight forwarders are gathered through shipment invoices through which shipment level details can be gathered to prepare the transportation data. Getting all the parameters contributing to a shipment in a single structured format is a challenge. Once the transportation data is prepared, it can help the business in planning the shipments and actual movement of goods through digitally equipped insights.

The following are the examples of how transportation data can be used in the aerospace business domain.

## *2.1.* Carrier Forwarder Selection

Carrier forwarders are vendors who ship goods from one point to another. Selecting an appropriate carrier is fundamental in saving time, money, and effort for the supply chain business. There are several modes of transportation through which the goods are shipped such as air, ocean, or road services. There are dedicated services available for each type of shipment. Various factors are involved in selecting a forwarder for a shipment. For example, a heavy-weight shipment is always convenient and cheaper to send by ocean, but smaller and light-weight shipments can be shipped by air (Figure 2).

Data Analytics and Optimization techniques can play a significant role in bringing out the insights hidden within the widespread transportation data. Techniques such as Recommendation Algorithms, Time series analysis, and simple regression can help in identifying the optimal forwarder for a specific type of shipment (Figure 2).

## *2.2.* Shipment Consolidation

There are plenty of shipments that happen on a large scale on everyday basis across the globe. There are several forwarders who ship multiple goods on the same day. Transportation data that contain shipment level details of shipper, consignee, total weight of the shipment, amount charged for the shipment, start & end points, dates of shipment etc. can be used in building analytics and optimization algorithms to reduce the number of shipments and effectively plan the space, time, and cost per shipment. Shipment consolidation decisions are driven by price, new route identification (next subsection), (Figure 3).

For example, assume 100 shipments happen on an average between shipper A and consignee B per week, due to specific type of good being shipped and requirements from B to ship the packages with independent invoice to track each good. This has resulted in exceeding the number of shipments per week, which in turn causes additional cost and delayed delivery.

Using optimization techniques can identify such patterns to optimize the number of shipments if there are repeated patterns causing unnecessary traffic and wastage.

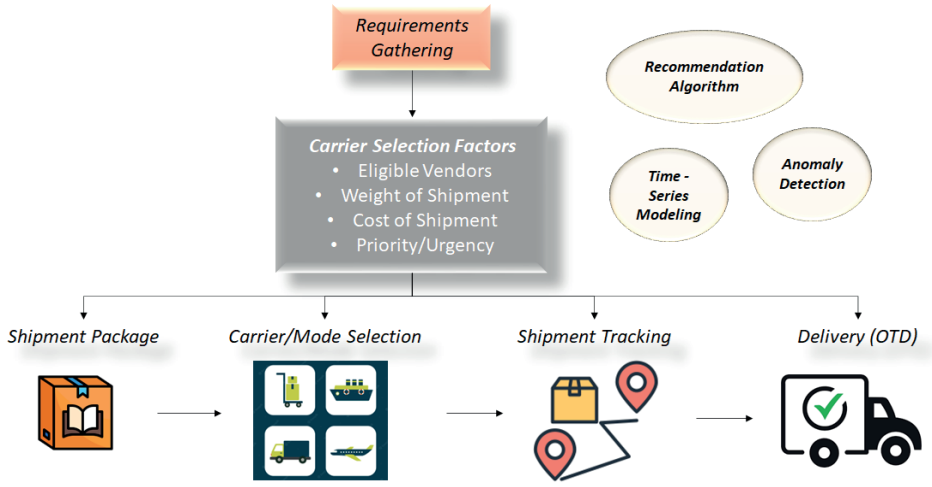


***Figure 2.*** Carrier Selection Factors are extracted from the Supplier/Shipment Hub specifications. Using Algorithms like recommendation algorithms, time series modeling, anomaly detection can help in yielding outcomes in terms of On-time Delivery, Shipment Tracking through optimal carrier selection for shipping. This infographic has been designed using images from Flaticon.com, uxwing.com & vecteezy.com

## *2.3.* Anomaly Detection

Dedicated services are used for shipping specific type of goods from one site to another. Data Analytics can help in identifying anomalous patterns that happen in shipments.

Example scenarios for anomaly detection:

***a. Route Analysis*** – A route is a common source and destination for any shipment. Heavy weight shipments are assigned to forwarders who ship these goods through specific mode of transport and charge as per the weight. Light weight and small packages are assigned express forwarders, who can ship faster through certain mode of transport. Sites use the express forwarders to ship heavy weight goods to deliver on time, which results in increased cost and penalty for shipping more than the allowed capacity. Transportation data like carrier's mode, freight costs, time taken, carrier reputation as well as carrier status (approved vendor or unapproved) etc. can be used in bringing out such insights that can provide answers to the businesses for questions such as –

a. Awarded forwarder charging price as per contract?

b. Does the weight break the best buy for light weight vs heavy weight shipment?

c. Is the nominated carrier moving the freight?

d. Is a non-nominated carrier giving us a better deal?

Patterns like these happens vice-versa and can be found from data, using appropriate anomaly detection techniques, to provide insights to the business to plan the shipment and choosing right forwarders.

***b. New Routes –*** To understand if there is sudden increase in traffic/number of shipments that led to increased spend in transportation on specific routes (Figure 3).

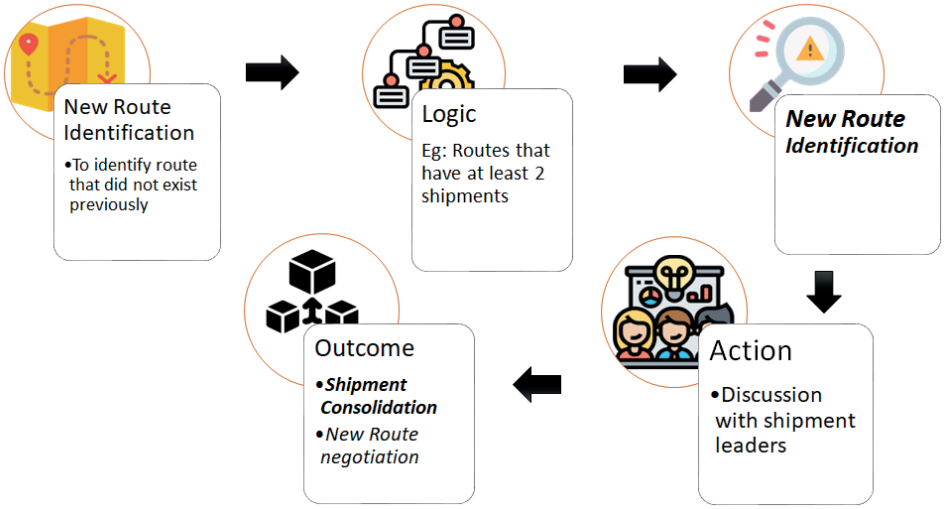


***Figure 3.*** New Route Analysis and Shipment Consolidation illustration. This infographic has been designed using images from Flaticon.com

## *2.4.* Data Driven Future of Transportation Analytics

Insights from transportation data analytics has enabled to make better decisions in supply chain line. Data analytics and data science models can help in overcoming the traditional challenges in supply chain.

With statistical and machine learning-based models, patterns, and trends observed in history can be used to build predictive models and forecast the needs in the future. This also allows us to have real-time visibility to the data and enables in navigating the demand-supply challenges.

The transportation data can pivot in several ways to bring out insights in several forms to businesses. With transportation data, the following are a few areas from which the businesses can benefit;

**a. Number of Shipments Forecast** – There are several sites across the globe, where

goods are shipped from one site to another on a large scale on a day-to-day basis. Estimating the number of shipments with the help of historic trends between sites, by considering various factors such as type of goods, cost per unit of weight, mode of transportation, and forwarder, can help in planning the shipments that are anticipated and there by meeting the delivery requirements.

**b. On-Time-Delivery Forecast** – Transportation data can be used to meet the requirements of customers by predicting the on-time delivery of goods. It can help in effective planning of resource allocation and inventory management. On-Time delivery is critical to each business as the process line gets impacted as a chain reaction to the end outcomes. With the help of analytics and machine learning algorithms, bottlenecks, anomalies, and delays can be anticipated and planned to save time. This also throws light on the available stock, and the estimated inventory to be planned.

**c. Route Optimization –** It is essential for businesses to scale and save on cost. Optimized route can help businesses in increasing the number of successful deliveries. Optimization algorithms uses the historic patterns between sites and compare several routes to pick the most optimal route between two sites, with optimal stops.

## 3. Conclusion

The supply chain activities, systematized to deliver a particular product or service to the final buyer, have been one of the areas most affected by the pandemic conditions and the Russia-Ukraine war. The rapid digitalization in the world has been both an opportunity and a threat depending on the attitudes of companies and countries in this process. Increasing costs, disruption of transportation processes and decreasing efficiency of production are the most prominent challenges. In order to overcome these challenges, a new supply chain planning and keeping up with digitalization is required.

Supply chain management aims to create a fast production cycle, balance costs, evaluate workforce requirements and establish a bond between suppliers and customers. While the challenges in front of the transportation companies in the new world system made transportation difficult, the inability of the factories to fully fulfil their functions also hindered production. Therefore, it is necessary to optimize, improve and digitalize the supply chain management process in the new world.

In today's new world, technological infrastructure, and system integration are required to increase operational efficiency, keep up with the digital transformation, ensure data security

and take the digital interaction between parts of the supply chain to higher levels. The technological infrastructure also enables the analysis of stocks, raw materials, sales rates, and transportation processes against sudden events that may change in the market. In this way, access to instant reports becomes easier and new strategies can be developed faster.

Although the supply chain challenges are too many and supply chain analytics is a vast and emerging area, we have focused on the challenges that we think are the most important in order to focus on a specific area without distracting the subject. In this chapter, the focus has been mostly on Transportation Analytics. More specifically, in this chapter, we have dealt with the challenges of carrier selection, shipment modality selection, shipment consolidation, shipment type, route analysis, and the formation of new routes. The intent has been to present to the reader some introductory examples from the industry where such analytics could be useful. The theoretical bases for the examples stated are not treated in this chapter, but the focus has been to mainly draw out the problem, the typical inputs & outcomes with some hints on future work.

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# CHAPTER 3

# COMMON HUMAN RESOURCES ISSUES AND NEW CHALLENGES IN LOGISTICS

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**ABSTRACT**

In this chapter, the HR challenges in the logistics sector and the way of overcoming these difficulties are discussed. Logistics is what keeps the economy alive worldwide. The economy couldn't survive if trucking, transport and storage companies cannot get materials from suppliers to manufacturers and finished products from manufacturers to consumers. The success of such an important industry depends on people. In addition to hiring and retaining well-equipped and competent employees, logistics managers should evaluate the performance and determine key performance indicators correctly, manage employee relations, occupational health and safety for the sector, ensure team management in a way that emphasizes the importance of teamwork in terms of logistics processes. Many HR related issues such as training, motivating, time tracking and empowering employees should also be managed successfully in logistics companies. From this perspective, in this study, first of all, the new trends in HR processes in the logistics sector will be evaluated, and the challenges faced in this sector will be evaluated in the context of the mentioned human resources management functions.

**Keywords:** HR challenges in logistics, logistics and supply chain competencies, performance, balanced supply chain management scorecard, training, hiring and retaining competent employees in logistics, Logistics management

## Introduction

The concept of logistics was used as a military concept in the 1990s. Nowadays it is perceived as a strategic activity that has a competitive advantage in terms of businesses (1). In the early 1900s with the transportation of agricultural products, it began to be considered as a science. Bowersox and Closs (1996) defined logistics as the correct management of the supply, transportation and storage activities of the right material within an organization with the right cost and profitability (2).

The original and most fundamental concept of logistics is a set of three operational activities that add value to goods: movement, warehousing and rearrangement. There are certain aspects on which the added value inherent in these activities is based. These are place, period & pace and pattern that can be called as "Three P-s (PPP)". Place can be defined as adding place value by moving items from locations of lower value to the customer to locations of higher value to the customer. Additionally, period & pace means that adding time value to products by storing them so that products are moved from the periods in which they are available (either extraction, harvest or post-production) to the periods customers need, making all processes more efficient. The inventory is optimal for each individual's economy and it ensures separation of processes along the value chain so that it can work at speed. Finally pattern can be described as adding order value to items by arranging them in desired quantities and patterns. Examples include consolidation, break-bulk, sequencing, picking/packing, etc. (3). That is the operational part of the logistics.

Today, countries determine strategies targeting "customer satisfaction" and "low costs" in order to achieve long-term competitive advantage. In addition, various developments such as the globalization of world trade and the increase in trade volume, the continuously developing expectations of customers within the framework of product quality as well as the level of logistics service, the shortening of product life cycles and the development of systems working with zero stock have an important place in the creation of "logistics strategies". In addition, the rapid developments in information technology, the long-term cooperation of the units within the distribution channels within the framework of logistics activities, creating "supply chains" and the increase in the use of outsourcing are among the main factors that play a role in the formation of these strategies. At the same time, all these have brought with it the necessity of using limited and valuable resources more effectively and efficiently. In such a competitive environment with limited resources, the priority of all systems has been to increase production. One of the most important factors affecting performance, life cycle,

design and research, which is effective in increasing production, is logistics. The concept of logistics is also related to human resources management. Human resource management includes specific activities such as the recruitment, training, development, health and safety protection, compensation and dismissal of employees employed in an organization. On the other hand, considering that logistics is a labor-intensive business with high service quality, technologies such as automation and information systems are used, it works 7/24 and it requires online control, it becomes clear how important the investment to be made in people is in terms of logistics. At this point, each of the human resources management functions is also important for logistics enterprises. The aim here is to create a work environment where the employee will be satisfied, to carry out activities that will protect their health and safety, and to get the highest efficiency from the employee. Every step taken in this direction will help to create the most suitable working environment for both the employee and the employer. The logistics industry is undergoing a significant transformation, characterized by new technological solutions in daily practice. It is a sector that is exposed to numerous legal, economic, social, technological and environmental changes. This kind of changes have a subsidiary impact on the values and expectations of the employees and, accordingly, the choices they make and their job satisfaction. The present circumstance is expressed by the lack of well qualified human resources and the requirement to discover appropriate answers to figure it out. Retaining well qualified human resources, particularly for employees with proven skills and vocational preparation, can be counted as the challenges faced by organizations. Identifying what inspires these types of employees in line with their choices and neccesities is the solving. In this direction, logistics firms are starting to give more importance to practices aimed at establishing the concept of employee brand. This makes reference to a condition that an owner makes the company engaging to present and potential workers. To achieve this, the head of the company proactively distinguishes itself from its rivals and incorporates developing HR functions. Thus, it becomes more effortless to attract and retain well qualified workers (4). In light of these developments, today the supply chain has ceased to be a half-and-half mix of infrastructure and information systems technology, and has become more of a mix of human behavior, system technology and asset infrastructure (5).

## 1. Management and Leading

Even if the best and most efficient equipment is used in logistics operations, the operation will fail without effective management. Unmotivated people can cause failures despite strong technical infrastructure and systems. All these reasons are the best proof that management is about people. The most critical function of a business is to make the most of its existing

workforce. The low motivation of the employees also increases the workforce turnover and absenteeism in the business. Organizations with high absenteeism and staff turnover also have relatively low productivity rates and higher operating costs, according to analyzes of distribution centers in large corporate networks. Getting the best for people isn't always an easy process. People work at different levels within the organizational structure, and while they contribute to the organizational culture by working as a team, they also get the results of their individual efforts (6). In other words, they need a work environment where they can realize their individual goals while realizing their organizational goals. The presence of an effective leader contributes to the formation of a supply chain that has the power to drive the necessary change in terms of sustainability and continuous improvement. If the organization and at the head of the supply chain does not have an effective supply chain leader supported by talented and enthusiastic personnel, steps taken to strengthen the supply chain will not be successful (7). It will not be effective to act without the support of senior managers who deal with the formulation and prioritization of corporate strategies in the development of relations with suppliers and customers in enterprises. In the absence of these features, both the company and the manager lose their competitive advantage, as senior managers are responsible for deciding the cap on resources to invest in the business. When evaluated from a management perspective, it can be said that leadership behaviors include the right amount of demand information from customers, creating positive perceptions for relational trust and long-term support. In addition, an important factor that differentiates businesses from their competitors and increases the overall visibility of the organization is the charismatic behavior of senior managers. As a result, external stakeholders, such as suppliers, increase their identification with businesses through such leaders and decide to cooperate with these organizations. For all these reasons, researchers emphasize that the formulation and implementation of supply chain strategies require effective leadership behaviors and senior management support (8).

## 2. Selection

Today, an active, highly- developed and innovational logistics and supply chain industry is of great importance in terms of achieving and sustaining global financial and economical growth and envolvement. In addition to the need for significant logistics infrastructure investments, the availability of qualified, talented and experienced employees will help the logistics and supply chain industry meet global economic demands. The multi-disciplinary nature of logistics makes it necessary for people who want to make a career in this field to work with people from many different disciplines with many different characteristics. For this reason, companies often look for people who have expertise in certain aspects of the supply chain,

but who can see the big picture and who can prioritize company goals rather than functional goals when making decisions.

The logistics industry is human-centered by its nature. For this reason, the selection of human resources that work in this sector is important for businesses. Human resource selection is defined as the process of hiring the right candidate for any position in the business. Failure to manage this process correctly will emerge as an important cost item for the business. It is possible to meet business expectations with objectivity and strategic perspective in the selection process. Recruitment of the right personnel will provide many benefits for the business, and the wrong selection will reduce productivity and have many negative effects on the business. An organization has to execute a number of human resources functions that are not an easy task, such as selecting, retaining and training an adequate and cabaple supply chain manager. A prosperous supply chain manager has to achieve success by implementing a comprehensive SCM strategy, overcoming daily functional challenges and interacting with other divisions and outer organization sharers on a worldwide proporiton. In order to achieve this, he must have the necessary skills. Although the supply chain is accepted as a crucial management activity for a business in terms of global competition, the literature about the talent management in terms of supply chain management has not developed sufficiently. The lack of literature on talent management and talent evolvement of supply chain managers has increased the difficulties in measuring the capability of supply chain professionals. There are several competencies required in this area, including technical competencies and social competencies. Technical competencies which called as hard skills and social competencies which called as soft skills are the two main areas of competence add to a supply chain professionals' knowledge and these skills will support managers in making their business determinations. A supply chain manager must possess technical knowledge and business competencies, as well as the talent to communicate and harmonize efficaciously through group work. Within the scope of the supply chain, high level of communication competence and effective communication skills are very important as there are more than one company across the countries (9).

## 3. Logistics and Supply Chain Management competencies

The conception of competency was handled in the field of management for the fist time by Selznick in 1957 to mean "distinctive competency" (10). White used the concept of competency for the first time in 1959 by associating it with people (11). However, its real popularity in the field of human resources became popular with McClelland's article "Testing for Competence Rather than Intelligence" published in the American Psychologist magazine in 1973.

The concept of competency has been specified in numerous ways by various researchers. As mentioned earlier, Boyatzis (1982) defined competency as an "underlying characteristic of the person that leads to or causes effective or superior performance" (12). It was stated that competencies are the DNA of organizations. The concept was defined as the structural creation of how the work will be carried out. Developing new competencies may need hiring new employee, moving authrity from insiders to outsiders, and germinate a new culture (13). Klein (1996) defined competency as "behavioral indicators or the sum of observable behaviors" (14). In general, competency is described as the group of behaviors, personality, abilities, interestingnesses, motivation, and observable behaviors and actions exhibited in the past to achieve desired results. Lindberg and Rantatalo (2015) define professional competence as "the inferred potential for desirable activity within a professional practice" (15). The competencies used by the individual to achieve the goals of the organization are defined as employee performance. The performance of the employee can be described as the degree to which certain standards and targets are achieved by pre-planning the work in business life or the degree of approaching the desired targets. Employee performance is an indicator that shows the level of work done in different sectors. It is stated that every action taken by an individual to perform a planned task is an indicator of employee performance. Organizational effectiveness is defined as the degree to which an enterprise achieves its objectives with the resources and tools available without placing an unnecessary burden on its employees. It is mostly related to how effectively and efficiently the resources are used while the organization continues its activities. Effectiveness refers to the values and activities of the human dimension of the business, but also includes the individual's cabability to accomplish a particular aim inside the time frame allotted for the duty (16).

The performance of the enterprises mostly depends on the competencies of the company managers and the quality of the management, which is directly related to their managerial potential. For this reason, companies have been trying hard to improve their management quality lately. Senior management is multidimensional and complex, also requires many competencies. With the increasing need for technological tools in business processes, digital transformation in the logistics industry has accelerated. In the logistics sector, technological applications are used to raise the effectiveness of operations and decrease costs, model the delivery flow, and monitor the order flow. Logistics managers benefit from technological programs while performing their duties. These technological programs include distribution requirements planning (DRP), material requirements planning (MRP), radio frequency identification (RFID), transportation management systems (TMS) and digital applications such

as barcoding. Today, certain competencies must be possessed in order to use the applications established in the logistics industry.

A series of surveys addressing human resources issues in the discipline of logistics and supply chain management. According to the literature, logistics and supply chain manager competencies cover a wide range of fields. Numerous researches have been carried on by different researchers in different countries of the world to identify the characteristic competency sets needed for prospering supply chains. According to those studies logistics managers require a new skill set. First of all, logisticians should have competencies suitable for today's conditions and market. It can be said that they have to work hard to stay up to date also, improve computer fluency, and stay connected/networked. Third-party logistics (3PL) providers battle with shippers for technological knowledge and talent in an extremely competitive environment (17). Sheffi and Klaus (3) indicated that the skills needed by a modern logistician are no longer limited to the awareness of how to run a warehouse or how to decrease the percentage per mile charged on a specific way. They also expressed that logisticians should be otfitted to set up supply chains that not only react to existent conditions but also are able to exchange and fit (3) and coordination assistances need a higher grade of managerial ability than fundamental functional services and are also more situation-special, and therefore harder to find or educate in the short trial. As believed by Minahan (1998), a supply chain manager requires to be a team player, know everyone's business (across functions and organizations), and become an information expert (18). On the other hand, a few of these researches concentrated on bringing out frameworks, concepts or models for the competencies of logistics and supply chain professionals and/or their role for examining the i i i a e of a wide sort of skills.

Today, senior logistics professionals are people who have knowledge and skills from a wide range of fields, have adapted to constantly changing conditions, and have high responsibilities and duties within the business. In the business logistics management approach proposed by Poist, the skills of logistics managers are gathered in three groups which are called as business cognition and competencies, logistics cognition and competencies, and management cognition and competencies. It contains all competency needs for logistics professionals according to three principal grouping. There are many competencies in that framework (19).

It is also aimed to perceive real market needs in terms of professional and core competencies of logistics and supply chain managers and to make general recommendations to higher education institutions to meet these needs by Cvetić, B., Vasiljević, D., & Danilović in their survey. The outcomes of this study have classified the necessary competencies in order to assist academicians who are trying to develop programs and/or issues in the field of logistics

and SCM, professional organizations that provide training and certification, employeess interested in career development, human resources, managers who recruit applicants from this area, and other concerned sides. They defined two indicators in their study. One of them is pointers of professional competences of a logistics and supply chain manager and the other one is the indicators of fundamental competences of a logistics and supply chain manager. According to both indicators, they discussed the five most needed professional competencies as customer relationship management, performance management, supplier relationship management, market prediction and stock management and production management. Moreover, the most needed core competencies are planning and organization of tasks, communication, foreign languages, Fundamentals of Information Systems and Technology, interpersonal skills, teamwork, business management, problem solving. They also believe that through their recommendations, higher education institutions can impart to constricting the space between marketplace requirements for the competencies of logistics and supply chain managers and the qualifications obtained by graduates who are coming applicants for these status (20).

Although academics consider managerial skill prevalently (21,22), the issue in the framework of logistics and supply chain management (L&SCM) is in its babyhood yet. This shortcoming is quite amazing, as investigate proof displays that L&SCM proficiency has a significant impact on companys' performance and economic fight (23). Latest study has highlighted the growing consequence of selecting, retaining and training qualified supply chain managers. Additionally, the required logistics and supply chain (L&SC) manager qualifications have transfomed in latest years due to complete business transformations in the area, such as the globalization of supply chains, ongoing outsourcing and far-flung acceptation of lean procedures. Supply chain managers that impact directly companys' functional and economical performance, have a crucial function in accomplishing functional and strategic aims in the supply chain (24). Given the impact of executive competencies on job performance in L&SCM and the paucity of study in this area, this issue earns further investigation. Studies on the competencies of the supply chain manager have been made from a variety of aspects (25,26). Myers et al. (2004) underscored the supply chain managers' critical competences such as problem-solving, decision-making, time management, social and honesty among many related skills (27). Dischinger et al. (2006) defined a more entire and brief competence model from five features that are technical, functional, global management, leadership, and experience and credibility (26). Equally economic globalization results in longer and more composite supply chains resulting in longer purchasing times, it is clear that today supply chain managers are responsible for broader, more complex functions than the supply chain

manager competency model, and essentially have to cope with more furious competition and challenges (28). Traditional training could no longer produce impressive training for supply chain practitioners to gain the necessary competencies. It can be understood that there is a gap between academia and practice.

Professionals with technical competencies, IT competencies and management competencies are needed within the framework of digital transformation (29).

The competencies that logistics managers should have have been determined in different ways by different researchers. The most cited and most used competencies in the literature review according to logistics professionals are listed as follows:

**3.1. Seeing the Big Picture:** The ability to see the big picture is the ability to think strategically. It is the company manager's ability to think beyond short-term concerns and consider the impact of decisions and logistics activities over time from a futuristic perspective. It means to look at the events in the logistics sector from a macro perspective, not a micro one. In brief, it expresses the ability of the logistics company to harmonize its current and future needs.

**3.2. Green Logistics:** It is the ability of products to provide feedback from the consumer to the producer. Green logistics competence aims to have a minimum impact on the environment in the logistics activity process. Logistics companies aim to use energy, water, air and natural environment efficiently and effectively with green logistics practices. When we look at the policies applied regarding green logistics practices in the world, it is seen that each country creates logistics systems with a green perspective in accordance with its physical location. In addition, these policies put pressure on both society and businesses on the necessity of being enforced by the state; thus, environmental and economic policies are required within the scope of sustainability. Social, economic and environmental dimensions of sustainable development can be adapted to green logistics, with green logistics gaining importance not only in its economic dimension but also in its environmental and social dimension. Products and packages produced as recyclable with environmentally friendly materials, measures to reduce greenhouse gas emissions during transportation, efforts to increase energy efficiency and the collection and disposal of waste by the manufacturer are considered within the scope of green logistics activities. All these activities are important for sustainable development (30). The logistics manager should pay attention to the selection of the mode of transportation that will minimize the carbon dioxide emissions of the vehicles selected during the transportation process. Logistics manager should prefer easily biodegradable materials during the packaging and packaging process of the products.

**3.3. Facility Location:** It has been provided extensive research, each illustrating a wide variety of techniques for solving facility location problems found in the management science literature. In the operations management literature, site selection models are usually based on mathematical programming (31,32,33). In order to select a location, in Weber's tradition of working, all spacial distinctions between sites are verbalized as costs. All of these models are non-competitive in the sense that a company does not respond to the location decisions of comptetitor companies and its selling predicts are externally enforced. These models of location focus primarily on the "where" aspect, paying little attention to "why" aspects. The solely reason defined in the literature is cost minimization. Nevertheless, due to the internationalization of supply, production and distribution activities, a more strategic perspective is needed. It can be defined as the facility location competence. It is the competence to determine where the logistics facility will be established. In short, it is the determination of the establishment of the logistics center or warehouses at the central point. The concept of centrality meant here is to be established at a point close to highways, railways and seaways. Choosing the facilities in a central location will provide a strategic advantage in the transportation of products (34).

**3.4. Informatics Skills:** It is digital transformation that allows logistics businesses to follow the delivery of goods in real time, classifiying fields for betterment and raising productivity. It also allows them to account for expected delays by optimizing their travel routes in the event of an accident or loss of vehicle. Digital competence is the ability to use hardware and software programs related to logistics. Today, information technology has been replaced by the concept of digital skill. Digital competence is the safe and crucial use of information society technologies for business, daily life and communication. Digital skill is the use of computers for accessing, evaluating, producing, storing, presenting and exchanging information with basic skills in the field of information and communication, providing participation in general systems through the Internet and supporting it through communication. In the logistics sector, managers are focusing on investing in technologies to provide real-time information, speed, flexibility and efficiency in resource planning, storage, transportation and distribution processes in logistics management by keeping up with digital transformation (35).

**3.5. Data Mining:** It is the extraction of significant information after obtaining previously unknown, valid and applicable data from large volumes of data warehouses and performing various mathematical operations on these data via computer and using this information for decision making by companies. Data mining technology can search for patterns in the database, quickly and automatically find patterns and useful information hidden in the data, and help users understand the causes and make predictions. The business can evaluate all sources and

historical data with the help of data mining tool. The business can analyze upstream suppliers and other suppliers, downstream retailers and logistics services to find their competitiveness and individual characteristics, which can help the business, analyze its organizational structure to select the best partners with analytical results of their own characteristics. Data mining also analyzes customer needs and expectations. It helps the business to predict the needs and expectations of the business by processing the historical information collected from the customers with data mining (36).

Data mining includes multidisciplinary technology such as statistics, database technology, high performance computing, machine learning, artificial neural networks, and pattern recognition. Data mining helps to solve internal and external problems in the logistics sector (37).

The logistics system is a highly composite system that includes a large number of goods and information flows. With the development of scientific information management and logistics efficiency, and the increase in the size of the database, the enormous data generated from logistics activities make it difficult for logistics enterprises to extract valuable information from large amounts of data to make it timely and correct. Determinations that benefit logistics' process control and functional efficacy also reduce logistics costs and increase company income. Consequently, how to use efficient technology to help managers analyze and advance data to obtain usable information for accurate predicting and determination has become the focus of logistics businesses (38). Internal issues are determining the facility location, minimizing costs, maximizing profits, and allocating different facilities to production over time. External issues are the selection of carriers and logistics service providers, the evaluation of their performance, and the planning of vehicles during product distribution. Logistics managers should have data mining competence in order to eliminate internal and external problems in the logistics process. Managers can use data mining in the analysis of the effectiveness of firms in the sector, performance analysis, risk analysis, cost analysis, load flow analysis, customer and supplier analysis. Managers ensure customer satisfaction through these analyzes. Thus, the quality and competitiveness of the company increase in logistics (19). Human resources are an important factor for logistics sector. Human resources' lack of or gaps in competence development cause serious consequences.

When logistics competencies and education are analyzed on a global rank, it is seen that logistics skill, training and personnel accessibility differ between countries with different logistics matureness levels and subject to changing economic status. Therefore, supply chain management can be classified into only four different occupations. These are formed of operative logistics/blue-collar worker, administrative logistics worker, logistics supervisors and logistics managers (39);

Operative logistics/blue-collar staff is a kind of group that comprises all logistics employees who accomplish fundamental functional duties and do not have any employee duty. Standard examples are truck operators, forklift operators and warehouse selectors.

Administrative logistics employee level covers expediters, traffic planners, warehouse assistants, customer service workers and customs clearance officers. Employee at this stage execute information-processing duties and have restricted executive or administrative obligations.

Logistics supervisors have the most advanced duty, checking logistics functions where the job is done rather than in the workplace such as shift leaders or team leaders in warehouses.

Logistics manager is a kind of category that involves administrative worker, with higher-level decision-making responsibility. The scope of these responsibilities can rank from lower through middle management functions to get on level responsibility for logistics and supply chain strategy.

When the labor force gap expected to emerge in the logistics sector is evaluated, it is foreseen that this will not only be at the level of middle and top managers. Smart logistics applications, which have become widespread due to technological developments, have become widespread at the operational level, making the operational workforce that can use these technologies more and more needed. In addition, due to the increase in automation in almost all sectors, machines and robots have started to replace the operational workforce in logistics processes. This situation will leave unskilled workers of the sector without any technical qualifications unemployed. Due to the rapid change in technology, there are many employees who will face the risk of unemployment in the labor market. Much more than the increase in unemployment caused by automation in the manufacturing sector in the last 50 years is expected in the service sector. In order to get better of this condition, it is essential to technically support and improve the competencies of the operational staff as well as the management level in the logistics sector.

In order for Turkey to become a logistics base, significant infrastructure investments have been made in road transport, rail transport, sea transport and air transport. These investments are increasing day by day and new ones are added to these investments. However, the investments made for the development of the logistics sector are not enough to solve the problems faced by the sector. There are many problems in the employment of competent human resources in the logistics sector. For example, according to the results of the 2018 Transportation and Logistics Sector Report prepared jointly by Istanbul University and Sakarya University, the most important problems in the logistics sector contain the inability of universities to

contribute enough to the logistics sector, the incompetence of sector employees and insufficient education levels. All these and similar problems are also reflected in international data. The low logistics performance index of Turkey also shows that it is not at a good level in the ranking (40). One of the main reasons for this can be expressed as the lack of competent professionals in the field of logistics. In order for Turkey to become a base in the logistics sector, in addition to carrying out many infrastructure works, the human resources employed in the sector must also be experts in their field and have sufficient knowledge and equipment. In other words, employees of logistics sector need to have significant logistics competencies.

## 4. Work performance, key performance indicators and Balanced scorecard approach to SCM

Organizations today compete in saturated markets. They often try to gain competitive advantage by disseminating their models, products and ideas among their partners. This is usually managed in a Supply Chain, which includes coordinating the flow of materials, information and payments between companies. Supply Chain has become a central focus for strategy and a critical factor in gaining competitive advantage. Leading companies such as McDonald's, Amazon, and Unilever recognize the importance of Supply Chain, making it a top priority due to its variability and process complexity. Thus, effective Supply Chain Management (SCM) has become a potentially valuable way to secure competitive advantage and improve corporate performance, because struggle is no longer between companies but between Supply Chain (41). For all sectors, the supply chain is an crucial component for the improvement of logistics. It can increase the efficiency and effectiveness of existing information sharing not only in the transfer of goods, but also in the complex hierarchy in the process from the point where the product is produced to the end point reaching the final consumer. Although there are different qualitative and quantitative performance evaluation methods, systematic grouping of different performance measures has not been included in the relevant literature. The expression of both quantitative and qualitative performance measures for easy reproduction and arrangement is represented by Chan. Isolated from general criteria such as quality and cost, other performance measures were described in Chan's research. These are resource usage; flexibility; visibility; trust; and innovation (42). It is noteworthy that different definitions in the literature have been developed for visibility, trust and innovation. In this research, with the expectation of a clear development of supply chain performance measures, the proposed solutions are presented by listing the details of the options for these performance measures.

Although there is a growing number of researches on supply chain management theories and practices in the literature, the performance measurement methods that can be used to

develop the supply chain are not sufficient, successful and effective. Traditional methods which is a variation of the many different methods and techniques used for supply chain management assessment takes into account familiar economical metrics such as net present value, return on investment, internal rate of return and payback period. Although these assessment technics based on economical criteria they are most suitable for measuring the value of simple supply chain management operations. On the other hand they are not very suitable for next generation supply chain management applications. These composite supply chains try to produce a number of advantages, comprising intangible ones. Therefore, measurement objectives need to represent a balanced approach and be cathegorized at strategic, tactical and operational levels, as well as financial and non-financial measures for effective management of the supply chain (43).

Different models such as Supply Chain Operations Reference (SCOR-model) and Balanced Scorecard (BSC) are used to evaluate organizational performance in businesses. The SCOR-model is a hierarchical and interactive business model that expresses business processes, performance metrics, good business practices and personal competencies in a unified structure. It is created by a plan, source, make, deliver, and return (41).

The SCOR model is adapted to different conditions and scenarios because it is an industry independent management tool for supply chain management. It can be also adapted to different industries such as manufacturing, construction, service, logistics operations and collaborative Supply Chain networks. As mentioned in the following section Balanced Scorecard was developed by Kaplan and Norton in the early 90s. It focuses on business strategy from four perspectives: finance, customers, internal processes, and learning and growth (44). Many studies combine both models; however, meaningful results emerge only when the type of company, sector, organizational culture and size of the organization are taken into account. The focus of these models is to support a part of an organization to achieve the planned goals. In addition, models such as SCOR and BSC have key performance indicators (KPIs) that enable companies to achieve their goals (41). KPIs act as a set of measures focusing on those sides of organizational performance that are critical for the success of the organization. KPIs are seldom new to the organization. They may have not been recognized or they were gathering dust somewhere unknown to the current management team (45).

In the literature, some researchers trying to define supply chain (logistics) performance with the Balanced scorecard approach have presented some criteria to measure logistics performance (46). Much of the literature on logistics performance seems to focus on models and frameworks and is about managing different aspects of logistics (47,48,49). There are

other studies that try to look specifically at certain units of the supply chain and measure performance on that basis. In this context, Choy et al. (2007) developed a performance management system for supplier relationship management for maintenance logistics providers using a benchmarking framework (50). Similarly, in measuring logistics performance systems using an activity-based costing approach, Koota and Takala (1998) applied this methodology to a case study in the basic metals industry (51). The balanced scorecard is designed to help firms that historically place too much emphasis on short-term financial performance. As the name suggests, the purpose of the scorecard is to provide a structured mechanism to influence managers to achieve a balance between non-financial and financial results over short-term and long-term time horizons. Much like SCM, it is important to note that there is currently a strong interest in balanced scorecard performance management systems among senior managers. Many managers are seeking to learn more about SCM and the balanced scorecard as separate management tools, but it is now more important that understanding the interrelationship between these two concepts in order to have a greater likelihood of leveraging supply chains into a source of competitive advantage (52). The balanced scorecard is the way of evaluating corporate performance from the perspectives of financial, internal business process, customer, and learning and growth dimensions. According to Kaplan and Norton (1992), their measurement tool which is called balanced scorecard is designed to complement "financial measures of past performance with their measures of the drivers of future performance". They developed this concept with the aim of keeping score on a set of elements that provide a balance between short-term and long-term goals, between financial and non-financial measures, between lagging and leading indicators, and between internal and external performance perspectives (44).

Traditional logistics performance measures, although useful, neither adequately assess supply chain orientation. The shift in philosophy that takes place when a supply chain point of view is embedded within the balanced scorecard framework is that the internal perspective of the scorecard is expanded to include both the "interfunctional" and "partnership" perspectives. Most of the performance measures used to measure supply chain performance consist of performance measures used for logistics performance evaluation, which provides internal focus. Logistics-oriented performance measures aim to optimize the performance of an enterprise in the supply chain, but do not consider the performance of other enterprises in the chain. Therefore, it falls short of measuring supply chain performance (52).

At the same time, traditional performance measures such as profitability are not suitable for SCM. Because it provides a focus for a single business and does not have a holistic

understanding that covers the entire chain for performance improvement. Many businesses are aware of the importance of financial and non-financial metrics. However, businesses are unsuccessful in using these criteria in a balanced structure. Some managers and researchers have focused on financial measures, while others have focused on operational measures. Such a difference in approach prevents the disclosure of performance criteria that will explain the performance of the enterprise. For a balanced approach, businesses need to realize that financial performance measures will be better analyzed together with non-financial measures of strategic decisions, reporting, daily production control and distribution operations. Another issue that differs between businesses is the number of performance measures to be used. Most of the time, businesses apply a large number of performance measures with the advice of their employees and consultants. In this case, they do not realize the fact that better results can be achieved with the use of a few good performance measures.

Businesses can apply the balanced scorecard by setting goals for time, quality, performance, and service and translating these goals into specific metrics. Firms should direct their day-to-day business operations in line with a combination of these measures and operational measures, rather than purely financial measures.

There are some certain steps to follow when creating a balanced supply chain management scorecard for businesses (43). One of them is increasing the awareness about balanced SCM scorecard in the company. Another one is gathering and analyse data on corporate, business strategy and SCM strategy. Particular aims and targets connected to corporate strategy, business strategy and SCM strategy. Also traditional metrics already in use for SCM appraisal. It is also known that potential metrics associated with four point of view of balanced scorecard. It is important to define the organization-specific aims for each of the four perspectives and the targets of the SCM operation. When developing a pre-balanced SCM scorecard, care should be taken that it is based on the defined goals and objectives of the business and the approach outlined. Getting comments and feedback from management on the balanced SCM scorecard and editing it consequently is another important step. Afterwards it should be accomplished a consensus on the balanced SCM scorecard that will be utilized by the corporation and the final step is to communicate both the balanced SCM scorecard and the underlying logic to all stakeholders.

Measuring performance is very important in terms of determining the place of countries in the competition, just like the competition between businesses. In order to increase the logistics service quality of countries, the importance of measuring and determining their global performance has emerged. The Logistics Performance Index (LPI), which shows the situation

of countries in this competitive environment and enables them to compare their logistics performance, is published by the World Bank.

The general logistics performance index of the countries is calculated in the range of 1-5 points by taking the weighted averages of these six indicators, and as the score rises to 5, it is interpreted as an increase in the quality of logistics performance. While the three indicators consist of input features such as public regulations, public policies and transportation infrastructure, the other three indicators are the outputs affected by the improvements and regulations made in these indicators. While indicators consist of customs, infrastructure, logistics quality and competence, which are the policy regulation tools that show the main inputs in supply chain service delivery, performance outputs in service delivery consist of two categories including international shipments, tracking and monitoring and timing indicators (53).

By measuring on-site trade logistics performance, LPI helps countries and their companies and partners understand the challenges they face in reducing logistics barriers to international trade. Logistics performance is evaluated as a tool to measure the level of economic development, as well as ranking countries, regions and cities according to the development of logistics infrastructure. Having a quality and sufficient logistics network can be effective on economic and social development and can be said to be effective in transitioning to a country position preferred by investors.

Turkey has the potential to be a logistics base in a strategic area, with its experience coming from being surrounded by seas on three sides and having its coasts suitable for making ports, being a bridge between Asia, Europe and the Middle East, and having similar trade routes in the past.

## 5. Occupational Health and Safety management

Today, the issue of occupational health and safety in businesses is considered as one of the human resources management functions. It is seen that businesses are increasingly giving importance to the subject in order to provide both legal regulations and administrative development. When the issue is viewed from the perspective of all sectors, it is noteworthy that the point of view that while determining the occupational health and safety policy in the enterprises should be adopted with the aim of providing a safe and healthy environment for the employees, it is necessary to act with the aim of preventing all kinds of losses that will prevent the normal working order, and accidents that result in people or machines. In this direction, businesses should aim to create a safe and healthy work environment for their employees. In order to achieve this goal, it should be adopted that the necessary responsibility

belongs to all individuals in the organization, together with managers and employees. This shared responsibility requires everyone's participation. The most important factor that causes accidents and will prevent them is people directly. An accident-free working environment will only be provided to the extent that occupational health and safety rules are known and can be used by employees in daily activities.

Occupational health and safety issue, which has started to be handled more comprehensively in recent years by considering its legal and economic dimensions in terms of all sectors, is important especially in terms of providing competitive advantage in the logistics sector, which can be considered as a new sector, and being in a better position compared to other enterprises in the sector. Today, while performing logistics activities, besides information and technology, an intense human power is also needed. Reducing work accidents plays an important role in terms of reducing labor costs in logistics activities, increasing employee motivation, increasing productivity, increasing and protecting business reputation. In order to reduce occupational accidents, it is necessary to adopt occupational health and safety practices and create an occupational health and safety culture within the enterprise. In addition, situations such as raising awareness and training of employees on occupational health and safety, running a feedback system by valuing the opinions of employees, taking protective and preventive measures by determining the risks and dangers in the work area, and operating a continuous control mechanism will reduce the occurrence of occupational accidents. In this way, workforce losses will be minimized, employee loyalty and motivation will increase, and expected increases in performance and productivity will be possible. From the point of view of logistics activities, it emerges that this situation will ensure that the products are delivered to the customer in the right amount and at the right time with minimum costs in competitive conditions.

