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MASTER’S THESIS

TRANSFORMATION TO SUSTAINABILITY OF THE LOGISTIC SECTOR
WITH INDUSTRY 4.0 TECHNOLOGIES : A CONTENT ANALYSIS

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İZMİR-2021

DECLARATION

I hereby declare that this master's thesis titled as “**Transformation To Sustainability Of The Logistic Sector With Industry 4.0 Technologies : A Content Analysis**” has been written by myself in accordance with the academic rules and ethical conduct. I also declare that all materials benefited in this thesis consist of the mentioned resources in the reference list. I verify all these with my honour.

Date

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Deniz Tüzün

ABSTRACT
Master's Thesis
Transformation To Sustainability Of The Logistic Sector With Industry 4.0
Technologies : A Content Analysis
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The effect of production and consumption processes on the ecological environment, which emerged with the Industrial Revolution and continues to increase in importance today, is an important issue that is dealt with globally. The awareness of reversing these great negative effects that caused this period to be called the Anthropocene - the human age- has also been the most important vision of today. Countries are now looking for solutions to make the necessary transformations to make these processes sustainable. The issue of sustainability, which was dealt with only the environmental dimension in previous years, is now being examined with a more holistic perspective, including economic and social dimensions. At this point, the efforts of enterprises to achieve sustainable development goals by addressing environmental, social and economic dimensions are very valuable. Industry 4.0 technologies, which we have heard frequently recently, include technologies that businesses include in their transformation in line with sustainable development goals.

The purpose of this study, while performing its activities in line with the objectives of sustainable development of enterprises in Turkey, is to investigate whether a transformation in the industry 4.0 technologies. While conducting the research, the logistics sector, which is thought to have an impact on sustainability in many processes, was chosen as an example. Content analysis method was used to understand the technological transformation in sustainable development oriented logistics processes. In the content analysis, the Sustainability Reports of

the companies and the press releases, news and announcements pages on the websites of the companies that do not publish reports were examined and the dimension of the relevant transformation was investigated. The result obtained as a result of the data analyzed with the ATLAS.ti program is that companies in an interaction with Industry 4.0 technologies have an awareness in their discourse, but this interaction is still at the beginning level.

Keywords: Sustainable Development, Industry 4.0, Logistics Sector, Technological Transformation, Content Analysis



ÖZET

Yüksek Lisans Tezi

Lojistik Sektörünün Sürdürülebilirlik için Endüstri 4.0 Teknolojileriyle

Dönüşümü: Bir İçerik Analizi

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İngilizce Dış Ticaret Programı

Endüstri Devrimleri ile birlikte ortaya çıkan, günümüzde de önemini arttırarak devam ettiren üretim ve tüketim süreçlerinin ekosistemler üzerindeki etkisi konusu küresel boyutta ele alınan önemli bir konudur. Bu döneme Antroposen - insan çağı- denmesine neden olan bu büyük olumsuz etkileri tersine çevirme farkındalığı da günümüzün en önemli vizyonu olmuştur. Ülkeler bu ekosistemlerin sürdürülebilir hale getirilebilmesi için gerekli dönüşümleri yapabilmek adına çözümler aramaktadırlar. Önceki yıllarda sadece çevresel boyutu ele alınan sürdürülebilirlik konusu günümüzde artık daha bütüncül bir bakış açısıyla ekonomik ve sosyal boyutları da dahil edilerek incelenmektedir. Bu noktada işletmelerin çevresel, sosyal ve ekonomik boyutları ele alarak sürdürülebilir kalkınma amaçlarını gerçekleştirebilmek için verdiği çabalar oldukça kıymetlidir. Son zamanlarda sıkça adını duyduğumuz Endüstri 4.0 teknolojileri de işletmelerin sürdürülebilir kalkınma hedefleri doğrultusunda dönüşümlerine dahil edebilecekleri teknolojileri içermektedir.