From the perspective of the logistics sector, the logistics management process, which includes activities such as demand forecasting, stock management, logistics communication, material handling, transportation/transportation, supply process, order processing, packaging, customer service, and after-sales support, has certain risks in terms of occupational health and safety. It is known that one of the most important activities that requires raising awareness of employees about occupational health and safety through various trainings is storage. Therefore, it will be possible to say that the issues that need to be emphasized in terms of occupational health and safety in terms of the activities included in logistics management are transportation and storage.

The management of the flow of goods and services and the process of transforming raw materials into finished products is defined as supply chain (SCM) management. It enables a

company to gain competitive advantage in the market by increasing customer value through active regulation of supply-side activities.

Supply chain management is a set of links covering the entire process from the procurement stage of goods and services to their production and reaching the final consumer. It consists of a network of raw material extraction, production, distribution and vendor. In terms of business processes, the supply chain sales process includes many areas such as production, inventory management, material supply, distribution, procurement and customer service. It is also one of the key strategies to increase organizational effectiveness. Standards are strategic tools to achieve efficiency gains by reducing waste in logistics. The logistics sector, which has a significant share of the national income measured by gross domestic product (GDP), is also one of the most important employers.

Having a successful supply chain management requires making important decisions regarding the flow of information, products and money. Every decision must be taken to improve the resource of the supply chain. The supply chain is the management of demand by strategic cooperation between all the different structures of the enterprises, which are located horizontally and vertically in the system in order to meet customer needs, in order to increase the performance of the whole system in the long term. The aim in the supply chain is to increase the overall performance of the system. For this, each business in the system must increase its performance within itself. Because the core of the supply chain is the idea of "better performance for a better future".

Businesses in the logistics industry can also include safety and health concerns as a part of their SCM operations. The policy stating the general purpose of the company provides a safe and healthy working environment. OHS risk assessment should assess risks and quantify them by using risk matrices. Occupational health and safety management programs are designed to provide tools to achieve goals through continuous improvement of OHS performance. OHS hazards should be controlled according to the risk control hierarchy and the OHS tool should also consider planning in non-routine operations. Occupational Health and Safety Management Systems (OHSMS) is a proactive and sustainable approach aimed at effectively protecting the safety of employees' work conditions, increasing health and safety performance, and continuously improving processes, with policies, strategies, procedures and activities implemented to prevent risks with the commitment of senior management. OSHMS ensures that all personnel who may pose a hazard to OHS receive appropriate training. Establishes safety and health committees in enterprises to support employee participation in decision-making processes. These elements are explored to prevent recurrence of work-related

injuries, health problems, illnesses, and incidents. A safety inspection or audit is performed to measure safety performance. Emergency Response Plan (ERP) should be tested regularly for emergencies such as fire, oil or hazardous chemical spill (54).

Workplace safety includes significant risks. The unintended consequences of workplace safety incidents include serious injury, death, serious insurance costs, legal consequences, and other losses. Although there are significant studies on workplace safety in the literature, there is limited research examining risks and safety in terms of supply chain security. From the supply chain perspective, two key features stand out. First, it takes into account the systems approach so that the entire supply chain is viewed as a single entity, and second, it requires a strategic orientation towards a collaborative effort to harmonize and unify operational and strategic capabilities within and between companies. This approach can be applied to manage workplace safety risk. The impact of supply chain risks due to supply chain variability requires collaboration with other supply chain partners. Therefore, the supply chain should be considered as a whole. A collaborative supply chain can be created by addressing the risks faced by a business through interactions with other supply chain partners. This provides an efficient environment for supply chain risk management (55). On the other hand, there is no interaction with only tangible risk sources that change their effects in the event of an interruption. It can also create a separate source of risk and increase supply chain vulnerability. Focusing on the core business is essential for both research and decision making. A supply chain will have an impact on job performance, as work can have adverse effects, particularly on the physical and mental health of employees (56).

## 6. Training, Motivating and Empowering Employees

In terms of gaining competitive advantage, technology or infrastructure is easily imitated. The human resource that can use technology and equipment effectively and efficiently is inimitable. Supply chains with this power have a sustainable competitive advantage. In order to increase the productivity potential of the employees in the enterprises and provide competitive advantage to the enterprise, there is a need for a workforce equipped with the necessary knowledge and skills. For this reason, businesses attach importance to training activities in order to train qualified personnel who know their own processes well.

Professionals who will work in today's large supply chains need to have the knowledge and skills to see the big picture and ensure seamless integration between system elements. This requires knowledge and skills in many subjects in business, logistics and management. However, the degree of importance of these knowledge and skills may vary according to the

characteristics of the position, characteristics of the business and the region where the business is located. Undoubtedly, it is necessary to take a logistics and supply chain training in line with the program created in the light of needs in order to have knowledge in this wide area.

Industry 4.0 brings radical changes in logistics processes due to new technologies. This includes the role, duties and required skills of logistics workers and requires them to be extensively qualified. Current research for deriving competency requirements in operational and cost-effective logistics lacks methodological support that adequately considers process, technology, training and competence.

The future logistics specialist will need to be knowledgeable not only in the management of place, period & pace and pattern services, but also in the management of extended supply chains, which includes building relationships and managing flows over far and wide networks. The challenges facing this specialist will increasingly involve the establishment of strategic partnerships and the dynamic control of the flow of items and information across the networks that connect these partnerships. As we move toward a more competitive global economy, there will be an increasing demand for highly qualified people to create and manage more efficient logistics systems and supply chains. As businesses are beginning to recognize the importance of having knowledge in this area (57). Various research studies have established suitably skilled logisticians and supply chain practitioners as a major challenge for global organisations. However, skills requirements may not be the same across the globe as they depend on the complexity and maturity of a particular country's logistics and supply chain environment. Furthermore, logistics education and training do not necessarily meet industry requirements. In the ever-changing supply chain environment, it is important to understand the broad range of industry requirements. It requires an educational and further developmental process that focuses on a holistic perspective to create and deliver customer value. Some studies indicate that too much educational emphasis has been placed on the technical aspects of the role of logistics (24). What is really needed in that industry is to be at a level of competence that will include an appropriate mix between soft and hard skills.

Considering that there has been a significant increase in the number of young managers in the logistics sector in recent years, it can be thought that this is due to the recruitment trend focusing on a better educated workforce with modern qualifications. However, in practice, it is very difficult to decide when it comes to choosing between a well-trained logistics professional with a recent university degree and a logistics specialization and a high school diploma, but with a long history with leading logistics companies. Where the need is urgent, priority will likely be given to the second candidate to fill the position. Kisperska-Moroń,

(2010) reached the conclusion that logistics and supply chain attributes are constantly changing. The increasing "logistics awareness" of operational and administrative personnel in supply chains and logistics drew attention. In their study, the most important issues in real human resources management in logistics, such as coexistence and cooperation of different generations, diversification and individualization of career types, a single person can be a serious power, temporary cooperation and long-term cooperation, virtual management world were emphasized (5).

In Supply Chain Management (SCM), inter-firm collaboration is considered as the key to effective management for the delivery of the value that a customer desires. When the definitions of logistics and SCM are interpreted, it can be seen that logistics activities take place both in the supply process, in the production process and in the distribution process of the enterprise. This situation causes the same logistics activities to be carried out with different understandings in different business processes. For example, the transportation and storage operations in the procurement process are different from the transportation and storage operations in the post-production distribution phase. The reason for this is that the product features moving in the chain and the expectations of the next customer after the businesses in the channel change. Increasing educated workforce and advanced information systems facilitate business activities by reducing the need for continuous monitoring and close supervision. Businesses are constantly faced with the challenge of managing the "human" variable in the management equation, which includes different variables. Empowerment involves sharing power, information, and rewards with employees to take initiative, make decisions and solve problems in their work. It is known that there are very few studies about empowerment in the field of SCM to date. Lakshminarasimha focused on hard variables in his research. Therefore, integrating empowerment as a latent variable structure into a SCM framework and assessing its role in SCM results is of interest from a sectoral as well as academic point of view. Lakshminarasimha's research was to demonstrate the role of empowerment in collaboration between organizations and their downstream partners (58).

Some companies in the USA not only train their own employees on SCM, but also include their suppliers and even their suppliers' suppliers in the training. The fact that the customer, the supplier and the supplier's supplier receive training on supply chain in the same room, ask questions and give examples from themselves, improves the cooperation significantly. While the partners are learning, they also get to know each other and start to speak the same language.

Due to the need for qualified workforce in Turkey, an increasing demand for higher education has emerged in the logistics sector. Especially in the fields of logistics and transporta-

tion, higher education has been commercialized and vocational schools have dominated the sector. This situation has made the contents of logistics programs focused only on improving operational capabilities, targeting short-term returns and far from an effective scope. Accordingly, the skilled workforce in the logistics sector has decreased, and serious human resource deficiencies have begun to be seen, especially at the tactical and strategic management level. In the logistics sector, there are some problems such as lack of organizational and managerial skills, skills that are not compatible with job descriptions, and insufficient research activities. The need for competent human resources is mostly found at the technical and tactical management levels.

## 7. The Importance of Team Work and Communication

Two competencies that are important for a supply chain manager in rapidly changing environmental conditions are communication and teamwork competencies. These two types of competencies are recognized as critical areas for the challenges that a competent supply chain professional will face in business life. The ability to communicate with others in practice is critical due to good communication and negotiation skills, being able to connect with other businesses, suppliers and customers. In addition, supply chain managers should have the ability to integrate, communicate and analyze financial performance. It should be able to maintain its sectoral relations and customer relations in a healthy way, and should be able to evaluate existing laws and regulations from an international perspective (9).

Supply chain (information flow) management is a teambased approach which continues improvement in the system. The first and foremost aim of this system is to add the value and eliminate the non-value adding communication factors from the system. At the first step, those non-value adding communication factors are traced out, and in the next step, those are eliminated through a proper Supply chain (information flow) management System. Literature witnessed that supply chain (information flow) management plays an important role in the deliverance of leadership approach to the employees. Less the understanding gap between leadership and employees will result in a strong and clear relationship. Supply chain (information flow) management makes it possible to reduce this commutation and understanding gap (59).

The importance of understanding integration and teamwork for the supply chain has made it important by highlighting issues such as integration, information, resource and risk sharing, proactive communication, joint development of supply chain processes and coordination plan and decision making. In order to create customer value in supply chain management, teamwork requires developing a collaborative relationship. To gain a competitive advantage

in the current market, a joint effort is required among the participants of an interconnected supply chain (9).

## Conclusion

While the concept of intellectual logistics capital is considered as the intellectual material to be used by businesses in the process of creating wealth, the concept of intellectual logistics material is defined as logistics information, information, intellectual property and experience. Intellectual logistics capital is the sum of all things known to all employees within the logistics enterprise or that will provide a competitive advantage to the enterprise (60).

Success, innovation and making a difference are the result of the collective experience, creativity and problem-solving capacity, leadership, entrepreneurial and managerial abilities of individuals working in the organization. Human-specific values come first among the values that cannot be captured by entrepreneurs. It is not possible to establish ownership over the human elements of thoughts, abilities, aptitudes, feelings, judgment and reasoning. Except for the skills of the workers, all factors of production can be established anywhere in the world. Capital can freely transcend internationally and be transferred from one country to another with the help of the latest technologies, computers, satellites. More precisely, capital, knowledge, raw materials and technology are easily available. However, it is not possible to qualify human capital in a short time and to benefit from its capabilities effectively. Human capital is the information hidden in the human brain for the organization. A clear addition to the intellectual assets of the organization is made through human capital. Therefore, a number of human resources management efforts are needed to determine the quality and quantity of this human capital that businesses need, to attract and retain them.

The effective implementation of Human Resources Management policies, which are considered a key element in the success of a business, is also of great importance in the developing logistics and supply chain service markets. Therefore, modern human resource management practices should be proactively applied to the supply chain of businesses rather than set aside (61).

Traditionally, HR strategy involves developing the best flexible HR practice systems that support an organization's business strategies. Applying these activities to the context of the supply chain progressively yields broader benefits. When developing a business HR strategy, it should consider the supply chain strategy, its features, and its partners. The HR systems (e.g.; incentives, performance management, long-term relationships) should be used to manage supply chain partners. When necessary, business and supply chain partners should colla-

borate to develop and coordinate HR systems for the supply chain as a whole. HRM practices can be used to stimulate supply chain partners to develop valuable relationships between the organizations and to create knowledge-sharing routines. In this way, gaining a better coordinated, streamlined supply chain and ultimately new competitive advantage becomes inevitable.

Seeing the entire process as a single system is of great importance in terms of supply chain management. For example, the performance of each member of the supply chain, such as suppliers, warehouses, customers, affects the overall performance of the supply chain (62). For the effective implementation of SCM, some basic factors such as the existence of a flexible organizational structure, implementing make-to-order, customer orientation, low cost, total supply chain coordination, developing relationships based on trust, and collecting qualified data come to the fore. In addition, factors such as reporting, creating a management leadership strategy, developing an overall human resources management policy, improving communication to reduce uncertainty are also important (63).

In order for businesses to achieve the listed goals, they need innovative, flexible and adaptable human resources that can adapt to their roles and adapt to change and restructuring. In addition, this human resource should have a wide range of skills such as problem solving, leadership, team building and work. International businesses with successful supply chain management implementations stated that they attach great importance to the development of human resources by adopting human resource management practices such as training and retraining of personnel and adapting to help them fulfill their role in the supply chain. In addition, human resources' understanding of the philosophy and principles that underlie supply chain management, and the cooperation and coordination between the company's human resources and its human resources are vital to the success of a supply chain management program.

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# CHAPTER 4

# SUSTAINABLE SUPPLIER SELECTION PROBLEM

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**ABSTRACT**

Supplier selection is one of the research areas of supply chain and logistics management which has extensively studied by practitioners and researchers. The sustainability is getting more important in supply chain and logistics management. Therefore, the sustainable supplier selection is one of the main components for both researchers and practitioners in the of a sustainable supply chain and logistics management because of the increase in environmental protection and social obligations awareness. This paper presents a bibliometric analysis to understand the current research on sustainable supplier selection problem. This literature review provides an insight for researchers and practitioners on sustainable supplier selection problem in terms of presenting current state and potential areas.

**Keywords:** Sustainable, supplier selection, multi criteria decision making, logistics

## 1. Introduction

Sustainability has increasingly attracted as an important issue by both researchers and practitioners in supply chain management in recent years. Both practitioners and researchers has focused on for more sustainable deliver in supply chain management (1). Supplier selection problem is one of the vital research areas in sustainable supply chain management (2). The supplier selection problem is considered as a multi-criteria decision-making problem that takes into account multiple criteria. On the other hand, sustainable supplier selection problem considers the sustainable criteria in addition to the economical, quality and social criteria. Different solution approaches are proposed by researchers and practitioners in literature review. While some approaches are applied in single version, the integrated approaches that is consisted of at least two different approaches.

Igarashi et al. (3) reviewed green supplier selection problem considering the analytical model. They also identified the key dimension of the green supplier selection problem as decision-making tools, strategic alignment, supply chain context, and supplier selection process. Govindan et al. [4] review approaches and criteria for green supplier selection problem. They classified the approaches as single and integrated approaches and classified the criteria into two separate classes as green and traditional criteria. Zimmer et al. (5) presented a review on sustainable supplier selection, monitoring and development focusing models on decision-making process. They stated that analytic hierarchy process, analytic network process and fuzzy-based approaches are dominance in literature. Konys (6) analyzed the green supplier selection criteria. Rashidi et al. (7) presented a meta-literature review in sustainable supplier selection problem. Fuzzy TOPSIS and fuzzy AHP are most applied hybrid methods according to the review. Schram et al. (8) presented a review on multi criteria decision making based approaches for sustainable supplier selection. According to their review, TOPSIS and AHP are the most implemented approaches.

In this paper, we presented a bibliometric analysis for the sustainable supplier selection problem. A total of 565 documents are analyzed. The journal, distribution year, and country of the author are analyzed. In addition, authors' keywords, co-authorship-countries, co-author network and bibliographic coupling are presented in detail. The rest of the paper is elaborated as follows. While section 2 presents the research methodology, Section 3 presents the details of the bibliometric analysis. The last section describes the conclusion.

## 2. Research methodology

In this paper, the review of the sustainable supplier selection is searched using Scopus as

the resource for published papers collection. We researched in review analysis "sustainable supplier selection" and "green supplier selection" keywords. The only paper in English is included. The research articles, review articles, book and book chapter are considered in analysis. At the final step of the articles analysis, the set of databases consist of 565 documents. The remaining papers are review and analyzed manually.

According to the review analysis, the most top journals are presented in Table 1. Almost 35% of the papers is published in top 11 journals. The topmost two top journals are Journal of Cleaner Production and Sustainability with 7.3%. It is also illustrated in Figure 1.

**Table 1.** The most top journal published for sustainable supplier selection problem

| **Journal Name** | **#Paper** | **Percentage** |
|---|---|---|
| Journal of Cleaner Production | 41 | 7.3% |
| Sustainability | 41 | 7.3% |
| Computers and Industrial Engineering | 18 | 3.2% |
| Journal of Intelligent and Fuzzy Systems | 17 | 3.0% |
| Mathematics | 14 | 2.5% |
| Soft Computing | 13 | 2.3% |
| International Journal of Production Economics | 12 | 2.1% |
| Expert Systems with Applications | 11 | 1.9% |
| Information Sciences | 11 | 1.9% |
| Mathematical Problems in Engineering | 11 | 1.9% |
| Environmental Science and Pollution Research | 10 | 1.8% |

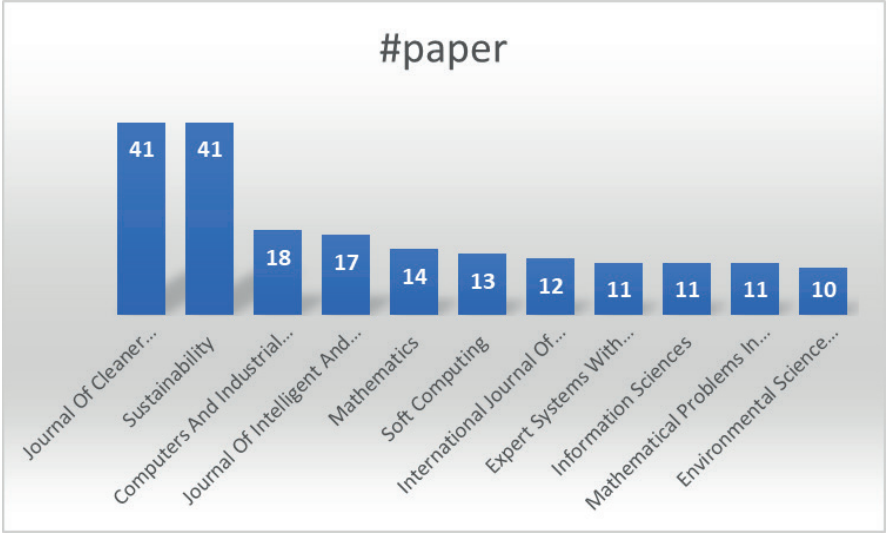


***Figure 1.*** The illustration of most top journal published for sustainable supplier selection problem

The 535 papers are considered to model the progress of paper to sustainable supplier selection problem in time, by adapting the distribution of the number of documents between the 2009–2022 via a regression analysis. 95% confidence level is considered in regression analysis. The year of 2023 is not included in analysis that 22 papers are published. It is inferred that after 2016, there is an significant increase in the production of papers (Figure 2). The trend becomes even more marked with a higher $R^2$ value (88.9%), demonstrating sustainable supplier selection problem papers have increasingly better reception within the literature.

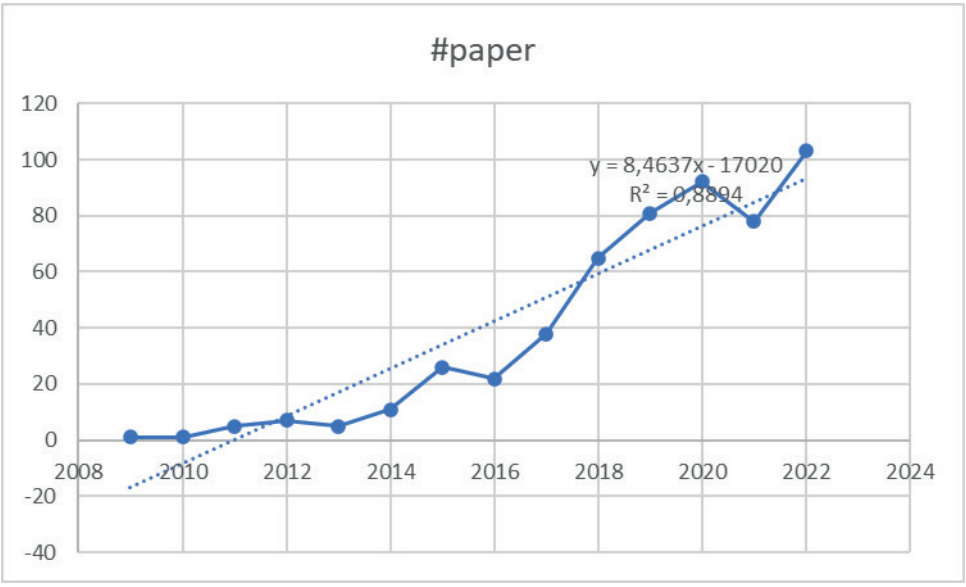


***Figure 2.*** The distribution of papers by years

The review analysis is also classified by country for each document, resulting in 10 portions and presented in Table 2. While China is the most papers published with 212 (35.9%) of all papers for sustainable supplier selection problem, the second country is Iran with papers published with 97 (16.4%) of all papers. On the other hand, Turkey is the most forth country with 53 (9%) of all papers.

**Table 2.** The distribution of papers by country

| **Country** | **#Paper** | **Percentage** |
|---|---|---|
| China | 212 | 35.9% |
| Iran | 97 | 16.4% |
| India | 68 | 11.5% |
| Turkey | 53 | 9.0% |
| Taiwan | 36 | 6.1% |
| United States | 36 | 6.1% |

| | | |
|---|---|---|
| United Kingdom | 26 | 4.4% |
| Malaysia | 23 | 3.9% |
| Spain | 20 | 3.4% |
| Germany | 19 | 3.2% |

## 3. Bibliometric analysis

Bibliometric analysis is an application of quantitative tools to analyze the scientific papers [9]. In this section, a bibliometric analysis of published works is presented in the green supplier selection problem. The set of databases consist of 565 documents. In this section, the applied analysis is presented in detail.

Author-keyword analysis is implemented to determine the most used author keywords using VOSviewer software. While Figure 3 presents the treemap of the top authors' keywords, the results of the Author-keyword analysis is illustrated in Figure 4. The most top keywords are green supplier selection, supplier selection, and sustainable supplier selection.

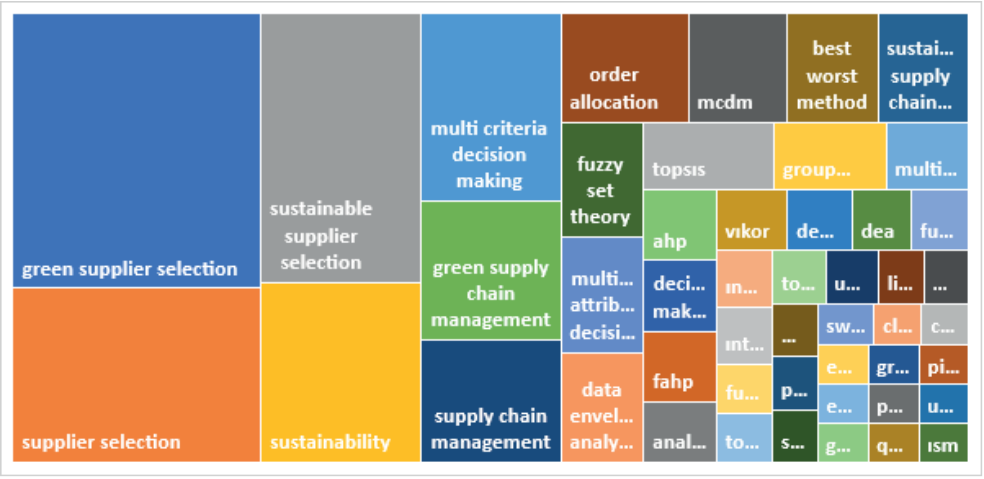


***Figure 3.*** The treemap of the most used authors' keywords

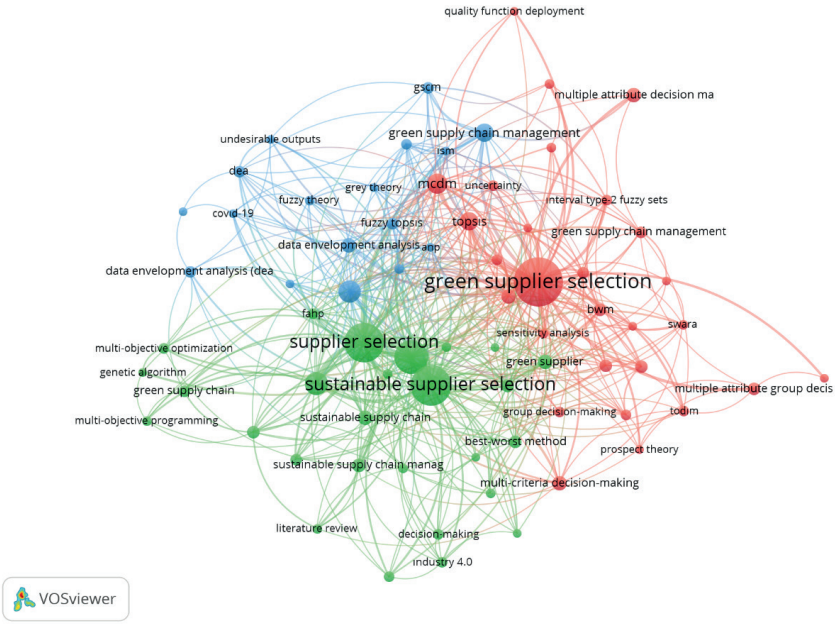


***Figure 4.*** The most used authors' keywords

According to the analysis 3 clusters are obtained as red, green, and blue. Sustainable supplier selection, supplier selection and sustainable supply chain are most used keywords in red cluster. In Red cluster, green supplier selection is most used author keywords. On the other hand, blue cluster focused on the approaches. Fuzzy theory, AHP, and TOPSIS are most used keywords.

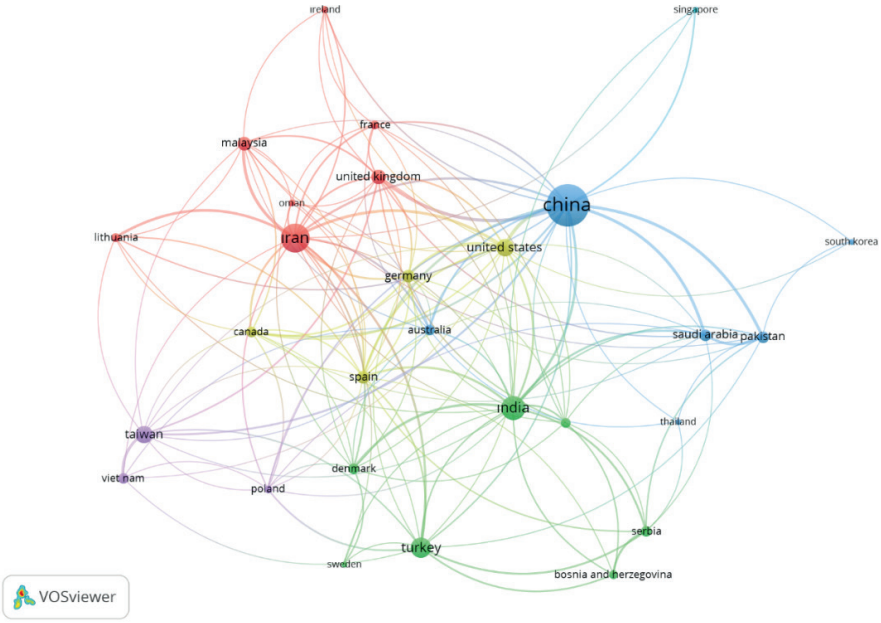


***Figure 5.*** Co-authorship-countries

The top countries that have published the most articles on green supplier selection problem are presented in Figure 5 and Figure 6. China has the most published paper with 212 articles. While Iran is in the second place with 97 published papers, India is the third country with the highest number of publications with 68 articles. In addition to the first third three country, Turkey is in the fourth place with 51 published papers. When the number of citations is analyzed, China and Iran are positioned the first two places as the number of published papers, like the number of published articles. However, when the number of citations is examined, it is seen that Denmark is in the third place.

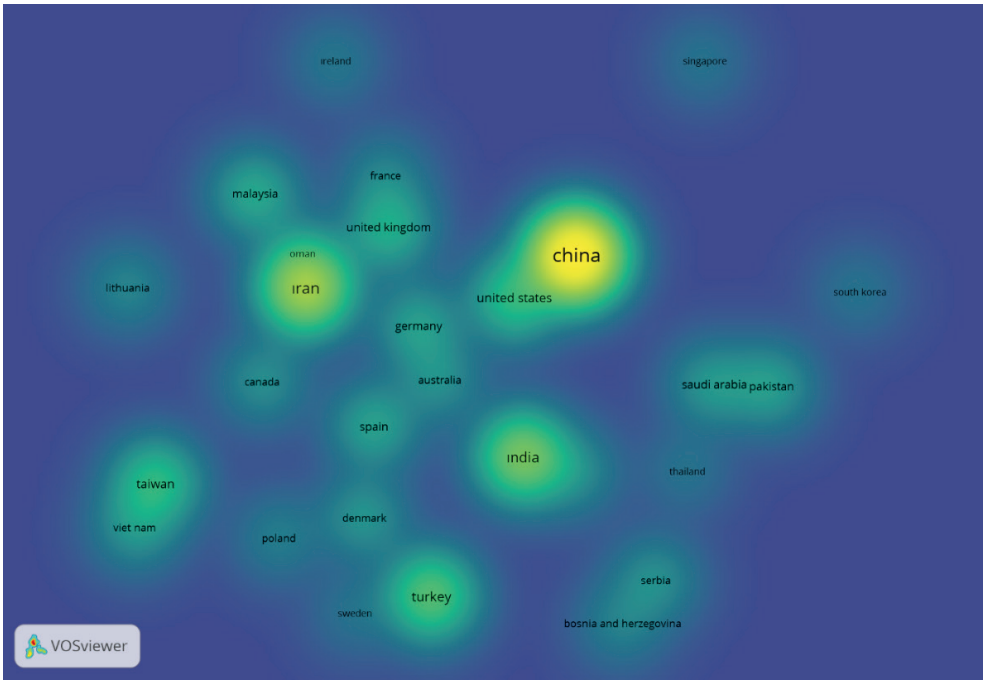


***Figure 6.*** Co-authorship countries network

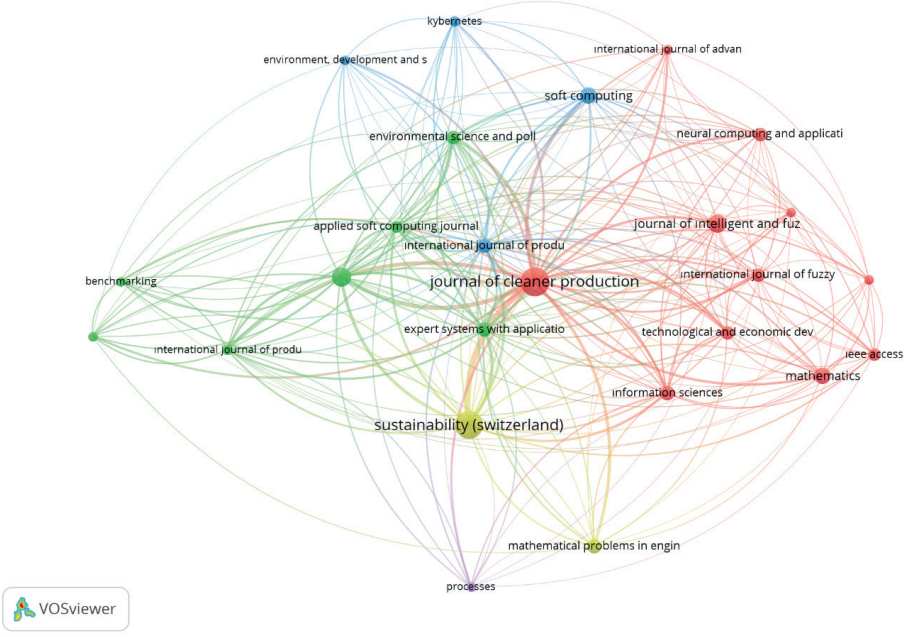


***Figure 7.*** The published papers in journals

In Figure 7, the most cited journals are illustrated. According to the number of citations, the top three journals are Journal of Cleaner Production, Expert Systems with Applications, and International Journal of Production Economics. On the other hand, Journal of Cleaner Production, Sustainability, and Computers and Industrial Engineering are top three journals with respect to number of published papers.

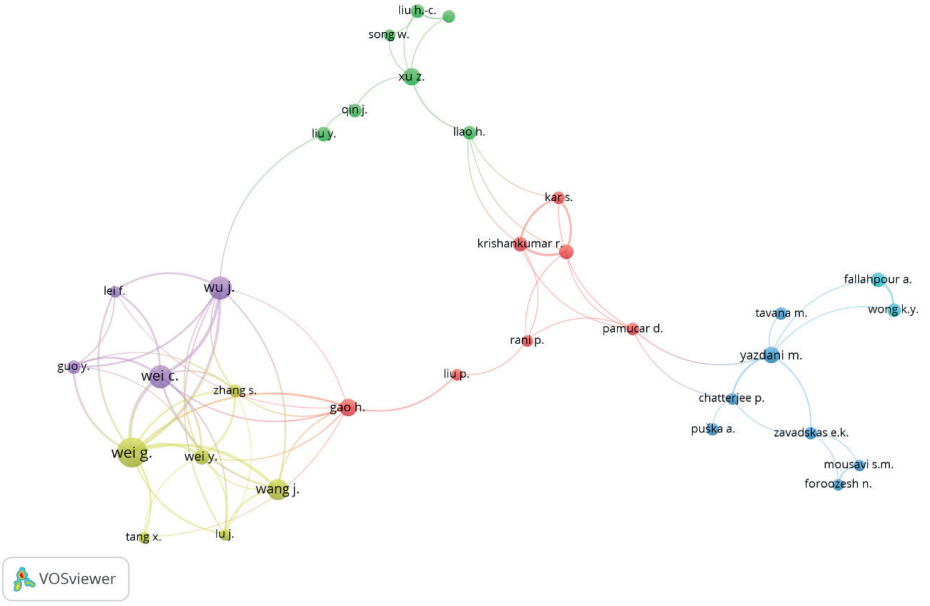


***Figure 8.*** Co-author network

It is stated that in common citation analysis, it is generally focused on references that come in pairs (10). The link strength of the co-authors on sustainable supplier selection problem is illustrated in Figure 8. For the co-author network map, the value "20" was selected for the minimum number of citations. The most commonly cited authors are; Wei (11) (1178 citations, 82 link strength), Wei (12) (673 citations, 68 link strength), Wu (551 citations, 53 link strength), Wang (13) (489 citations, 31 link strength), Wei (396 citations, 30 link strength), and Yazdani (14) (637 citations, 11 link strength).

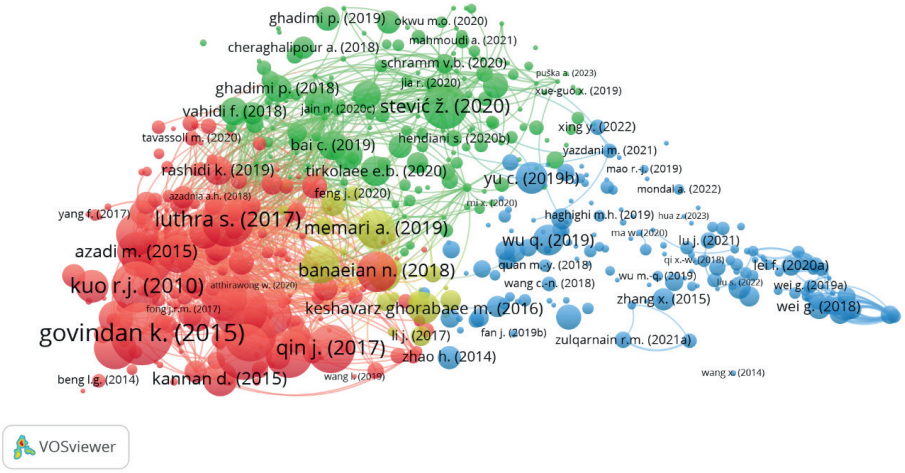


***Figure 9.*** Bibliographic coupling

In bibliographic coupling, the link strengths depend on the number of common references (10). The bibliographic coupling appears when two publications refer to the same third publication (15). The link strength of the authors is presented in Figure 9. In this paper, "2" was selected for the minimum number of citations of a document for the bibliographic coupling network map. The documents of the authors with the highest number of bibliographic matches on sustainable supplier selection; Zimmer (5) (266 citations, 4131 link strength), Zhou (2018) (48 citations, 3862 link strength), Kilic (2020) (61 citations, 3383 link strength), Gören (2018) (125 citations, 3364 link strength), Kannan (2018) (190 citations, 3148 link strength), Menon (2022) (4 citations, 3017 link strength), Şişman (2022) (0 citations, 2925 link strength), Aslani (2021) (9 citations, 2835 link strength), Jain (2020a) (93 citations, 2775 link strength), Sen (2017) (16 citations, 2774 link strength), Celik (2) (15 citations, 2633 link strength).

## Conclusion

In this paper, a total of 565 documents are analyzed in bibliometric analysis for sustainable supplier selection problem. Different analyses are implemented as the journal, distribution year, and country of the author. The results of the authors' keywords, co-authorship-countries, co-author network and bibliographic coupling are analyzed in detail.

Sustainable supplier selection problem is considered as multi criteria decision making considering sustainable criteria in addition to traditional criteria as economic, social, and qu-

ality criteria. Therefore, many different multi criteria decision making solution approaches are developed for sustainable supplier selection problem. The analytic hierarchy process, analytic hierarchy process, best-worst method, DEMATEL, TOPSIS, VIKOR and DEA are proposed in different application areas in supply chain management. Integrated approaches have been considered in the literature. The most commonly used integrated approach is AHP and TOPSIS. While the importance weights of the criteria are determined with AHP, the ranking of the suppliers is obtained with TOPSIS. In addition to AHP, the best-worst method is also used for determining the importance weights of the criteria in recent studies. In addition to the classical approaches, fuzzy sets based multi criteria decision making solution approaches are also proposed in sustainable supplier selection problem. Different versions of the fuzzy sets as triangular fuzzy sets, trapezoidal fuzzy sets, interval type-2 fuzzy sets, intuitionistic fuzzy sets and Pythagorean fuzzy sets are applied in applications.

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# CHAPTER 5

# SUSTAINABLE AND REVERSE LOGISTICS RISK MANAGEMENT

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**ABSTRACT**

The purpose of this chapter is to explore the latest research developments in sustainable and reverse logistics risk management (SRLRM) and provide a comprehensive outline for researchers and practitioners attempting to identify the current state of the art in the field of SRLRM. For this aim, first, the general framework of risk management is introduced in three phases, including risk identification, risk assessment, and risk mitigation. Then, some potential risks associated with sustainable and reverse logistics are determined based on a literature review. Afterward, the popular approaches used for risk analysis are investigated. Finally, the risk mitigation stage in the field of study is discussed. The outputs of this study develop new research avenues for future researchers studying the risks related to SRLs.

**Keywords:** Sustainable logistics practices, reverse logistics, supply chain management, risk management, logistic management

## 1. Introduction

Due to the recent global disruptions to supply chains (e.g., the Covid-19 pandemic), the role of supply chain management (SCM) and logistics management has been highlighted in improving the living standards of end-costumers. The management of logistics systems involves inventory management, warehouse management, and transportation (1). Logistics systems link the supply chain entities and facilitate the movement of goods from suppliers to manufacturers and eventually to end customers. This, in turn, affects the overall performance of various organizations in responding to market demand. In addition to the positive socio-economic impacts of logistics systems (e.g., job creation and fulfilling demand for mobility and accessibility), these systems may have several negative effects on the environment and societies (2). Dependency on nonrenewable resources, global warming, occupational health and safety of workers (i.e., injuries and accidents), and congestion are some of the negative socio-environmental impacts of logistics systems. Therefore, managers and decision-makers have focused on the integration of sustainability practices with logistics management (e.g., the development of a traceability system) to create sustainable logistics systems. This can minimize the negative socio-environmental impacts while improving the efficiency and profitability of supply chains (3). The incorporation of the concept of sustainable development into logistics systems to create a sustainable and green logistics procedure is shown in Figure 1 (4).

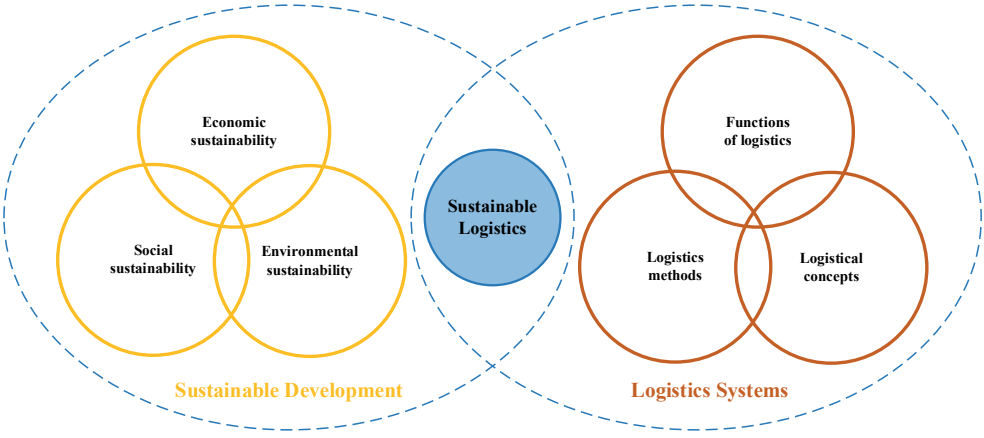


***Figure 1.*** The components of sustainable logistics management

Reverse logistics management is another important topic in the SCM area. Reverse logistics includes all practices and operations related to the upstream movement of products and processes of reusing materials, remanufacturing and disposal of goods at the end-of-life. This type of logistic greatly influences relationships between stakeholders and contribute to the

long-term profitability of supply chain activities by managing the backward currents in the network (5). Sustainable and reverse logistics (SRL) systems help managers get economic benefits and consider the socio-environmental aspects of their activities simultaneously. More precisely, these systems support organizations to establish a socially friendly reputation among stakeholders and protect the environment in addition to achieving a competitive advantage (5,6). Nevertheless, the implementation of SRL systems in various industries is tied to great challenges and barriers (2). One of the main barriers is the complexity of logistics operations and the management of such systems. This complexity results from the need for a substantial level of expertise, infrastructure, and technology (5). Therefore, managers may reluctant to adopt SRL systems due to existing risks posing an economic threat to their businesses (7).

To improve the performance of SRL systems, managers should analyze the risks associated with these systems and implement some mitigation measures to address managerial conservatism. Furthermore, managers are required to control the inherent uncertainty and risk of logistics operations to ensure the success of logistics management and the service delivery process (6). The limited budget to establish the required physical and technological infrastructures for returning residues and managing waste flows, reluctance to change the traditional practices, and lack of government financial incentives can be also considered as the risks affecting the implementation and success of SRL systems (5). Hence, managers need a comprehensive framework to manage and control such risks. A risk management framework can enable managers to prevent severe negative impacts of existing risks on the performance of logistics operations. Sustainable and reverse logistics risk management (SRLRM) aims to identify the potential risks, asses risks based on different factors (e.g., severity and occurrence probability), and define measures to mitigate the adverse impacts of critical risks. Since SRLRM is an emerging field within SCM, this research introduces the risk identification, assessment, and mitigation stages to deal with challenges associated with SRL systems. Then, this study explores the risks affecting the SRL and investigates the approaches developed to analyze these risks. We also discuss the risk mitigation measures proposed to improve the performance of logistics systems.

The rest of this research is organized as follows: In Section 2, the framework of risk management, from risk identification to risk mitigation, focusing on the SRL, is introduced. Section 3 explores the risks associated with SRL systems based on the literature. Then, the analytical and conceptual approaches proposed for risk analysis are investigated in Section 4. Section 5 introduces some risk mitigation measures to improve the performance of logistics systems. The practical and managerial implications of SRLRM are discussed, and research avenue for future researchers is provided in Section 6.

## 2. Risk management methodology

SRLRM is a comprehensive framework for identifying, assessing, and mitigating the risks associated with SRL systems to guarantee the profitability of supply chains, especially during disruptions. SRLRM aims to manage areas of risk that could adversely influence the success of SRL operations. This section discusses the main SRLRM stages, including risk identification, assessment, and mitigation. The first stage of the SRLRM framework is risk identification. This stage seeks to identify the risk types, risk factors or both (8). Decision-makers can identify the potential risks using conventional techniques (e.g., failure modes and effects analysis) or based on interviews with experienced experts in the field of logistics management. These internal and external can be divided into different categories, such as strategic, tactical and operational risks. In addition to identifying and categorizing the potential risks, the negative consequences of each risk should also be determined in this stage. This can help decision-makers analyze the identified risks and model their relationships more properly in the risk assessment stage.

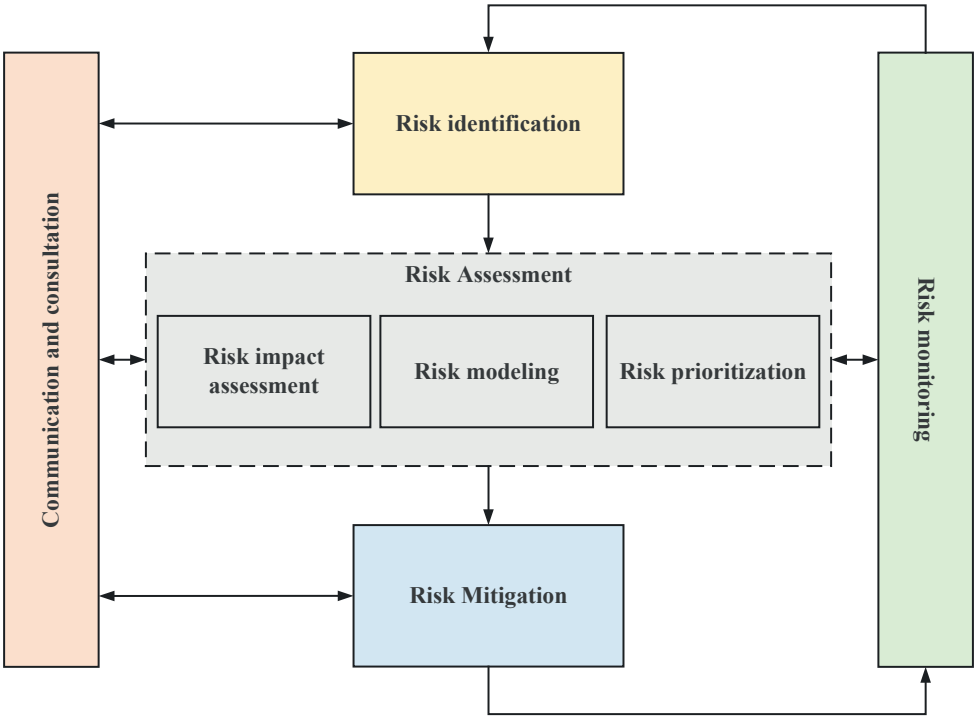


***Figure 2.*** SRLRM framework

Risk assessment is another main pillar of SRLRM to evaluate risks based on their probabilities (6). In fact, risk assessment deals with the probability of an event occurring and its consequences (8). This stage includes risk impact assessment, risk modeling, and risk prioritization to identify critical risks. Several risk assessment methods have been introduced in the literature to analyze the various risks, especially supply chain risks. However, risk assessment methods can be divided into quantitative or qualitative methods. Quantitative methods enable decision-makers to quantify the probability of occurrence and impact of a risk (i.e., severity) based on the recorded data in an organization. On the other hand, qualitative or conceptual risk assessment frameworks focus on the characteristics of risk rather than its probability values. The qualitative risk assessment often employs experts' opinions in the form of linguistic scales to determine the probability of occurrence and impact of a risk. Using linguistic variables for investigating the factors associated with the identified risks can also be beneficial for managers to identify the weaknesses of the systems (9).

After identifying and assessing risks associated with logistics systems, decision-makers should define and implement risk mitigation measures to reduce the adverse impacts of the existing risks (6). Risk mitigation refers to the development of effective mitigation measures to reduce risks and consequently facilitate achieving the determined management goals (e.g., increasing customer satisfaction and profitability). The main aim of the risk mitigation measures can be different and include avoidance, reduction, and transference strategies. However, today's organizations may face various limitations (e.g., budget), and they cannot struggle with all identified risks. Organizations, in this case, should target the most critical risks identified in the risk assessment stage to ensure the success of SRL systems or facilitate the adoption of such systems. More precisely, the mitigation of negative impacts of critical risks may affect other risks, inherently interconnected with these risks. After implementing the risk mitigation measures, managers should also monitor the behaviour of critical or target risks to guarantee performance improvement in the logistics systems.

## 3. Risk identification in SRLs

It has been stated in the previous sections that the activities of identifying, assessing and mitigating risks are at the center of SRL management. In this section, we will focus on the identification of risk, and the next sections cover assessment and mitigation. Risk identification provides a list of risks that are likely to affect the sustainable and reverse supply chain and, thus, the wider organization (10). When considering risks from a sustainability perspective, it can be seen that in many ways they differ from typical supply chain risks in many ways. Giannakis and Papadopoulos (11) address sustainability-related risks as environmental,

social and financial/economic hazards. For each of these hazard groups, a classification of endogenous (i.e., internal risks arising from the activities of companies along their supply chain) and exogenous (i.e., external risks posed by the interactions of companies with the external environment in which they operate) has been proposed. Regarding the environmental dimension, the risk steering principle is to meet the requirements for the quality of a shared ecosystem. Environmental accidents, natural disasters, pollution, emission of harmful gases, non-conformance to sustainability rules (e.g., unnecessary packaging, unsuitable use of energy, and waste), and water scarcity are the most important risk factors that come to mind initially under the environmental dimension (11). The social dimension refers to the assignment of responsibilities to employees, customers, business partners, governments and communities. Working life-based inequalities (e.g., unfair wages, child labour/forced labour, discrimination, and bad working conditions), unethical treatment of animals, pandemics, and social instability are considered under the social dimension (11). The economic dimension includes the monetary risks brought by the financial environment, the deceptive behaviour of companies and individuals, and the effort for sustainable economic growth. Risk factors such as price fixing accusations, antitrust claims, boycotts, energy price instability and financial crises are also the main risks evaluated under the economic dimension (11).

On the other hand, a comprehensive study on reverse logistics risks (12) revealed 41 different factors. These risk factors are placed in clusters in three main groups: strategic, tactical and operational. The strategic cluster mostly includes the information-oriented aspects of the business and the risks that directly affect the decision-making of top management. This cluster includes 21 risks, such as poor communication, lack of shared goal, poor strategic development, technological change, competitive uncertainty, and corporate social responsibility, that affect an organization's long-term strategic operations. The tactical set consists of 14 risks, such as demand fluctuation, labour instability, and political instability, that affect an organization's medium-term tactical operations. Mostly, inventory and supply management issues are included in this cluster. The operational cluster includes six risks (i.e., financial instability, macroeconomic uncertainty, transportation, security, customer and outsourcing risk) that directly affect daily operations. Any disruption as a result of exposure to such risks has an immediate and direct impact on the performance of reverse logistics systems. Senthil et al. (13) combined a list of nine SRL risk types as follows: environmental, inventory, data managing, time management, managerial, cultural, quantity, outsourcing and distribution risks. In another research by (14), the main risks associated with the operation of SRL are defined under eight items. These include inadequate storage and collection process, lack of a suitable

vehicle for transportation, equipment and communication between the supply chain actors, vehicle routing issues, overstock inventory, and low quality of the residue.

In this context, the methods used to identify risks include risk checklists, taxonomies, risk mapping, subjective evaluation of experts through surveys, interviews, group meetings and the Delphi method, and extensive literature reviews (i.e., content analysis of academic articles, industry reports, and white papers) (10-12). Undoubtedly, the SRLRM process, which struggles with many types and numbers of risks, is very difficult to manage. Different categories can be introduced to focus on the most important types of risk. The standardized triple classification of internal operational risks, risks within the chain, and risks arising from the external environment make it easy for managers to identify risks. Some formal procedures are needed for this identification. The usual way is to divide the chain process into a series of activities, systematically examining each activity in turn and identifying the risks in each. To do this, managers can analyze past events, gather insights or directly analyze operations (10). The risk identification ensures that significant risks of SRL systems are recorded. But problems can always occur. Besides the inherent difficulty of identifying risk, managers may be reluctant to acknowledge that risks exist and must take appropriate action to deal with them. After compiling the most critical risks associated with SRL, managers ensure that they are assessed using logical and scientific methods.

## 4. SRL risk assessment

In this section, the published papers on SRL risk assessment focusing on their used approaches are analyzed. To evaluate the risks of SRL, there are methods called qualitative, quantitative or semi-quantitative, which are among the risk assessment methods followed by the traditional health and safety perspective. In order to evaluate the risks of SRL, there are methods called qualitative, quantitative or semi-quantitative, which are among the risk assessment methods. It is seen that there are limited studies in academic databases such as Scopus with appropriate key terms (e.g. “sustainable reverse logistics” AND “risk assessment”). However, due to the diversity of the study spectrum, we have determined that the studies in which the risks that occur directly in an SRL system, evaluated in the context of the framework in Figure 2, are limited. In Table 1, we have included some selected focus studies. When these are evaluated, it can be stated that multi-criteria decision making (MCDM), traditional risk analysis techniques such as failure mode and effect analysis (FMEA) and Bayesian network, and fuzzy logic are used.

MCDM is a field that operates on the basis of determining the most appropriate among the options and is frequently used by researchers in risk assessment. It is generally applied

as a combination of two basic stages. The first is the determination of the importance level of the parameters that include the description of the risk. In this part, MCDM methods based on pairwise comparisons such as analytic hierarchy process (AHP), analytic network process (ANP), and best-worst method (BWM) are generally used. The second stage is the stage, where the risk types determined in the SRL process are handled in the light of these parameters, scored with expert opinions, and the risk scores and ranks are determined. At this stage, mostly compromise and outranking-based MCDM methods (e.g., TOPSIS, VIKOR, PROMETHEE, ELECTRE) are used (13, 16-17, 22-23). Fuzzy logic is also frequently used in risk assessment, both to better present the uncertain environment in decision-making and improve the limited flexibility provided by linguistic evaluations expressed in precise numbers (15, 18-21). It can be said that MCDM methods combined with fuzzy logic produce useful solutions compared with traditional risk assessment approaches.

Apart from MCDM, fuzzy logic theory, and traditional approaches, there are different concepts used, especially in the assessment of SRL risks. Among these, it is possible to count optimization-oriented operations research techniques such as linear programming, goal programming, game theory, nonlinear programming and stochastic programming (24). In these models, instead of evaluating the risks, the optimization objectives, mostly economic and environmental objectives, are satisfied with a mathematical model in which the risks will be minimized.

**Table 1.** Studies and used methods in SRL risk assessment

| Study | Focus | Method | Method details |
|---|---|---|---|
| Giannakis and Papadopoulos (11) | Explore sustainability-related supply chain risks | FMEA | A mixed method risk assessment approach including statistical analysis and FMEA |
| Senthil et al. (13) | Analysis and prioritisation of risks in a reverse logistics network | MCDM | Hybrid AHP-Fuzzy TOPSIS method; Hybrid AHP-PROMETHEE method; Hybrid AHP-Diagraph and Matrix method |
| Omosa et al. (15) | Reverse logistics supply chain for end-of-life vehicle recycling risk management | Fuzzy set | Fuzzy knowledge representation theory embedded in the risk assessment process that helps to quantify risk ratings |
| Huizhe and Donglin (16) | Risk assessment of reverse logistics of retailing | MCDM | The unascertained measurement and attribute hierarchy model (AHM) employed to risk assessment of reverse logistics of retail enterprise |

| | | | |
|---|---|---|---|
| Huizhe and Lihua (17) | Effective index of retailing reverse logistics risk factors | MCDM | AHM and index weigh merged |
| Yan et al. (18) | Retailing reverse logistics risk factors assessment | Fuzzy set | A triangular fuzzy number-based risk assessment approach |
| Meng (19) | Risk analysis of reverse logistics outsourcing | Fuzzy set | Fuzzy comprehensive analysis method |
| Zhou et al. (20) | SME reverse logistics outsourcing risk analysis | Fuzzy set | Fuzzy comprehensive evaluation method |
| Insuasty-Reina et al. (21) | Prioritization of operational risks in a reverse logistics network for the recovery of waste cooking oil | Fuzzy set | Fuzzy quality function deployment |
| Duran and Zafeirakopoulos (22) | Environmental risk assessment of e-waste | MCDM | ANP, COPRAS |
| Rostamzadeh et al. (23) | Evaluation of sustainable supply chain risk management | MCDM | TOPSIS, CRITIC |
| Jayasinghe et al. (25) | Cause and effect relationship risks in reverse logistics supply chains for demolition waste | Bayesian network, Interviews | A mixed method approach (Semi- structured interviews, structured interviews, thematic analysis, and Bayesian belief network) |

Another important element in the fuzzy logic integrated MCDM SRL risk assessment studies is the decision-making experts. The fact that their evaluations are stated with fuzzy linguistic expressions, and the formation of a group decision also strengthens the accuracy of the results of the study. Apart from MCDM and fuzzy logic theory, traditional risk assessment approaches such as FMEA and Bayesian networks are also used for assessing SRL risks. Giannakis and Papadopoulos (11) determined the relative importance of a defined set of sustainability-related supply chain risks using FMEA. As a result of their studies, it has been stated that endogenous environmental risks are the main risks. In another study (25), semi-structured and structured interviews were conducted to identify and assess the interdependencies of risks in SRL systems. Data were analyzed using thematic analysis, and a Bayesian network was used to develop a risk model.

## 5. Risk mitigation for SRL management

Risk mitigation is the final stage of the SRLRM methodology. In this context, managers need to discuss the decisions and actions they will take to deal with the high-scoring risks that emerged in the previous stage. It is necessary to make measures and recommendations for the risks that are less controllable. In the study of Giannakis and Papadopoulos (11), six basic

strategies, including avoid, mitigate, prevent, cooperate, insure, and retain, are mentioned. These measures need to be structured so that at least the SRL system can operate normally or with little disruption, be effective in dealing with risks, allow efficient use of resources, and comply with legal constraints (10). There are several techniques to put such strategies into action. Among them, it is necessary to mention the what-if analysis and cost analysis or cost-benefit analysis (26). In the literature, although not directly for the SRL risk mitigation stage, there are models recommended for the prioritization of control measures in reducing the risks arising from occupational health and safety, especially in the process industries (27). It is important to prioritize these preventive measures and develop models by considering performance, applicability, functionality and integrability, which are the factors that affect the decision process.

## 6. Conclusion

Logistics systems play a major role in improving customer satisfaction and supply chain network efficiency and, consequently, increasing the profitability of a company. Due to the increasing importance of the sustainability concept in various fields, SRL systems have been created to improve resource utilization, protect the ecological environment, improve social responsibility, and increase the supply chain's profitability simultaneously. However, the success of the implementation of SRL systems in various industries can be challenging because of existing infrastructure requirements and organizational limitations. Therefore, managers should manage risks and barriers associated with SRL systems to improve the performance of such systems. Hence, a comprehensive SRLRM framework can enable managers to deal with potential risks to prevent their negative impacts on the performance of logistics operations. More precisely, SRLRM aims to identify these potential risks, asses risks based on various factors, and propose effective measures to mitigate the adverse impacts of critical risks.

Based on the literature, such risks are identified through checklists, interviews with experts and extensive literature reviews. Furthermore, most existing approaches for SRL risk assessment in the literature are developed based on MCDM techniques and fuzzy sets. To address some shortcomings associated with these frameworks, such as biased comparisons and not considering the interactions among risks, the development of decision support systems based on the advanced versions of MCDM and data analytics techniques can be considered for future research. The SRL mitigation stage can be considered as an intact part, while the definition and prioritization of mitigation measures are of cardinal importance to improve the performance of logistics operations. Accordingly, future researchers can focus on evaluating the effectiveness of the defined risk mitigation measures considering the interactions between

potential risks and the supply chain's objectives. In fact, the adoption of effective risk mitigation strategies can significantly affect the performance of SRL systems to deal with future disruptions.

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# CHAPTER 6

# TURKISH NATIONAL TRANSPORTATION, LOGISTICS POLICIES AND ECONOMIC GROWTH

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**ABSTRACT**

In this study, the developments in the basic transportation channels of the Republic of Turkey from the foundation to the present and the contributions of these developments to economic growth have been investigated. First of all, the transportation development of the country is summarized from a historical perspective. In the following stage, the contribution of each transportation channel to economic growth has been tried to be analyzed. Finally, the effect of the developments in all transportation channels on aggregate production was tried to be analyzed in time dimension.

**Keywords:** Airway, Economic Growth, Highway, Maritime way, Railway

## 1. Introduction

In this study, the transportation adventure of Turkey, which has been experienced in its 100-year history since its establishment, has been examined in a historical perspective and the effect of this development on economic growth has been investigated. Transportation and Logistics is an important production factor that the country's economies use to supply their products to the markets and to supply the necessary inputs for their production. The Republic of Turkey has given great importance to transportation and logistics channels for economic development since the day it was founded. While railway investments were adopted as a state policy until the Second World War, road transportation was given importance after the Second World War. With the development of the aviation sector around the world, Turkey has shown the necessary importance to this sector and Turkish civil aviation has covered significant distances. While there has been progress in all transportation sectors, unfortunately, the necessary development has not been observed in the Maritime sector. Developments in all sectors except the maritime sector developed in the same direction as the economic growth. In this study, the half-century adventures of the highway, railway, airline and seaway sectors were summarized and their relations with economic growth were tried to be explained.

## 2. Road Transportation

When the Republic of Turkey was founded, the unit responsible for highways was the Ministry of Public Works. In the following process, attention was paid to the construction of roads and bridges under a presidency within the Ministry of Public Works.

It is accepted that the modern regulation of Highways in Turkey started in 1950. General Directorate of Highways was established in 1950. Thus, the country's highway policy was prepared and plans and programs were initiated in line with this policy. The institution, which primarily focuses on the rehabilitation of old roads, has also turned to the construction of new roads that are needed. At the same time, modern methods and mechanized production processes have begun to be followed in highway construction. As a general policy, reaching the smallest housing unit has been accepted as a national goal. In this process, reaching the highway network extending to villages and districts has been adopted as a general goal and studies have been continued in line with this aim (1).

In the following years, importance was given to the construction of highways in European standards. In particular, road constructions continued by determining highway standards and adhering to these standards. These years were also the years when import substitution foreign trade policies were followed. It has been observed that foreign automobile manufacturers

make factory investments in Turkey. The automotive sector has increased its domestic input ratio day by day. The increasing number of vehicles has made the construction of urban and intercity highways a necessity. In particular, the first bridge built on the Bosphorus, the first toll highway between Istanbul and Kocaeli, and the ring roads providing transportation from outside the cities were realized in this period.

On January 24, 1980, Türkiye took new economic decisions. At the beginning of these decisions came the industrial policy based on exports instead of the import substitution industrial policy. It is now aimed to carry out production not only for domestic consumption but also for export abroad. New highway projects have been adopted as a national transportation policy in order to establish the necessary supply chain for the production required for export and to safely export the final products from the production. In particular, the roads connecting the country where the export is made with abroad were brought to highway standards, the second bridge to the Bosphorus was built, and the highway needs of the production and industrial zones were met during this period.

With the 2000s, Türkiye has attached great importance to the construction of the national integrated divided highway network. Connecting the national divided road network to international transit routes has led to new methods in the road construction process. Legal arrangements have been made to increase the private sector's investments in highway construction. The private sector was invited to invest through the build-operate-transfer method. With this method, the third bridge of the Bosphorus, a bridge to the Gulf of Kocaeli and a bridge to the Dardanelles were built. In addition to these bridges, highways have been built by private companies in many geographical regions and are still in operation.

During the last 30 years, there has been a significant increase in the construction of divided highways. We can follow the road developments in Turkey in Figure 1. While a part of this increase is the conversion of existing old roads into divided roads, the other part consists of the construction of new divided roads apart from the existing old roads. While the total length of divided roads was 1437 km in 1984, this figure increased to 2151 km in 1990 and 6040 km in 2002. has reached. Divided road length reached 10178 KM in 2005, 20273 KM in 2011, and 26973 KM in 2021.

There appears to be a significant decrease in the length of the roads other than the divided roads. The reason for this development is that these roads have been developed over time and turned into divided roads, or they have been canceled and replaced by new divided roads over other routes. While the total undivided road length was 57752 km in 1984, this figure decreased to 41553 km in 2021.

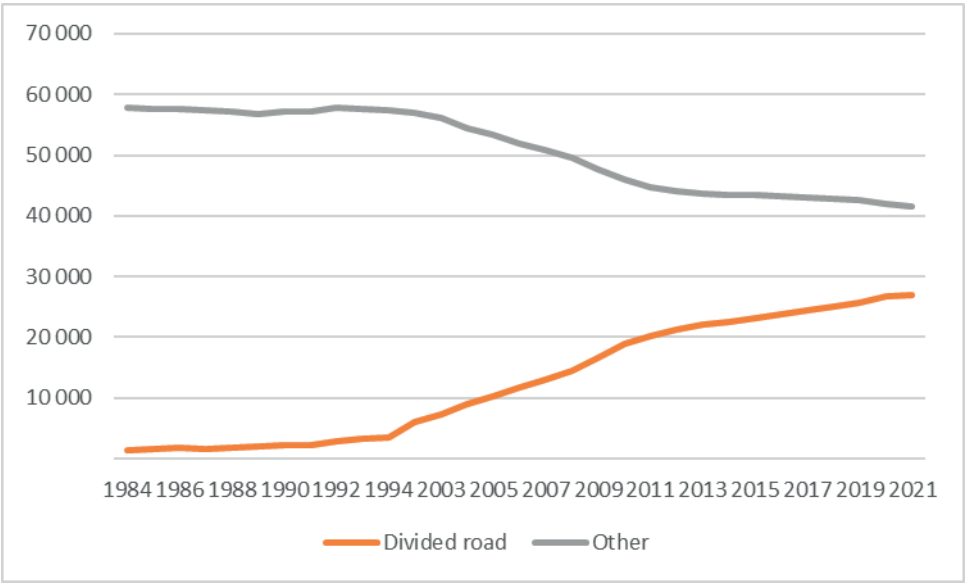


***Figure 1.*** Road (km)

Turkey has given great importance to the construction of highways after choosing the export-oriented production policy it adopted in 1980. We can see the motorway development in Turkey in Figure 2. The total motorway length, which was 77 km in 1984, increased to 101 km in 1987. Total highway length was recorded as 1012 KM in 1993, 2036 KM in 2009 and 3532 KM at the end of 2021.

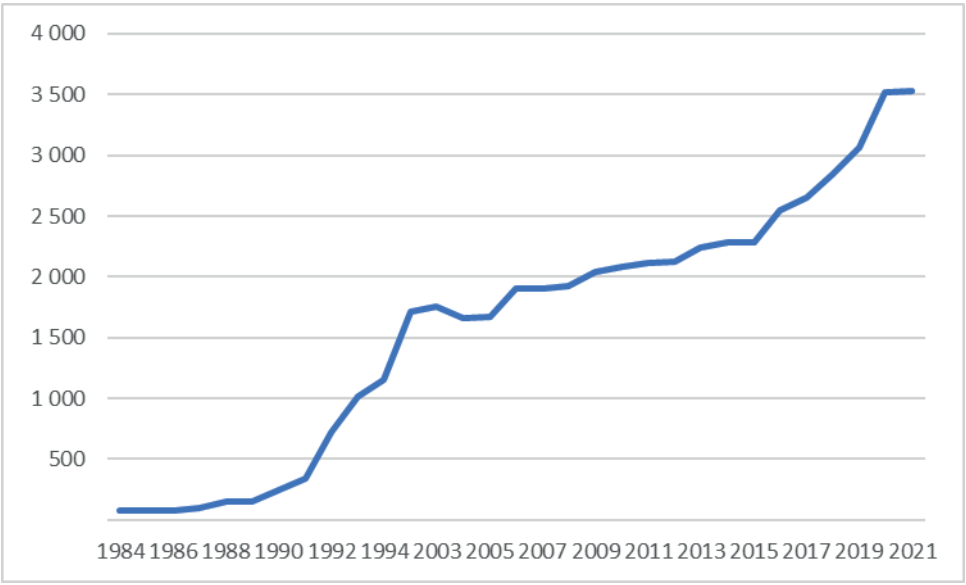


***Figure 2.*** Motorway (km)

## 2.1. Number of Motor Vehicles

During the import substitution industry policy period, foreign manufacturers who wanted to operate domestically made investments in Turkey. Especially after 1980, when export-oriented industrial policies were adopted, besides automobile factories, bus and truck manufacturers also invested in Turkey.

Automobile production is given in Figure 3. While 112,367 automobiles were registered on highways in 1967, this figure increased to 560,424 in 1977. While the number of registered cars was 1,193,021 in 1987, this figure was 3,570,105 in 1997, 6,472,156 in 2007, 10,589,337 in 2015 and 14,269,352 in 2022.

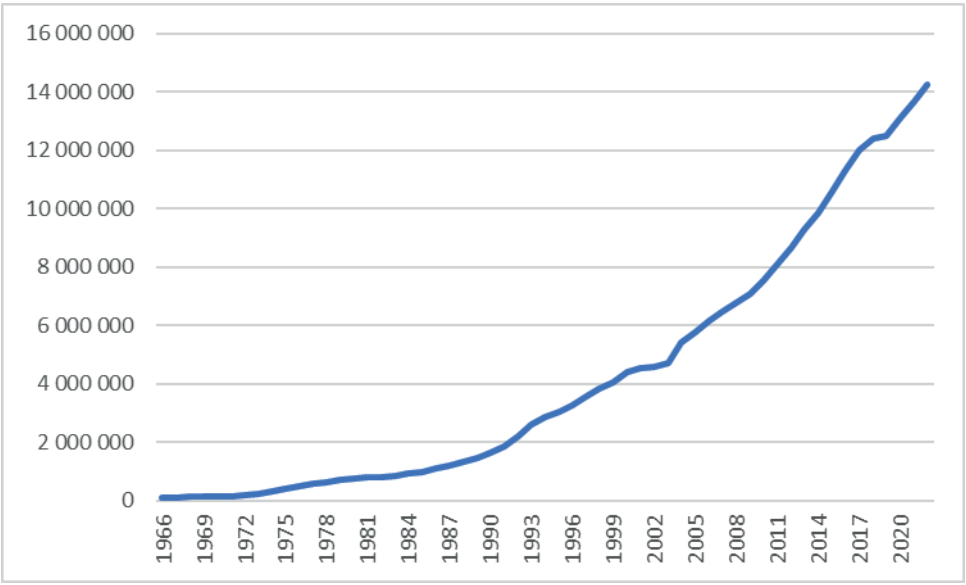


***Figure 3.*** Number of Cars

General production of motor vehicles is given in Figure 4. Since 1967, when motor vehicle statistics were started to be kept, significant increases were experienced in minibuses, buses, pickup trucks and trucks on the highways. According to 2022 figures, the number of minibuses registered on the highways is 487,381, the number of buses is 208.442, the number of pickup trucks is 4,277,424 and the number of trucks is 919,125 (1).

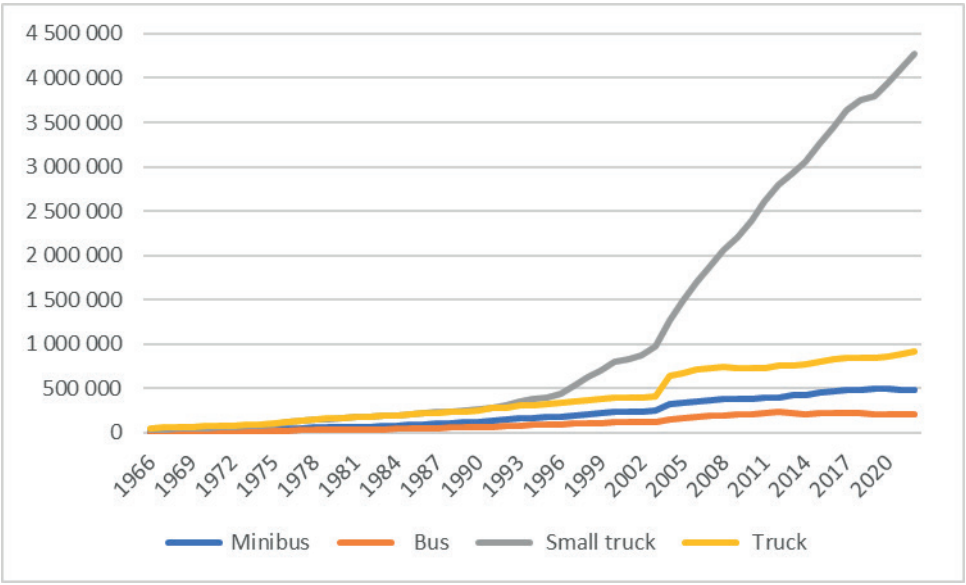


***Figure 4.*** Number of Vehicles

## 3. Railway Transportation

The history of Turkish Railways dates back to about two centuries. From the end of the 19th century, the first local lines began to be built on the lands of Europe, Anatolia and Africa within the borders of the Ottoman Empire. A directorate responsible for railways within the Ministry of Public Works has been authorized for the construction of railways. In the following years, the increase in the need for the railway and the specialization of the railway management caused the foreign and foreign partner companies to take part in the sector. Nationalization activities were carried out with the Republic and the railways became one of the main determinants of the national transport policy (2).

As in every country that uses the railway, the Ottoman Empire also turned to local and regional railway transportation at first. In particular, the railways that provide the transportation of the western Anatolian cities to the İzmir port made a great contribution to the commercialization of the crop. The same regional railway investments showed themselves in western Thrace and the Balkans. The transportation of the cities in the terrestrial inner region to the main commercial cities and the Aegean Sea has made important contributions to the development of the region that can reach the railway. The same transportation strategy has also been seen in the African continent. The line between Alexandria and Cairo was built during this period.

In the following periods, it is aimed to provide a national railway network by connecting regional lines with each other. In particular, the construction of the Berlin-Istanbul, Hejaz and

Baghdad railways is an important indicator of this policy. First of all, it was aimed to connect the local lines in the Balkans to a main line and then to connect the regional lines in Anatolia to the Hejaz and Baghdad railway line.

With the First World War, the construction of railways almost stopped. In the years following the establishment of the Republic, it was aimed to extend the line in Anatolian territory. Especially with the extension of the line to eastern and southeastern Anatolia, great efforts were made to connect the line between the Black Sea and the Mediterranean Sea. With the multi-party system that started in 1950, the country became affected by international industrial policies. Turkey was also affected by the developments in the automotive industry after the Second World War all over the world. Highway constructions started to increase in this period. As in the whole world, there were pauses in railway constructions in Turkey as well. In the 1970s, automobile production based on import substitution led to an increase in the rate of domestic inputs in the automotive sector, thus accelerating the construction of highways. With the 2000s, emphasis was placed on high-speed train transportation instead of traditional railway constructions. New lines have been started to be built in line with the operation of the high-speed train. While the construction of these new lines continues, the old conventional lines have been renewed. In the planning of the high-speed train line, importance was given to ensure that it is uninterrupted along Turkey's east-west latitude and north-south longitude.

The length of railways owned over the years is given in Figure 5. As of the end of 1977, the total railway length in Turkey was recorded as 8139 km. In 2009, this figure reached 9080 km. While the total railway length was 10087 km in 2014, the railway length at the end of 2021 was observed as 10546 km (3).

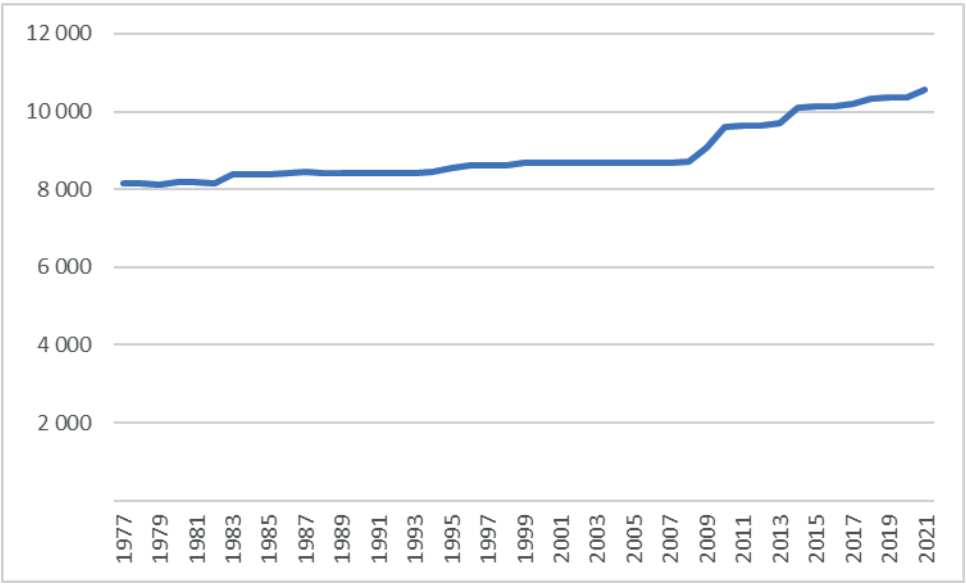


***Figure 5.*** Railway (km)

The number of passengers transported by railway in Turkey is given in Figure 6. The total number of passengers carried by railways in 1977 was 112607000. This figure reached 146359000 in 1989. In the following years, decreases were observed in this number. In 2002, the number of passengers transported by rail decreased to 73088000. While the number of passengers carried on the railways reached 121190000 in 2011, 246013000 people were transported on the railways in 2019, reaching the highest number of passengers in the country's history. In 2021, this figure decreased to 1916 million. The reason for this decline is the covid19 epidemic (2).

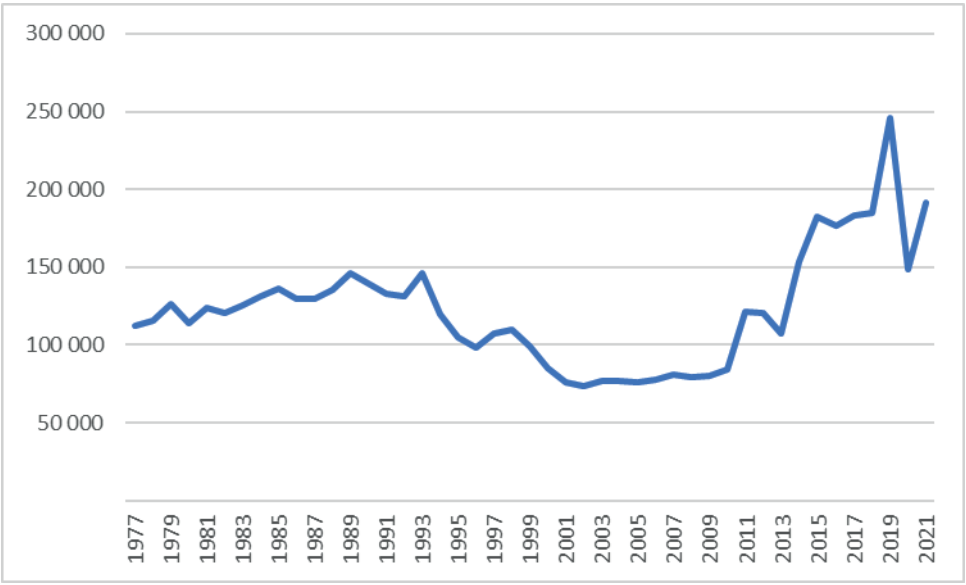


***Figure 6.*** Number of Passengers (thousand)

Freight values carried by railway in Turkey are given in Figure 7. The amount of freight transported by rail was 13,938,000 tons in 1977. Until 2004, the amount of freight transported on railways did not exceed 15,000,000 tons, except for 1999. The amount of cargo carried in 2004 reached 17,989,000 tons, 20,185,000 tons in 2006, 25,421,000 tons in 2011, 31,673.00 tons in 2018 and 38,157,000 tons in 2021 (3).

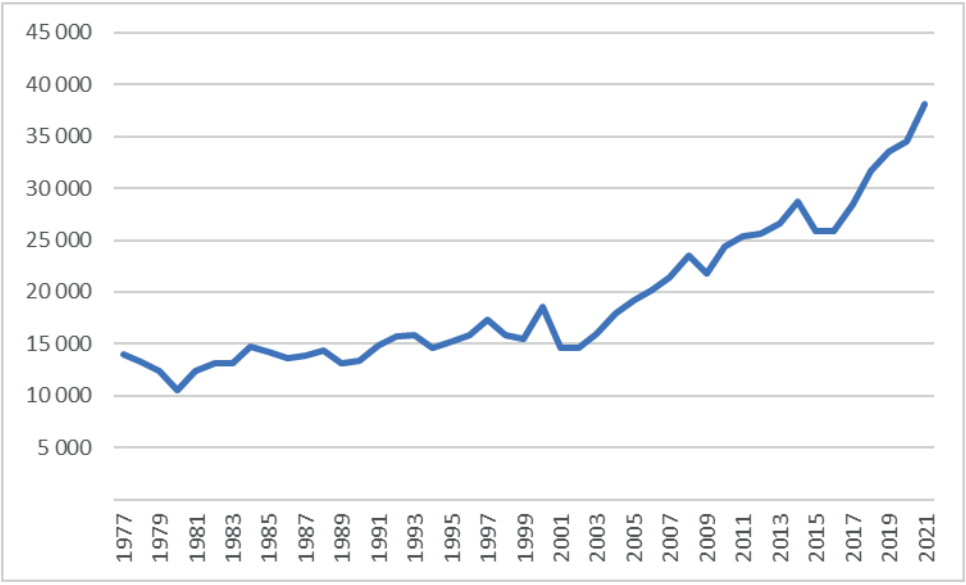


***Figure 7.*** Freight (thousand tons)

## 4. Air Transportation

It is generally accepted that the first Turkish aviation activities started in 1912. The adventure of Turkish air transportation, which started with a runway and two hangars in Yeşilköy, continues to grow with the world's leading fleet and infrastructure facilities. In 1933, the Turkish Air Mail institution was established with 5 aircraft in its inventory. In the following years, the Airline State Enterprise Administration was established under the Ministry of Defense. The main duty of this institution has been determined as carrying passengers and cargo as a civil air transport. After the Second World War, based on the new world order, changes were made in the field of transportation in Turkey. The General Directorate of Civil Aviation was established under the current name of the Ministry of Transport. All civil aviation passenger and freight transport operates under the legal supervision of this institution.

The number of passengers transported by air in Turkey is given in Figure 8. The total number of passengers carried in 1960 was recorded as 713,217. The total number of passengers carried by air reached 977,913 in 1965. The total number of passengers carried in 1969 was 2,037,467. This figure reached 3,301,143 in 1971, 4,179,900 in 1972, and 5,979,087 in 1976. In 1988, the total number of passengers carried by air increased to 10,840,179. This figure was 20,674,531 in 1993, 30,780,662 in 1996, 55,545,473 in 2005, 70,352,876 in 2007, 102,800,392 in 2010, 165,720,234 in 2014 and 208,373,696 in 2019. realized as. The years 2020 and 2021 have been recorded as periods of decline in terms of the number of passengers carried on airlines due to the covid19 epidemic (4).

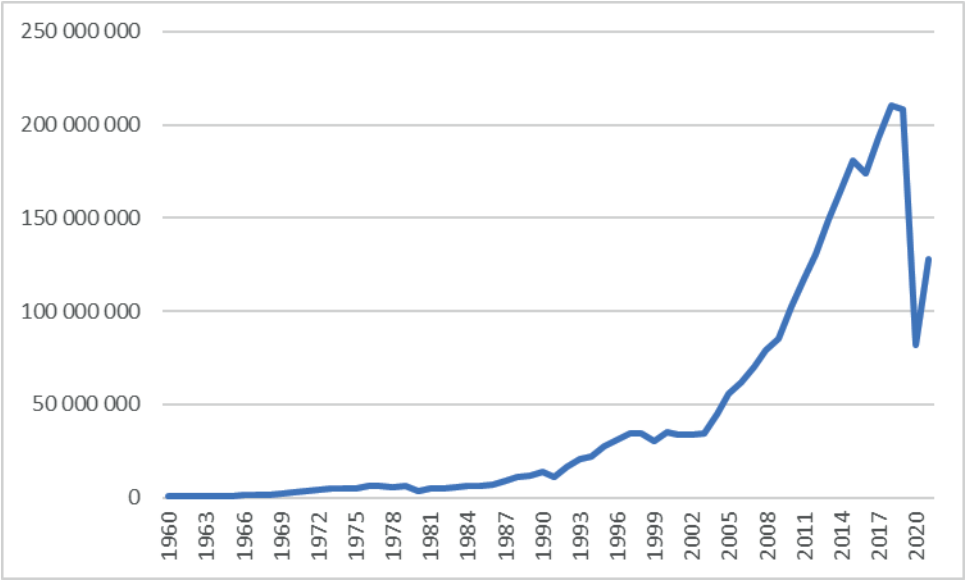


***Figure 8.*** Total Passenger

The distribution of the number of passengers carried by air in Turkey between domestic and international flights is given in Figure 9. When the number of domestic and international passengers carried on airlines is compared, it is seen that both figures were close to each other, around 3 million passengers until 1987. Since 1987, Turkish civil aviation has started to export services abroad with its integration into the globalizing world. While the number of passengers carried on domestic lines was 5,347,723 in 1990, the number of passengers carried on international lines was 8,282,242. In 1995, these numbers increased to 10,347,528 in domestic lines and 17,419,851 in international lines. As of 2021, the number of passengers carried abroad has been approximately twice the number of passengers carried domestically. Today, Turkish Civil Aviation provides transportation services between foreign cities to foreign citizens, especially via Istanbul (5).