Bu çalışmanın amacı, Türkiye'deki lojistik sektöründe faaliyet gösteren işletmelerin sürdürülebilir kalkınma hedefleri doğrultusunda, Endüstri 4.0 teknolojileri ile bir dönüşüm içerisinde olup olmadığını araştırmaktır. Araştırma yapılırken özellikle bir çok süreçte ve faaliyetlerinde sürdürülebilirliğe etkisi olduğu düşünülen lojistik sektörü odak olarak seçilmiştir. Sürdürülebilir kalkınma odaklı lojistik süreçlerdeki teknolojik dönüşümü anlayabilmek için

içerik analizi yöntemi kullanılmıştır. İçerik analizinde firmaların Sürdürülebilirlik Raporları, rapor yayınlamayan firmaların ise web sitelerinde yer alan basın bültenleri, haberler ve duyurular sayfaları incelenerek ilgili dönüşümün boyutu araştırılmıştır. ATLAS.ti programı ile incelenen veriler sonucunda elde edilen sonuç firmaların Endüstri 4.0 teknolojileri ile bir etkileşim içerisinde oldukları, konuşma dillerinde bir farkındalığın olduğu, fakat bu etkileşimin henüz daha başlangıç seviyesinde olduğudur.

Anahtar Kelimeler: Sürdürülebilir Kalkınma, Endüstri 4.0, Lojistik Sektörü, Teknolojik Dönüşüm, İçerik Analizi



TRANSFORMATION TO SUSTAINABILITY OF THE LOGISTIC SECTOR WITH INDUSTRY 4.0 TECHNOLOGIES : A CONTENT ANALYSIS

CONTENTS

THESIS APPROVAL PAGE	ii
DECLARATION	iii
ABSTRACT	iv
ÖZET	vi
CONTENTS	viii
ABBREVIATIONS	xi
LIST OF TABLES	xiii
LIST OF FIGURES	xiv
LIST OF APPENDICES	xvi

INTRODUCTION	1
--------------	---

CHAPTER ONE

SUSTAINABLE DEVELOPMENT

1.1. SUSTAINABILITY AND SUSTAINABLE DEVELOPMENT	4
1.2. SUSTAINABILITY AND ITS DIMENSIONS	7
1.2.1. Economical	8
1.2.2. Social	10
1.2.3. Environmental	12
1.3. SUSTAINABLE DEVELOPMENT IN THE HISTORICAL PROCESS	14
1.4. SUSTAINABLE DEVELOPMENT GOALS	16
1.4.1. Energy, Economy and Industry	19
1.4.1.1. Goal 7: Affordable and Clean Energy	19
1.4.1.2. Goal 8: Decent Work and Economic Growth	27
1.4.1.3. Goal 9: Industry, Innovation, and Infrastructure	30
1.4.2. Production and logistic	34
1.4.2.1. Goal 12: Responsible Consumption and Production	34

1.4.2.2. Goal 14: Life below Water	39
1.4.2.3. Goal 15: Life on Land	45
1.4.3. Climate Crisis and Logistics	48
1.4.3.1. Goal 13: Climate Action	49

CHAPTER TWO

INDUSTRIAL REVOLUTIONS

2.1. HISTORICAL DEVELOPMENT OF INDUSTRIAL REVOLUTIONS	58
2.1.1. Industry 1.0	59
2.1.2. Industry 2.0	60
2.1.3. Industry 3.0	61
2.1.4. Industry 4.0	62
2.1.4.1. Industry 4.0 Technologies	63
2.1.4.1.1. Cyber Physical Systems (CPS)	64
2.1.4.1.2. Big Data and Analytics	65
2.1.4.1.3. 3D Printers	67
2.1.4.1.4. Cloud Computing	68
2.1.4.1.5. RFID	69
2.1.4.1.6. Internet of Things	70
2.1.4.1.7. Artificial Intelligence	73
2.1.4.1.8. Augmented Reality	74
2.1.4.1.9. Autonomous Robots	76
2.1.4.2. Criticism of Industry 4.0 technologies	77
2.1.4. Industry 5.0	79