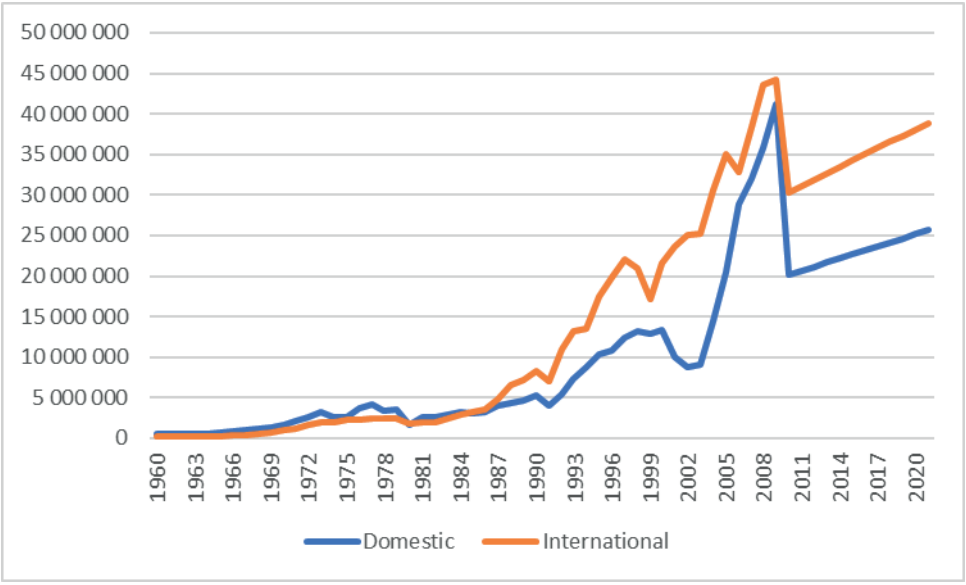


*Figure 9.* Passenger Distribution

The amount of cargo transported by air in Turkey is given in Figure 10. The total freight transported by airlines in 1960 was 13,002 tons. The total amount of cargo carried in 1976 increased to 103.447 tons. This figure was recorded as 226,813 tons in 1988, 301.403 tons in 1990, 576.920 tons in 1995 and 931,191 tons in 2003. While the total amount of cargo transported by air was 2.021.076 tons in 2010, this figure was 3.072.831 tons in 2015 and 4.090168 tons in 2019.

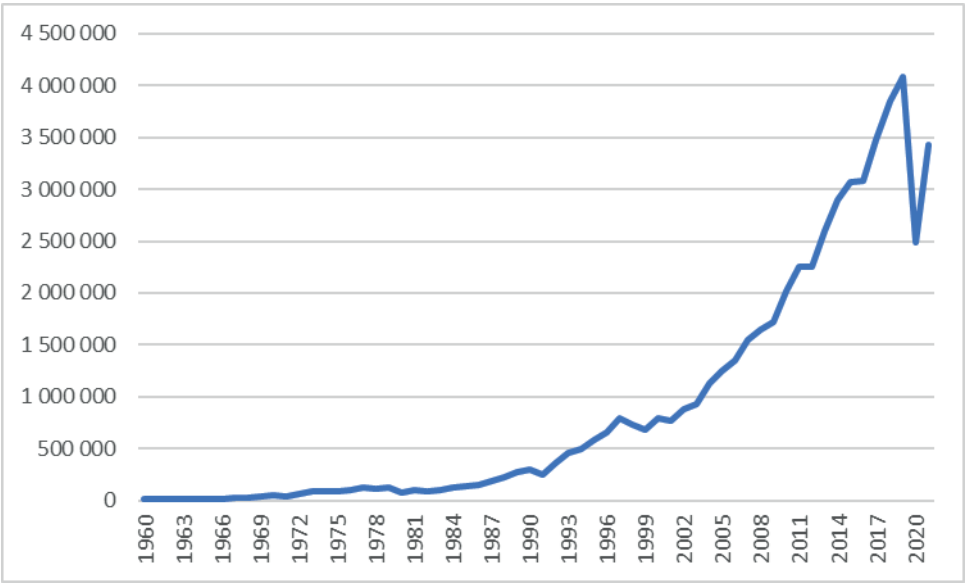


*Figure 10.* Total Freight (ton)

The distribution of the total amount of cargo transported by air in Turkey on domestic and international lines is given in Figure 11. Between 1960 and 1980, the amount of freight transported domestically and internationally by air was approximately equal. Since 1980, the tonnage in international freight transportation by air has exceeded the domestic freight amount and the difference has increased with each passing year. In 2000, domestic air freight transportation was 226,356 tons, while international freight transportation was 570,271 tons. In 2010, these figures were 554,710 tons for domestic and 1,466,366 tons for abroad. In 2019, the amount of domestic cargo transportation by air was 833,769 tons, while the amount of international cargo transportation was recorded as 2,969,206 tons (5).

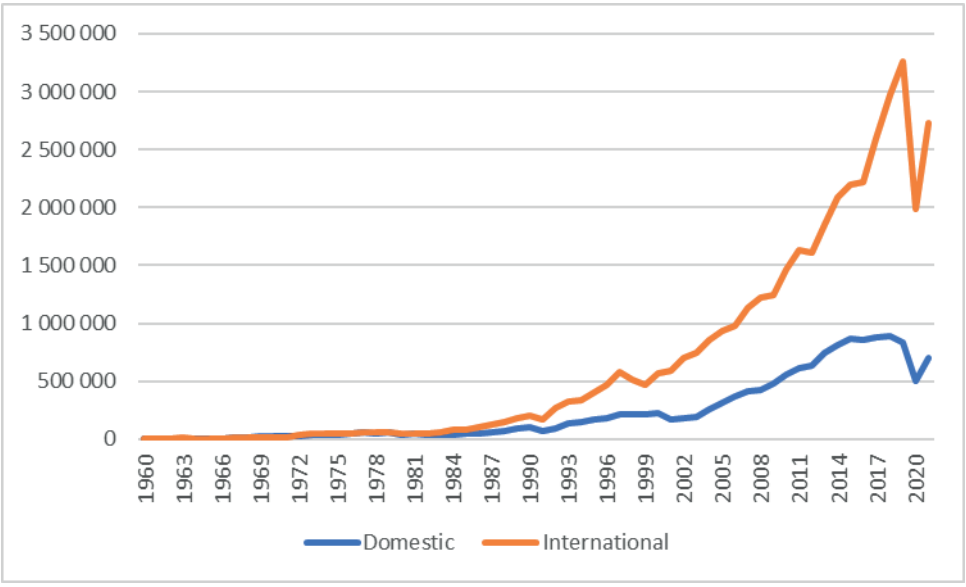


*Figure 11.* Freight Distribution (ton)

The total number of aircraft is given in Figure 12. The number of aircraft registered in air transport was 138 in 2002. This figure increased to 202 in 2005, 332 in 2010, 422 in 2014, and 564 in 2019.

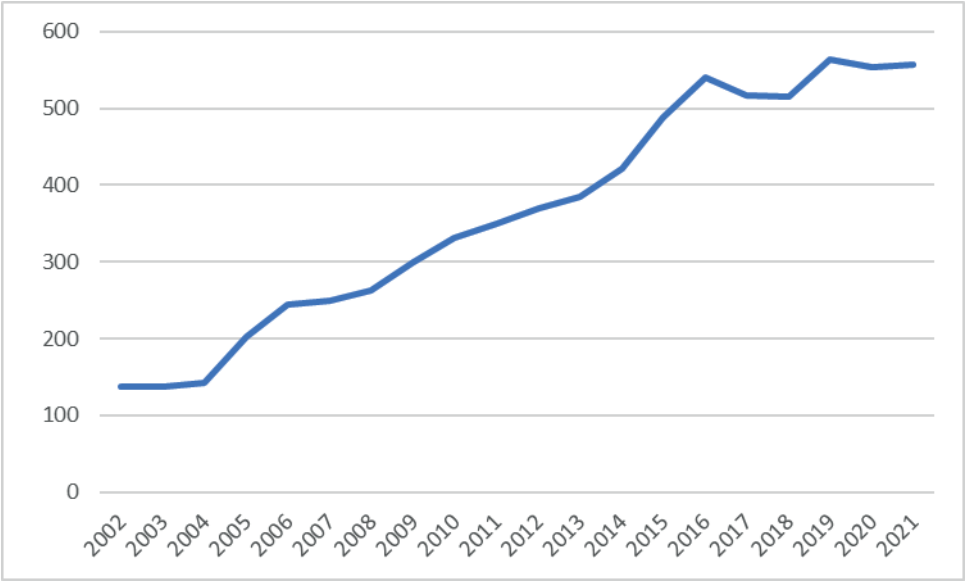


***Figure 12.*** Number of Aircraft

Total airline seat capacity is given in Figure 13. Over the years, there has been a significant increase in seat capacity in air transport. The seat capacity in Turkish civil air transportation realized in 2002 is 25,114. This figure increased to 57,899 in 2010 and to 100,365 in 2016. As of 2020, air transport seat capacity was recorded as 104,464 (4).

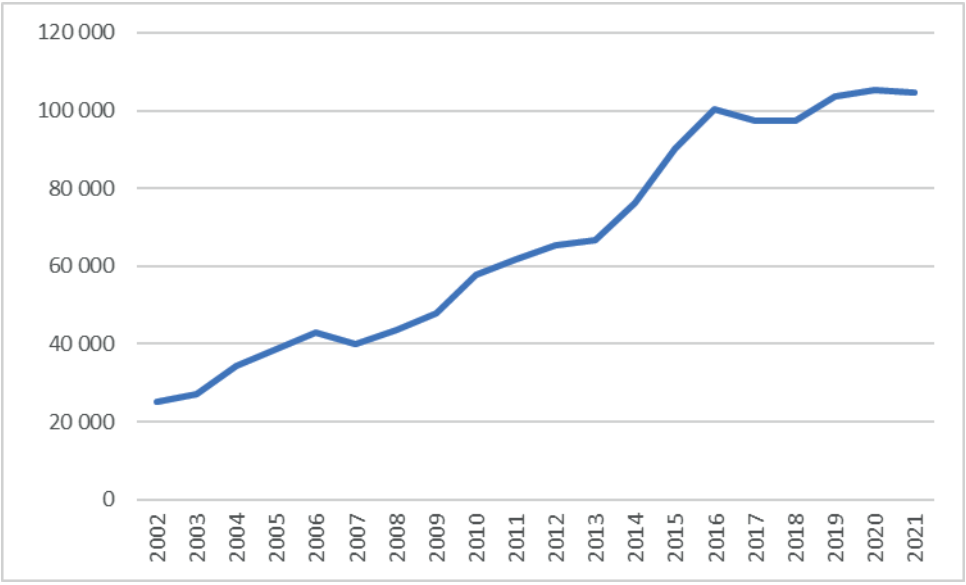


***Figure 13.*** Seat Capacity

## 5. Maritime Transport

The fact that our country is surrounded by seas on three sides provides a great advantage in terms of maritime trade. However, leaving the cabotage right in our seas to foreign states has caused the decline of Turkish maritime. Western countries that have experienced the industrial revolution have monopolized the maritime trade in our country with the technical advantages they have provided and the privileges they have provided in our seas. With the abolition of the privileges given to foreigners with the Republic and the cabotage law accepted, Turkish maritime started to develop. With the development of maritime came specialization. It was aimed to manage all maritime activities from a single point by establishing the General Directorate of State Port Operations and the General Directorate of State Maritime Lines. In the following years, these two different institutions were transformed into a single institution as the General Directorate of State Maritime and Port Operations. Later, Maritime Bank was established. In the process following the Second World War, globalization affected all world economies. Turkey has been affected by this development. As in the rest of the world, privatization has also shown itself in Turkish Maritime. Ports have entered the privatization process. Today,

most of our commercial ports are managed by private entrepreneurs (6).

Total airline seat capacity is given in Figure 14. The number of Turkish merchant ships of 150 gross tonnage and above has doubled in the last 20 years. The Turkish fleet, which was 1,242 in 1999, reached 2,102 by the end of 2022 (7).

Turkish-owned ships either prefer to fly the Turkish flag or they carry a foreign flag. While the number of foreign flagged and Turkish owned ships was 0 in 1999, this figure was recorded as 1,001 in 2022. In the last twenty years, the number of Turkish flagged ships has shown a horizontal course and has not been subject to a significant increase. In 2022, the number of Turkish flagged commercial ships was observed as 1,001 (7).

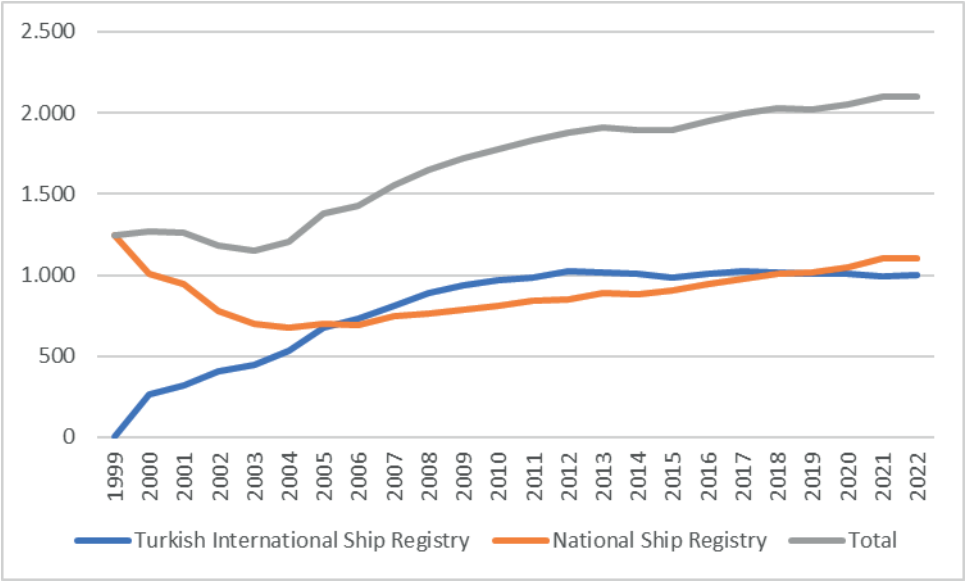


***Figure 14.*** Turkish Merchant Fleet (Vessels of 150 GT and over)

The structural situation of the total Turkish merchant marine fleet is given in Figure 15 and Figure 16. The total deadweight (DWT) capacity of the Turkish merchant marine fleet has decreased over the last two decades. Dedveyt is accepted as the empty weight of the ship. From the chart below, it is observed that despite the decrease in the deadweight capacity of Turkish flagged vessels over the years, there has been an increase in the deadweight capacity of Turkish-owned but foreign-flagged vessels (7).

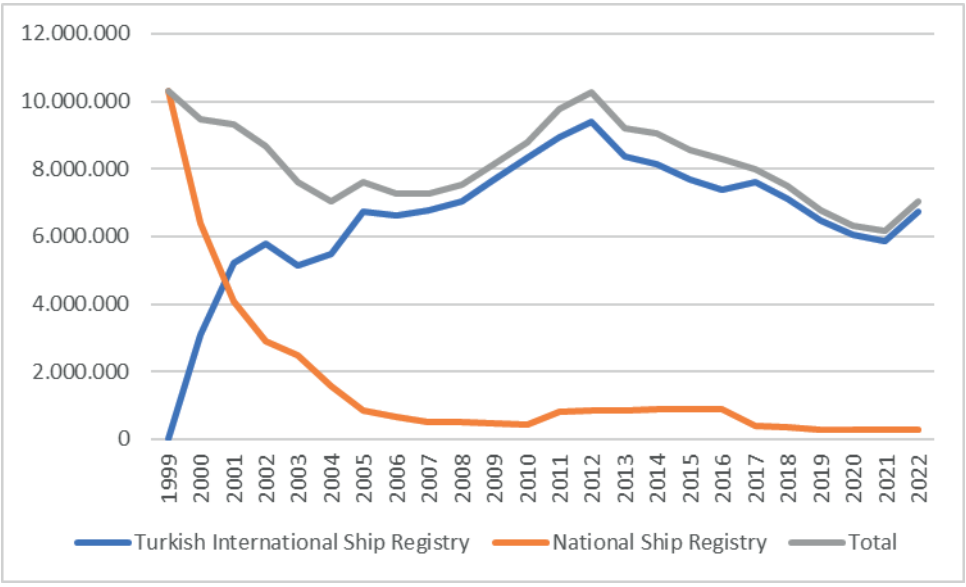


***Figure 15.*** DWT Development of the Turkish Merchant Fleet (Vessels of 150 GT and over)

Total gross ton (GT), the Turkish merchant marine fleet has shown a horizontal course in the last two decades. Gross is an indicator of capacity in which a ship is included in the total volume that it can carry along with its own weight. Gross capacity also showed an increase in Turkish owned but foreign flagged ships, just as in the deadweight indicator.

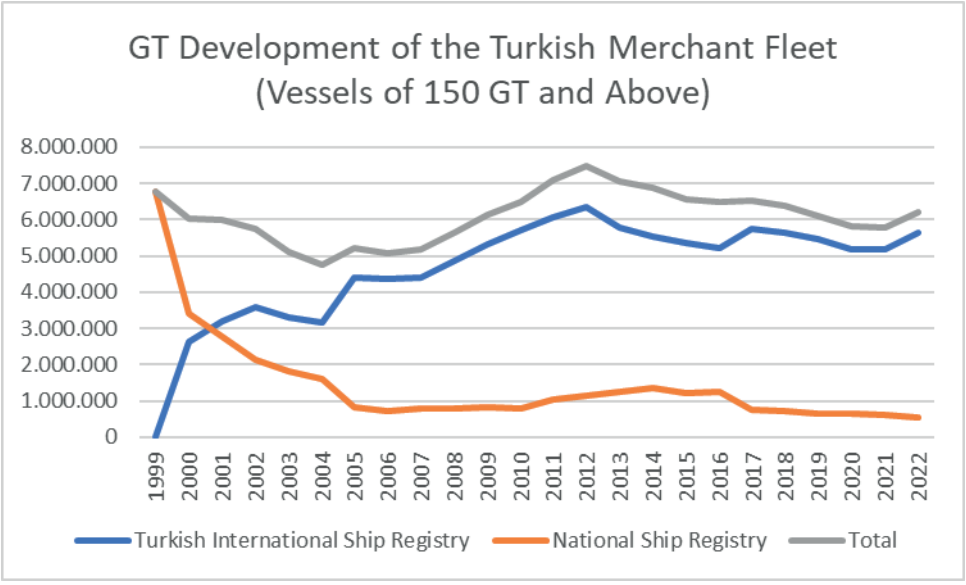


***Figure 16.*** GT Development of the Turkish Merchant Fleet (Vessels of 150 GT and over)

The average age of the Turkish merchant marine fleet is calculated as 22, as shown in Figure 17.

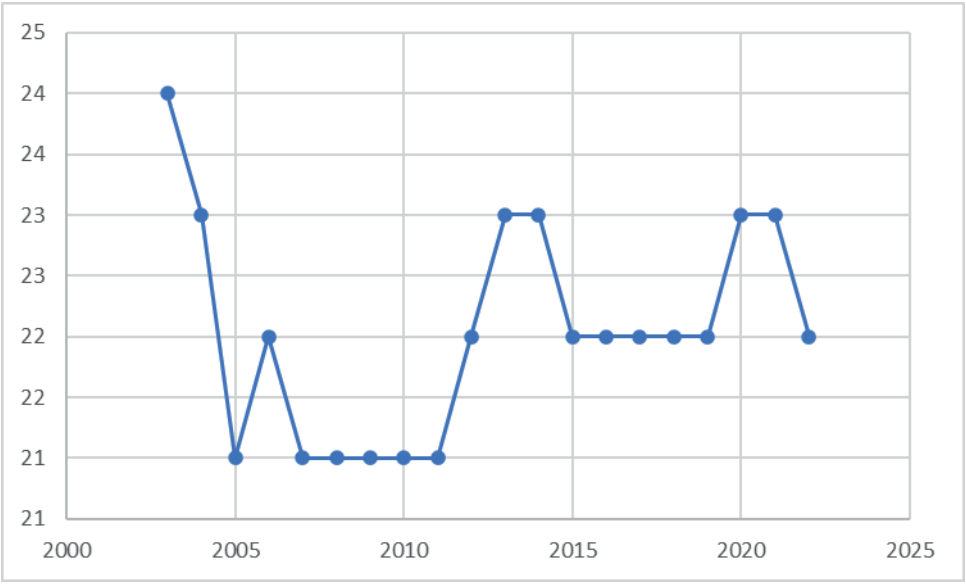


***Figure 17.*** Average Age of Turkish Fleet

## 6. Economic Growth

Türkiye preferred the import substitution growth system in the 1970s. In this period, imports were made almost impossible by high tariffs, and it was adopted that similar products to be imported should be produced domestically. This period is generally accepted as the time period when the first private entrepreneurship developed. This development showed itself in the form of increases in production. In 1973, per capita income was 674 dollars, and in 1979 this figure increased to 2,068 dollars. Per capita income figures over the years are given in Figure 18.

By the 1980s, the foreign exchange problem experienced in the economy increased excessively. On January 24, 1980, new economic decisions were taken. One of these decisions was the abandonment of import substitution industrial policies and the adoption of export-based industrial policies instead. With this new preference, Turkey has adopted to produce not as much as it needs, but also to sell abroad. During this period, production increased very rapidly. Income rose rapidly. While the per capita income was 1,561 dollars in 1980, this figure increased to 2773 dollars in 1990.

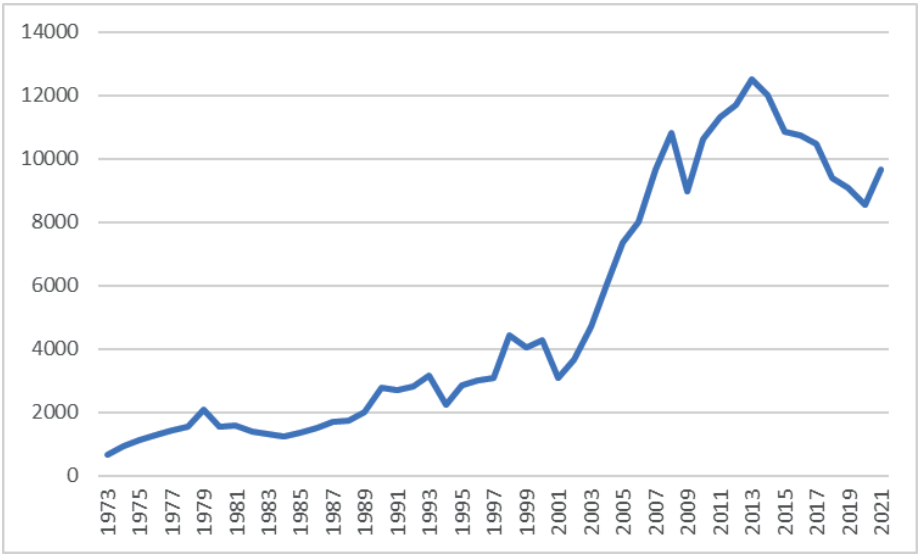


***Figure 18.*** GDP per Capita (Nominal USD)

The 1990s were the years when Turkey developed its relations with the European Union. Along with being a very important export market for Turkey, Europe has also become an important input supply area. In 1996, Türkiye signed a Customs Union agreement with the European Union. The effect of this agreement was observed in the following years. While per capita income was recorded as 2711 dollars in 1991, this figure was observed as 4278 dollars in 2000.

The economic crises experienced at the end of the 1990s necessitated restructuring in the economy. Especially since the beginning of the 2000s, structural arrangements have been made on the issues that the economy needs. New legal and practical changes that increase competition for the country's economy to enter the international markets unhindered have made themselves felt immediately in the production of the country. While per capita income was 3,100 Dollars in 2001, it was 10,615 Dollars in 2010 and 12,507 Dollars in 2014. The economic crisis in the following years caused per capita income to fall and the figure for 2021 was 9,661 dollars.

## 8. Turkish Transport System and Economic Development

In this section, the development of production and income in the Turkish Economy and the development of the transportation sector are discussed in a comparative perspective.

The Turkish economy has grown especially since 1970. This growth showed a continuous positive development, except for some crisis periods. It has been observed that most of the

economic crises experienced originate from within the country itself. It is understood that some crises, which are very few, are of global origin.

Road transportation is the most important transportation sector, which is associated with the positive development in the economy. The rapid increase in highway construction and the dizzying development in the number of motor vehicles traveling on highways are proof that road transportation moves together with economic growth. It is known that road transport is a very important tool in supplying the necessary inputs for production and delivering the production to the markets. For this reason, it is observed that production and road transportation move together.

The sector, which fluctuates with the national economic development, is observed as the airline sector. With the increase in income, the airline sector is important in the transportation of important and expensive inputs, first in passenger transportation and then in production. As a result of the specialization in production, the delivery of expensive products with high added value to the markets is also realized through the airline sector. The fact that air transportation vehicles are too expensive makes it difficult to invest in this sector. The supply of finance is a very important issue for this sector. In order for airline investments to pay for itself as quickly as possible, the added value of the products transported must be very high. For this reason, the fluctuation of air transportation with economic development is lower than snow transportation.

Railway transportation was adopted as a national policy with the establishment of the republic. Since the foundation of the Republic, heavy machinery, which is in need of industrial investments, has been transported with the help of railway transportation, and the products produced have been transported to the markets via railway. However, the globalization process that took place after the Second World War made itself felt more heavily in the automotive sector, and it lagged behind the railway and road transportation all over the world. There have been developments in railway transportation in our country, but this development has not occurred at the same rate as the increase in national income. The main reason for this is that the road transportation from one point to the other takes place in a deserted way at night. However, in railway transportation, additional transportations are required for the products to be delivered to the railway and then to the last point by the railway. For this reason, the relationship between the development of railways and economic development in Turkey lags behind the relationship of highways and airways with the economy.

Turkish maritime history dates back to the arrival of the Turks in Anatolia, but unfortunately, commercial maritime has lagged behind in Turkey. For many years, foreigners have

made seafaring in our territorial waters due to capitulations. With the republic, the capitulations were abolished and the place of the Turks in the seas was defined. Legal arrangements were made for the development of maritime and new institutions were established. However, maritime did not develop as desired. When the economic development of Turkey is examined, unfortunately, the development experienced in the economy and the change in maritime do not coincide with each other. Investment in the maritime sector remains low, and Turkish sailors prefer to own foreign flagged vessels. Turkish products are constantly transported by foreign ships, and the inputs Turkey needs are supplied by foreign ships. When the economic development and transportation sectors are examined mutually, it is understood that the transportation sector with the weakest relationship with economic development is the Turkish maritime sector (6).

## 9. Conclusion

It is observed that road, rail and air transportation channels in the Turkish national transportation network are in a positive relationship with Economic growth. However, it is observed that there is no significant development in the historical development of sea transportation. For this reason, it is not possible to determine a same directional relationship between Turkish maritime transportation and economic growth. The positive effects of future developments in potential sea lanes on possible future economic growth can be investigated by investigating why Turkish maritime has not developed in new studies following this study.

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# CHAPTER 7

# INTERNET OF THINGS (IOT) APPLICATIONS IN LOGISTICS AND SUPPLY CHAIN MANAGEMENT

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**ABSTRACT**

Wireless connectivity has revolutionized all industries today by adopting the Internet of Things (IoT) technology stack. IoT enables any physical entity to be connected to the Internet and perform intelligent actions based on its environment. IoT-equipped sensors qualify logistics with real-time asset tracking, condition monitoring, data visualization, safety and security, fleet management, and other logistics and supply chain forecasting applications.

First, this study will provide general information about the Internet of Things architecture structure, data transmission infrastructure, and protocols. Then, the latest technological applications in logistics and supply chain management, such as artificial intelligence, blockchain, and big data digital twins, which are a part of the Internet of Things, will be discussed. The last section of this study will guide logistics and supply chain management with IoT by discussing the gaps in future projections and work areas for academia and industry.

**Keywords:** IoT, Supply Chain, Smart Logistic

## 1. Introduction

The widespread use of the Internet, the decrease in hardware costs, and the developments in the field of artificial intelligence have allowed the development of the Internet and the emergence of the concepts of the Internet of Things. In particular, the easier accessibility of wireless communication technologies and the decrease in unit costs have started a new digitalization process in many industries. This study will discuss general information about the essential components of the Internet of Things and its applications in logistics and supply chain management.

We can define the Internet of Things (IoT) as structures where objects are connected to the Internet with wireless communication technology and contain smart sensors. The approach in IoT allows sensors and smart devices to perform necessary tasks without any human interaction. Apart from connecting objects to the Internet and sending data, it is also aimed that these objects can be accessed and controlled over the Internet. Therefore, it can define the Internet of Things as an extensive global network that can perform specific tasks by communicating with each other and over the Internet of objects (1).

We can interact with the virtual world using physical objects thanks to the IoT. These devices can intelligently process the data they perceive or create, thanks to the sensors they contain or the customized functions. In this way, it enables us to exchange data over the Internet and develop smart applications. However, sensors that connect the physical world and the virtual environment have limited resources due to their nature. An IoT sensor has a limited processor, memory, hard disk, and battery, and it is impossible to perform all the work on the device. Instead, the collected data is transferred to the cloud environment, sometimes directly, sometimes with limited processing. In this way, tasks that bring more resources and computational capabilities (such as artificial intelligence applications) run on systems that can scale dynamically in cloud environments (2).

Thanks to the potential of the Internet of things, it is actively used in social, economic, health, education, military, logistics, engineering, intelligent power grids, home and entertainment systems, agriculture, etc., and is becoming widespread day by day (3). The widespread use of technology in various fields has led to digital transformation. Now, devices and sensors can generate data besides humans. The rapid growth of data has led to the transition of each industry to a data-driven business model, eventually leading to the emergence of application areas such as artificial intelligence, big data, etc. Sensors can record images, sound, or any signal, and these data can be analyzed with different methods to generate business value. The

inadequacy of classical techniques in data processing has led to the rapid development of artificial intelligence and data analytics. Industries that enable quick adaptation to artificial intelligence applications, such as customer segmentation, profitability planning, investment planning, and future forecasting, monetized the sector.

In the Internet of Things ecosystem, data is essential. There are different approaches to managing data, from centralized to decentralized management. Decentralized management involves multiple authorities reaching a consensus and is vital advancement in academia and industry. The blockchain is the most promising approach for decentralized approaches with the help of cryptographic tools to manage data securely and transparently. The technology has become popular with cryptocurrencies. However, its applications are not limited and can be used to track goods and services in logistics and supply chain use cases.

The rapid and real-time data transmission and developments in artificial intelligence have begun to change simulation approaches. These changes have started to be replaced by digital twins realized with real-time digital copy instead of simulations performed with abstraction methods. It is possible to perform real-time analysis and investigate what-if simulation scenarios through digital twins in logistics and supply chain applications.

The primary objective of this chapter is to introduce how next-generation information technologies contribute to logistics and supply chain management from a technology perspective. These technologies are the IoT and the relationships of the IoT with artificial intelligence, data analytics, blockchain, and digital twins from the logistics supply chain management standpoint.

In this chapter, the Second Section discusses the Internet of Things, data transmission, and application protocols. The Third Section demonstrates the IoT-based artificial intelligence, big data analytics, blockchain, and digital twin in logistics and supply chain management introduced. The final Section concludes the chapter.

## 2. Internet of Things (IoT)

Many building blocks comprise the Internet of Things, and it is impossible to discuss a single generally accepted architecture. Considering the applications, devices, and the Internet that make up the Internet of things, it is understood that it should have a multi-layered architecture. While three- and five-tier approaches stand out, architectures are not limited to this. The layers of the three and five approaches in Figure 1 are visible. If we inspect the three-layer structure:

i. The perception layer: where data from different sensors are collected, and the physical environment is interacted with in this layer.

ii. Network layer: the transmission of sensor data is also the data transmission layer, which includes one- or two-way designs.

iii. The application layer is the product-oriented layer, and services are carried out through this layer.

The difference between the five-layer structure is that the transport layer refers to the layer that transmits the data, and the processing layer refers to the layer where the analysis is carried out, and the data is processed. The business layer is the layer of the business where the entire IoT ecosystem is run (2). We can discuss the building blocks of the IOT.

## 2.1. Data Communications in IoT

One of the Internet of Things' essential components is physical sensors' data communication. The highlight here is the mobility of devices thanks to wireless communication and the ability to communicate independently of the location. For this, first of all, the necessary infrastructure and the sensors must be capable of transmitting data from this layer. Many technologies serve this infrastructure today. At the beginning of these, LoRaWAN, LoRa, RFID, LTE, Z-Wave, NFC, UWB, M2M, 6LoWPAN, 5G, Nb-IoT, SigFox, IEEE 802.11, Bluetooth protocols are coming.

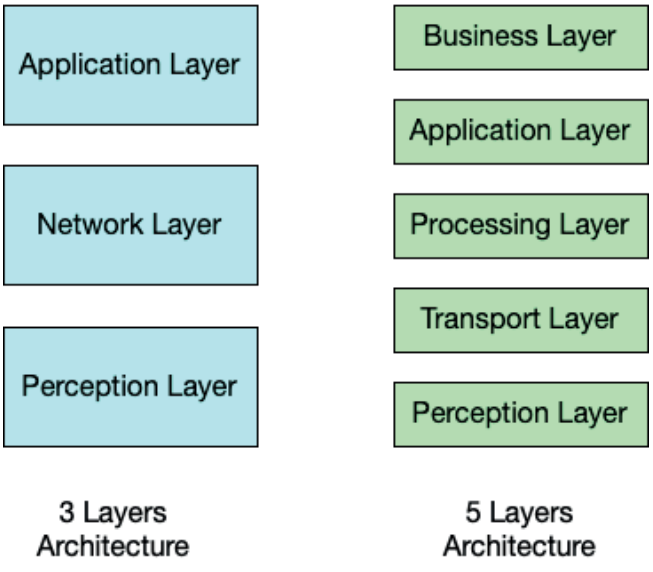



***Figure 1.*** IoT Architecture Approaches (2)

| **Table 1:** IoT Data Communications Technology Comparison | | | | | | |
|---|---|---|---|---|---|---|
| | **Sigfox** | **NB-IoT** | **LoRaWAN** | **WiFi** | **ZigBee** | **Bluetooth** |
| **Standards** | Sigfox | 3GPP | LoRa Alliance | IEEE 802.11 | IEEE 802.15.4 | Bluetooth SIG |
| **Modulation** | BPSK | QPSK | CSS | DSSS, OFDM | DSSS, QPSK | GFSK |
| **Frequencies** | ISM: 433 MHz, 868 MHz, 915 MHz | Licensed under LTE | ISM: 433 MHz, 868 MHz, 915 MHz | ISM: 2.4 GHz, 5 GHz | ISM: 868 MHz, 2.4 GHz | 2.4 GHz |
| **Coverage** | 10–40 km | 2–20 km | 1–10 km | 10–100 m | 10–100 m | 10–100 m |
| **Bandwidth** | 100 Hz | 200 kHz | 125 kHz, 250 kHz | 20 MHz, 40 MHz, 80 MHz, 160 MHz | 2 MHz | 1 MHz |
| **TX Limit** | 140 Packets per Day | Unlimited | Duty Cycle Lim. | Unlimited | Unlimited | Unlimited |
| **Max Data Rate** | 100 bps | 200 kbps | 50 kbps | Gbps | 250 kbs at 2.4 GHz | 2 Mbps |
| **Private Deployments** | No | No | Yes | Yes | Yes | Yes |
| **Energy Consumption** | Low | Low | Low | High | Low | Low |
| **Security** | Low | High | High | Low-High | High | Low-High |

Each technology has its communication structure, and there are differences according to the usage area. The prominent comparison of LoRaWAN, Sigofx, NB-IoT, WiFi, Zigbee, and Bluetooth is given in Table 1 (4). When compared, LoRaWAN works on an unlicensed spectrum; it can be deployed as public or private and enables long-distance data transmission with a builtin security model.

Although we do not have the opportunity to examine all communication technologies, we will evaluate the open protocol LoRaWAN, which is on its way to becoming a de facto standard today. In addition, we will mention that LoRaWAN comes to the fore in supply chain applications, among other communication networks.

LoRa stands for Long Range, a Radio Frequency (RF) modulation corresponding to the OSI reference model's physical layer. Whereas LoRaWAN is a MAC layer standard that coordinates the medium. In this section, we will discuss the technical aspects of both LoRa and LoRaWAN in detail. LoRaWAN is a MAC layer protocol that aims to solve medium and network congestion management issues. Any node using the LoRaWAN protocol can benefit from the following features provided by the standard; management of the medium, power consumption, adaptive data rates, and security(4).

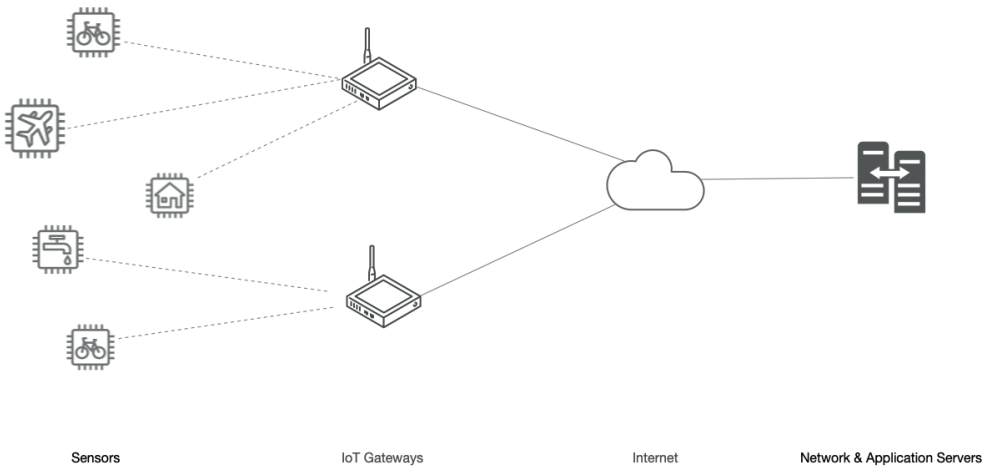



***Figure 2.*** LoRaWAN Architecture (4)

A general architecture of LoRaWAN is given in Figure 2. The sensors can provide data communication up to 2 km in the dense urban and up to 15 km in rural areas with LoRa modulation. The data sent from the sensors is captured by the LoRaWAN base stations and routed to the network server. The network server manages the LoRaWAN network and forwards incoming messages to the corresponding application server. LoRaWAN is Low Power Wide Area Network (LPWAN) providing long-distance data transmission with low power consumption. This feature makes LoRaWAN an effective candidate for logistics and supply chain applications.

## 2.2. Application Protocols in IoT

Layer 7 of the OSI reference model is the application layer. For example, protocols that enable data exchange between computers on the Internet or in a local network are application layer protocols in the seventh layer.

Today, we use these applications, which have developed many application layers, daily. In the Internet of Things paradigm, the primary element is to provide an internet connection for devices with limited capacity and to provide applications and services with the data obtained from these devices. Therefore, many protocols have been developed in the application layer specialized for IoT.

One of these application protocols is the Constrained Application Protocol (CoAP). Designed with energy efficiency in mind, CoAP works over the UDP protocol. UDP offers a faster connection, so no session management is found in TCP. In addition, CoAP provides security using Datagram Transport Layer Security (DTLS) (5).

Another important IoT application protocol is Message Queue Telemetry Transporter (MQTT). The protocol works on the subscription principle. Parties subscribed to a particular topic are notified when a message is received on that topic. It is an effective method to transmit data, especially to devices with limited hardware resources. Since data transmission is in the form of broadcasts, bandwidth is used effectively (5).

An Extensible Markup Language (XML) complete protocol used in instant messaging applications is Extensible Messaging and Presence Protocol (XMPP). Advanced Message Queuing Protocol (AMPQ) is a messaging protocol that works with subscription logic similar to XMPP. The working principles of AMPQ are similar to MQTT (5).

## 3. Applications in Logistics and Supplychain

The age of smart production started after the fourth industrial revolution, and the essential tool of this age has been the Internet of things. It is the Industrial Internet of Things (IIoT), which is specialized for industry and on which Edustri 4.0 is emphasized. The fact that information technologies and production robots have become smart has become a part of the fact that the data obtained with IIoT, thanks to artificial intelligence, is carried out with lower production costs and personalized intelligent elements. With the expansion of IIoT, smart applications have started to take place in many sectors. Smart cities, smart transportation, smart health, smart living spaces, smart vehicles (Internet of Vehicles - IoV), autonomous vehicles, and big data applications are some of the prominent ones (6).

The Supply Chain encompasses all of the assets and processes that encompass orders, supplier to customer. SC process includes the right item to be delivered at the right price and the right volumes on time. This process can be very complex. However, we can overcome addressed issues using information technology and smart techniques. In this case, IIoT is the critical technology. Each product or service order can be tracked from supplier to customer with smart devices in real-time. In traditional supply chain processes, we need help delivering products on time or keeping excess stock. Using IIoT makes it possible to run supply chain processes more intelligent, connected, autonomously, integrated, and innovatively (7).

Making supply chain processes smart is possible with infrastructures to be designed in different areas. The first step is to make things smart. In this step, it will be ensured that all kinds of objects moving from one point to another in the procurement processes can be tracked. Different technologies can be used to make objects smarter. The first step is to make things smart to enable sensing, which corresponds to the perception layer. In this step, it will be ensured that all kinds of objects moving from one point to another in the procurement

processes can be tracked. Different technologies can be used to make objects smarter. The first of these is to associate the object with being tracked with sensors that provide long-range communication, such as RFID, Bluetooth, QR Codes, or LoRaWAN.

It will be shaped in itself in other processes according to the connection structure of the communication integrated attached to the objects. For example, in a warehouse where RFID is used, it is possible to read every object entering and leaving the warehouse with RFID readers and to follow the necessary movements. This approach will not only be the tracking of objects, but it will also be a part of the infrastructure that can trigger processes such as automatic stock counting and the ordering of new products under a certain stock or the supply of materials needed on the production line.

Equipping objects with smart sensors will improve tracking processes and learn and monitor the status of products with special needs, such as cold chains or healthcare applications. For example, these sensors can monitor the factors such as temperature, pressure, and leakage of the object they are in, generate a warning against possible danger, or inform the changes in the physical nature of the product. We can give a few examples of life-threatening gas leaks, monitoring the validity period of drugs, and physical changes such as cracks or fractures. This ability transforms physical entities into perceptible objects.

Intelligent sensors are generally limited in battery life, processor capacity, and memory resources. Therefore, the operations that can be performed on devices with limited resources are limited, and it is aimed to obtain maximum efficiency with the least possible operation. These sensors are not general purposes; they are just specialized tools for a specific target. So, algorithms running on the sensors are expected to be efficient regarding time and space complexity.

Today, energy-efficient operations can be performed on sensors with limited resources. Therefore, tools and methods that prioritize energy efficiency have been developed while designing algorithms and embedded software on sensors. The LoRaWAN protocol we mentioned in the previous section is one of them. It has methods and structures developed for wireless data transmission to provide energy efficiency in A, B, and C classes. The LoRaWAN protocol we mentioned in the previous section is one of them. It has methods and structures developed for wireless data transmission to provide energy efficiency in A, B, and C classes. In addition, machine learning, a sub-branch of artificial intelligence, can be customized and work on the sensor. Tensorflow Light, which is a machine learning platform Tensorflow's customized version, is applied in embedded systems is one of them (8).

## 3.1. Artificial Intelligence

Artificial intelligence is widely used in supply chain and logistics management as well as in every area of our lives. When we look at the historical development process of artificial intelligence, we see that it goes back to the 1950s. There has always been an open question of whether machines can think like humans. From this point of view, we can define AI as systems or machines that mimic human thinking and behavior (9).