CHAPTER THREE

TRANSFORMATION OF THE LOGISTICS SECTOR IN INDUSTRY 4.0

TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT

3.1. CONCEPT AND IMPORTANCE OF LOGISTICS	83
--	----

3.2. MAIN ACTIVITIES IN LOGISTICS	86
3.2.1. Transportation	87
3.2.2. Inventory Management and Warehousing	94
3.2.3. Information Flow, Purchasing, and Protective Package Design	97
3.2.4. Reverse Logistics	102
3.3. LOGISTICS SECTOR IN TURKEY	104

CHAPTER FOUR

A CONTENT ANALYSIS OF LOGISTICS SECTOR FOR SUSTAINABILITY & INDUSTRY 4.0

4.1. THE PURPOSE OF THE STUDY	107
4.1.1 Research Questions	107
4.2. METHODOLOGY	108
4.3. TYPE OF STUDY	110
4.4. DATA COLLECTIVE METHOD	110
4.5. DATA ANALYSIS	112
4.6. FINDINGS	116
4.7. LIMITATIONS AND SUGGESTIONS	124
CONCLUSION	126
REFERENCES	129
APPENDIX	

ABBREVIATIONS

BBC	British Broadcasting Corporation
BC	Before Christmas
CCWG	Clean Cargo Working Group
CDP	Carbon Disclosure Project
CNC	Computer Numerical Control
COVID	Corona Virus Disease
CPS	Cyber Physical Systems
CSD	Commission for Sustainable Development
EC	European Commission
EEDI	Energy Efficiency Design Index
EPA	Environmental Protection Agency
ERP	Enterprise Resource Planning
ETSI	European Telecommunications Standards Institute
EU	European Union
FAO	Food and Agriculture Organization
FSC	Forest Stewardship Council
GAVI	Global Alliance for Vaccines and Immunizations
GHG	Green House Gas
GPS	Global Positioning System
IEA	International Energy Agency
IFO	Intermediate Fuel Oil
IIED	International Institute for Environment and Development
ILO	International Labor Organization
IML	Fraunhofer Material Flow and Logistics Institute
IMO	International Maritime Organization
IPCC	Intergovernmental Panel on Climate Change
IT	Information Technology
ITF	International Transport Federation
ITS	Intelligent Transportation System
ITU	International Telecommunication Union

LPI	Logistics Performance Index
NOAA	National Oceanic and Atmospheric Administration
OECD	Organization for Economic Cooperation and Development
OHSAS	Occupational Health and Safety Assessment Series
PAGEV	Türk Plastik Sanayicileri Araştırma Geliştirme ve Eğitim Vakfı
PRI	Principles for Responsible Investment
RFID	Radio Frequency Identification Device
SDG	Sustainable Development Goal
TÜSİAD	Türk Sanayicileri ve İş Adamları Derneği
UDHR	Universal Declaration of Human Rights
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNWTO	United Nations World Tourism Organization
VER	Verified Emission Reductions
WB	The World Bank
WCED	World Commission on Environment and Development
WFO	Waste Free Oceans
WSN	Wireless Sensor Network
WWF	World Wildlife Fund

LIST OF TABLES

Table 1: CSD Theme Indicator Framework - Economic	p. 9
Table 2: CSD Theme Indicator Framework – Social	p. 11
Table 3: CSD Theme Indicator Framework – Environmental	p. 13
Table 4: A Comparison of Industry 4.0 and Industry 5.0 Visions	p. 81
Table 5: Logistic Performans Index	p. 85
Table 6: Logistic Performans Index, Turkey	p. 86
Table 7: Changes in Container Trade Volume by World Region, 2020	p. 93
Table 8: Document Details of Selected Companies	p. 112
Table 9: Codes for Goal 9: Industry, Innovation and Infrastructure	p. 113
Table 10: Codes for Goal 12: Responsible Consumption and Production	p. 114
Table 11: Codes for Goal 13: Climate Action	p. 114
Table 12: Codes for Industry 4.0 Technologies	p. 115
Table 13: Codes for Logistic Process	p. 115