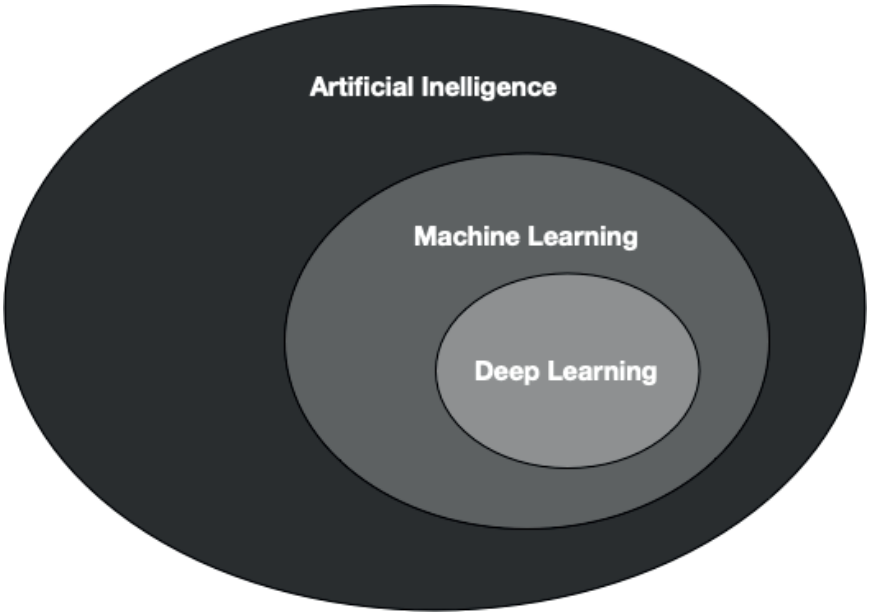



***Figure 3.*** Artifical Intelligence, Machine Learning and Deep Learning

Artificial Intelligence is a significant discipline; some sub-concepts and topics make it up. Machine Learning and Deep Learning are at the forefront of topics widely used in today's applications. Figure 3 shows the relationship between Artificial Intelligence, Machine Learning, and Deep Learning. Deep Learning is a sub-field of Machine Learning, while Machine Learning is a sub-field of Artificial Intelligence. Machine Learning algorithms are basically grouped under two main headings supervised and unsupervised learning. While supervised learning consists of labeled datasets, unsupervised learning does not have labels.

Artificial intelligence is used in most IoT-based supply chain and logistics management aspects, from sensors to enterprise resource planning (ERP) applications on the cloud. Using TensorFlow Lite on microcontrollers with limited resources makes it possible to develop smart applications with the information obtained from the sensors. For example, an IoT module with an acceleration sensor can infer whether the object is moving or not, and if it is in

motion, it can detect which axis it is moving. While performing these operations, the available resources will be sufficient without using any cloud or server connection. Another application example, it is possible to detect at what speed objects are moving. Navigation systems can be designed for indoor warehouses. Thanks to sensors customized for Supply Chain and Logistics, objects that need to be kept under specific temperatures and pressure can be monitored by data reading and machine learning analysis of these sensors.

Thanks to the machine learning technique used in devices with limited capacity, it is possible to design energy-efficient devices without continuous data transfer to cloud servers. This approach will minimize costs by extending the life of battery-powered mobile sensors.

Expanding Machine Learning and Artificial Intelligence applications with satellite-assisted systems is possible. For this, the satellite-oriented internet of things is technologically emerging. It offers the opportunity to monitor objects worldwide with its satellite-based communication tools. Furthermore, with Artificial Intelligence, it is possible to make high-cost satellite communication more efficient by optimizing data transmission periods (10).

The variety and level of data production have increased with the Internet of Things sensors. Administrative tools can be developed by analyzing this data with Machine Learning. This way, predictions about the future can be made based on ML algorithms. For example, a business can operate without stock, and the rate of change of stocks and the products that will be needed in the future can be ordered by estimating. In this way, stock holding costs will be minimized. These analyzes are usually gathered under data analytics or big data analytics.

## 3.2. Big Data Analyics

In the past, the source of the data was humans. Today, not only humans but also machines produce data. The produced data can be structured or unstructured from database tables, the working sound of a machine, a picture of an object, or a video stream of a security camera. The change in the size, shape, and speed of data has caused data analysis with classical methods to be insufficient and has led to the development of big data analytics. Big Data Analytics are methods in which data are analyzed with machine learning methods apart from classical methods. In order to consider data analysis to be big data, the data must have volume, velocity, value, veracity, and a variety of properties known as 5V (11).

With big data analytics, how data is held and processed has also changed direction. Now, there is software such as Apache Hadoop and Apache Spark, where distributed structures replace central data centers.

Today, in supply chain applications, data is produced from many sources, such as sensors,

people, trade sites, and logistics. Issues such as analysis and future forecasting in supply chain management, which are quite complex in nature, can be resolved with big data analytics.

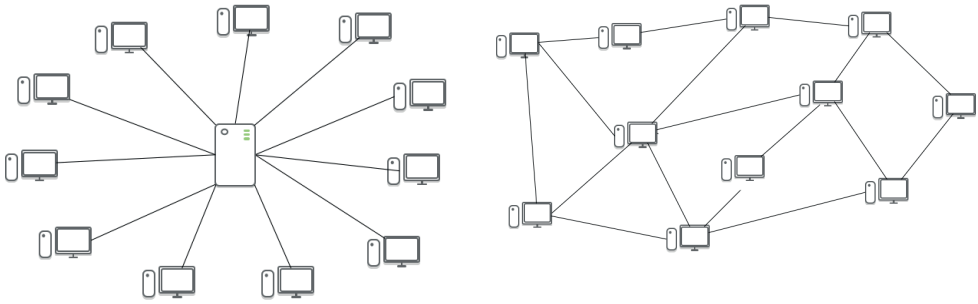
In Supply Chain management, in addition to known parameters such as capacity, demand, and cost, there are also uncertain and risky variables. Many computational methods and statistical tools have been developed to make future predictions in uncertain environments. When the data parameters included in the supply chain management are examined, It contains information such as stores, customers, products, sales, orders, shipping, and delivery. Reducing costs can be reduced by analyzing these data in detail and making estimations. In addition, it is possible to forecast the future in the fields of risk and quality management, product planning and control, logistics planning, and demand management by using big data analytics. Therefore, supply chain demand estimation is an important issue, and Artificial Neural Networks, Regression, Time Series estimation, Support Vector Machines, and Decision trees are among the most frequently used methods (12).

Another technology where data is tracked more effectively in logistics and supply chain management applications is blockchain.

### 3.3. Blockchain

The first idea about digital ledger and the blockchain dates back to 1990s. However, the technology has become popular with its financial application, the cryptocurrency Bitcoin (13). So when a decentralized trust-based cryptocurrency network was introduced, it caught awareness and started appearing in different applications from education to health, finance to logistics, and supply chain.

The idea of a distributed system is it does not require central management. In blockchain networks, tasks on the network, such as transactions, work peer to peer. Both systems have their advantages and disadvantages. The main disadvantage of a distributed system is performance. The centralized architectures have faster operation times since everything is coordinated and validated through a central system. On the other hand, operations on distributed systems can take a lot of work and time. Figure 4 represents centralized and decentralized network architectures.



a. Centralized b. Decentralized

**Figure 4:** Centralized and decentralized architectures

Blockchain depends on secure encryption and consensus methods that allow data to be persistent, correct, and unmodifiable in the network. A record represents the single traction, which is called a block (Figure 5). Blocks knit together to construct the blockchain. Blockchain is a distributed database system that does not require central control. Whenever a transaction is triggered, the operation is distributed to all nodes over the blockchain network. Therefore, it is necessary to validate if the operation is valid. If the action is valid, it is agreed to be persistent in the database, which is the ledger. Therefore, an agreement mechanism is essential to check if the current action is correct; it is called Proof of Work.

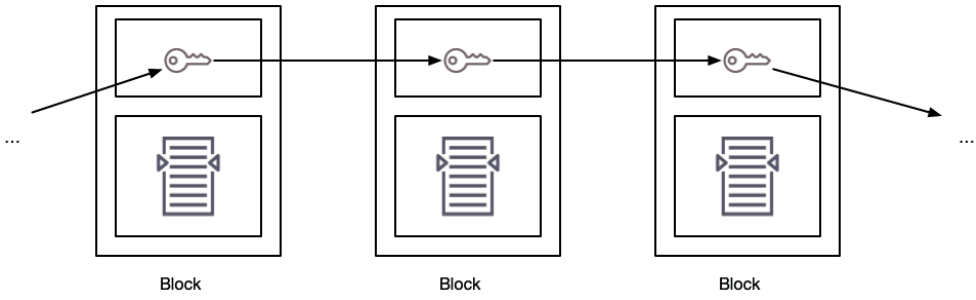



**Figure 5.** Blocks and blockchain

Once a transaction is verified and added to the blockchain network, any party can no longer modify it. In this way, it is possible to develop transparent applications. As a result, a more transparent process can be carried out with the blockchain infrastructure in all processes and transactions of the supply chain management process, from order placing to delivery.

Blockchain applications can be used in private or public network infrastructures. A logistics process or firm may privately set up its infrastructure or maintain its services from a public

network infrastructure. If we look at the prominent blockchain approaches, blockchain can be used in authentication and authorization processes. Authentication allows the authorization of both human and agent applications with artificial intelligence and the strategies to be automated. Moving product tracking and logistics processes to a different dimension with Blockchain infrastructure is possible. In particular, all movements of an object can be recorded without compromising information security and can be followed transparently by various authorities.

Using the trust mechanisms provided by blockchain structures without central management in logistics processes with many stakeholders is possible. In addition, with the smart contract applications that come with the blockchain, supply chain processes can be reduced to more automated and less human-independent processes that are subject to fewer errors.

### 3.4. Digital Twins

Digital twins are virtual representations of physical systems that enable real-time analysis, simulation, and management. We can consider the three main layers of the digital twin architecture. These layers are the data layer, virtualization layer, and service layer. Data obtained from different physical layers are consolidated in the data layer, and data communication with other layers is provided. IoT sensors or third-party system data are examples of these data sources. The virtualization layer is the process that includes the virtual representation of a physical object. In this layer, a physical object or a process is designed one-to-one in the virtual environment. On the other hand, the service layer contains the tools through which the end users benefit from the services (14).

The most important feature distinguishing digital twin technology from other simulations is real-time analysis with two-way data flow. An analysis consisting of live data can be made on a digital twin that is fed instantly from a physical entity or process. It is possible to perform simulations on different scenarios. In this approach, accurate replication of the physical twin is modeled. Thus, the digital twin is a realistic replica of a physical twin. Digital Twin systems do not use the abstraction approach of classical simulations. Instead, they perform instant analysis on a more realistic model. Another difference is that the physical twin can be updated due to analysis. This enables the instantaneous transfer of the obtained configuration space through an analysis or a simulation of the physical system. In this way, a bidirectional data transfer is guaranteed.

Digital twin technologies, which stand out in the field of supply chain management and logistics and are planned to take place in all sectors in the future, are based on the real-time replication of a physical object or process in virtual environments. This technology offers the

opportunity to perform analysis, simulation, configuration, and management activities with digital twins, which cannot be done with classical methods in a virtual replica of a real system. Using real system data in real-time enables us to perform what-if simulation analysis, future predictions, and predictive maintenance with digital twins(14).

Digital Twin technologies play a role in the execution of many monitoring and administrative activities in the field of logistics. In addition, it plays a role in many areas of usage, such as optimization of packaging and collection processes, smart management of container fleets, 3D modeling of containers, and repair or scrapping of products to be used in the fleet based on historical data (15).

## 4. Conclusion

With rapid technological developments and low hardware costs, all electronic devices and sensors have started to serve by connecting to the internet. In this way, the transformation of the Internet of Things began and shifted to the Industry of the Industrial Internet of Things (IIoT). This study examines IoT's data transmission structure, application protocols, and usage areas in Supply Chain Management and Logistics applications. In addition, the application areas of artificial intelligence, big data, blockchain and digital twin technologies and their contributions to Supply Chain and Logistics management were evaluated.

The usage area of Digital Twin technologies has become widespread due to the rapid development of wireless communication technologies, the development of wireless and fast broadband networks, and the acceleration of studies in this field. Studies show the logistics and supply chain processes of Digital Twins, and Digital Twins will be used more widely context in the future. In this context, it will be necessary to create realistic models of logistics processes using Digital Twins. Especially in high-volume object tracking processes, the Digital Twin of each object will increase its spatial and computational complexity. It is an open research problem to develop more efficient methods with research in this field. In addition, the bidirectional data flow and the configuration of the physical object hosted by the Digital Twins will also bring cyber security threats. Seizing a digital copy of an industry's physical assets and processes and unauthorized transactions therein will raise serious security threats. Research on the subject is still underway to ensure the safe and secure integration of Digital Twins in logistics and supply chain management.

Blockchain applications still need to be actively used in Digital Twins and logistics and supply chain processes. The security measures that this approach will bring, the delays in blockchain consensus mechanisms, and whether the Digital Twins will solve the needs of instant data analysis or the development of alternative consensus mechanisms will be an open issue.

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# CHAPTER 8

# FREIGHT FORWARDERS IN CONTEMPORARY LOGISTICS AND TRANSPORTATION LAW: CURRENT PRACTICE AND CHALLENGES

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**ABSTRACT**

Businesses such as agents, brokers, organizers, and forwarders are frequently serving in this sector and can affect the international trade processes of the logistics sector directly and indirectly due to their legal status.

Freight forwarders, which are established and operated as a separate commercial enterprise that also takes the titles of agency, broker, and carrier, are the main and most broadly responsible actors. While they perform the operations required by this position through contracts; it is not important whether they perform them or not.

Freight Forwarders, more broadly defined as logistics business operators, are a common example of these businesses and can undertake and offer a complete process in the door-to-door logistics service process by frequently operating in the logistics sector. In practice, Freight Forwarders undertake to be responsible for many activities of businesses that undertake similar services but outsource them to other businesses.

In practice, it is necessary to evaluate the legal status of Freight Forwarders according to the concepts determined in the international conventions that draw limit of liability for the enterprises serving in the logistics sector and the concepts of carrier, freight forwarder and agent in the Turkish Commercial Code numbered 6102, which regulates general Carriage Business within the 4th Book.

In this book chapter, firstly the general functioning of the logistics sector and its connection with international procurement will be determined; then the conventions applied in the sector and the main business operations and finally the relationship with Freight Forwarders will be evaluated. The aim of this chapter is to present the complex types of businesses in the logistics sector and their functioning, their status, and relations between them from a legal perspective. Therefore, the evaluation of the contractual position of freight forwarders in terms of their obligations and responsibilities must be done to know risks and benefits within each operation.

**Keywords:** Freight forwarder, transport organizer, broker, contractual carrier, actual carrier, logistics management

## 1- Purpose and Scope

Depending on the complex structure of international supply and trade processes, businesses operating in the logistics sector differ in many respects. Businesses such as agents, brokers, organizers, and forwarders are frequently serving in this sector and can affect the international trade processes of the logistics sector directly and indirectly due to their legal status.

Freight Forwarders, more broadly defined as logistics business operators, are a common example of these businesses and can undertake and offer a complete process in the door-to-door logistics service process by frequently operating in the logistics sector. In practice, Freight Forwarders undertake to be responsible for many activities of businesses that undertake similar services but outsource them to other businesses. They are taking high economical priority on satisfying the requirements of their customer as importers or exporters. Legal considerations is also very important in indirect way for the customers (1, p1). Customers' benefits and forwarders' risks are on carriage and other logistics operations affects their economical estimation in same way.

In the Turkish legislation, while the concept of freight forwarder was not explicitly included in the laws, it found its place in the field of law in the Road Transport Regulation published in the Official Gazette dated 25.02.2004 and numbered 25384, and continues to be regulated in the Regulation, which was last updated on 14th January 2023 (2). On the other hand, there is no such concept within Road Transport Law numbered 4925, which is the base of said legislation.

Subsequently, the Regulation on the Organizer of Transportation Works, which can be defined as freight forwarder, published in the Official Gazette dated 06.07.2018 and numbered 30470. Accordingly with inadequate content, the new Regulation was lastly published in the Official Gazette dated 27.08.2022 and numbered 31936 replacing fist one (3). This legislation is regulating the principles of operation, market entry conditions and operating principles of the freight forwarder. In this case, it is still debatable whether they still have a legal status in the law or whether they only play a special role in the implementation of the law through secondary rules within legislation.

In practice, it is necessary to evaluate the legal status of Freight Forwarders according to the concepts determined in the international conventions that draw the limit of responsibility for the enterprises serving in the logistics sector and the concepts of carrier, freight forwarder and agent in the Turkish Commercial Code numbered 6102, which regulates general Carriage

Business within the 4th Book. Turkish Commercial Code is a main body of commercial law and comprises with 6 main book that one of them is Carriage Business, which mainly depends on the Convention on the Contract for the International Carriage of Goods by Road (CMR). On the other hand, in international carriage conventions that differ according to each type of transportation, it is important which provisions should be applied in which ways for freight forwarders. Because, within those conventions, there is no such forwarder concepts, there is contractual carrier concept and the persons or entities whom the carrier is responsible. So that the position of forwarder must be determine accordingly.

In this book chapter, firstly the general functioning of the logistics sector and it's connection with international procurement will be determined; then the conventions applied in the sector and the main business operations and finally the relationship with Freight Forwarders will be evaluated. The aim of this chapter is to present the complex types of businesses in the logistics sector and their functioning, their status, and relations between them from a legal perspective. Therefore, the evaluation of the contractual position of freight forwarders in terms of their obligations and responsibilities must be done to know risks and benefits within each operation.

## 2- The Concept of Freight Forwarder / Logistics Organizer Or Organizer of Transportation Works

A freight forwarder is generally considered as a concept related to mixed (multimodal) transports. It was born out of the need to provide services such as connecting the transports taking place in different environments in these transports, transferring their loads to vehicles moving in different environments and providing services such as handling, transfer or temporary storage. In fact, this need is not new when we look at the history of transportation. However, because of the extraordinary increase in container transportation as a transportation technique in recent history; it has enabled the establishment of transportation contracts for the delivery of commodities subject to international trade at the workplace of the seller/exporter (non-exporter seller manufacturer) and delivery at the workplace of the buyer/importer. Developments in cargo transportation have also been effective in the same direction, so that all logistics activities from one point to another point have become carried out as whole. Container transportation also requires special ports and piers equipped with container ships and appropriate handling equipment. In these ports, the main infrastructure is provided by the port administration or management and the container service equipment and organization is provided by container terminal companies. In this case, in order to provide regular line-liner voyages, mutual chartering agreements between shipowners based on an operating (supply)

agreement are required. They enter into voyage charter agreements for a specific section or area of the container ship to accommodate their customers' commodity-filled containers. The contracts concluded in this process contain complex indemnity clauses, which the shipowners pass on to their customers through bills of lading, bills of lading and contracts of carriage. In some joint service contracts, each logistics operator may market a service; in this process, the clauses in the contracts and bills of lading specify who is the carrier, agent, broker, freight forwarder and what kind of responsibilities they undertake, and that the contract is between the shipowner named in the bill of lading and the customer (4).

As a result of the stage reached in container transportation, it has profoundly affected the terminology of modes of delivery and transport law in international trade, for example, it has led to the development of concepts such as door-to-door transportation as well as port-to-port transportation. Thus, due to the need for mixed transportation operations, the importance of the freight forwarder, who organizes the entire transportation through sub-contracts and performs the entire transportation through or with other carriers, has increased respectively. When freight forwarder enterprises become powerful within sector, they come into scope of law and governmental authorities. So that, to decide upon their rights and duties, they become together within such associations as an economical actors.

Almost all of the major freight forwarders in the UK are members of BIFA (The British International Freight Association) (5). The Freight Forwarders' Institute, which is affiliated to BIFA, works as a professional support institute for those involved in international freight forwarding. BIFA registered members agree to apply the Standard Terms of Trade, employ a minimum number of professional members, maintain continuous liability insurance and abide by the association's code of conduct. Trial membership is available for companies new to the industry. Ordinary commercial membership is available for companies that cannot comply with all the conditions and specifically want to use their own terms of trade (4).

In Turkey, UTIKAD - International Transportation and Logistics Service Producers Association, which has the same purpose and provides similar support to its members, is in charge. As a historical process, it was established in 1986 as UNMAD-International Transportation Contractors and Agents Association, 1995-UTIKAD- International Freight Forwarders and Agents Association, 1999- UTIKAD- International Transportation and Logistics Service Producers Association (*see more information, online, at https://www.utikad.org.tr/UTIKAD-Tarihce*). Here, as can be understood from the title alone, terms such as transport contractor, freight forwarder and logistics service providers have been and are being used, rather than the expression of freight forwarder. However, what is in question is an organizer activity that

organizes the contractual transportation process and is subject to the provisions of the carrier as determined by the Regulation.

FIATA (International Ferderation of Freight Forwarders Associations) was established as an international federation of freight forwarders associations established in other countries, including UTIKAD and BIFA. These associations and such international bodies provide model rules for the Freight Forwarding service and some associations explicitly recognize that their rules provide a minimum degree of customer protection (*4*). This means that these bodies are such guarantees for the member enterprises' customers.

Forwarders may issue various documents, contract standards and proposals relating to customers, goods, process, carriers for their customers and other interested parties. Forwarders are usually intermediaries, using documents relating to the carriage, such as bills of lading and consignment notes, issued by carriers they designate, without actually performing the carriage themselves. Sometimes they may act as agents as the carrier's representative and have the authority to issue the transport documents themselves. Sometimes they may issue documents in the form of intermediate transport documents to indicate that the goods have been instructed to be picked up from the customer's place of business or to indicate that the goods have been shipped to the consignee. It is common practice for forwarders to issue a Forwarder Certificate of Receipt (FCR or House BL) for commodities in their possession or control.

The FCR is mainly used in intercontinental trade and functions similar to a bill of lading. It is the FCR that actually starts the transportation process, but it does not necessarily mean that the long-distance transportation process has started in a mixed transportation process or in overseas transportation. However, the forwarder issuing the H/BL is not obliged to contract for the carriage of the commodity, it is possible to contract only as an agent without being considered as a carrier (4).

If the name of the forwarder appears on the House BL and it is signed as a carrier or multimodal transport operator-MTO (*7*), they will be considered as a carrier in terms of both public obligations and the transportation process. The forwarder providing multimodal transportation services may use its own bill of lading form with the will to accept responsibility as a carrier or may use a FIATA bill of lading (FBL), which clearly indicates that it assumes responsibility for the carriage of the goods.

In terms of Turkish law, if the carrier carries the goods in its own name and on its own account, it shall be deemed to be a carrier in accordance with the Forwarder Regulation and the provisions of Art. 921, Art. 926 and Art. 927 of the Turkish Commercial Code (TCC). Here, it is more

important that the carrier undertakes the work, brings the goods together and transports them, and collects the transportation fees on its own account, rather than the transportation documents it issues. Especially when it comes to the follow-up of the process, instead of stepping out of the way after concluding the contract like a broker and leaving the cargo interest and the actual carrier in the execution of the process together, the forwarder will now have to show the care and responsibility of the carrier. It is an acting carrier for process responsibility that any loss or damages or delay resulted in damage to be compensated, liabilities will be on, with for the actual carriers (8).

## 3- Contract Terms For Freight Forwarders

Generally, forwarders are companies that serve their customers with continuous commercial relationships such as monthly, quarterly, or annually. The customer's main objective in the contract is to be attracted to the provisions limiting or eliminating the company's liability and the provisions requiring the customer to indemnify in certain circumstances and is expected to be a party to the contract accordingly. It draws attention to the terms that are most likely to affect the client's situation and, when combined with the reference to the terms on the face of the forms issued for each individual work with a service, aims to ensure that such terms are included in the contract by encouraging adequate notice to the client. In a contract based on standard terms, whether general terms of business or negotiated by the parties, the party relying on them must prove that the terms incorporated into the contract are consistent with the will. This will be possible either by the customer's acceptance of the inclusion of such terms in the contract or by the party relying on them proving that the other party was notified of their inclusion at the time of the conclusion of the contract.

Due to the nature of forwarder operations, it may be difficult to notify the forwarder at the time of conclusion of the contract, such as in cases where the forwarder is the consignee acting on behalf of the consignee with respect to the instructions given by the consignor-carrier. However, in cases where there are two forwarders providing mutual correspondent services and operating in different countries, it is sufficient for the defendants who wish to rely on the terms of a member association such as BIFA or UTIKAD to send an e-mail or fax containing the phrase "*the terms of this business are shown on the back*" (4). It should be noted here that the general terms of business and framework contract terms developed by IATA-International Air Transport Association may be equally binding in air cargo transportation operations.

In particular, the inclusion of the framework contract terms developed by member associations in the scope of the individually concluded contract may also depend on whether the forwarder has entered a direct legal relationship with the customer as a contractual intermediary agent or as the performer of the service.

The incorporation of such corporate framework clauses into the content of the logistics service contract during the transportation process may also be written directly in the form of contractual terms and not by reference. Sometimes, the forwarder may act as an agent in a continuous representation relationship. This should also be interpreted according to the provision of the framework contract.

The scope of the framework contract is completely formed by the free will of the parties. However, it can be stated that the general terms will apply to all kinds of logistics services and some free services other than transportation. Since transportation in logistics processes is also specified in all international contracts as a commercial business, it cannot be done free of charge. For international perspective, transportation must be agreed to be carried out for a price. Otherwise, international conventions such as1999-Montreal Convention, CMR or COTIF-CIM will not be applicable. Again, in terms of the Hague and the Hague Visby Rules, the issuance of a bill of lading and the commercial nature of the business require carriage for consideration.

## 3-1. Freight Forwarder Services and Contractual Parties

Freight Forwarder services means services related to the transportation, consolidation, storage, handling or packaging and distribution of goods, as well as any activity related to making declarations for official purposes, insuring, and refrigerating goods or providing payments and documents related to goods (4). The forwarder, who undertakes these services, but does not have to perform them personally, is considered as a carrier in all international conventions and practices and is equipped with the rights and obligations of the carrier.

Freight Forwarder services means the planning, execution, and control of all necessary logistics activities, including but not limited to the transportation of goods from the point of origin to the destination. In this process, services are received from multiple people and institutions, notifications are made, and different contractual relationships are entered. In all of them, the forwarder acts either as a responsible party or as a representative and is either alone or jointly and severally liable for any breaches. In this respect, under the appearance of assuming full responsibility, there is also a subcontractor auxiliary enterprise to which it can transfer full responsibility according to the contract.

Freight Forwarder services include, but are not limited to, all payments, including customs charges, administrative, auxiliary and consultancy services related to the movement of the goods subject to transportation. The remuneration received here is covered by the expression “final remuneration” in Article 921 of the TCC and is defined as “...agreeing on a single price

including transportation costs...". Here, the broker working with a fee including all costs will now have to be interpreted as an organizer, acting carries, in other words, freight forwarder.

Article 4 of the Regulation on Freight Forwarder "i) Transportation business organizer (freight forwarder): *Real and legal persons and legal entities who are accepted as carriers within the framework of the obligations and responsibilities imposed by this Regulation and other relevant legislation on those who operate in the capacity of transportation, real and legal persons who have obtained authorization certificates in the field of goods and cargo transportation in accordance with the relevant legislation, and real and legal persons who issue transportation invoices by having goods and cargo transportation on their own behalf and account, including combined transportation, by using or using the facilities, capabilities and capacities of vehicles with foreign license plates operating in the field of goods transportation and other types of transportation when necessary, provided that they comply with international agreements*". There is a similar definition in the Road Transport Regulation Art.4, ğğğ, that in Turkish law this definition is generally accepted so on.

Logistics activity means all services undertaken by service providers within the scope of the movement of goods, including collection, loading, unloading, acceptance, inventory control, storage, control, handling, order processing, consolidation, palletization, preparation for loading, loading, assembly, labelling, invoicing, preparation of loading documents, customs clearance, delivery, and shipment tracking. Likewise, in the Road Transport Regulation, besides freight forwarder, the definition of logistics enterprises also determined as "*Logistics enterprise: In addition to transportation activities, real and legal persons who have the right to use an independent workplace and undertake all or part of the loading, unloading, storage, stacking, packaging, sorting, labelling, order planning, distribution, delivery and similar services under their own supervision and control after receiving all kinds of goods belonging to their customers*" within Art. 4-ğğ. Essentially, all of these activities are logistics activities and the businesses that have the competence to organize them are freight forwarder businesses. For Turkish Law, logistics enterprise has a capacity to operate as his business; freight forwarder has a capacity to organise but not actually do it.

The main thing in forwarder activities is the movement of goods and it is not necessary for sender or any logistics sector enterprise to own goods in the transportation process. The sender who gives the goods to the transportation process, has the cargo interest, including the goods and its packages, pallets, containers and other transportation equipment, which are the subject of any contract concluded as the cargo interest or related to the contract. This is essentially the sender and is in the position of contractual party as the sender at the destina-

tion. In logistics services, the customer for the forwarder is the person who makes a request or on whose behalf a business is undertaken, or services, information or advice are provided. He can be a buyer, seller, tenant or borrower as such. The customer is often involved in the dispute process as the sender or the consignee in terms of liability.

## 3-2. Forwarder Activity and Logistics

Apart from providing gratuitous and reward activities, the activities, and tasks to be undertaken by the Forwarder are those with the objective of generating income. In any case, the movement of goods belonging to the customer is important. Moving its own goods will not be considered as a logistics activity.

There are some drawbacks in trying to define the scope of forwarder or logistics activities that can be undertaken, and in imposing limitations. Such a limitation carries the risk that there may be several unforeseen works during the movement process from the point where the goods are located to the point where they should arrive, and in such cases, the operation may fail. For this reason, restrictions, or limitations in the definition of work to be done may lead to the need for re-evaluation later. In other words, it may be necessary to agree separately for the framework agreements of institutions and associations that are not explicitly foreseen to be applied to the contract between the parties, or for a new set of works foreseen in the individual contract.

Logistics activities require the actual realization of all the work required in the entire process, while the forwarder requires the establishment of the contractual relationship necessary for its planning and implementation. The customer vis-à-vis the forwarder can often be an owner, buyer, seller, lessee with financial leasing. In the forwarder contract, the capacity of the customer for the purpose of transportation must be included. Thus, disputes regarding ownership and other rights on the transported goods can be minimized. In determining the party to the forwarder agreement, it is important to determine whether it is an agent, exporter, importer, customs broker or other intermediary and to define its duties. In cases where the goods are sent by a consignor to a consignee by road, if there is no basis for an agreement, it is accepted that the consignee-shipper is a party to the contract of carriage in accordance with Article 89/2 and 3 of the Turkish Code of Obligations (TCO). Thus, although the consignor and consignee are essentially the same person in terms of the contract, the cargo means the goods that must be picked up from the seller-supplier address or the place where the goods are located. In terms of INCOTERMS 2020 the legal place of delivery seems to be determined as EX-Works delivery However, the forwarder contract must specify the mode of delivery

in terms of the customer's entitlement to the goods and for whom the transportation process is organized.

When the contractually undertaking carrier is accepted as the organizer of the carriage, it should consider both the person requesting the service and the person on whose behalf the service is requested as the customer in terms of its own receivables. Instead of both of them being simultaneously regulated as customers, they are alternatives to each other in the exercise of rights and powers. In both the Roman Germanic and Common Law systems, the party to the contract is normally one of them. However, it may be possible in cases where the capacity of representation is not disclosed or where the representative personally concludes the contract instead of the represented party. In other words, in the case of brokers who act on their own behalf but on behalf of the cargo interest, and in the case of agents who do not clearly state the representative relationship, these persons will also be in the position of customers for the forwarder.

## 3-3. Application of Imperative Law in International Logistics Process

International conventions and state law and regulations about transportation and logistics process mostly impose mandatory rules to be applied. However the concept is within trade and international commerce that, always there are so many issues to be determined by the parties.

Art.2 of the BIFA framework contract "In the event that the application of any legislation is mandatory for the undertaking of any work, such conditions in relation to such work shall be understood to be subject to such legislation, and nothing in such conditions shall be deemed to waive any of the company's rights or immunities, to increase any of its responsibilities or obligations under the legislation, and if any part of such conditions is contrary to such legislation to any extent, such part shall be invalidated to that extent and no more in relation to such work" (4), both national legislation and international conventions emphasize the need for mandatory application. As important as contracts are in the implementation of commercial provisions, it is also clear that these contracts should be drafted in accordance with the absolute and relative mandatory legislation and convention provisions. Contract terms that violate the mandatory provisions will be invalid but cannot be interpreted to mean that the entire commercial contract between the parties is invalid.

This provision explicitly recognizes that there is the possibility that there may be legislation governing a particular operation and restricting the freedom of the parties to contract on the debt relationship. In some countries, the restrictions imposed on freedom of contract may be different from those imposed in other countries, according to their own public order and

understanding of the law. If a transportation subject to a special liability regime for international transportation is supplied by the Forwarder or performed by subcontractors, differences may arise depending on the country where the relevant service is carried out. Such regimes contain provisions that prevent the carrier from reducing or eliminating its responsibilities or that treat limitations differently. In the event of a breach of the mandatory provisions governing the service undertaken by the Forwarder, partial invalidity will result in. Contractual provisions that violate the mandatory provisions are invalid, but those that do not violate them remain valid. The inclusion of such provisions in a long-term framework contract does not require their validity in the face of changing mandatory legislation and convention provisions.

### 3-4. Unfair Contract Terms

The Articles 21-25 of the Turkish Code of Obligations (TCO) for Turkey and the Unfair Contract Terms Act 1977 (The Unfair Contract Terms Act 1977/UCTA) for the UK and the necessity of analysing unfair terms within contracts and the necessity of invalidation or non-application accordingly are also clear for legality.

Although there is no such distinction for Turkey, according to Article 26 of the UCTA, the Law will not apply to international supply contracts concluded by parties with places of business in different states where the possession of the goods passes. A British Forwarder contracting with a foreign customer may avoid the application of the Law if it takes possession of the goods. On the other hand, in the unlikely event that a foreign Forwarder enters a contract under the terms of BIFA, this provision may only apply if it is the law chosen by the parties in accordance with Article 29 of the terms of BIFA. In other words, like the mandatory and public order rules of each country, the unfair terms included in the general terms and conditions of the contracts will also be subject to the control of the law applicable to the substance of the contract. Be that as it may, the provisions in the contracts do not eliminate the obligations and defences provided by an international liability regime such as the CMR Convention (4). For example, the 2 SDR limit of liability in the FIATA terms does not apply as a limited liability ceiling outside the maritime transportation process.

Where the forwarder contract falls within the scope of the UCTA - as further defined in Chapter 13 - any contractual term intended to exclude or limit liability for negligence (slight negligence) will be subject to section 2 and will be void if it covers death or personal injury and subject to a reasonableness test in other cases of loss or damage. 3 and other terms intended to exclude or limit liability as defined in section 13 will be subject to the reasonableness test in section 3. This happens either where the forwarder’s customer is a consumer or where

the forwarder writes standard business terms (general terms of business). There will be little doubt that BIFA terms and other similar terms of trade are "written standard terms of business" and that they constitute the forwarder's standard written terms "invariably or at least usually if they contract on them". However, where a forwarder or logistics service provider operates based on negotiated terms, these are unlikely to be regarded as standard terms of business unless the negotiations had little effect on the added terms. The forwarder must prove that the term to be deemed to be included in the scope of the contract is fair and reasonable and was known or contemplated in detail by the parties at the time the contract was concluded. Courts are free to exercise their judgment in determining whether a term meets this test. At this point, it should be noted that the condition to be relied upon must be communicated to the customer. In practice, unless there is a great economic imbalance between the parties (in a bargaining position), the view is expressed that custom and commercial practice is also an important factor in commercial relations (4).

Apart from UCTA, the "EU Council Directive on Unfair Terms in Consumer Contracts" entered into force in July 1995 (5th April 1993, 93/13/EEC). These will apply where the Forwarder, as a service provider, is dealing with a consumer. As the provisions of the Directive will apply at the same time (side by side) with the UCTA terms, it will be necessary to consider the circumstances in which each applies. While there is a similarity between UCTA's reasonableness test and the Directive's concept of unfairness, there are contractual provisions that are not currently controlled by UCTA but should be subject to control by the Directive, such as, for example, a price variation clause. As required by Article 3 (3), the Regulatory Annex contains a list of terms that may be considered unfair terms. In these respects, where UCTA provides greater consumer protection, Article 8 of the Directive appears to allow such protection to be maintained.

## 3-5. Choice of Law

It is important to choose a state law in international contracts between the parties and to indicate such a law in cases where the parties do not expressly agree or for the interpretation and completion of their declarations of will. In determining the law applicable to contracts in Private International Law, reference is generally made to the law chosen by the parties (9).

Article 24 and 29 of the Law numbered 5718 stipulates that if the parties have made a choice of law, that law shall be applied. However, here, the provisions of the international conventions to which Turkey is a party in Article 1/2 of the Law shall be applied first. Which means that, if a convention exists to be applicable, firstly it will be practised, and for the gaps and unregulated issues, chosen law will be applied to the case.

In this framework, the choice of law is important both in framework logistics service and freight forwarding agreements and in any individual agreements. The law of the chosen country shall also be taken into consideration in the interpretation and dispute resolution of the provisions of the convention to which it is a party. However, the mandatory provisions of the convention will be applied first, then the contractual provisions of the parties, and only after that, the chosen law will be applied since it is also chosen by contract.

As it is seen in international transportation and logistics operations, the conventions that will find application firstly should be subjected to common interpretations and evaluations to make a uniform application of law independent from the country laws in the Common Law or Roman legal systems. It becomes difficult to establish a uniform liability in international logistics processes to the extent that the regulations on consumer legislation, unfair contract terms, liability reducing and irresponsibility agreements, which are brought by each state with public order and mandatory law concerns in its own country, differ. So that, when choosing such law, the main concern must be on liability terms and public order rules of chosen law.

It should be taken into consideration that clauses such as non-liability, non-responsibility for the acts and omissions or slight negligence of men and assistants in contracts are invalid in the face of international conventions that impose mandatory legal rules. In practice, it is observed that such contractual provisions, albeit invalid, are inserted into contracts and de facto applied between the parties. If they are not brought before a judicial authority, the content of the contract contrary to the mandatory rules of law and the provisions of the conventions may be enforced without inspection.

## 3-6. Authorization Requirements for Forwarders

Forwarders accept and guarantee that the customer is the owner of the goods or the authorized representative of the owner of the goods for the cargoes entering into the logistics process and for the ownership of rights over these cargoes and that the contract concluded is binding not only on the shippers but also on the owners of the goods by virtue of their capacity as authorized representatives of the owner of the goods. Thus, the freight forwarder leaves the risks based on the rights of the cargoes that come under its de facto control on the customer.

The owner and the consignor, in their contract with the forwarder, when authorizing the forwarder to enter into any contract and/or accepting any document issued in connection with such contracts, agree that the contract concluded is binding on these third-party contracting parties and their representatives acting for them. However, this means that the forwarder also accepts that the forwarder has the right to enforce against them jointly and severally all liability for compensation that has not been paid upon proper demand against the cargo interest (4).

Similarly, Article 918 of the TCC stipulates that the freight forwarder "...also includes the performance of other obligations agreed upon in relation to the carriage, such as insurance, packaging, marking and customs clearance of the goods. Unless otherwise stipulated, the commission agent is only obliged to conclude the contracts required for the fulfilment of these performances." There is a regulation as follows. In this regulation made for the broker, in the case of Art. 921, Art. 926 and Art. 927n of the TCC, this time it will not only be sufficient to conclude contracts but will also carry out the performance of the contracts in the capacity of the transportation works organizer. This is because, in these articles, the term "broker" is replaced by "organizer", which is the broker deemed to be the carrier.

Consequently, forwarders, by virtue of their title, have the power of representation and execute the contracts necessary for the organization of the carriage on their own behalf and on behalf of the customer. However, while the benefits arising from these contracts belong to the cargo interests, the process of concluding and executing the contracts is carried out by the forwarders.

## 4- Legal Status of the Forwarder

At the current stage, although it is determined according to the contract; it is a commercial enterprise that has the right to provide any, some or all of the services included in the logistics process by supplying any, several or all of the services in the logistics process as a representative or to provide these services to the cargo interest as a representative, managing and supervising this process even if it does not actually perform this process. At the request of the Customer, the Company shall ensure the documentary order of any contract concluded as the Customer's representative. Within the scope of the authorization provided according to the orders and instructions of the cargo interest, for the "carriage of goods" pursuant to Article 918 of the TCC:

a) To determine and plan the mode of transportation, vehicles, route,

b) To find intermediaries and persons who will actually perform transportation, warehousing and storage works, transportation and customs, and to make contracts with them,

c) Giving necessary information, orders and instructions to the carriers and other performance auxiliaries involved in the process,

d) They are obliged to guarantee the compensation rights of the cargo interests against the carriers in case of realization of possible risks during the transportation process.

These duties are solely since they act as a freight forwarder for and on behalf of the cargo

interest. A carrier is deemed to be a carrier when it determines the exact fee in accordance with Article 921 of the TCC and collects it on its own behalf and account, when it takes the carriage business upon itself in accordance with Article 926 of the TCC and undertakes the actual carriage in such a way that it will have the carriage carried out and managed by itself, and when it organizes the carriage of the cargoes belonging to different cargo interests together by consolidating them in a single transport equipment container or trailer or semi-trailer. In this case, he also undertakes the performance of the contracts he has concluded, and in case of possible risks, he undertakes to pay compensation jointly with his assistants and subcontractors who perform. The fact that it will transfer the responsibility in the internal relationship does not prevent the continuation of its responsibility to the cargo interest. Even taking out freight forwarder liability insurance-FFL insurance does not remove its joint and several liability. For this reason, forwarders should be careful to work with the right people in the internal relationship and to carry out business with carriers, warehousemen and similar performance aids that can cover the liability.

The process of quoting and accepting an inclusive price for the performance of any service shall be carried out by the Company acting as agent or Contracting Principal. In other words, forwarders have to measure how much cost the whole organization will incur by contracting through their own agents or directly on their own behalf and accounts, and contract accordingly. In logistics operation processes, which may involve dozens of participants, the entitlements of those involved in the performance process at each step must be measured correctly. Otherwise, the freight forwarder will no longer be able to make a claim for the defined works and the forwarder may have to bear the entire cost within the definition of “definitive fee”.

When acting as an agent, the Company may not be under any contractual obligation with the Customer for the transportation, storage, packaging and handling of any goods or any other physical service related thereto, to establish direct contractual relations between the Customer and such third parties and to secure the contract with the third parties. However, when a transportation operation is carried out on its own behalf and on its own account and not as an agent, it shall be chained to all obligations together with those who perform them personally.

## 5- Liability of the Forwarder

As the principal contractor for the entire logistics operation process, it undertakes to provide the performance of these services and/or to ensure the performance of these services on its behalf at the time and to the extent that it has contracted and accepts responsibility for the loss and/or damage that occurs between the time it receives the goods and the time it delivers them.

At this point, the liability for the carriage of goods shall be determined in accordance with the TCC as well as the conventions that set forth mandatory rules such as CMR, COTIF-CIM, Montreal Convention. In all these rules, the liability provisions that cannot be amended in favour of the carrier in a relatively mandatory manner but can be amended in favour of the cargo interest, find an area of application.

Within this framework, forwarders are also required to act with the highest degree of care and diligence required for carriers and to fulfil their obligations with the highest degree of care, diligence, skill and judgment.