LIST OF FIGURES

Figure 1: Sustainability: The triple bottom line	p. 8
Figure 2: Sustainable Development Goals	p. 17
Figure 3: World Energy Access Rate Map	p. 23
Figure 4: CO ² Emissions and Past Economic Crises	p. 26
Figure 5: Unemployment Rate	p. 30
Figure 6: Global Materials Use in Gigatons	p. 36
Figure 7: Waste Generation by Region	p. 37
Figure 8: Largest Oil Spills Affecting U.S. Waters	p. 41
Figure 9: Increase in Global CO ₂ Emissions Since The Industrial Revolution	p. 49
Figure 10: Overview of Greenhouse Gas Emissions in 2018	p. 50
Figure 11: Global Land-Ocean Temperature Index	p. 51
Figure 12: Variation in the Concentration of NO ₂ in China During the COVID-19 Lockdowns	p. 56
Figure 13: From Industry 1.0 to Industry 5.0.	p. 58
Figure 14: From 3Vs, 4Vs, 5Vs, and 6Vs Big Data Definition	p. 66
Figure 15: IoT-Enabled Capabilities	p. 72
Figure 16: Greenhouse Gas Emissions from Transportation, 1990-2018	p. 88
Figure 17: How IoT Technologies Transforms Fleet Operations?	p. 90
Figure 18: Intelligent Transportation Systems Network	p. 91
Figure 19: DHL Implements Smart Warehouse Initiative	p. 96
Figure 20: Categorization of Logistics Functions	p. 98
Figure 21: Reverse Logistics	p. 103
Figure 22: Conceptional Framework	p. 109
Figure 23: Goal 9 "Industry, Innovation and Infrastructure" & "Industry 4.0 Technologies"	p. 116
Figure 24: Goal 12 "Responsible Consumption and Production" & "Industry 4.0 Technologies"	p. 118
Figure 25: Goal 13 "Climate Action" & "Industry 4.0 Technologies"	p. 119
Figure 26: "Logistic Process" & "Industry 4.0 Technologies"	p. 121
Figure 27: "Sustainability" & "Industry 4.0 Technologies"	p. 122



LIST OF APPENDICES

Appendix 1: Appendix Title	.app. p. 1
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INTRODUCTION

With the new globalization perception that emerged after the Industrial Revolution, as a result of the growth-oriented production and consumption understanding of the world countries, the consumption of natural resources and environmental damage problems have emerged. All ecological problems such as climate change, global warming, pollution of the seas, deforestation, destruction of natural life, consumption of natural and scarce resources have become important and these problems have emerged as global crises affecting the whole world. In order to meet the increasing consumption due to the increase in the population, the enterprises adopting a more intense production approach and the increase in the variety of consumption products caused the problems to grow gradually.

Greenhouse gas emission have exceeded 50 gigatons on a global basis today. If the current policies do not change, it is expected to reach 55-58 gigatons per year by 2030 (Ricciardi et al, 2020). Atmospheric carbon dioxide gas concentration, which was 280 ppm before the industrial revolution (IPCC, 2013), reached its highest level on April 9, 2020 and was measured as 417.85 ppm (NOAA, 2020). In addition, it is seen that global warming has reached record levels in the last 10 years (NASA's Goddard Institute for Space Studies (GISS)). On the other hand, due to the pollution caused by plastic wastes, an area symbolized as the 7th continent has been formed in the world. This area, called the Great Pacific Landfill, corresponds to an area of approximately 3.4 million km² (Çelik, 2020).

On the other hand, with the developing technologies of the 4th Industrial Revolution experienced in recent years, production processes have been accelerated and these technologies have been included in all practices in almost every aspect of life. Mechanical production, electrical energy, automatic production and information systems technologies developed with the first 3 Industrial Revolutions have developed further and transformed into a technological revolution with the addition of many new technologies with Industry 4.0. At this point, while technological advances cause more resource consumption with the increase in speed and quantity in production, on the other hand, the use of these technologies has been preferred to make processes more efficient and effective in order to reduce environmental problems.