Considering the regulations establishing liability provisions that vary with the mode of transportation according to the contract undertaken by the forwarder, especially the differences in international conventions, differences in liability limits, differences in relief from liability, significant unexpected consequences and responsibilities are likely to arise. At least, there are significant differences in limited liability limits, relief from liability and similar issues:

a) Pursuant to Article 23/3 of the CMR Convention (Convention Concerning the Contract for the International Carriage of Goods by Road), limited liability is limited to 8.33 SDR per unit gross kg and one freight per m delay. In addition, depending on the gravity of the fault, it may become unlimited pursuant to Article 29. In addition, it is possible for the court of each state party to interpret the degree and gravity of fault according to its own law.

b) The 1999-Montreal Convention, to be reviewed regularly by ICAO - International Civil Aviation Organization, limits the liability to SDR 22 per gross kg with Article 22/3 and adopts this limited liability in all cases regardless of fault with Article 22/5. The release of the carrier from liability for air carriage is determined only for four specific reasons. Other than that, it has a content approaching to absolute liability but envisaging limited liability as absolute.

c) In terms of the Hague Visby Rules, in addition to the limited liability of SDR 2 per unit gross kg as per Art. 1186/1 TCC, an alternative limited liability of SDR 666,67 per unit loading unit has been adopted. In case of delay, the principle of liability limited to 2,5 freight is in accordance with Art.1186/6.

d) Pursuant to Article 30/2 of the COTIF-CIM of the International Convention on Railways Annex-B Uniform Rules for the Contract for the Carriage of Goods, a limited liability of 17 SDR per gross kg per unit is adopted. With Art.36, liability for gross negligence becomes unlimited. Under Art.33/1, liability for delay damages is limited to 4 times the freight.

e) In multimodal transports, although there is no convention in force, as per Article 903 of the TCC, if the stage of carriage at which the damage occurred is known, compensation

will accordingly be determined; otherwise, if the stage at which the damage occurred cannot be determined, the TCC liability scheme in accordance with the CMR will be taken as basis.

f) Again, in the case of the application of Turkish law with the Law on Civil Procedure, the Turkish law adopted as the chosen law will require the settlement of disputes in accordance with the conventions to which it is a party.

Provided that it is not contrary to the rules of mandatory rules of law, and as stated above the parties referred to in their contracts and agreements or chose them specifically;

a) UN-Geneva Convention on multimodal transport,

b) Rotterdam Rules for maritime and mixed maritime transports,

c) Hamburg Rules on contracts of carriage by sea,

d) FIATA Rules as general terms of business proposed for its members,

e) IATA Rules for air transportation,

f) Rules such as the BIFA Ruler,

In terms of the freight forwarder's liability, every choice may lead to different results as the applicable law. Therefore, when choosing law, consideration must be on liabilities determined in those rules.

## 6- Liability Risks

Although the performances subject to the logistics service contract are not strictly based on legislation or commercial custom, they are determined according to commercial practice and custom in the transportation of goods. Especially when the legislation and conventions refer to commercial custom, this content will need to be investigated and applied. This will cause different liability risks to arise according to both the transportation method used and the different types of logistics activities that are obligated under the contract.

Even the activities that may be subject to a logistics service contract such as storage, inventorying, preparation, brokerage, transportation, packaging, packaging, measuring (weighbridge service), supply of pallets and/or containers, marking, loading, unloading, customs clearance, shipment and completion are not limited, the most important activities are listed as examples.

After the contract is concluded, separate and new obligations may be made for each individual job, depending on the need. In the sales and supply chain process, the logistics operator may also engage in activities related to sales or other supply methods. In this case, the activity

may be an agency, brokerage, or other performance assistance or even representation outside the scope of logistics management. In this case, transportation and logistics activities may be considered as ancillary performance obligations of the sales contract. In terms of Turkey, customs clearance is already a separate contractual relationship in the provision of customs brokerage services.

In the logistics services contract analysis, in general:

a) Carriage,

b) Order management - call centre management,

c) Storage, entry of goods into storage, storage, labelling-marking, control-inspection, maintenance-surveillance, brokerage, division into small packages

d) Sending-shipping, monitoring-tracking, damage tracking-complaint handling, reverse logistics-return and return to origin

e) It is also said that goods price collection-payment control and factoring activities are the primary and most important logistics performances. In the event that these tasks are managed by forwarders through contracts concluded on their own behalf and on their own account, the risk of liability is borne by the forwarders.

## 6-1. Principal Performance of Forwarder Operations: Carriage

The central concept in the logistics services contract refers to the national or international transportation of goods. While performing this performance, it is necessary to pay attention to the mandatory character of national and international legislation. Here, it is possible for the logistics operator to perform this performance personally, as a broker or as an organizer.

Does the logistics operator undertake the transportation personally during the conclusion of the contract, or does he undertake the transportation as an organizer? This will be the most important element of the contract. This is because, depending on the situation, he/she will take the title of carrier or freight forwarder or freight forwarding organizer, and a liability scheme will be established accordingly.

The logistics operator may undertake the problems, orders and instructions encountered during transportation, or it may limit this issue and stipulate that the instructions of the customer (the customer) are directly implemented.

The conditions under which the logistics operator will be held liable in case of defects of the enterprises used in the performance of the work can also be written in the contract. In

matters of limited liability or abolition of liability, regulations should be made by considering the mandatory character of the provisions of the TCC.

If the logistics operator carries out the supervision and control during the transportation of the goods, the logistics operator may also assume the responsibility of the carrier arising from the loading and stacking and other acts pursuant to the intermediary transportation contract.

If the logistics operator has undertaken the transportation itself, if a single fee has been agreed for the fee-commission-logistics activity, if it mediates the transportation by collecting cargo together, it will now be subject to the provisions of the carrier. Here, even if there are contractual provisions stating that he will not be considered as a carrier, his carrier title will not be prejudiced.

### 6-1.1. Carriage Process

In the Framework Logistics Services contract, the places of origin and destination must be given with specific definitions, and the place of loading and the place of unloading of the goods must be specified in each transportation. Therefore, it is necessary to concretize the place of origin and destination in each individual transportation process. Likewise, the mode of transport, the route and the nature of the vehicles to be used in the transportation must also be specified. The logistics operator will not be liable for incorrect instructions; however, failure to provide instructions may result in the operator's liability. Especially in cases such as deviation from the route, failure to make the requested vehicle available, liability as a carrier will be in question.

If there are no instructions to the contrary, the logistics operator can act freely in terms of route-vehicle and other issues. The logistics operator may withdraw the goods in the transportation organized by itself, and may instruct to transport the goods to a different location. However, this instruction must be compatible with the customer's instruction and contractual rights.

### 6-1.2. Collection Cargo

In the logistics services contract, it may be agreed that the cargoes of other persons shall not be mixed with the cargoes of the customer, and that the cargoes of more than one customer shall not be carried in the same transportation. If there is no such agreement, the operator acting as a carrier is free. In this case, the customer must clearly state his/her own interest and demand from the logistics operator, and the prohibition of transhipment must be stated in the partial load, especially if the damage caused by transhipment is desired to be within the scope of liability.

### 6-1.3. Duration of Transportation

A transportation period may be agreed in the contract. This period must be reasonable. Unless necessity, administrative intervention or force majeure is demonstrated, exceeding the time limit is itself a reason for liability. The logistics operator, as the carrier, is obliged to reveal and explain the reasons for extraordinary time overruns.

### 6-1.4. Proof of Delivery of Goods

It is the duty of the logistics operator to prove the delivery of the goods to the consignee - the buyer with a document such as a delivery note - transportation note - transportation bill - delivery receipt to prove that the seller has fulfilled his performance arising from the sales - supply contract. The logistics operator who fails to prove that the goods have reached their destination will be liable. Specifying the type, number and weight of the goods in the delivery document is important in terms of liability law.

### 6-1.5. Receipt from Unauthorized Person and Delivery to Unauthorized Person

It is important that the goods are delivered at the place of destination to the person named as consignee on the transport and shipping documents or to his authorized representative. Although full commercial representation or commercial agency is not required there, it must be confirmed whether the consignee is an employee of the consignee. The negotiable character of the bill of lading and the delivery of the goods to the rightful bearer are important in terms of authorization. The delivery of the sea carrier will be the delivery of the logistics operator.

Delivering to the wrong person, who will be the right person, who will be authorized to deliver and receive the goods must be written separately in the logistics services contract.

If a commitment has been made to the customer for the collection of the price of the goods or any other payment, the logistics operator must refrain from delivering the goods if this money is not collected. In this case, an instruction must be obtained from the customer on the grounds that there is a delivery obstacle. Otherwise, it is inevitable that the goods will be sold (converted into money) according to the law of the place where the goods are located and the goods will be evaluated for the customer.

## 6-2. Road Transportation

When the carriage is carried out by road, the mandatory character of the international CMR provisions and the mandatory character of the provisions of Book 4 of the TCC should be observed domestically.

## 6-3. Other Modes of Transportation

If the logistics business contract clearly states in which cases other modes of transportation will be used, it should also be considered that the liability scheme will operate according to this mode of transportation.

## 6-4. Other Transportation Works in Addition to the Contract of Carriage

As stated above, certain works are included among the transportation works in the provisions of the TCC. The logistics operator may have undertaken these as performance.

### 6-4.1. Packaging

Pursuant to Article 862 of the TCC, if packaging is required considering the transportation process, it is essential that this is done by the sender (the sender of the contract of carriage). However, within the scope of the logistics services contract, it may be undertaken by the logistics operator as a performance in addition to the transportation.

If it is contractually undertaken by a separate company and packaging is performed, it will be considered as an independent work contract. The logistics operator may also impose the packaging performance undertaken by the logistics operator on the carrier as an ancillary performance.

The adequacy of the package, the type of foil-metal-wooden-shrink packaging to be used is a problem directly related to the nature of the goods. The mode of transport, whether it is partial or full carriage, the nature of the goods are decisive for the form and type of packaging. In fact, the orders and instructions of the manufacturer-seller of the goods on packaging suitable for the nature of the goods are important. Sometimes, the type of packaging alone may even be the cause of total loss.

The logistics operator, who undertakes the packaging separately, should specify in the contract the additional charges and costs for the packaging. There will be a significant difference even between the fact that it will only take the cost and that it defines this work as a job.

### 6-4.2. Pallet and Container Supply

How long and by whom the pallets and containers to be used in the transportation process will be supplied is a very important issue. In logistics service contracts, it is important who will supply pallets or containers and under what conditions, and how they will be returned and how they will be returned.

Will the logistics operator be able to charge rent for the pallets and containers it supplies? This issue should be written in the contract, will it be able to request the costs incurred on the assumption that it will not receive a rental fee; again, in cases of overdue demurrage-delayed containers and pallets, the responsible party for the payment should be determined in the contract.

Here, the costs of pallets and containers, ownership, whether the ownership belongs to the logistics operator, the unloading time and delivery time of pallets and containers must be included in the contract. The delivery points to which empty pallets and containers will be returned must also be specified.

The robustness of the pallets, their dimensions, their suitability for flood or rough handling, their suitability for use with forklifts, cranes or other means must be inspected, and who is responsible for damages caused by the vehicles used in loading and unloading must be included in the contract.

### 6-4.3. Weighing and Drawing List

Especially in land transportation, unless weighing is performed, the record written on the bill of lading does not constitute a presumption as to the quantity of the goods. In other transportation methods, if the weighing information is written on the bill of lading, it is accepted as valid as a presumption.

If weighing is the obligation of the logistics operator, the weighing method, costs, weighing and recording system must be agreed upon in the contract and the fact that the cargo has been weighed must be recorded in the bill of lading. In this regard, it is important that the goods are weighed and characterized in terms of quantity.

### 6-4.4. Marking

According to Article 862/2 of the TCC, the duty of marking also belongs to the shipper. However, when the logistics operator undertakes these works, he shall be liable for the damages caused by this.

In particular, signs regarding the loading, stacking and fixing of the goods, warning points and signs regarding how the goods will be handled during transportation and transfer processes, weight-number-shipped information are also considered as signs.

When the logistics operator undertakes the marking obligation, in order for this obligation to be valid; it may be undertaken for goods in a certain period of time, in a certain warehouse,

in a certain place, for the defined goods of a certain customer, for the goods of certain buyers. In other words, when the marking obligation is mentioned, the goods must be specific. The marking obligation will not be mentioned in an indefinite and comprehensive manner.

Goods damaged due to inadequate marking may be broken, explode when stacked on top of each other, may be mixed due to lack of support, the logistics operator, who is under obligation to mark the goods in accordance with the chemical or other dangerous nature of the goods, must know and perform accordingly and receive this service from third parties as required.

There are generally valid markings for logistics operators and the meaning of these markings should be considered by the performance assistants and men who take part in each stage.

Whether the goods are subject to customs clearance or not, and how the transportation stacks and packages are unpacked, may also need to be specifically indicated in the marking. There may be differences depending on the goods and the mode of transportation.

### 6-4.5. Loading and Unloading

Pursuant to Article 863 of the TCC, loading and unloading must be carried out by the consignor, unless it is otherwise understood from the contract, the necessity of the situation or commercial practice. In the event that the consignee on behalf and account of the shipper is different, the unloading of the goods shall belong to the consignee. However, it is possible for the logistics operator to undertake these obligations under both the contract of carriage and the logistics service contract.

For the cargo to be transported without any damage during transportation, loading should be done in accordance with the vehicle and the road. Loading that considers the vehicle and road conditions can be said to be in compliance with “transportation safety”. For the vehicle to travel safely in traffic, the traffic order must be ensured as “operational safety”.

If the logistics operator undertakes loading and unloading, both operational safety and loading safety are within the scope of the operator’s obligations. Even when the carrier and driver are outsourced, the operator will be responsible for the entire process.

In addition to the driver, it is the joint responsibility of the parking lot manager, the business manager of the shipper, the port or area exit officer, the authorized officer for the transportation of dangerous goods, the relevant authorized managers, and officers to ensure operational safety. However, if the logistics operator has undertaken this work with a contract, all these persons should be evaluated within the scope of the responsibility of the logistics operator.

Responsibility for loading exceeding the loading capacity, gauge, overloaded cargo or the limit of loading can also be evaluated within the same scope. Responsibility for administrative sanctions due to these reasons and their final responsible parties will also be determined according to the provisions of the contract.

The liability of the driver for carelessness and imprudence in exceeding the transportation capacity and the liability of the logistics operator must be included in the contract.

The TCC considers loading as the sum of the acts of placing on the vehicle, stacking and securing. Even in the case of special stacking and lashing companies, it is a legal requirement that the work should be considered as a whole and stacking, fixing and placing on the vehicle should be considered as a single act in terms of logistics services. However, it is possible to separate these activities in the logistics services contract.

In cases where the cargo overturns in the normal course of the vehicle, the stacks deteriorate, and damage is caused by pressure and friction, it cannot be ignored that the main cause of damage is caused by loading. However, sometimes there are cases where different risks related to loading and goods are the cause of damage together, and there is a common fault and responsibility. Here, it is inevitable to discuss the effect of tipping, friction or the nature of the goods on the damage and to apportion fault accordingly.

The loading and unloading periods must be specified separately in the contract as free time and time periods for which compensation may be calculated. Paragraphs 862/2 and 3 of TCC Art. 862/2 and 3 should be taken into consideration here and should be observed in the contract between the parties.

## 6-5. Brokerage Activities as a Broker and Other Activities

### 6-5.1. Storage

The cargo may be securely stored in places such as ports, airports, terminals or warehouses, as well as in warehouses or warehouses and warehouses with storage agreements. In this case, the forwarder, who is in charge of concluding the contract, may separately claim and sue for the payments arising from these works. The costs and expenses incurred in works exceeding the ordinary transportation works shall be claimed from the cargo interest.

### 6-5.2. Order planning

Necessary contracts can be made to plan how much and when the raw materials and/or intermediate materials required in production will be available. For this purpose, it is inevitable

to store at the nearest point and to make shipments with partial transfer accordingly. In this case, there must be a special agreement in the contract. Otherwise, the costs and costs incurred for such works that arise with orders and instructions may be reflected on the cargo concerned.

### 6-5.3. Preparation

Preparation of cargo for transportation is a general term. In particular, activities such as assembly, disassembly, packaging for commercial use and marketing activities, preparation of user manuals, translation and printing of documents, warranty and compliance documents are within this scope. Such works should be defined and undertaken separately. This is because the costs of these activities, which are included in the production process and which are also among the logistics operations, but which are not usual in transportation operations, will be based on special instructions.

### 6-5.4. Customs procedures

In addition to direct representation before the customs authorities, in addition to the indirect representation authority granted to customs brokers, other customs regimes with economic effect and other customs procedures may be carried out in addition to summary declaration, export declaration or import declaration works and transactions based on the powers granted to the organizers of transportation works. Here, tax payment or other legal obligations may be reflected on the cargo to the extent that they are incurred. However, the representation of the transactions may be considered among the works carried out with a definite fee included in the logistics process. Therefore, it should be specifically considered in the contract process.

## 7- Conclusion

Among the enterprises that carry out logistics activities that require important systems and applications in the procurement process, freight forwarders, which are established and operated as a separate commercial enterprise that also takes the titles of agency, broker and carrier, are the main and most broadly responsible actors. While they perform the operations required by this position through contracts; it is not important whether they actually perform them or not. In other words, while establishing contractual relations and taking part in the responsibility network, they take part in the process together with those who actually do the work.

The contracts concluded by these enterprises are atypical contracts that can be evaluated within the general boundaries of the work contract, which covers many important and separate contractual activities, although the logistics services are concluded as a framework contract with continuous performances and fixed-term contracts. It should be applied as a combined

contract. It should not be ignored that the main operation consists of transportation works that must be actually carried out in terms of all logistics processes.

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# CHAPTER 9

# EVALUATION OF SUSTAINABLE PRACTICES AND COMPANY PROFITABILITY OF TRANSPORTATION AND LOGISTICS BUSINESS

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**ABSTRACT**

Sustainability assessments are made by considering financial and non-financial indicators. Various profitability measures (such as EVA, CFROI, ROA, ROE) are used to analyze the financial status of companies and measure their profitability. The aim of the article is to apply the profitability criteria to the corporate data of 6 logistics and transportation companies in Europe and Turkey and to measure the level of significance between the sustainability performance criteria of the companies. This study is based on the information obtained through a comprehensive literature review on sustainability and profitability criteria, and the financial statements and balance sheets of companies. Obtained data were analyzed by correlation and ANOVA. As a result of the research, EVA, which is among the profitability criteria, gave the most similar result to the total sustainability performance score ranking. However, the closest result to the social sustainability performance score ranking was the ROA and ROE profitability criteria ranking, while the closest result to the economic sustainability performance score ranking was the EVA profitability criterion.

**Keywords:** Sustainability, Logistics management, Financial profitability

## 1. Introduction

Businesses, which form an important part of economic, social and environmental life, are expected to act responsibly and to report not only the economic impact and results of their activities, but also the social and environmental impacts and results, due to their position and roles. The reporting of an enterprise's activities, including its economic results as well as its social and environmental consequences, is perceived by its stakeholders as an indicator of the value given to their expectations. Reports containing the economic, social and environmental impacts and results of an enterprise's activities are also called by various expressions such as sustainability reporting, non-financial reporting, triple responsibility reporting, corporate social responsibility reporting.

In this section, the relationship between the level of knowledge disclosed in sustainability reports on economic, environmental and social performance and company profitability will be examined. Sustainability reports of a total of 6 companies operating in the fields of "storage, transportation, logistics and courier services" and "travel and transportation services" in Europe and Turkey were examined. For this purpose, the company profitability and sustainability performances of the enterprises were analyzed and ranked. The reports of businesses published in 2021 according to the Global Reporting Initiative (GRI) reporting principles were considered.

The aim of this study is to determine the relationship between the knowledge levels of the companies that publish sustainability reports according to the GRI reporting framework in Europe and Turkey, regarding the sustainability performance indicators, and the profitability of the company. For this purpose, firstly, the level of knowledge disclosed by the companies that publish sustainability reports in accordance with the GRI reporting framework regarding the performance indicators in the aforementioned reports will be determined. Then, the relationship between the determined sustainability performance levels and company profitability will be revealed.

The studies examined within the scope of this study were categorized similar to the classification system used by Baah et al., who examined the sustainable practices and financial performance in detail in the logistics sector (1). Although it examines sustainable / green logistics practices and financial performance, studies that are not included in the classification system used in the aforementioned study are listed under the title of "Other". In this context, in the literature review, it is seen that studies that reveal the relationship between sustainable logistics practices and financial performance have gained popularity in the last 10 years. On

the other hand, in order to ensure that the literature review covers current developments and practices and to look at the phenomenon from a wider perspective, care was taken to include studies carried out in 2000 and later.

The total number of studies selected and included in the literature study after a detailed and comprehensive search is 64. The specified number of studies were categorized in accordance with the classification system used in the above-mentioned study, as can be seen in Table 1. Regardless of the category, in most of the studies, qualitative methods are preferred instead of quantitative; In quantitative studies, which are very few, it is seen that the data obtained through questionnaire forms are analyzed with the structural equation model. The studies in question were often carried out by Chinese or Hindu scientists; It was mainly published in the Journal of Cleaner Production.

**Table 1.** Literature Classification

| **Literature Classification Title** | ***Number*** |
|---|---|
| **Sustainable Transport** | 7 |
| **Reverse Logistics** | 8 |
| **Waste Management** | 7 |
| **Sustainable Packaging and Distribution** | 8 |
| **Green Monitoring and Evaluation** | 9 |
| **Sustainable Knowledge Sharing and Corporate Reputation** | 10 |
| **Other** | 15 |
| **Company Profitability** | 17 |
| **TOTAL** | 81 |

*Literature created by authors*

## 1.1. Sustainable Transport

Deakin analyzed the current strategies on sustainable transportation in a qualitative context within the framework of transportation and land use planning; He stated that strategies such as demand management, operational management, pricing policies, innovations in vehicle technology, clean fuel, transportation, and land use integration can be seen as an element of sustainable development (2).

Ramudhin et al., in their study, examined the steel industry, whose right to carbon emission is restricted within the framework of the existence of new legal regulations on carbon emissions; They aimed to design a supply chain through goal programming, considering carbon emissions and total logistics cost (3). In the supply chain strategies that are tried to be created, they examined the alternatives of iron, air and road for the shipment of products; They tried to

determine the minimum cost strategy for each mode of transport. In this context, they focused on finding the optimum balance between cost and carbon emissions with the help of goal programming; the solution they obtained is only 0.14% in terms of cost, from the minimum cost-oriented strategy; They concluded that the carbon emission focused strategy is 26.1% more in terms of carbon emissions.

Gao et al. have defined a flow optimization-based framework (FORTE) for route planning and traffic engineering demands; After listing the usage areas, they explained how the user groups, data centers and the information containing the data would be entered into the system in order to determine the effect on the decisions of different users (4). After the explanation, the authors, who carried out a case study on the Akamai content distribution network, used 24-day workload as data; They aimed to estimate the carbon emissions in each data center and the waiting time between the user and the data center. As a result of the study, it has been revealed that if the route planning demand is handled with the stated approach, the carbon footprint can be reduced by 10% without increasing the electricity costs in Akamai and without compromising the simultaneous access time. Thanks to the system in question, Akamai's total carbon footprint is expected to be reduced by 25% within three years.

Maheshwari et al. were inspired by the Prey-Hunter Model developed by Lotka and Volterra in their work, which aimed to design a dynamic model that would detect the independent behavior of transportation, economic and environmental systems; They found that the performance of the transportation system and the activity system exhibits a lagged periodic structure, while there is a decreasing trend in the environmental system performance (5).

De Souza et al., in their study to evaluate the difference between current fuel use and electricity that can be used as an alternative power source in Brazil, argue that less fossil fuels and more renewable energy should be used in order to reduce air pollution and carbon emissions (6). In this study, which examines and compares the environmental impact of vehicles in Brazil, 5 different scenarios were created in which the fuel consumption of a vehicle and its running gear were evaluated throughout the life of the vehicle. These analyzed scenarios were determined as a conventional internal combustion engine vehicle running on petroleum, a conventional internal combustion engine vehicle running on biofuel (hydronus ethanol), a conventional internal combustion engine operating with mixed fuel, a rechargeable hybrid electric vehicle, and a battery electric vehicle, respectively. As a result of the evaluations made on the fuel or electricity consumed in the 1 kilometer journey, the vehicles using biofuel have the highest environmental impact in the categories of acidification, eutrophication and photochemical oxidation, and the vehicles using petroleum have the highest environmental

impact in the categories of consumption, depletion potential of fossil fuel resources and global warming potential, It has been observed that vehicles using lithium-ion based batteries have the highest effect on human poisoning. It was determined that the vehicles with the lowest environmental impact were electric vehicles, followed by vehicles using biofuels.

Shi et al. conducted a study in which supply and demand elements in the electronic passenger transportation sector were modeled in an integrated manner with the sustainability dimension; they evaluated the current results from both an economic and environmental perspective in each of the studies they identified by scanning the academic literature (7). According to the aforementioned study, very few of the existing studies in the literature also cover the social perspective.

Tercan et al. studied three different sustainable transportation design scenarios, including a solar open circuit power plant as an alternative to diesel-fueled touristic boats (8). In this case study, which considers many financial and technical dimensions such as local lighting, energy load, and system energy loss, it was determined that diesel fuel consumption would decrease by 15% in solar powered diesel boats as an economical option. The simulation, made with an all-electric boat, will cover nine years with the investment to be made for the battery that will produce 60 kWh of energy at first, and 13 years with the investment to be made for the battery that will produce 120 kWh of energy; It points out that a solar-powered open-circuit power plant that will provide 300 kW of power will result in 330 tons less carbon emissions per year.

## 1.2. Reverse Logistics

De Brito, with his work to better explain the concept of reverse logistics, contributed to the evaluation of the concept of reverse logistics as a research topic, to understand reverse logistics applications, to the establishment and support of decision-making mechanisms related to reverse logistics, and also steered other studies to be carried out in this field (9). ). He underlined that logistics applications cannot proceed without considering the framework for returns.

Mollenkopf et al., underlining that the logistics sector is leading in packaging and packaging services, argued that with reusable packaging systems, businesses will not only reduce their carbon footprints, but also reduce their costs (10). In this research on the relative cost of an existing reusable container system in an automobile manufacturing facility, container cost, transportation cost, labor cost, waste cost and recycling revenue were used as independent variables. The dependent variables selected for each independent variable are shown in Table 2. After the regression study using the processes and comparative analysis carried out over the GM Powertrain Division, it was concluded in the study that a cost advantage can be

achieved as a result of improving packaging and packaging services -not only limited to the automotive sector-.

| **Table 2.** List of variables by Mollenkopf et al. (10) | |
|---|---|
| **Related Cost ($/piece)** | ***Effect*** |
| **Cost of Container** | Unit purchase price |
| | Packing quantity |
| | Average daily volume (Y) |
| | Currency fluctuation volume (Y) |
| | Container turnaround time (Y) |
| | Container rate of return (Y) |
| **Cost of Transportation** | Basic transport schedule |
| | Delivery distance |
| | Frequency of supply |
| | Average daily volume |
| | Discount rate applied to transportation income (Y) |
| | Number of stops (Y) |
| | Number of standings (Y) |
| **Labor Cost** | Container loading time |
| | Worker wage |
| | Packing quantity |
| **Cost of Waste** | Waste cost amount (G) |
| | Container weight (G) |
| | Packing quantity (G) |
| **Recycling Yield** | Recycling tariff per kilo |
| | Container weight |
| | Packing quantity |
| | Number of working days per year (Y) |
| | Recycle time (Y) |
| | Container lifetime (Y) |
| *Y: Reusable System Only, G: Extended System Only* | |

Abdullah and Yaakub have worked to determine the extent to which reverse logistics practices are adopted in Malaysia and various pressures that they classify as customer/stakeholder, regulatory, financial and competitive, and corporate social responsibility that led to its adoption (11). In addition, they also examined the relationship between the level of adoption of reverse logistics applications and business performance. In the light of the data obtained through the questionnaires answered by the managers of the manufacturing enterprises in Northern Malaysia, 101 samples were examined. Examples indicate that the adoption level of reverse

logistics practices is very low in the Malaysian manufacturing sector. The set obtained from the sample was subjected to partial least squares regression analysis method via SmartPLS 2.0 software; Among the independent variables, it was determined that only regulatory pressures had a strong effect on the adoption of reverse logistics applications. However, the impact of customer and stakeholder pressure on the adoption level of reverse logistics applications was limited to moderate. It has been pointed out that business performance does not affect the adoption of reverse logistics practices.

Govindan, Soleimani, and Kannan conducted a detailed literature review in their study, which they classified by examining a total of 382 academic publications on reverse logistics and closed-loop supply chain between 2007 and 2013; identified existing gaps in the literature and made suggestions for future studies (12).

Cannella, Bruccoleri, and Framinan, in their study where they analyzed the inventory and order flow in the closed-loop supply chain, argued that the materials introduced into the system for recycling complicate reverse logistics, therefore, inventories should be followed closely, and supply regulations should be designed (13). There is a strong hypothetical analysis of various operational and market conditions under the closed-loop supply chain in their work, which they carry out by adopting the mathematical equation of difference and experience design approaches after a systematic literature review. The analysis, performed under the assumption that all other variables are constant, shows that the closed-loop supply chain outperforms the forward supply chain in both single-stage and multi-stage structures, both in fixed and fluctuating market demands. In addition, the production order delivery time is shortened; It was concluded that the issue of information transparency was also supported.

Dias and Braga, in their case study in which they examined a grocery supplier in Sao Paulo, Brazil for six months, observed the amount of cardboard and plastic waste produced by each department within the supplier business (14). Using the Wuppertal method, the authors, as a result of their observations, claimed that the supplier company, which is the subject of the case study, generates approximately 20 tons of biotic and abiotic wastes per month, and that these wastes are capable of causing global warming and destruction of the ozone layer. After reverse logistics practices are integrated into the business, 2.18 kilograms of abiotic and 0.75 kilograms of biotic waste are prevented from being released into the environment for every 1 kilogram of recycled plastic and cardboard waste. In addition, it was concluded that 107.68 kilograms of water and 0.56 kilograms of air pollution were prevented, and it was emphasized that reverse logistics practices protect the environment and increase the quality of life of families and other social structures living in that area.

Khan et al., in their work on the idea of a Cradle-to-Cradle industrial model (Figure 1) in South Africa, established a conceptual decision-making model for the reverse logistics of electronic devices (15). Considering the efficiency-based cost, the authors classify the reverse logistics of electronic devices in four stages: collecting the devices to be recycled, classifying the devices to be recycled in terms of quality and product activity, transporting the devices to be recycled to recycling facilities and storing them. They emphasize that although both reverse logistics and green reverse logistics applications are supported by the created model, the strategies that only electronic products manufacturing companies will adopt will not be enough to put green reverse logistics into action, and the participation of customers and the support of the government will also provide great benefits.

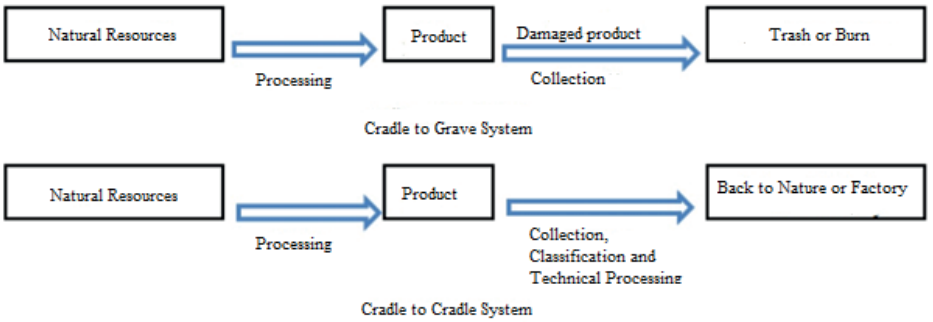


***Figure 1.*** Cradle to Grave System and Cradle to Cradle System (15)

Morgan et al., by examining resource procurement within the framework of the structure-behavior-performance paradigm, conducted a study linking this paradigm to sustainable supply chain management (16). The authors, who analyzed the data they obtained through the questionnaires they obtained from 180 supply chain professionals with the structural equation model, suggested that the model suggesting resource procurement could be used to develop sustainable reverse logistics capabilities, thus reducing the environmental impact of reverse logistics activities.

## 1.3. Waste Management

Nagurney and Toyasaki designed a multi-stage e-recycling network equilibrium model (See Figure 2) in their study to create a reverse supply chain model for the management of electronic waste, including recycling applications (17). In the study, a model that can address many recycling problems in relation to the current rules specified in recycling legislation such as the regulations covering the recycling of small household appliances in Japan or the instructions for the waste of electronic devices of the European Union has been formulated

and reverse-supplied during the recycling of electronic waste. Suggestions for solutions to the problems encountered in the chain are presented.

Verghese and Lewis, in their studies, compiled the studies on the industrial packaging supply chain in Australia between 2003 and 2005 and examined them with the supply chain approach; they used nine case studies to develop an overall approach to supply chain practices for waste reduction in packaging (18). In the study, it was emphasized that waste reduction strategies are very important in the industrial packaging supply chain, and it has been suggested that they have some benefits such as saving in packaging and reducing waste costs. The study contributes to the implementation of a sustainable packaging program that is compatible with both business partners and supply chains of businesses through a two-stage approach defined as "Connecting and Accomplishing Change" (see Figure 3).

Guerro, Maas, and Hogland, in their study, conducted in two academic journals (Waste Management Journal and Waste Management and Research), since waste generation in developing countries has become a major problem due to the increasing increase, and the said activities have started to create a serious burden in the context of local government budgets (19). They analyzed publications published between 2005 and 2011; they aimed to identify the existing stakeholders/behaviors in the waste management process and to identify the factors affecting the system. The data used in the study were obtained from scientific studies, existing databases, observations on visits to regions, interviews with experts in the field, and exercises and studies implemented in workshops attended by stakeholders. As a result of the study, the elements of waste management systems and the factors affecting the dimensions of the waste management system were determined and listed as follows (see Table 3); It has been emphasized that they are important in planning, changing and/or implementing waste management systems in cities.

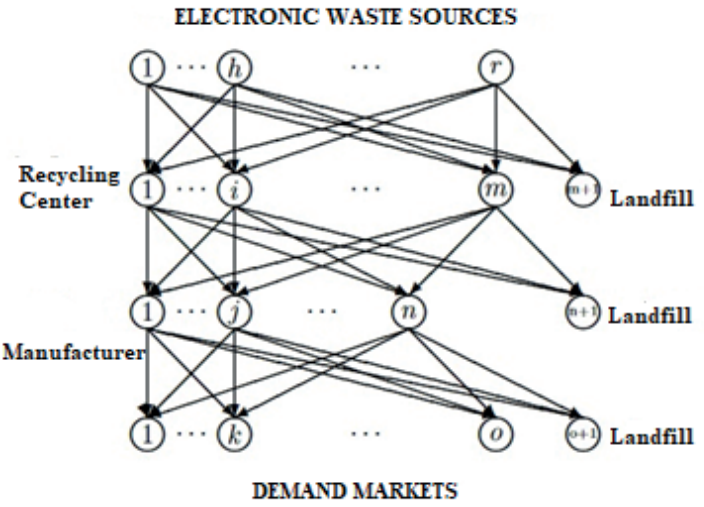


***Figure 2.*** Cascading E-Transformation Network (17)

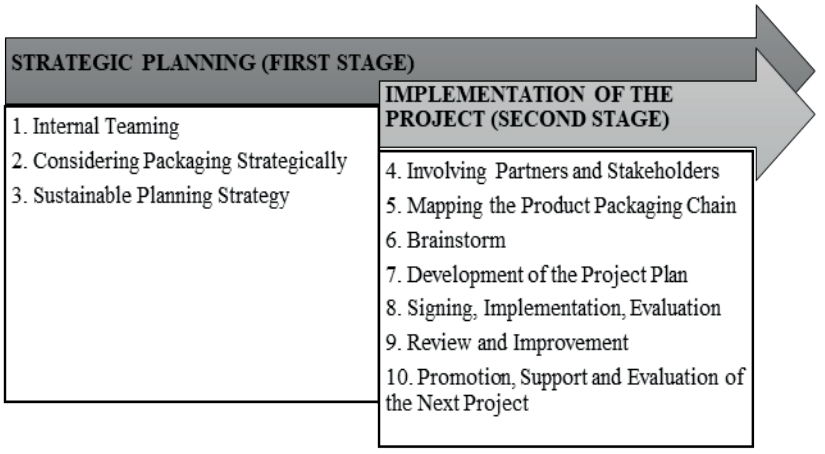


***Figure 3.*** Method of Connecting and Succeeding Change (18)

**Table 3.** Waste Management Factors (19)

| **Factors Affecting Elements of Waste Management Systems** | **Factors Affecting Dimensions of Waste Management Systems** |
|---|---|
| Creation and Extraction | Technical Factors |
| Collection, Transfer and Transport | Environmental Factors |
| Improvement | Financial/Economic Factors |
| Destruction | Socio-Cultural Factors |
| Recycle | Institutional/Government Factors |
| | Political/Legal Factors |

In their study, Bartolacci et al., in the light of the Circular Economy Strategy of the European Union, examined the relationship between the financial performance of 45 enterprises operating in the field of waste management in Italy between 2012 and 2015 and their waste collection performance from an environmental point of view (20). In the study, the return on assets ratio was used to evaluate the financial performance, and the separated waste collection rate and the amount of garbage collected per capita were used as variables to evaluate the environmental performance. With the study, it was determined that there is a low-level positive correlation between financial performance and waste management. Again, the same authors, in another study in which they tried to determine the factors affecting the financial sustainability of waste management, conducted an analysis of 880 Italian municipalities and their financial performance through waste management enterprises operating in these municipalities (21). As a result of the study, the collection of separated waste has a positive effect on the financial performance of the enterprises; On the other hand, it has been observed that the geographical spread of municipalities over a wide area negatively affects the said financial return. In addition, no relationship was observed between the potential existence of a waste disposal facility or the geographical region in which they are located and financial performance. As a result, it has been argued that it would be more appropriate to encourage segregated waste collection activities rather than expanding the geographical areas served.

Pujara et al., who criticize the open dumps that cause urban waste problems in India, conducted three different scenario analyzes covering the years 2001-2051, which are likely to contribute to the 2030 sustainable development goals (22). In the first scenario, the amount of waste that will be encountered if India does not change its current practices is calculated. In the second scenario, it was evaluated that these wastes could be reduced by 60% according to the conditions of 2031. In the third scenario, it was observed that the waste could be reduced by 80% according to the conditions of 2031, and it was concluded that the third analysis was the most ideal scenario (See Table 4).

**Table 4.** Scenarios for the sustainable management of solid waste (22)

| **Scenario** | ***Population (Billion)*** | ***Waste Amount (Billion Tons/ Year)*** | ***Technology*** |
|---|---|---|---|
| **I** | 1.46-2.59 | 0.303–0.735 | General collection, separation, pouring |
| **II** | 1.46-2.59 | 0.121–0.294 | Waste separation at the source, 60% reduction of waste by composting, biogasification, fuel produced from waste, material remediation facilities, bulk |
| **III** | 1.46-1.77 | 0.121–0.167 | Controlled population regulation, waste source separation, 60% reduction of waste by composting, bio gasification, fuel produced from waste, material remediation plants, bulk |

Gull et al., in their large and international study containing data from 41 countries between 2002 and 2019, aimed to analyze how waste management affects the relationship between sustainability performance and financial performance of enterprises (23). As a result of the study, the increase in the amount of waste produced is equally negative to the business performance; the increase in the amount of recycled waste has a similar positive effect on business performance; It has been determined that transaction costs are a primary motivation source in the adoption of studies on waste management and business performance.

## 1.4. Sustainable Packaging and Distribution

In his introductory study on packaging and its effects on the environment, Lewis discusses the results of the questionnaire he applied to the stakeholders operating in Australia in 2003 (24). This study, which aims to record the opinions of stakeholders about environmental impacts and packaging management, highlights a systematic lack of need for more economical transportation and distribution systems to create high environmental awareness and positive impact.

Sonneveld et al., in their study, developed a decision tool (PIQET©) that would allow businesses to quickly assess the impact of packaging, including packaging strategies, packaging material selection, packaging R&D studies, and customization of packaging selection to merchandise (25). The authors also criticized that the waste reduction and recycling oriented view is not as popular as it used to be and underlined that sustainable packaging methods should be approached with a holistic approach in a way to cope with future social and industrial challenges. Therefore, they argued that with the decision tool they developed, PIQET© (see Figure 4), users can easily and accurately evaluate the technical, commercial, social and environmental performance of packaging systems.

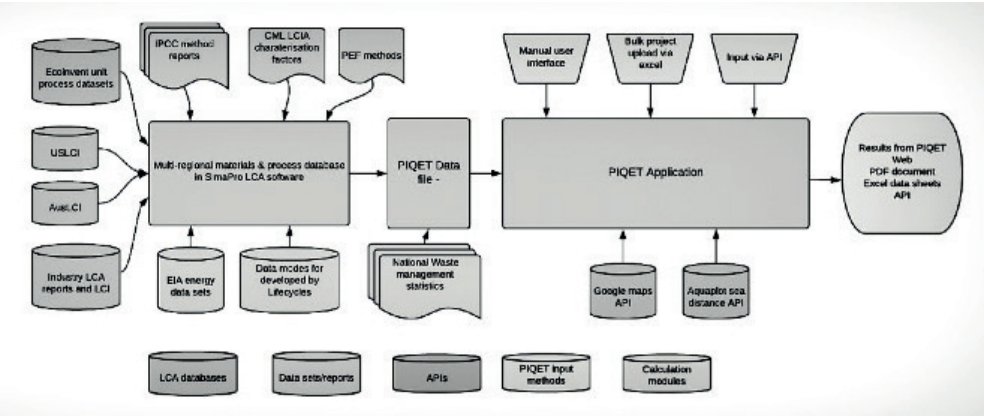


***Figure 4.*** PIQET© as a concept (25)

Bucci and Forcellini included an environmental perspective in the beginning of the process, taking into account the product and packaging development processes and the inseparability of the aforementioned processes in their work aimed at creating an integrated sustainable packaging design model (26). Stating that ecological design and tools should be incorporated into every stage of the process, the authors argue that a better ecological efficiency can be achieved through the model they present, regular use of the model will provide time and cost advantages in packaging, and also minimize the damage caused by packaging to the environment.

Zailani et al. examined the impact and results of environmental purchasing and packaging practices in sustainable supply chain management, using data from approximately 400 businesses in Malaysia through a questionnaire form (27). In the study, which is carried out on four main dimensions as environmental, economic, social and managerial, it is argued that sustainable supply chain practices have a positive effect on businesses that are the subject of research, especially in economic and social terms.

Chhabra, Garg, and Singh, in their study of an automobile company in India, investigated alternative green logistics practices that could have a positive ecological impact due to the rapid increase in vehicle volume recently and that would be compatible with the organizational goals of the business (28). Alternative green logistics practices in the assembly and packaging process were categorized as green efficiency (GE), safety factor (SF) and ease of operation (EO), and the Analytical Hierarchy Process was used to determine the best among the alternatives (see Figure 5). As a result of the study, it was concluded that press joining application in assembly and carbon positive packaging material in packaging is the best alternative.

Atmaca and Çalgüner discussed how the changes in packaging design from past to present contribute to sustainable development in their studies in which the definition of the concept of sustainability is included (29). Underlining that it is the designers who will minimize the consumption of raw materials and the harm of such consumption to the environment, the authors argue that it will be important and constructive for the designers to raise their awareness in this context.

Meherishi, Narayana and Ranjani systematically examined the academic literature of the last 18 years in the field of sustainable packaging in the supply chain and classified them as circular economy (30). As a result of the study, three basic structures related to sustainable packaging in the supply chain were determined; Gaps in the literature were identified and suggestions were made for future studies.

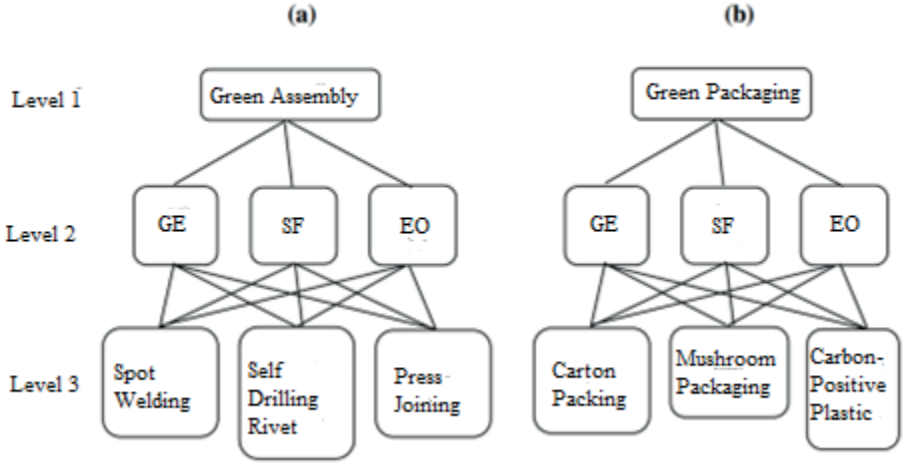


***Figure 5.*** Analytical Hierarchy Process Schematic Table (28)

Afif, Rebolledo, and Roy, in their study, in which they analyzed 48 very influential academic publications published in 26 different academic journals in order to determine the motivations that support the adoption of sustainable packaging strategies, the factors that hinder them, and the performance outputs of sustainable packaging, they concluded that there are seven main sources of motivation and three main obstacles (31). Emphasizing that motivation and barriers are related to business size, the authors argue, in the light of their findings, that the adoption of integrated packaging strategies improves packaging sustainability at three different levels (see Figure 6).

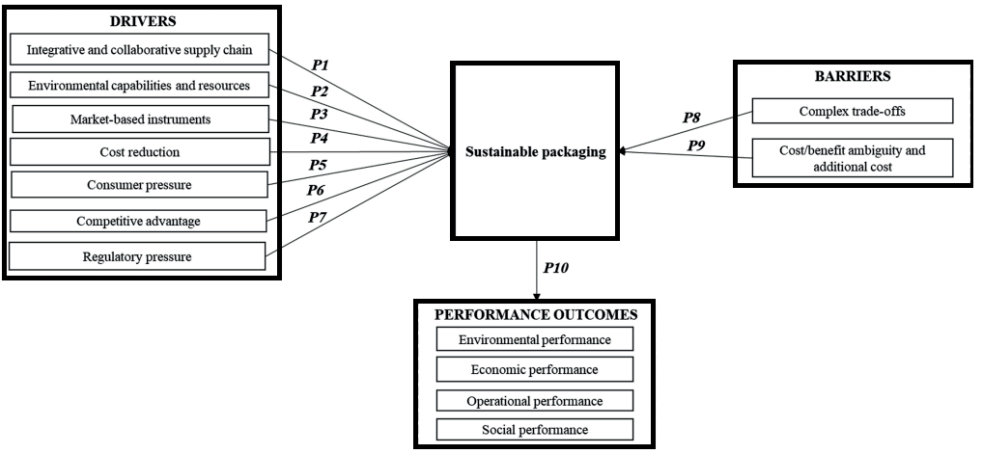


***Figure 6.*** Concept Framework (31)

## 1.5. Green Monitoring and Evaluation

Carter and Jennings applied a questionnaire form to 26 managers under the main heading of logistics as a social responsibility. and managers' views on purchasing, transportation, and warehousing, and then compared the data they obtained with studies in the literature on logistics management, general management, corporate social responsibility, and business ethics (32). As a result of the study, it has been determined that the people working as managers in the logistics sector have a positive effect on the reshaping of the organizational culture and the evaluation of logistics activities as a social responsibility.

Olhager and Selldin, in their study, focused on supply chain design, integration, planning, control and communication tools for supply chains for 128 manufacturing companies in Sweden (33). The analysis they conducted on the data obtained through questionnaires from 128 of 511 companies that are members of the Swedish Production and Inventory Management Society (PLAN) indicates that the supply chain design aims to improve resource use and reduce costs in general and each process included in the supply chain is of great importance, especially in terms of quality, in the search for business partners.

Eeseley and Lenox examined the activities of more than 600 secondary stakeholders dealing with environmental issues in the United States between 1971 and 2003 in the context of the stakeholder analysis model of Mitchell, Agle, and Wood (34). The analysis carried out reveals that the power of the stakeholder depends on the power of the business, the legitimacy of the demands made in addition to the legitimacy of the stakeholder is also important, and the urgency of the demand comes before the urgency of the stakeholder group. The results obtained are also important for public order. The authors also underline that they suggest that policy makers can be encouraged by secondary stakeholder groups to self-control the impact of businesses on society.

Colicchia et al., in their study to determine the motivations and barriers that lead to the adoption of environmental initiatives operating in the field of contract logistics as logistics service providers, and to determine which scales they use to evaluate their environmental performance, created their research framework after a comprehensive literature review and evaluated their environmental reporting by applying the framework to 10 different logistics service providers (35). To make an in-depth analysis, the study including interviews with three selected businesses shows that logistics service providers have adopted numerous sustainable practices, especially in distribution and transportation, that they do not have a standard method that includes both costs and benefits in order to evaluate their environmental effects, and that the biggest motivation sources for adopting sustainable practices are their customers.

Santis, Albuquerque and Lizarelli compared the performance of companies in the Corporate Sustainability Index in Brazil with the performances of companies in the Sao Paulo Stock Exchange Index in their studies to determine whether businesses that have adopted sustainable practices have better financial and economic indicators (36). Profit and liquidity ratios were calculated for the said comparison, and possible trends, similarities and differences were tried to be determined statistically; As a result, no sustainability factor was found among the examined businesses that would cause any financial or economic change.

In his study, which argues that environmental sustainability is not a priority for many businesses today, Fernando compiled visionary businesses that have already embraced developing green economic activities (37). The author, who included Puma, Unilever, General Electric and Tesla in his research, emphasizes that the blue ocean strategy should be adopted to prevent climate change and provide strategic environmental sustainability.

Gupta, Singh, and Suri, in their study, aimed to rank the critical success factors required for logistics service providers in India to provide sustainable service and to rank these factors according to their importance in the fuzzy TOPSIS method (38). Expert opinion was sought for the evaluation of the 12 identified critical success factors (see Figure 7); management orientation and workforce, understanding and analyzing customer needs, service quality and logistics management integrated with reliability were determined as the four most important factors.

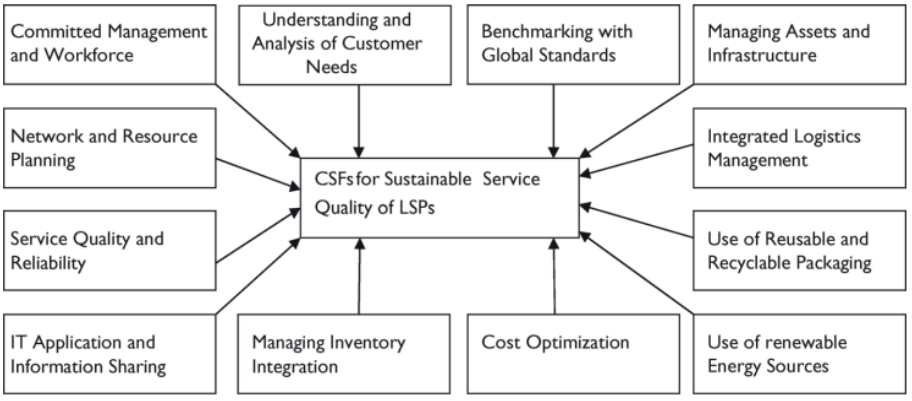


***Figure 7.*** Identified Critical Success Factors for Sustainable Service Quality of Logistics Service Providers (38)

Gustavo Jr et al. examined the impact of redesigned packaging products on retailers under the headings of motivation, opportunity and barrier and conducted a case study on a global supermarket chain (39). As a result of interviews with senior managers and customer observations, it has been determined that the biggest motivation source for both the supermarket and

its suppliers to turn to packaging improvement is economic gains, and environmental gains can be created through these economic returns. Opportunities were expressed as changes in packaging depending on the amount that customers purchase during their supermarket visits, while it has been argued that obstacles arise from commercial uncertainties.

Agyabeng-Mensah et al., in their study, examined green logistics management, social, environmental and financial performance and market performance sub-dimensions in order to determine whether it results in a sustainable performance (40). In order to determine the direct and indirect relationships between the variables in the data set obtained from a total of 249 businesses operating in the entertainment, production and logistics sectors, a structural equation model using the partial least squares regression analysis method was run through the SmartPLS 3.2.8 software. In the light of the results obtained, it has been determined that while green logistics practices have a positive effect on environmental performance, it does not have a significant effect on social and financial performance and market performance. The authors argue that adopting green logistics management does not make a significant contribution to improving social welfare, the health of employees and society, but improves financial performance through environmental and market performance.

## 1.6. Sustainable Knowledge Sharing and Corporate Reputation

Bansal and Roth, in their study, in which they examined the data obtained from 53 businesses in England and Japan through questionnaires, interviews and document review, focused on explaining the reasons for businesses to adopt environmental practices, determining the sources of motivation for these practices, and developing contextual variables (41). Thanks to the data they obtained because of comprehensive research, they identified three main motivations that affect ecological sensitivity and can be defined as competition, compliance with the law and ecological responsibility. However, the authors underline that technological opportunities, experienced human resources and other resources are needed to adopt a full-fledged environmental practice and argue that the failure of some businesses to adopt environmental practices may be due to the high cost of these facilities and resources.

Carter and Dresner aimed to reach a deeper result by limiting the survey form method, which is frequently used in the literature, to case analysis, and in this direction, they included both successful and unsuccessful businesses from various sectors in their research (42). Using the snowball sample, the authors, aiming to create a theory because of their research, revealed that the way for business managers to qualify an environmental project as successful is not only through improved financial performance, but that the project has to be truly successful in

environmental terms. It has also been underlined that the projects that are successful in practice will provide cost advantage, increase in production quality and a more effective relationship with the stakeholders.

Zsidisin and Siferd dealt with transaction costs and risk within the broad framework of the concept of supply chain, examined the studies in the literature in terms of environmental purchasing strategies, and determined that there is a causal relationship between purchasing activities and the effect of transportation, packaging, reuse and recycling (43).

In their study, Seuring and Müller conducted a literature study in which they examined 191 studies published between 1994 and 2007 in detail, supply chain management is too broad to be examined in a narrow scope, that the sustainability of sustainable supply chain management should also cover environmental and social dimensions, and that cooperation with joint ventures in a sustainable supply chain is extremely important (44).

Zhu and Sarkis examined the relationship between green supply chain management practices, environmental and economic performance in their study, in which they applied hierarchical regression analysis to the data set they created through questionnaire forms obtained from 341 manufacturing enterprises operating in China (45). In the framework of the findings, which are divided into three classes as financial, legal, and competitive pressure, they determined that environmental pressures are gradually intensifying when Chinese enterprises adopt green supply chain practices, and the presence of financial and legal pressures has an effect that improves the environmental performance of enterprises. In addition, they have shown that manufacturing businesses facing increasing legal pressures are turning to green purchasing and investment protection policies, significantly increasing economic returns by adopting many green supplies chain practices without adversely affecting environmental performance under competitive pressures. They also found that no corporate pressure contributed to businesses or diminished any possible “win-win” strategy.

Carter and Rogers, as a result of their literature study on the understanding of sustainability in supply chain management, emphasized that enterprises can achieve financial sustainability in the long run with environmental, social and economic integration (46). Similarly, Teuteberg and Wittstruck systematically reviewed research on sustainable supply chains; revealed that these studies are often handled from an economic point of view (47). The shortcomings of how sustainable supply chain can be measured with which performance indicators, what kind of a causal relationship between sustainability and financial success in the long run, and how to solve the deficiencies in the supervision of sustainable supply chain practices have been criticized.

In their study, which aimed to investigate the role of eco-oriented culture in the relationship between stakeholder pressures and the adoption of environmental logistics activities, Kim and Lee examined the structural equation model that they applied to the data they obtained through the questionnaires they applied to logistics and production enterprises in South Korea (48). Environmental logistics activities are handled in three main dimensions as Internal Environmental Management (DÇY), Environmental Resource Utilization and Packaging (ÇKKP) and Environmental Process Design (ÇST). On the other hand, it was determined that eco-focused culture also has three sub-dimensions: Ecological Intelligence Creation (ICM), Ecological Intelligence Distribution (EZD), and Ecological Intelligence Resolution Capability (ECCM) (see Figure 8). As a result, it has been determined that eco-oriented culture acts as a full mediator at the point of adopting stakeholder pressures and environmental logistics activities.

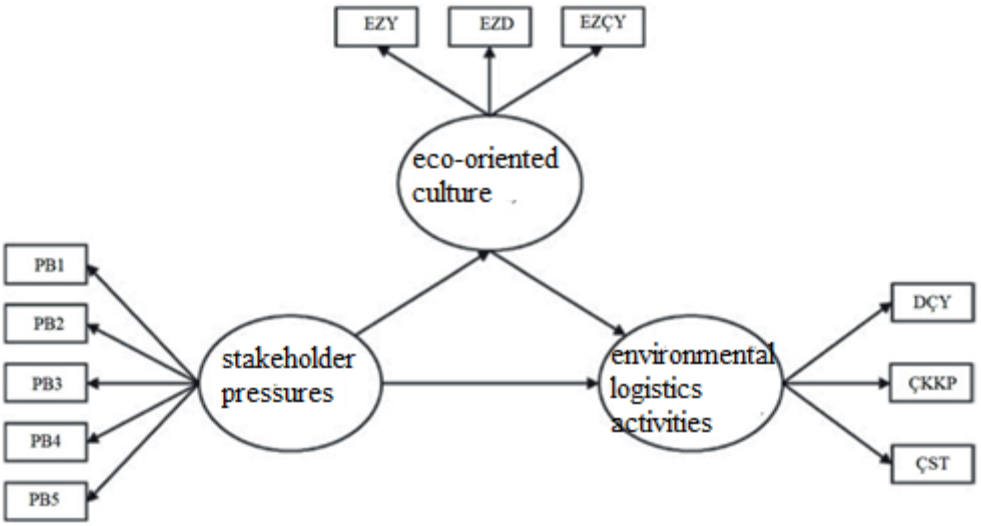


***Figure 8.*** Intermediary Structural Equilibrium Model (48)

Li et al., in their study, investigated the effect of corporate environmental responsibility on corporate financial performance on the data of a total of 1,179 energy-intensive enterprises operating in China between 2012 and 2014 (49). The results obtained show that corporate environmental responsibility has a significant positive effect on corporate financial performance; shows that government regulations also have a positive effect.

Huang and Wang focused on three different remanufacturing scenarios in their study, which aimed to demonstrate the benefits of information sharing within a closed-loop supply chain consisting of manufacturers, distributors and third parties interested in technology licen-

sing (50). The researchers defined the scenario as the producer's assuming the reproduction responsibility, the producer assigning the reproduction responsibility to the distributor, and the producer assigning the reproduction responsibility to the third party. For each scenario, information sharing was evaluated as yes/no, and the Stackleberg Game Model was used to decide on the balance. As a result of the study, it has been observed that wholesale and retail prices increase with the increasing demand forecast in information sharing scenarios, wholesale and retail prices are higher in the scenario where remanufacturing is done by the producer compared to the other two scenarios, and information sharing in the scenario where remanufacturing is done by the producer does not affect the supply amount. In the scenario where there is no error in demand forecasting, it provides financial advantage to all members in the supply chain, and the distribution is undertaken by the distributor.

Hassan and Nasereddin, in their study examining information sharing in the supply chain, after presenting detailed information about information sharing in the supply chain, they focused on explaining the advantages and disadvantages of information sharing and explaining how losses and leaks in information sharing will affect supply chain performance (51). As a result of the aforementioned qualitative study, the authors underline the importance of ensuring the integration of information between the elements in the supply chain in a safe and effective manner, and they argue that the deliberate damage of information sharing by suppliers or retailers may hinder future information sharing practices.

Baah and Jin examined logistics enterprises in the Republic of Ghana in their study to investigate how sustainable supply chain practices in the logistics sector affect the operational performance of enterprises (52). They analyzed the data obtained through the questionnaire form, using the partial least squares regression analysis method, using the SmartPLS software; They concluded that sustainable supply chain practices improve the performance of enterprises operating in the logistics sector, provide competitive advantage to enterprises and increase the corporate reputation of enterprises.

## 1.7. Other

Christmann, in his study using data obtained from 88 businesses operating in the chemical industry through questionnaires, tried to determine which activities provide businesses with the highest advantage in terms of environmental awareness and competition (53). Dillman's TDM method was used for the questionnaire used in the study, which examined three main elements that can be classified as using technologies to prevent environmental pollution, inventing technologies to prevent environmental pollution specific to the enterprise, and/or to

address environmental problems before their competitors. In the study, it was concluded that only the fact of inventing enterprise-specific environmental pollution prevention technologies can provide cost advantage.

Carter et al., in their study investigating the effect of environmental purchasing practices on business performance, used a questionnaire applied to 50 people authorized to purchase and retrospective data analysis methods (54). As a result of the study, in which the variables related to net income and cost of goods were determined as dependent income, influence and earnings as control variables, it was observed that environmentalist purchasing practices were in a significant relationship with both net income and cost of goods.

Sarkis, in his study that plans to create a strategic decision framework that will contribute to the decision-making strategies in management, is based on an environmental program that focuses on the external relationship between businesses (55). Making use of the practices of environmentally conscious enterprises and the existing literature while creating the strategic decision framework, the author evaluated the applicability of a dynamic nonlinear multi-qualified decision-making model defined as the Analytical Network Process. As a result of the study, it has been revealed that the model and the applied method in the literature and applications are limited due to their complex features and need more development. In addition, the Analytical Network Process approach has been criticized because it requires intensive data entry in order to reach the decision-making result even in the simplest structure.

Watson et al., in their work, have presented a framework that will help quantitatively evaluate improvements in environmental management systems and contribute to testing the impact of such improvements on financial performance (56). Enterprises that are members of the National Environmental Performance Monitoring program and enterprises that state that they adopt the Corporate Core Green Practices approach were selected as research sample and each enterprise was classified on a sectoral basis and matched with another enterprise with similar financial value. Financial information required for each business pair was obtained from the Thomson Analytics database covering the years 2001-2003. Using the Wilcoxon Paired Sequence Test, the authors determined that the cost of reducing environmental impacts does not significantly reduce the profit of a business, the benefits of environmental management systems cannot be fully realized due to current practices, and businesses that adopt an environmental management strategy may not fully benefit from their competitive advantages.

Li et al. aimed to test the relationship between supply chain management, competitive advantage and organizational performance, which they defined in five main dimensions (stra-

tegic supply partnership, customer relations, level of information sharing, quality of information sharing and procrastination) (57). They applied the questionnaire form they developed to 196 businesses they accessed through the Society of Manufacturing Engineers (SME) in the USA. Structural equation model analyzed the data obtained through the questionnaire form; They argued that supply chain management practices have a positive effect on competitive advantage and organizational performance.

Gonzales-Benito and Gonzales-Benito, in their study in which they evaluated the relationship between environmental pressure on stakeholders and the views and beliefs of business managers, medium and large scale; they used 186 industrial enterprises operating in the chemistry, electricity/electronics, furniture and installation sectors as examples (58). In the context of the data, they obtained through the questionnaire they developed, they determined that there are two different types of pressure: public (generally focused on legislation including regulations, etc.) and non-public (more proactive and volunteer-oriented). However, they argued that out of the two different types of pressure, only those classified as non-public could be considered as the reason for turning to environmental logistics practices.

Darnell et al., in their study examining the relationship between environmental management systems and green supply chain management, investigated the hypothesis that businesses that adopt environmental management systems may be willing to apply for green supply chain applications, through a 12-page questionnaire prepared by the Organization for Economic Cooperation and Development (OECD) (59). The questionnaire was sent to 3,746 manufacturing facilities in the USA. OECD presented two more follow-up questionnaires and the study was concluded with the answers from 489 managers. It was aimed to reach the optimum result by evaluating the obtained data with three different statistical methods (Pearson chi-square tests, Fisher exact probability tests and two-group t tests). As a result, it has been determined that enterprises with old sectoral activities in environmental management practices adopt the green supply chain at least as much as enterprises with new sectoral activity. In addition, it has been determined that the length of the enterprises' experience in the sector is not related to their adoption of green supply chain, and enterprises that use environmental management practices are prone to adopt green supply chain management.

Lin and Ho examined the decision elements that contribute to the adoption of green logistics practices in the logistics industry from a technological, institutional, and environmental point of view in their study in China (60). The analysis process, which they have subjected to the data obtained from 322 enterprises with the survey form they developed, indicates that if the logistics enterprises adopt green logistics management and practices, they gain positive

and constructive contributions to the relative advantage and compliance return, institutional support, and the improvement of the quality of human resources. However, it is emphasized that the uncertainties in environmental issues and the complexity of green logistics practices have a significant negative impact on the adoption of these practices. On the other hand, it has been determined that customer pressure has no effect on the adoption of green logistics practices.

In their study, Lai and Wong argue that if they adopt green logistics practices, Chinese exporting enterprises can both meet the increasing international demand more efficiently and achieve their environmental performance in a profitable way (61). As a result of the literature review, the authors defined four sub-dimensions of green logistics practices: (i) procedure-based practices, (ii) evaluation-based practices, (iii) partner-based practices, and (iv) general environmental management practices. Contrary to the generally accepted opinion, it has been observed that the idea that there are economic motivations for the adoption of green logistics management practices is not supported by the applied questionnaire, but it has been determined that green logistics management positively affects both environmental and operational performance and regulatory pressures support the relationship between green logistics management and performance.

In their study, Beske, Land and Seuring conducted a comprehensive literature review to determine how sustainable supply chain management practices affect businesses to have authority over their supply chains and to gain competitive advantage (62). The authors, who analyzed 52 articles written in English specifically for the food industry, concluded that sustainable practices and dynamic capabilities in the supply chain increase the possibilities of tracking and traceability and support customer demands.

Bag started by conducting a comprehensive literature study to determine the motivation behind choosing the green supply chain, and a fully interpretative structural model was developed by classifying the factors he determined with the help of expert opinions obtained through interviews with 5 supply managers working in the manufacturing sector in South Africa. (63). In the model in question, the determined factors are arranged in order from the most preferred to the least preferred. In this context, reducing the inventory and shortening the lead time, level 1; customer satisfaction, flexibility and supply chain risk management, level 2; Ensuring trust between suppliers and integrating quality environmental management into process and planning, level 3; information systems were determined as level 4. Afterwards, the knowledge and technology accumulation and innovation skills of the enterprises were added to the model in question.

De Camargo Fiorini and Jabbour conducted a comprehensive literature study in order to identify and systematically classify academic studies investigating the use of information systems in sustainable supply chain management practices; analyzed 22 academic articles published in the last 15 years (64). This detailed analysis, which is thought to be beneficial for academics and administrators, identifies gaps in the literature and offers suggestions for future studies; provides useful information on the adoption of the use of information systems to support sustainable supply chain management.

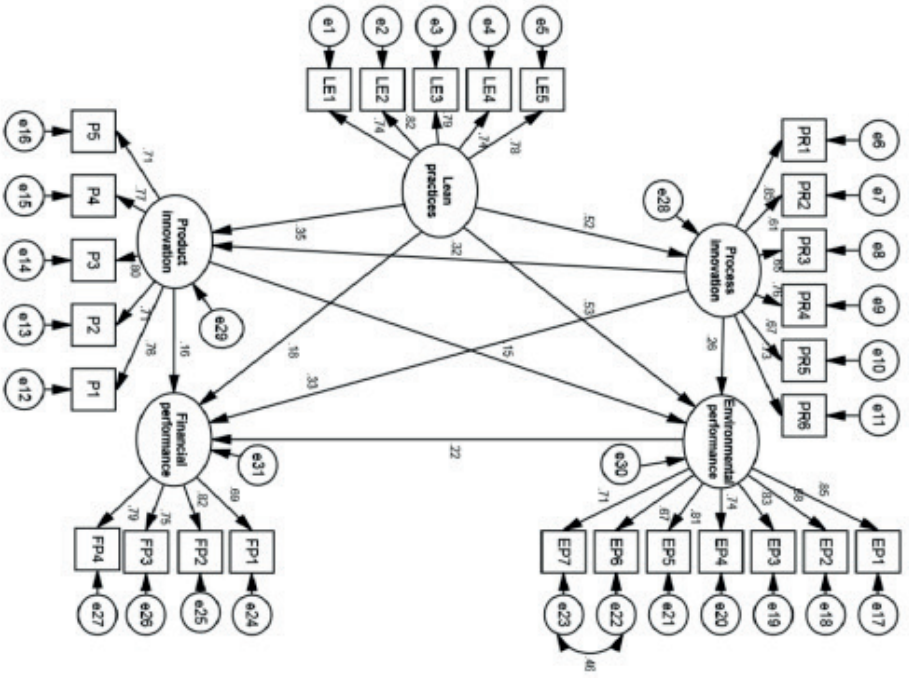


***Figure 9.*** Result of Model (65)

Centobelli et al. used 374 medium-sized Indian manufacturing firms as an example in their study on analyzing the relationship between simplicity, process improvement, product improvement, and environmental and financial performance (65). The authors, who analyzed the data obtained through the questionnaire they developed with the structural equation model, determined that both simplicity and innovation had a significant positive impact on financial and environmental performance (see Figure 9).

Baah et al., in their study examining the impact of environmental production activities on business performance from a proactive and reactive perspective, conducted a questionnaire that they applied to 218 enterprises that they randomly selected from among 1,000 enterpri-

ses operating as production enterprises in the Republic of Ghana using the sample selection technique of Krejcie and Morgan. They subjected the data they obtained to the partial least squares regression analysis method via SmartPLS software (66). As a result of the study, it has been determined that proactive environmental production activities contribute positively to the production process and environmental performance, while it has a negative effect on financial performance. It has been determined that reactive environmental production activities have a positive effect on both the production process, environmental performance and financial performance.

Ali, Gruchmann and Melkonyan, in their work that started by introducing the sustainable logistics service quality scale, aimed to measure customer satisfaction and relationship quality in Egypt by using the aforementioned scale. Evaluating small and medium-sized enterprises, the authors applied the sustainable logistics service quality scale to 421 samples. The data obtained through the scale were evaluated using the structural equation model, and it was determined that customer satisfaction, measured with the help of the sustainable logistics service quality scale, was at a level that would affect the customers' decision to place an order for the second time (67). In order to reveal the indirect relationship in the findings obtained, some detailed analyzes were carried out on the customer satisfaction, loyalty, trust and loyalty elements that determine the quality of the relationship, and it was determined that loyalty and trust are of considerable importance.

## 1.8. Company Profitability

It is very important to calculate and evaluate profitability ratios in order to objectively evaluate the efficiency, competitiveness and continuity of company activities. Analysis based on profitability ratios highlights the company's performance as the ratio between the effects achieved (benefits) and the effort spent to achieve them. Profitability can be defined as "the ability of an enterprise to make profit by using the factors of production and capital, regardless of its source" (68).

In strict economic terms, profitability refers to a company's ability to generate profits. Profit is the effect of running a profitable economic activity and proves that the economic business system is functioning properly. Profitability is the basic condition for ensuring the business success of an economic entity and is measured by comparing financial efforts with financial impacts and obtaining positive results (69). A business may be profitable, but only comparing its profitability to the average rates of return of its main competitors shows how competitive it is in the market. Any decision made at a company level should be motivated

by its impact on profitability. Expressing profitability in relative terms takes the form of profitability ratios.

Analysis of outcome indicators in absolute terms can provide useful information for analysis, but is not representative enough for managers or investors, especially for comparisons between economic units. Relativizing results (gross operating profit, operating profit, gross profit) by comparing them with other metrics (eg turnover, assets or capitals) leads to the determination of rates of return (profit ratios). Generally, rates of return are determined as the percentage between an outcome indicator and the company's effort to achieve it.

Economic theory scholars generally recommend calculating two profitability ratios: gross margin and net profit margin. Since these ratios are calculated by dividing the gross and net profit, respectively, by the sales revenue, it is appropriate to call it the gross and net profitability of sales. However, these two indicators are not enough to fully assess the effectiveness of the company's activities. Since the company's profit is largely dependent on the efficient use of assets and equity, it is imperative to calculate and analyze not only the sales profitability, but also the asset profitability and equity ratios. Researchers and authors (70, 71, 72, 73, 74, 75, 76) use two terms to describe profitability in many of their works: "profitability" and "return". The term "profitability" is used when analyzing sales profitability ratios, while "return" describes assets and return on equity.

Bryson and Lombardi researched the business practices of two real estate development companies that balance profitability against sustainability values. They discursively found the balance between profit and value systems (77). In addition, they argue that a company should balance the short-term profitability with the long-term.

By focusing on the operational and financial profitability of companies in Croatia, Bedenik found that they fell short in terms of sustainability (78). Dan Perbankan, who also carried out a study to support this, states that as the profitability of companies increases, sustainability reporting systems will increase and apply (79). Rizki et al., on the other hand, show that sustainability reports do not affect firm value, while profitability affects firm value (80).

Yang and Crowther analyze the potential benefits of CSR for a financial company and show that there is a positive relationship between profitability and CSR (81).

## 2. Methodology

In the study, the sustainability reports of a total of 6 companies operating in the field of "storage, transportation, logistics and courier services" and "travel and transportation ser-

vices" in Europe and Turkey were examined. Apart from these 6 companies, they were not included in the study because there was no company that published a sustainability report. With the published sustainability reports, the level of knowledge disclosed by the enterprises regarding the sustainability performance indicators was determined and company profitability was compared using profitability criteria. The relationship between sustainability performance and company profitability ranking has been examined. Enterprises for which index scores are calculated from sustainability reports are listed in table 5.

**Table 5.** Businesses Calculating Sustainability Index Score

| **Abbreviation** | ***Company Name*** |
|---|---|
| **BRYAT** | Borusan Yatırım ve Pazarlama A.Ş. |
| **CMACGM** | CMA CGM Group |
| **IAG** | International Consolidated Airlines Group |
| **LHA** | Lufthansa |
| **PGSUS** | Pegasus Hava Taşımacılığı Anonim Şirketi |
| **THYAO** | Türk Hava Yolları Anonim Ortaklığı |

*Literature created by authors*

Businesses share information on sustainability performance indicators with the parties in their annual activity and sustainability reports. Sustainability scores of businesses were calculated in accordance with the scoring model developed by Morhardt, Baird, and Freeman (82). In this context, the scores are determined as follows:

- 0 Points if there is no explanation in the report
- 1 point if short and general information is given
- 2 Points if non-numeric but qualitative information is presented
- 3 points if numerically measurable and comparable criteria are given

After the mentioned scoring process, it will be possible to reach the total economic, environmental and social score of the enterprises. In the study, the total score that the three dimensions can get will be 252. 30 indicators in the environmental dimension, 45 indicators in the social dimension and 9 indicators in the economic dimension were used.

The profitability criteria used in the study and the formulas used for analysis are shown in Table 6:

| **Table 6.** Profitability Metrics | |
|---|---|
| **Profitability Criterion** | ***Formula*** |
| **Gross margin** | Gross Profit / Net Sales |
| **Operating profit margin** | Operating Profit / Net Sales |
| **EBITDA margin** | EBITDA / Net Sales |
| **Cash flow margin** | Cash Flow / Total Revenue |
| **Return on assets (ROA)** | EBIT / Total assets |
| **Return on equity (ROE)** | Net Earnings / Equity |
| **Return on invested capital (ROIC)** | Net Income / Average total invested capital for two periods |
| **Economic Value Added (EVA)** | Net Sales-Cost of Sales-Operating Expenses-Taxes-Cost of Capital |
| **Cash Flow Return on Investment (CFROI)** | Operating Cash Flow/ Total Equity + Short Term Debt + Capital Lease Liabilities + Long Term Debt |
| *The EVA formula was taken from Karahan (83). Literature created by authors* | |

## 3. Analysis

In the research, the data in the financial statements (balance sheet) published by the companies in Table 5 for 2021 were used to calculate the profitability criteria in Table 6 and Table 7 was created. Sustainability performance score rankings are as shown in Table 8.

**Table 7.** Ranking of company profitability by profitability criteria

| | Gross Profit Margin (GPM) | Operating Profit Margin (OPM) | EBITDA Margin (EM) | Cash Flow Margin (CFM) | Return on assets (ROA) | Return on equity (ROE) | Return on invested capital (ROIC) | Cash Flow Return on Investment (CFROI) | Economic Value Added (EVA) |
|---|---|---|---|---|---|---|---|---|---|
| **1** | CMACGM | BRYAT | BRYAT | BRYAT | CMACGM | CMACGM | CMACGM | THYAO | THYAO |
| **2** | THYAO | CMACGM | CMACGM | THYAO | THYAO | THYAO | BRYAT | CMACGM | CMACGM |
| **3** | PGSUS | THYAO | PGSUS | CMACGM | BRYAT | BRYAT | THYAO | PGSUS | BRYAT |
| **4** | LHA | PGSUS | THYAO | PGSUS | PGSUS | PGSUS | PGSUS | LHA | LHA |
| **5** | IAG | LHA | LHA | LHA | LHA | LHA | LHA | IAG | PGSUS |
| **6** | BRYAT | IAG | IAG | IAG | IAG | IAG | IAG | BRYAT | IAG |

*Literature created by authors*

**Table 8.** Ranking of companies according to their total sustainability performance scores

| | Economic (ECP) | Environmental (ENP) | Social (SOP) | TOTAL (TP) |
|---|---|---|---|---|
| **THYAO** | 20 | 70 | 58 | 148 |
| **BRYAT** | 18 | 56 | 62 | 136 |
| **CMACGM** | 14 | 64 | 42 | 120 |
| **LHA** | 11 | 56 | 30 | 97 |
| **PGSUS** | 5 | 37 | 31 | 73 |
| **IAG** | 7 | 50 | 4 | 61 |

*Literature created by authors*

When correlation analysis was applied within the groups in Table 8, it was found that there was a positive relationship between them. However, when all groups in Table 7 and Table 8 are examined, it is observed that there is a negative relationship between Operating profit margin and Gross margin, ROIC and Gross margin, Operating profit margin and Cash flow margin, Cash flow margin and ROA, Cash flow margin and ROE, and Cash flow margin and ROIC (See Table 9).

**Table 9.** Relationship between profitability criteria and sustainability performance scores by correlation analyzing

| | GPM | OPM | EM | CFM | ROA | ROE | ROIC | CFROI | EVA | ECP | ENP | SOP | TP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **GPM** | 100% | | | | | | | | | | | | |
| **OPM** | -20% | 100% | | | | | | | | | | | |
| **EM** | 3% | 9% | 100% | | | | | | | | | | |
| **CFM** | 26% | 77% | 31% | 100% | | | | | | | | | |
| **ROA** | 14% | 83% | 14% | 94% | 100% | | | | | | | | |
| **ROE** | 14% | 83% | 14% | 94% | 100% | 100% | | | | | | | |
| **ROIC** | -9% | 94% | 3% | 83% | 94% | 94% | 100% | | | | | | |
| **CFROI** | 77% | -9% | 14% | 14% | -9% | -9% | -20% | 100% | | | | | |
| **RVA** | 3% | 89% | 43% | 77% | 71% | 71% | 77% | 26% | 100% | | | | |
| **ECP** | 49% | 66% | 43% | 77% | 66% | 66% | 60% | 60% | 89% | 100% | | | |
| **ENP** | 26% | 77% | 31% | 66% | 60% | 60% | 66% | 49% | 94% | 94% | 100% | | |
| **SOP** | 26% | 77% | 31% | 100% | 94% | 94% | 83% | 14% | 77% | 77% | 66% | 100% | |
| **TP** | 26% | 77% | 54% | 89% | 77% | 77% | 71% | 37% | 94% | 94% | 89% | 89% | 100% |

*Literature created by authors*

When we subjected the above tables to the ANOVA: One way test with the help of the ranking scale, it was observed that there was a significant difference between the groups (See Table 10).

**Table 10**. ANOVA: One way test result values of companies' sustainability performance rankings and profitability rankings

| Variance Source | SS | df | MS | F | P-value | F criterion |
|---|---|---|---|---|---|---|
| **Between Groups** | 146,7143 | 5 | 29,34286 | 23,28663 | 3,09E-14 | 2,331739 |
| **In Groups** | 98,28571 | 78 | 1,260073 | | | |
| **Total** | 245 | 83 | | | | |

*Literature created by authors*

Post Hoct test results were examined to see which groups had a statistically significant difference. According to the results of the Post Hoct test, there is no difference between the

Gross profit margin, EBITDA margin and Cash flow investment return and the total sustainability performance of the companies. It was observed that there was a statistical difference between the others. An important point to note here: There is a significant similarity between EVA scores and sustainability scores, and between ROA and ROE. When the sustainability performances are examined under the sub-headings, it has been observed that there are very close results between social sustainability score rankings and Cash flow margin rankings, and between environmental sustainability score rankings and EVA rankings. These findings were confirmed by performing correlation analysis between the groups.

## 4. Conclusion and Suggestions

In this study, the profitability and sustainability performances of transportation and logistics companies in Europe and Turkey were examined and tested whether there was a significant difference between them. It has been observed that financial statements of 5 companies, except CMACGM, can be accessed from information portals such as finnet, tradingview, investing and marketshare, and all companies, including CMACGM, publish their financial statements on their own websites. Based on this information, it can be said that it is possible to access the financial statements and financial reports of companies, even retrospectively, and that European and Turkish logistics and transportation companies are transparent and similar in report sharing.

The financial and sustainability performances of European and Turkish logistics and transportation companies may differ according to profitability criteria, sustainability criteria and country situation. A significant difference was observed between the operating profit margin, return on equity, return on assets, return on economic value added, cash flow margin, return on invested capital and sustainability performance measures, which are shown as profitability criteria. These results support that there is a positive relationship between firms' expansion of sustainability-focused innovation and financial returns as stated by Bogers and Ghassim (84). When the correlation analysis is made between the groups, the pairs with the highest correlation value of 94% are as follows: ROIC with Operating profit margin, Cash flow margin with ROA, Cash margin with ROE , ROA with ROIC, ROA with social sustainability, ROE with ROIC, ROE with social sustainability, EVA with environmental sustainability, EVA with total sustainability, economic sustainability with environmental sustainability, and economic sustainability with total sustainability. These results and Jankalová and Kurotová (85) suggest that the link between sustainable value and EVA provides great synergy potential; the discourse of Jyoti and Khanna (86) and Pam et al. (87) that sustainability performance scores and ROA and ROE have a significant relationship are consistent.

When we group companies into European and Turkish companies, it is observed that companies in Turkey are significantly more successful in terms of profitability and sustainability performance criteria other than gross profit margin, compared to companies located in Europe. While it was found that PGSUS was the most unsuccessful company in Turkey, it was found to be IAG in Europe.

Some sustainability practices, namely sustainability reporting, are becoming industry "best practice" and are therefore necessary. However, it is obvious that some businesses gain a real competitive advantage by adopting environmental policies that their competitors cannot easily follow. The results show that sustainability can be both a necessity and a differentiator.

Future research should aim to expand this research in a global context, given the availability of data necessary for empirical analysis. In addition, it will be of great benefit to analyze whether the results obtained are validated for wider time periods. Of course, both accounting-based and market-based measures of financial performance should be used, as they are better suited for long-term analysis of financial performance. In addition, a cause-effect relationship can be found between the data by using a panel data regression model.

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# CHAPTER 10

# LOGISTICS SERVICE QUALITY AS A DETERMINANT OF CUSTOMER LOYALTY IN ONLINE RETAILING

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**ABSTRACT**

This study focuses on logistics services in online retailing, which is becoming increasingly important in consumer life. Various studies have shown that customers' perceptions of logistics service quality are essential in developing loyalty to retailers. Accordingly, this study aims to identify the effect of logistics service quality (LSQ) on customer loyalty in online retailing and the role of other variables in this structural relationship by proposing a literature-based conceptual model. A systematic literature review method was employed in line with this purpose, and a search strategy was formed. The research articles that identified with the search strategy were included in the research sample. The scale dimensions (order condition, timeliness, availability, order processing quality, order accuracy, information quality, communication quality, and recovery & return) representing logistics service quality were defined as a result of analyzing the content of these articles. In addition, the structure of the relationship between LSQ and customer loyalty and other variables involved in this relationship is determined with a literature-based conceptual model. Study results show that LSQ, directly and indirectly, affects customer loyalty. Customer satisfaction and trust are identified as essential variables in indirect relationships.

**Keywords:** Logistics service quality, Online retailing, Customer loyalty, Customer satisfaction, Logistics management, Systematic literature review

## 1. Introduction

Online retailing (also known as business-to-consumer (B2C) online shopping), one of the substantial types of e-commerce, is being used increasingly by consumers daily. Online retailing, which had a global market value of approximately USD 5.2 trillion in 2022, is estimated to reach USD 8.1 trillion in 2026 (1). The convenience that online retailing provides consumers, especially effortless access to a wide range of products and services without time and space constraints, increases the system's adoption. Increasing internet penetration in households, easier access to fast internet connections and the growing use of smartphones are contributing considerably to the expansion of online retailing (2). Especially during the COVID-19 pandemic, practices such as quarantines and curfews have popularized online retailing in urban and rural areas, making it an important issue for consumers and businesses. Online retailing has expanded rapidly to new companies, customers and product types due to the conditions caused by the COVID-19 pandemic (3). People now use e-commerce and online retailing even for their daily shopping needs.

The facilitating effects of the Internet make it possible for businesses to realize similar services and promotion methods with their competitors. In parallel with this, the same type of online stores is rapidly increasing. This situation makes it difficult for businesses to differentiate and causes the online stores consumers can choose from to become increasingly similar (4). Thus, consumers can easily find more standardized products and a broad range of products in various online retailers. Internet and e-commerce technologies have made it relatively simple and cheap for consumers to search for alternative online retailers, compare stores and change their preferred stores at the click of a button. This makes it more difficult for consumers to develop loyalty to specific online retailers. Therefore, building and maintaining customer loyalty in online settings is even more critical (5). To survive and profit, online retailers need to focus on customer loyalty by satisfying their customers (6). However, creating loyalty is more complex and vital for online retailers than offline retailers (7).

In differentiating online retailers from their competitors and building customer loyalty, product variety, the quality of their web environments, the shopping experience they offer, as well as the quality of fulfillment, preferred delivery time intervals, order accuracy, free shipping, payment on delivery, easy return and exchange policies come to the fore (4). Service and experience-oriented differentiation efforts contribute to the development of the system in the competition among online retailers. In parallel, customer expectations are rising. For example, consumers expect to receive their orders the next day, and their purchasing decisions are increasingly influenced by delivery times (3).

The literature suggests that online retailers should focus on the services provided through the website and the fulfillment of customer orders (preparation, information, transportation, delivery, etc.) to build customer loyalty (6). Many online retailers have belatedly realized the importance of fulfillment and delivery processes and, thus, logistics services. In the past, neglecting order fulfillment and other logistics services has been the downfall of many online retailers (8).

Consumers' attention and interest in the delivery process, the last stage in online retailing, is increasing. Customers' negative experiences, such as defective deliveries like damaged and wrong product deliveries, delayed or wrong-time deliveries, and negative communication with personnel in delivery and return processes, are among the primary reasons for this. In this respect, the ability of consumers to access their orders accurately and on time has become an essential dimension of the system. Therefore, logistics services have a crucial role in online retailing (4,9,10). At this point, logistics often stands out as a service that provides significant opportunities for online retailers to gain a competitive advantage (11–14).

The role of logistics service quality (LSQ) in e-commerce is increasing day by day (11). Due to the rapid growth of online retailing, poor LSQ has increasingly become a constraint for businesses. LSQ has increasingly become a new area of competition for online retailers. Online retailers need to deal with LSQ while managing the quality of their overall service offerings (15), such that the success of online retailers is fundamentally linked to the LSQ (11).

The concept of LSQ is a construct of service quality based on customers' opinions and should be considered separately from other online retailer services (15–18). LSQ is the result of comparing customers' expectations and perceptions of the logistics processes and services provided (3). LSQ is equally crucial for customers, online retailers, and logistics service providers (19,20).

Managing logistics services requires paying attention not only to operational but also to relational processes. More specifically, online retailers can establish effective contact and relationship with their customers through logistics services (11,13). Many interactions occur during the preparing, transportation and delivery of an order. These interactions significantly shape the perceived value of the customers (15). Superior service quality offered to customers creates customer satisfaction and loyalty (21). Therefore, excellent LSQ is essential to improve customer-shopping website relationships. Customers' trust and satisfaction will construct a better customer-company relationship, leading to customer loyalty (22). As a result, LSQ for online retailers is one of the critical success factors in creating customer loyalty.

The literature on LSQ has mainly focused on business-to-business (B2B) commerce. Most of the research is about third-party logistics companies (4). However, there is an increasing number of studies investigating the importance of LSQ in B2C online shopping. Existing studies reveal that LSQ is a critical factor in differentiating customer experience in the competitive online retailing market (23–27). In addition, several studies show that LSQ is one of the strategic factors for the success of online retailers, but it is still an area that has yet to be fully explored (11).

On the other hand, despite this growing interest in LSQ in B2C online shopping, only a limited number of studies have investigated the effect of LSQ on customer loyalty in the B2C environment and its relevance (4). In the existing studies, there is no systematic review of the findings describing the multidimensional role of LSQ on customer loyalty. This study focuses on this literature gap.

This study aims to address this issue by systematically analyzing the literature on the role of LSQ in customer loyalty in online retailing using quantitative research techniques. More specifically, it aims to synthesize the existing literature with a systematic literature review approach and propose a conceptual model that explains the role of LSQ on customer loyalty with other variables based on existing studies. The focus of this study is only LSQ in B2C online shopping; B2B and other aspects of e-commerce are out of scope.

This study prioritizes answering the following questions:

- RQ1: What is the role of LSQ in building customer loyalty in online retailing?
- RQ2: What other variables are involved in the relationship between LSQ and customer loyalty in online retailing?
- RQ3: Which scale dimensions are used to evaluate LSQ in online retailing?

The findings to be provided by systematically analyzing and integrating the results of different studies in the literature will contribute to understanding the relationship between LSQ and customer loyalty and multidimensionally researching this concept in future studies. In addition, these findings may guide sectoral practitioners.

The study's conceptual framework, the research methodology designed to answer the research questions, and the analysis and findings are presented in the following sections.

## 2. Online Retailing and Logistics Service Quality

In today's digital age, online retailing refers to the activities carried out to offer and sell products and services to customers over the Internet without time and geographical constraints

(6). Online retailing involves a service-intensive business model. The core value proposition offered to customers includes services related to customers' easy and effortless access to the products they need (28).

Through the services offered by online retailers, customers can purchase products directly from their seats without intermediaries. Customers also have the opportunities to choose from a wide range of products, compare different products/brands and choose from the various promotions available to them. Prominent factors such as qualified information, convenient and comfortable shopping, less time spent, price comparison as well as enriching services such as free shipping, cash on delivery, convenience on return encourage customers to shop more from online retailers. In addition, shopping from online retailers also has some limitations. For example, it can be difficult for customers to try out products and make a purchase decision. In addition, the increase in product categories and variety may make it difficult for customers to access and order the product they are looking for easily. Security and privacy issues may also occur in processes such as payment and information exchange. Customers may also experience problems with logistics processes and deliveries (e.g., wrong products, damaged and/or delayed deliveries). On the other hand, customers may also experience difficulties with return processes (29). As a result of these situations, customers have formed service expectations such as quick and easy access to the product they are looking for, comparison between alternatives, easy payment, and order placement, information security and privacy, quality service in logistics and delivery processes, convenience in return processes, and provide quality information. These situations require online retailers to design their business processes carefully.

Online retailers must carefully consider some critical issues in designing their business processes. These include providing good services, delivering a superior customer experience, reducing the perceived risks of online shopping, ensuring effective website design, and reducing the number of returns (30). Especially in online retailing, the nature and quality of the services provided are critical for customer preference.

Service quality is vital to the long-term success of a business; more satisfactory service provides a competitive advantage (13). Service quality helps to differentiate a company from its competitors in competitive market conditions and is therefore a competitive advantage factor for service-based companies (31). By improving service quality, companies can improve customer retention and loyalty (32).

Service quality is a concept that varies depending on the nature and structure of the service (3). Therefore, service quality in the context of online retailing needs to be considered separa-

tely from offline environments. In online retailing, service quality (e-service quality) covers all stages related to the processes before, during, and after the order, especially the customer's interaction with the website. In this context, e-service quality focuses on the website's ability to facilitate shopping, purchasing, shipping, delivery, and return activities and to make these processes efficient and effective (33). The existing literature on e-service quality has separately addressed various types and constructs of service quality, such as website quality, service delivery quality (or fulfillment), and reverse logistics (2). Logistics service quality is also one of the crucial constructs among these.

Before explaining logistics service quality, it is necessary to explain what logistics service is in online retailing. Logistics services relate to the fulfillment and delivery of customers' orders and cover the operational and relational activities related to delivering the order at the time, place, and in the way they wanted. These activities include the supply, packaging, and shipment of the product(s) included in the order and the delivery of the order to the customer in a timely, accurate, and undamaged manner and providing accurate information to all parties in all these processes. It also includes product returns and reverse logistics efforts in this process (26, 34, 35).

Online retailers often use delivery companies (especially express delivery and cargo) to deliver products to customers as part of their logistics services. These delivery companies support functions such as packaging, transportation, delivery to the end customer (last-mile delivery), and providing information. In addition to these traditional services, they may perform some functions, such as taking payments at the door, receiving returns, and receiving personal feedback from consumers (36). As a result, logistics services can arise from online retailers or third-party service providers. Accordingly, customers expect quality services from online retailers and logistics service providers (37).

The quality of these logistics services can be reflected by how customers can reliably and accurately receive the logistics services promised by companies/retailers. The quality of logistics services, including product availability, shipment status, on-time product delivery, and qualified information on shipment tracking, is also central to customers' online purchasing decisions (2).

Logistics service quality (LSQ) refers to performance-related factors that focus on delivering orders in a way that meets customer needs (2,38). Mentzer et al. (1999) developed the LSQ model by integrating marketing and logistics activities, defined LSQ as fulfilling consumer needs, and divided LSQ into two parts: reliable delivery service and customer rela-

tionship service (9,19). Accordingly, LSQ has two major factors. These are operational LSQ and relational LSQ. Operational LSQ is "the ability to deliver the promised service reliably and accurately." At the same time, relational LSQ is "the ability of the store (or service provider) to understand customer needs and expectations" (39). Logistics processes and services directly affect the benefits and satisfaction customers derive from purchasing products. Therefore, it is necessary to improve the logistics processes and the quality of logistics services and manage customer expectations for logistics services correctly (40). A business focusing on managing LSQ needs to address and manage operational LSQ and relational LSQ factors in an integrated manner.

In online retailing, LSQ ensures that products are delivered at the right quality, at the right time and under the right conditions (11). Therefore, LSQ is a very crucial issue for the success of online retailers (13).

LSQ measures the difference between customers' expected and perceived service when they shop from different private, corporate, and platform websites. LSQ considers all the processes, from order fulfillment to receiving or returning time to the product (15).

Figure 1 describes the appearance and formation of LSQ in the online retailing context from the consumer's perspective (18).

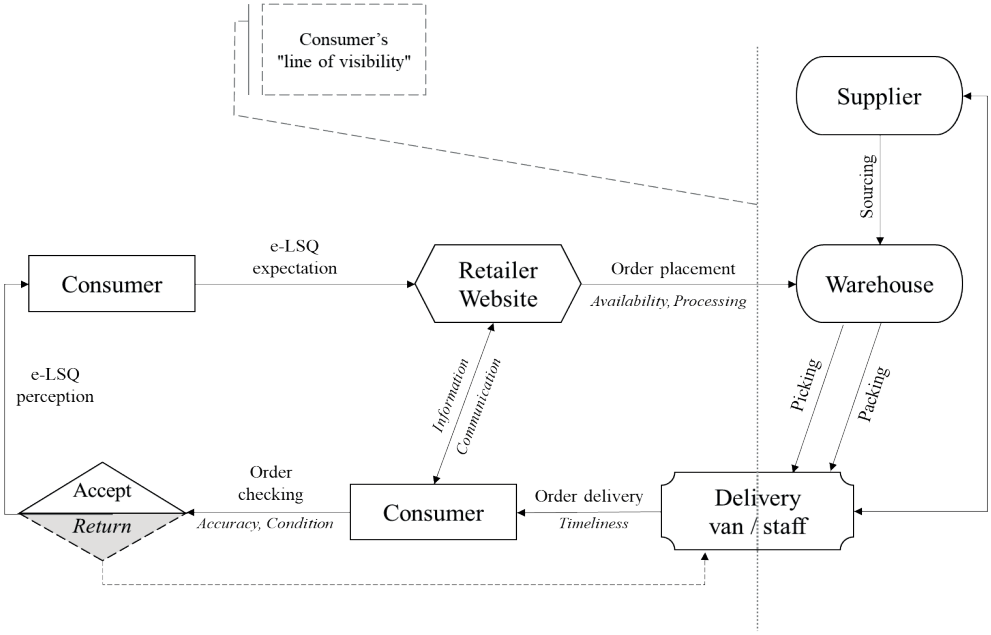


***Figure 1.*** Consumer perspective on LSQ in the online retailing
***Source:*** *Adapted from Xing et al (2010)* (18).

According to Figure 1, before ordering from the online retailer's website, the consumer has expectations about the quality of the retailer's logistics services. Accordingly, the consumer places an order on the retailer's website. The online retailer who receives the order processes this order. In this process, the availability of the product(s) in the order is critical. Accordingly, the online retailer picks and packs the product(s) in the order from the products that suppliers provide to the warehouse. Subsequently, the order package is given to the delivery van and is delivered to the consumer. Timely delivery of the order stands out in this process. The consumer who receives the order checks the condition of the order in terms of issues such as the accuracy and undamagedness of the product(s). If the product(s) is/are delivered correctly, the consumer accepts the order; if not, the consumer can return the order. In the return process, the consumer contacts the online retailer's website, delivery van, and staff to ensure the product is returned to the online retailer's warehouse. Information and communication-based interaction occur between the consumer and the online retailer through the website in all these processes. While some of these processes are visible to the consumer, others are not. For example, the order's processing, preparation, and packaging take place in a part the consumer cannot see. However, the consumer can see the information provided about these processes. On the other hand, the consumer can see the order itself, the delivery elements (such as people and vehicles) involved in the delivery process, the retailer's website and the information provided through this website, and the communications with the website. Thus, they are separated in Figure 1 by a hyphenated line (consumer's "line of visibility"). The consumer experiences all these logistics service processes, both visible and invisible. At the end of all experiences, the consumer's perceptions of logistics service quality will be formed by comparing their expectations of logistics service before placing an order with their perceptions of the actual logistics service. These perceptions will be based on a cumulative assessment of the individual aspects of the process.

LSQ, formed due to the abovementioned process, has various effects on consumer attitudes and behaviors. There are various findings in the literature on these effects. It is widely recognized that LSQ partly determines customer satisfaction and thus gives firms a competitive advantage (3). LSQ is critical to delivering an excellent customer experience (26). Moreover, high performance in LSQ significantly affects customer satisfaction and loyalty; therefore, LSQ is a crucial business factor (8,11,13,34,35,41). In addition, several studies have shown relationships between LSQ and different variables. Some of them are as follows: perceived value, recommendation behavior, brand image, website service quality, and sustainability (11,15).

## 3. Dimensions of Logistics Service Quality and Measurement Methods

Companies must be able to measure the service they provide with an accurate and valid measurement approach to evaluate the current state of service quality. In the literature, there are various general and specific scales developed for different service concepts.

The logistics discipline has a long history in LSQ research. What started as a physical distribution service quality (PDSQ) has evolved into LSQ (27). There is no single approach to the scope and dimensions of LSQ; various scholars have conceptualized LSQ in their ways (20).

In the B2C context, LSQ was first measured using the SERVQUAL scale, one of the most important constructs in the marketing literature (8,16). In SERVQUAL scale, there are basically five dimensions. These are "reliability", "responsiveness", "empathy", "assurance," and "tangibles" (16). However, there have been criticisms that measuring PDSQ and LSQ with SERVQUAL does not provide full validity due to their unique characteristics (41). Accordingly, measurement structures have been developed specifically for the LSQ, and alternative measurement approaches continue to be developed. Different measurement methods are in the literature, especially for PDSQ and LSQ.

Measurement methods have primarily focused on physical distribution service (PDS). PDS includes many transactional activities and process that support the flow of materials and related information from the point of origin (warehouse location) to the point of consumption (consumer location) (8). PDS was conceptualized by Mentzer et al. (1989). According to this approach, PDS consists of "availability," "timeliness," and "quality" dimensions (42). Based on this approach, Bienstock et al. (1997) developed a comprehensive scale of PDS quality. This scale addressed the dimensions of "availability," "timeliness," and "condition" of the delivered products (21,41).

Afterward, Mentzer et al. (1999) developed the LSQ scale, which incorporates the components of SERVQUAL into the logistics domain (19). While developing this measurement approach, they took the PDSQ structure as a basis and introduced a broader perspective in evaluating LSQ than the PDSQ. In this context, they defined nine dimensions that make up the LSQ. These constructs include "information quality," "ordering procedures," "ordering release quantities," "timeliness," "order accuracy," "order quality," "order condition," "order discrepancy handling," and "personnel contact quality." In their following study, Mentzer et al. (2001) developed a structural model describing the interrelationships among the nine dimensions of the LSQ by relating these dimensions of the LSQ to customer satisfaction.

Furthermore, they demonstrated the validity of the scale (35). This LSQ scale primarily for the traditional B2B environment and continues to be used frequently in different studies with various adaptations by different researchers (21). In addition, Bienstock et al. (2008) expanded the dimensions in Mentzer et al.'s (1999, 2001) study by considering them as separate processes as "process quality" and "outcome quality" (43). On the other hand, Thai (2013) also developed another scale for the LSQ. The dimensions of this scale are "customer focus quality", "timeliness", "order fulfilment quality", "information quality", and "corporate image" (20).

Several studies emphasize that the relative importance of LSQ dimensions is different in B2C contexts than in B2B contexts (44). Based on this, studies in the literature develop different scales to measure LSQ in the online environment in the B2C context. For example, Parasuraman et al. (2005) revised the SERVQUAL scale for online environments (e-S-QUAL) and emphasized the "fulfillment" construct (33). Xing et al. (2010) developed the e-PDSQ scale, which includes the dimensions of "availability," "timeliness," "condition," and "return" (18). Rao et al. (2011) adapted the LSQ to the online shopping context and proposed an e-LSQ measurement approach. They defined its dimensions as "shipping options," "item availability," "on-time delivery," and "order tracking" (8). Murfield et al. (2017) selected and used only three components of the PDSQ scale: "timeliness," "availability," and "condition" (24). In addition, Cotarelo et al. (2021) added "return," that is, the product return process, as another LSQ dimension (9).

Considering the different scales of LSQ in the literature, many factors can be found that make up the structure of the LSQ. Studies use different constructs, mainly due to methodological limitations (3). The critical dimensions of LSQ are summarized in Table 1 by considering the dimensions in different studies (3,8,11,18–20,23,26,27,35,37,42,45):

**Table 1:** Critical dimensions of LSQ

| **Dimension Name** | **Description** |
|---|---|
| **Order Quality** | The customer's perception of how well the ordered products are processed and how effectively and efficiently the process is carried out. |
| **Availability** | The customer's perception of the usability and availability of the products in the company/service provider's stocks to fulfill orders and that the stocks reflect the actual situation in real-time. |
| **Timeliness** | The customer's perception of the time between placing and receiving an order, and whether it is delivered on time. |
| **Order Accuracy** | The customer's perception of how closely shipments match their orders upon arrival, i.e., whether the products delivered are the right products in the right quantities. |
| **Order Condition** | The customer's perception of the condition of orders during delivery (i.e. whether they are undamaged). |

| | |
|---|---|
| **Information Quality** | The customer's perception of the extent to which the company/service provider provides the various logistical information (i.e., order status, time, delivery location) that the customer needs about their order in a high quality format. |
| **Personnel Contact Quality** | The customer's perception of the demeanor, the image portrayed, the attitudes, and the interest of the personnel involved in the logistics processes such as order processing and delivery of the company/service provider towards the customers. |
| **Order Discrepancy Handling** | The customer's perception of how well the company/service provider handles and resolves inconsistencies in order processing and delivery processes after receiving the customer's order. |
| **Return** | The customer's perception of ease/difficulty regarding the processes (i.e., including the product in carrier processes, process information) after the customer wants to return the product after receiving the order. |

Although there are measurement models explicitly created for logistics services in the literature, researchers frequently use the traditional SERVQUAL model for LSQ measurement. Some studies use LSQ scales developed based on the B2B context. This shows that the research on LSQ dimensions and measurement methods still needs to be improved for online retailing. Therefore, the scale development process to reach a generally accepted LSQ measurement method continues, and there is a need in this direction (21).

## 4. The Relationship between Logistics Service Quality and Customer Loyalty in Online Retailing

Loyalty is a widely researched concept in the marketing literature, and customer loyalty is considered one of the most important factors in company success (46,47). Loyalty is defined as the customer's tendency, attitude, and behavior to re-purchase or re-prefer a product or company that the customer has previously preferred or purchased, despite various situational influences and marketing practices that may cause the customer to prefer competitors (48). Loyalty can also be defined as the customer's positive attitude and behavioral intention to continue to purchase the same product from the same company, even when there are other alternatives (competing companies/products) in the market (49).

Increased customer loyalty increases the likelihood of customers choosing the same company/service provider for their future needs and wants, which can provide long-term revenue for the business. Moreover, due to the competitive nature of many industries, acquiring new customers is more costly than retaining existing customers. It also requires more time and effort (50). Since retaining existing customers is less costly, building customer loyalty makes it possible for the companies to achieve long-term profitability (6). In addition, loyal customers not only continue to buy but can also encourage others to buy from the company, generating

a significant profit stream (51). Therefore, companies focus more on building long-term relationships with existing customers and strengthening their loyalty. This viewpoint includes strengthening the loyalty of newly acquired customers. As a result, customer loyalty is an important and strategic matter for companies (3).

The strategic importance of customer loyalty for companies and the opportunities it provides are also valid for online retailers. The increase in consumers' use of digital technologies and their preference for Internet shopping, in parallel with the increase in alternative online retailers, has made the competition fiercer. However, low barriers for market entry in online retailing allow new competitors to enter the market, making it much more critical for online retailers to gain customer loyalty. Customer loyalty is a crucial driving factor in online retailing, and long-term loyalty brings long-term profitability to the online retailer (52–54). Therefore, it is critical for the online retailer to understand the building of customer loyalty and to manage this process.

In online retailing, face-to-face interaction between the customer and the retailer is absent, and customers have limited contact with retailer's personnel. Because interaction and contact are critical for building customer relationships, relationship building is challenging for online retailers. In addition, since good relationship is vital for building loyalty, it becomes even more difficult for an online retailer to build customer loyalty. Therefore, online retailers must find ways to build stronger relationships with their customers to retain them (55). One of the essential things online retailers can do to improve their relationship with customers is to provide good services that meet customer expectations and give customers positive experiences with their services. Accordingly, online retailers need to improve the quality of their services in order to retain customers and strengthen customer loyalty (56).

One of the critical services provided to customers in online retailing is logistics services. Online retailers' logistics services and strategies are critical for the customers to access the products they buy wherever and whenever they want, with as little effort as possible in the contactless online shopping process (57). In this respect, revealing the effect of LSQ on customer loyalty is critical for online retailers (6).

Studies conducted in the context of traditional retailing environments may provide insight into the role of LSQ on customer loyalty in online retailing. In traditional environments, logistics studies have found that operational attributes such as product availability, product condition, delivery reliability and speed, and relational attributes such as communication and responsiveness positively affect customer satisfaction and buying habits (4,58). Previous

studies have shown that LSQ affects customer loyalty (i.e. 8,9,26,59,60). In addition, existing results suggest that LSQ affects customer loyalty directly or indirectly through customer satisfaction (i.e. 13,24,37,61).

Existing studies conducted in online environments reveal that LSQ also leads to customer satisfaction and retention (3,8,13,24,27). Few studies have considered LSQ as a direct antecedent variable of customer loyalty in the research on the factors affecting customer loyalty in online environments. Most of them addressed the loyalty formation mechanism from a satisfaction perspective (4). In addition, there is a need to identify other variables that may affect loyalty besides LSQ in loyalty formation. In this regard, evaluating the literature findings on the relationship between LSQ and customer loyalty in the online retailing environment is helpful for a better definition of the structure and revealing possible research gaps.

## 5. Methodology

This study employed the systematic literature review (SLR) approach to answer the research questions. In this context, studies focusing on the relationship between LSQ and customer loyalty in online retailing were analyzed with SLR, and a literature-based conceptual model was developed.

SLR is a distinct and organized method for analyzing and evaluating the literature. SLR attempts to comprehensively identify, analyze, synthesize, and interpret all relevant studies that meet the eligibility criteria according to a predetermined and explicit method to answer a specific research question (62–66).

Several literature review approaches exist (e.g., traditional literature review, systematic literature review, bibliometric review, meta-analysis, hybrid) (11). The traditional literature review and the SLR are the most commonly used and compared. However, SLR is considered superior to the other because it has a comprehensive and unbiased search strategy (67). SLR also has many advantages over traditional literature reviews, including a well-developed research methodology that makes the results less biased and provides a comprehensive summary of the literature relevant to the research questions (63). SLR is characterized by a scientific and transparent process that minimizes bias, enhances objectivity, prioritizes methodological rigor, and ensures reproducibility (67–70).

An SLR should follows specific steps to ensure accuracy, precision, and reliability (71). The present study followed Denyer and Tranfield's (2009) five-step approach: 1) formulate one or more research questions, 2) find studies, 3) select and evaluate studies, 4) analyze and

synthesize studies, and 5) report and use results (72). Finding studies (material collection) reflects the collection of all relevant articles according to predetermined criteria based on the specific research question (21). This process involves a predefined search strategy to find comprehensive and complete information on the subject. This strategy includes an approach with inclusion and exclusion criteria to filter and categorize relevant studies (63).

A search strategy was developed to conduct SLR in this study. Table 2 summarizes the criteria determined in the search strategy.

**Table 2:** The search strategy for systematic literature review

| **Process** | **Description** |
|---|---|
| **Databases** | Web of Science, Scopus |
| **Publication type** | Journal Article |
| **Publication language** | English |
| **Time period** | 1998-2022 (25 years) |
| **Search criteria** | Title, abstract and keywords |
| **Search terms** | "Logistics service quality", "physical distribution service quality", "last-mile quality", "loyalty", "commitment", "retention", "reuse", "repurchase", "continuance" |
| **Search query** | (((("logistics" or "logistic" or "physical distribution") and ("service" or "services")) or ("last-mile" or "last mile")) and ("quality" or "qualities") and ("loyalty" or "commitment" or "retention" or "reuse" or "repurchase" or "continuance") |
| **Inclusion criteria** | Articles analyzing the relationship between logistics service quality and customer loyalty in online retailing using quantitative research methodology |
| **Exclusion criteria** | Not in the targeted databases, duplicates in the targeted databases, not in the specified time period, not in English, not relevant to the focus area (logistics service quality and customer loyalty relationship), not relevant to online retailing, not quantitative research |

Web of Science and Scopus databases, which offer extensive literature in business and economics-oriented studies, was chosen to identify articles on LSQ and customer loyalty in online retailing as part of the search strategy. The articles to be included in the study were selected from journal articles published between 1998 and 2022 in English. In addition, search terms were determined by selecting among the attributes representing LSQ and customer loyalty. Considering that LSQ has been researched in the literature with different names, such as "physical distribution" and "last mile." Therefore, these words were also included as search terms in the search strategy. Similarly, the terms "commitment," "retention," "reuse," "repurchase," and "continuance" were included as keywords besides the keyword "customer loyalty." Figure 2 summarizes the systematic search process of the present study.

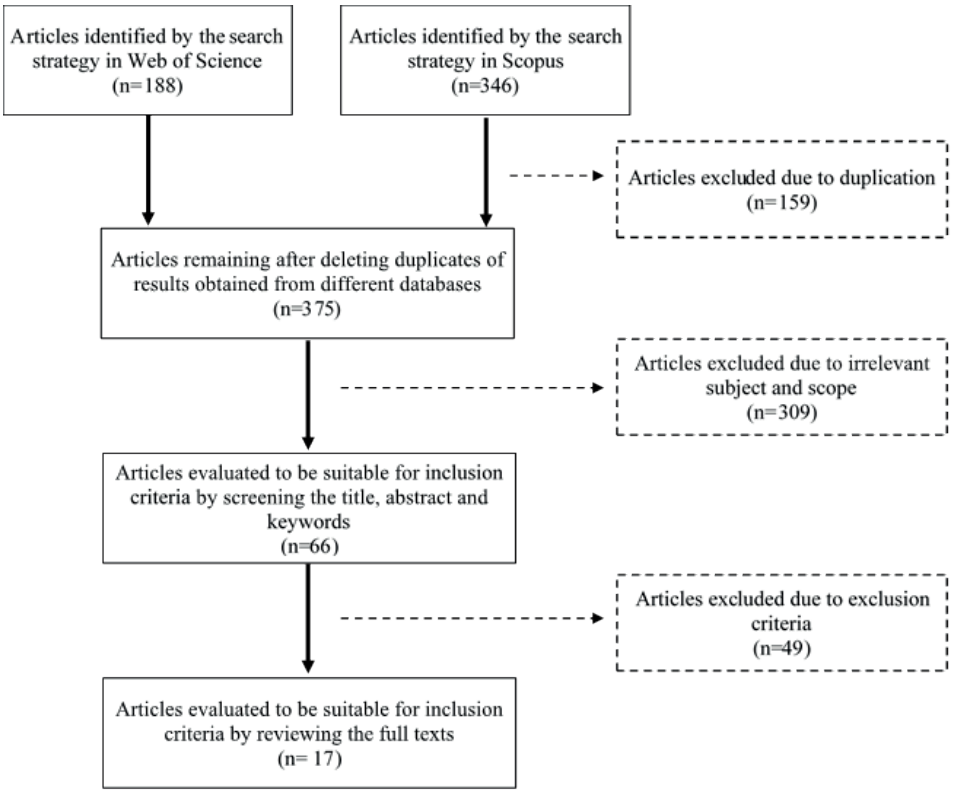


***Figure 2.*** Systematic review process of this study

A search query was formed for the search terms determined within the scope of the search strategy. This query expression was searched separately in the title, abstract, and keywords sections of the specified databases. Accordingly, 188 articles in the Web of Science database and 346 in the Scopus database met the search criteria. After deleting duplicates from both databases, the remaining 375 articles were included in the review. In the next stage, the title, abstract, and keywords of these articles were examined, and studies unrelated to LSQ and customer loyalty in online retailing were excluded. The remaining 66 articles were analyzed as full text. The content of these articles was analyzed, and articles that did not follow quantitative research methodology and were not related to the study subject were also excluded from the scope. As a result, the research sample of the present study consisted of 17 articles.

Table 3 summarizes the list of articles included in the research sample. These articles were subjected to content analysis and the findings are presented in the following section.

**Table 3:** List of articles included in the research sample

| | Author(s), Year | Indexed Database(s) | Reference Code |
|---|---|---|---|
| 1 | Dadzie, Chelariu and Winston (2005) | Web of Science, Scopus | (73) |
| 2 | Rao, Goldsby, Griffis and Iyengar (2011) | Web of Science, Scopus | (8) |
| 3 | Yongqing, Nan, Meijian and Shanshan (2011) | Scopus | (74) |
| 4 | Hsieh and Kuo (2014) | Scopus | (61) |
| 5 | Lin, Luo, Cai, Ma and Rong (2016) | Web of Science, Scopus | (75) |
| 6 | Murfield, Boone, Rutner and Thomas (2017) | Web of Science, Scopus | (24) |
| 7 | Kavitha and Rapoor (2019) | Scopus | (76) |
| 8 | Cotarelo, Calderón and Fayos (2021) | Web of Science, Scopus | (9) |
| 9 | Jain, Gajjar and Shah (2021) | Web of Science, Scopus | (13) |
| 10 | Su, Zhao, Qi, Kim and Park (2021) | Web of Science | (60) |
| 11 | Akıl and Ungan (2022) | Web of Science | (3) |
| 12 | Al-Adwan, Al-Debei and Dwivedi (2022) | Web of Science, Scopus | (2) |
| 13 | Hansopaheluwakan, Arief Elidjen and Utami Tjhin (2022) | Web of Science, Scopus | (77) |
| 14 | Oh, Kang and Oh (2022) | Web of Science, Scopus | (78) |
| 15 | Pal, Funilkul, Eamsinvattana and Siyal (2022) | Web of Science, Scopus | (79) |
| 16 | Prassida and Hsu (2022) | Web of Science, Scopus | (26) |
| 17 | Zheng, Wang, Golmohammadi and Goli (2022) | Web of Science, Scopus | (4) |

## 6. Findings and Discussion

The articles in the research sample were analyzed in terms of the publication date, and it was seen that the studies focusing on LSQ and customer loyalty in online retailing started to be published in 2005 and increased significantly after 2010. However, the majority were published, especially after 2020.

Afterward, these articles were analyzed regarding the dimensions focused on measuring LSQ. In these studies, LSQ is measured using scales with different names, and similarly, LSQ dimensions are also defined with various names. Considering the nature of the scales used, the operational definitions, and scale items, the dimensions that measure similar situations are grouped. Each grouped dimension is named in this study based on its equivalents in the literature. Table 4 presents LSQ dimensions in the articles, grouped dimensions, and the studies that used these dimensions. Accordingly, it is determined that the dimensions used for LSQ measurement are *order condition, timeliness, availability, order processing quality, order accuracy, information quality, communication quality,* and *recovery & return.*

**Table 4:** Dimensions used in the measurement of LSQ

| Grouped dimensions | Dimensions in Articles | Articles using these dimensions |
|---|---|---|
| **Order Condition** | · Condition<br>· Order Condition<br>· Shipment Condition<br>· Delivery Stability<br>· Delivery Quality | Lin, Luo, Cai, Ma and Rong (2016); Murfield, Boone, Rutner and Thomas (2017); Kavitha and Rapoor (2019); Akıl & Ungan (2021); Cotarelo, Calderón and Fayos (2021); Jain, Gajjar and Shah (2021); Su, Zhao, Qi, Kim and Park (2021); Al-Adwan, Al-Debei and Dwivedi (2022); Oh, Kang and Oh (2022); Prassida and Hsu (2022); Zheng, Wang, Golmohammadi and Goli (2022) |
| **Timeliness** | · On-Time Delivery<br>· Timeliness<br>· Timely Product Delivery<br>· Order Timeliness<br>· Cycle Time | Dadzie, Chelariu and Winston (2005); Lin, Luo, Cai, Ma and Rong (2016); Rao, Goldsby, Griffis and Iyengar (2011); Murfield, Boone, Rutner and Thomas (2017); Kavitha and Rapoor (2019); Cotarelo, Calderón and Fayos (2021); Jain, Gajjar and Shah (2021); Su, Zhao, Qi, Kim and Park (2021); Prassida and Hsu (2022); Akıl and Ungan (2022); Al-Adwan, Al-Debei and Dwivedi (2022) |
| **Availability** | · Availability<br>· Item Availability<br>· Product Availability<br>· In-Stock Availability | Dadzie, Chelariu and Winston (2005); Rao, Goldsby, Griffis and Iyengar (2011); Murfield, Boone, Rutner and Thomas (2017); Cotarelo, Calderón and Fayos (2021); Jain, Gajjar and Shah (2021); Su, Zhao, Qi, Kim and Park (2021); Al-Adwan, Al-Debei and Dwivedi (2022); Prassida and Hsu (2022) |
| **Order Processing Quality** | · Order Quality<br>· Order Release Quantities<br>· Delivery Quality<br>· Delivery Service Quality<br>· Ordering Procedures | Lin, Luo, Cai, Ma and Rong (2016); Prassida and Hsu (2022); Zheng, Wang, Golmohammadi and Goli (2022); Pal, Funilkul, Eamsinvattana and Siyal (2022); Oh, Kang and Oh (2022) |
| **Order Accuracy** | · Order Accuracy<br>· Cycle Time | Lin, Luo, Cai, Ma and Rong (2016); Kavitha and Rapoor (2019); Prassida and Hsu (2022); Akıl and Ungan (2022); Dadzie, Chelariu and Winston (2005) |
| **Information Quality** | · Delivery Information Service<br>· Information Quality<br>· Order Tracking<br>· Information<br>· Response Quality | Oh, Kang and Oh (2022); Lin, Luo, Cai, Ma and Rong (2016); Rao, Goldsby, Griffis and Iyengar (2011); Hsieh and Kuo (2014); Zheng, Wang, Golmohammadi and Goli (2022) |
| **Communication Quality** | · Personnel Contact Quality<br>· Quality Of Personal Contact<br>· Response Quality | Hsieh and Kuo (2014); Lin, Luo, Cai, Ma and Rong (2016); Su, Zhao, Qi, Kim and Park (2021); Zheng, Wang, Golmohammadi and Goli (2022) |
| **Recovery & Return** | · Order Discrepancy Handling<br>· Return<br>· Return Logistics Service | Lin, Luo, Cai, Ma and Rong (2016); Cotarelo, Calderón and Fayos (2021); Su, Zhao, Qi, Kim and Park (2021); Akıl and Ungan (2022); Zheng, Wang, Golmohammadi and Goli (2022); Oh, Kang and Oh (2022) |

Brief descriptions of the grouped dimensions in Table 4 are as follows:

- *Order condition* refers to the condition of the order at the time of delivery, such as undamaged.
- *Timeliness* refers to the time between the placement and delivery of the order and whether it is delivered at the expected time.
- *Availability* refers to whether the ordered products are in stock as previously specified.
- *Order processing quality* refers to the quality of the processes related to the supply, collection, packaging, and transportation of the products included in the order after placing the order.
- *Order accuracy* refers to the extent to which the products in the delivered order match the order placed by the customer (quantity, specifications, etc.).
- *Information quality* refers to the quality of the information provided to the customer about the order processing and all logistics processes.
- *Communication quality* refers to the communication between the company and the customer in processes such as order placement, processing, preparation, delivery, and return.
- *Recovery & return* refers to handling and correcting wrong orders and, if necessary, the quality of the return processes.

Based on the main research question, the articles included in the research sample were analyzed to determine the structure of the effect of LSQ on customer loyalty in online retailing. First, whether this effect is direct or indirect, mediated by another variable or not, was investigated. These articles were classified as 1) studies emphasizing only the direct effect of LSQ on customer loyalty, 2) studies emphasizing only the indirect effect, and 3) studies emphasizing both direct and indirect effects.

Table 5 presents the findings of this classification. Accordingly, the literature more often emphasizes the effect of LSQ on customer loyalty through other mediating variables. After the number of studies demonstrating the indirect effects, the number of studies investigating both direct and indirect effects is also noteworthy. However, only one study investigated the direct effect of LSQ on loyalty. As such, both the direct and indirect effects of LSQ on loyalty should be considered together.

| **Table 5:** Structure of the relationship between LSQ and Customer Loyalty | | |
|---|---|---|
| **Structure of the relationship** | **Number of articles** | **Information of the Articles** |
| Studies emphasizing only direct effect of LSQ on Customer Loyalty | 1 | Dadzie, Chelariu and Winston (2005) |
| Studies emphasizing only indirect effect of LSQ on Customer Loyalty | 9 | Rao, Goldsby, Griffis and Iyengar (2011); Yongqing, Nan, Meijian and Shanshan (2011); Lin, Luo, Cai, Ma and Rong (2016); Su, Zhao, Qi, Kim and Park (2021); Cotarelo, Calderón and Fayos (2021); Akıl and Ungan (2022), Al-Adwan, Al-Debei and Dwivedi (2022); Prassida and Hsu (2022); Zheng, Wang, Golmohammadi and Goli (2022) |
| Studies emphasizing both direct and indirect effects of LSQ on Customer Loyalty | 7 | Hsieh and Kuo (2014); Murfield, Boone, Rutner and Thomas (2017); Kavitha and Rapoor (2019); Jain, Gajjar and Shah (2021); Hansopaheluwakan, Arief Elidjen and Utami Tjhin (2022); Oh, Kang and Oh (2022); Pal, Funilkul, Eamsinvattana and Siyal (2022) |

The articles in the research sample were analyzed regarding the variables that had significant direct or indirect effects on the structural relationship between LSQ and customer loyalty in online retailing.

Table 6 summarizes the variables and structural relationships identified accordingly. When Table 6 is analyzed, it is determined that "customer satisfaction" is the mainly researched variable in the relationship between LSQ and customer loyalty in online retailing. Customer satisfaction is addressed separately based on transactions and overall experiences. In addition, although limited, "customer trust" is another variable that has been investigated in this relationship, and its effect has been revealed.

| **Table 6:** Structural relationship between LSQ and Customer Loyalty | |
|---|---|
| **Structural Relationships** | **Information of the Articles** |
| LSQ → Loyalty | Dadzie, Chelariu and Winston (2005); Hsieh and Kuo (2014); Murfield, Boone, Rutner and Thomas (2017); Kavitha and Rapoor (2019); Jain, Gajjar and Shah (2021); Hansopaheluwakan, Arief Elidjen and Utami Tjhin (2022); Oh, Kang and Oh (2022); Pal, Funilkul, Eamsinvattana and Siyal (2022) |
| LSQ → Satisfaction → Loyalty | Rao, Goldsby, Griffis and Iyengar (2011); Yongqing, Nan, Meijian and Shanshan (2011); Hsieh and Kuo (2014); Lin, Luo, Cai, Ma and Rong (2016); Murfield, Boone, Rutner and Thomas (2017); Kavitha and Rapoor (2019); Cotarelo, Calderón and Fayos (2021); Jain, Gajjar and Shah (2021); Su, Zhao, Qi, Kim and Park (2021); Akıl and Ungan (2022); Hansopaheluwakan, Arief Elidjen and Utami Tjhin (2022); Oh, Kang and Oh (2022); Pal, Funilkul, Eamsinvattana and Siyal (2022); Prassida and Hsu (2022); Zheng, Wang, Golmohammadi and Goli (2022) |
| LSQ → Trust → Loyalty | Zheng, Wang, Golmohammadi and Goli (2022) |
| LSQ → Satisfaction → Trust → Loyalty | Al-Adwan, Al-Debei and Dwivedi (2022); Zheng, Wang, Golmohammadi and Goli (2022) |

Based on the articles included in the scope of the study, the effect of LSQ on customer loyalty in online retailing and the effect of other variables mediating this effect were synthesized together, and a literature-based conceptual model was proposed. Figure 3 demonstrates this conceptual model.

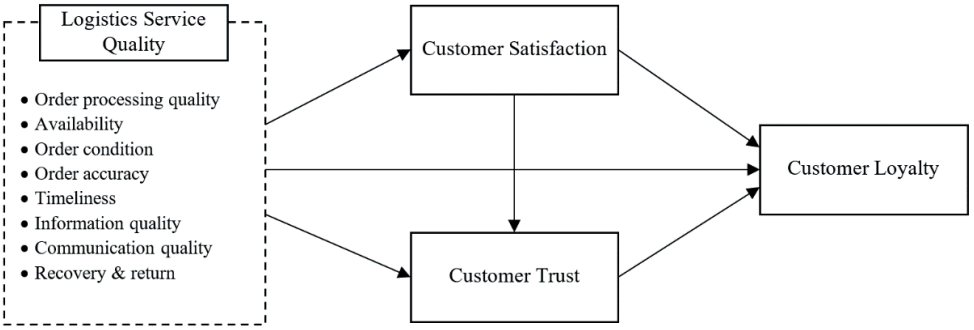


***Figure 3.*** Literature-based conceptual model

The overall evaluations and comments within the framework of the proposed conceptual model are presented in the next section.

## 7. Conclusion

This study, which focuses on addressing the role of LSQ on customer loyalty in online retailing with several dimensions, aims to develop a conceptual model based on the existing literature. In this regard, a systematic literature review method has been employed in this study. Studies published between 1998 and 2022 in the databases of high-impact journals in the field of business and economics, which include quantitative research on LSQ and customer loyalty in online retailing, were identified and analyzed within the framework of the research questions.

Studies focusing on LSQ and customer loyalty in online retailing started in 2005 and increased after 2010, but most were published after 2020. This increase is likely due to the increasing use of online retailing and the increasing importance of logistics, mainly due to the restrictions caused by the COVID-19 pandemic. However, these databases have relatively limited studies focusing on the relationship between LSQ and customer loyalty in online retailing. Increasing the research on this subject will help better understand this relationship.

The present literature uses various structures and scales to measure and evaluate LSQ for online retailing. The scales' nature, the dimensions' operational definitions, and the scale items have been evaluated, and the dimensions measuring similar situations are grouped.

Accordingly, it is concluded that the dimensions used in the literature for LSQ measurement are *order condition, timeliness, availability, order processing quality, order accuracy, information quality, communication quality*, and *recovery & return*. This classification is similar to the integrated structure of the dimensions of the Mentzer et al. (1999, 2001) scale and the dimensions of the Xing et al. (2010) scale, which are widely used LSQ scales in the literature (18,19,35). Although a grouping approach has been employed for creating a common LSQ structure in this study, a standard LSQ measurement structure has yet to be adopted and validated in the online retailing literature. Especially considering the evolving structure of online retailing, there is a need for an LSQ measurement structure and scale that can be valid in different online retailing formats. The dimensions identified in this study can be used as a basis for developing this scale.

The findings revealed that the direct and indirect effects of LSQ on customer loyalty should be addressed in online retailing. In this regard, it has been determined that customer satisfaction is the mainly researched variable in the relationship between LSQ and customer loyalty in online retailing. Customer satisfaction is addressed separately based on transactions and overall experiences. In addition, although limited, "customer trust" is another variable that has been investigated in this relationship, and its effect has been revealed. This finding aligns with the findings of different studies in the literature that reveal the existence of the structural relationship LSQ → customer satisfaction → customer loyalty in other contexts than online retailing. This study confirms that the relationship that has been found in other contexts is also valid for online retailing. In addition, this study adds a different perspective to the literature by including the role of trust in this process.

A conceptual model based on the literature has been proposed in this study within the framework of the structural relationships mentioned above. According to this model, LSQ, directly and indirectly, affects customer loyalty. In the light of indirect effects, it is defined that LSQ affects customer satisfaction, and customer satisfaction affects customer loyalty, as well as customer satisfaction can affect customer loyalty through customer trust. On the other hand, it has been revealed that LSQ affects customer loyalty through customer trust.

Based on the model proposed in this study, quality perceptions of customers from online retailing services significantly affect the preference of the same retailer in subsequent purchases. In this process, customer satisfaction increases with fulfilling customer expectations, and increased satisfaction shapes loyalty. In addition, increased satisfaction and positive perceptions of LSQ lead to increased trust, and increased trust leads to loyalty. As a result, the customer may prefer the same online retailer for their next shopping and generate positive word-of-mouth communication about this online retailer.

The proposed model in this study is recommended to be empirically investigated in different contexts. This will provide empirical support for the validity of the conceptual model and its usability in practice. In addition, the conceptual model in this study is proposed based on the findings of existing studies in the literature. Considering the limited number of studies on online retailing, other variables (e.g., perceived value) may not be investigated in the literature. However, they may play a role in LSQ and customer loyalty relationships. Therefore, the conceptual model in this study is recommended to be developed and tested with the variables examined in other studies with different scopes.

This study has limitations, including keyword selection, database selection, language selection, and year selection within the framework of a specific search strategy. Research findings should be considered according to these limitations. Additionally, the validity of the findings of this study can be improved by including different databases, different keywords, non-English language publications, and different types of publications other than academic articles in future studies.

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