Many studies are carried out on a global scale to solve environmental problems of the Planet Earth. The "Sustainable Development Goals", which are created by the United Nations, offer businesses a roadmap for sustainable development. By the enlargement to 17 Sustainable Development Goals, the scope of the sustainability included not only environmental, but also economic and social dimensions. Thus, when it comes to sustainability of the earth ecosystems and civilization, all environmental, economic and social efforts of enterprises in general become extremely important. Since the activities of the enterprises directly affect the economic development of the countries, the sustainability understanding they adopt and the transformations in this direction will cause both economic, social and environmental effects for the countries. Industry 4.0 technologies play a major role in the transformation adopted by businesses to achieve more efficient processes. With technological transformation, more efficient processes are aimed, while the effect of these technologies, transformation need, and firm's understanding of sustainability has been a matter of curiosity.

In this thesis, it is aimed to explore the extent of transformation experienced with Industry 4.0 technologies and their relationship with the sustainable development goals achieved in various processes such as warehousing, inventory management, packaging and transportation of logistics companies operating in Turkey. For this reason, in the first chapter of the study, sustainable development is discussed by selecting the goals that are thought to be the most related to the logistics sector and explained with examples from the dimensions of Industry 4.0. In the second chapter of the study, Industry 4.0 technologies, which constitute the second pillar of the subject, are generally introduced and their applications in the logistics sector are included. In the third chapter of the study, the general processes of the logistics sector are explained, and examples of sectoral practice are shown in accordance with the intersection of these processes with sustainability and Industry 4.0 technologies. Finally, in the fourth chapter of this study a content analysis has been conducted with the data of 20 logistic companies which operates in Turkey. The sustainability reports, the firm's press releases, news and announcements pages published in their websites generate the data for content analysis. The role of technological transformations in the

sustainability approaches of companies was investigated, by analyzing all the data obtained through the codes created with the ATLAS.ti program.

Considering the literature, although sustainability and Industry 4.0 issues are subjected to very common research in their own right, the number of studies examining the intersection of these two issues is very limited. With this study, it is thought that these two issues, which have gained importance on a global scale and have both positive and negative interactions in the logistics sector, will contribute to the literature on a sectoral basis. In addition, it has not been encountered in the literature to examine the reports in which the companies publish the Sustainable Development Goals in accordance with the purpose of the study. For this reason, this thesis will make important contributions to the literature both in terms of examining the intersection of two important issues and in terms of analyzing the sustainability reports, which are considered to be important for the traceability of companies globally.

CHAPTER ONE

SUSTAINABLE DEVELOPMENT

The concept of sustainable development, whose importance has increased rapidly in recent years, is based on the correct use of resources in all activities in daily life and their transfer to the future. As a result of the development of technologies with industrialization and transformation of production-consumption patterns, problems of rapid consumption of resources and pollution of the environment have emerged in the last century. The environmental damage caused by waste generated in production facilities and consumption, climate crisis and biodiversity loss create a global threat. To prevent these dangers worldwide, the concepts of sustainability and sustainable development have started to be discussed more. With this developing awareness, many sectors are experiencing transformations aimed at reducing environmental damage. In this sense, as in many other sectors, the logistics industry must transform its commercial activities for sustainability purposes. It is expected that commercial activities will contribute to sustainable development with the transformation of developing Industry 4.0 technologies. In this section, the concepts of sustainability and sustainable development will be examined in detail, then the Industry 4.0 transformation with the sustainable development goals will be examined about the activities of the logistics sector.

1.1. SUSTAINABILITY AND SUSTAINABLE DEVELOPMENT

The giant production processes fueled by the Industrial Revolutions have accelerated the rapid consumption and destruction of basic resources in nature. As a result of the realization of this irreversible destruction, the concept of sustainability appears as an approach in every field to take measures to prevent this destruction. Especially in the business world, as of the end of the 1700s, environmental problems began to be discussed with the Industrial Revolutions (Ashton, 1948). Industrial Revolutions are seen by many researchers as one of the most important historical events, affecting environmental pollution and climate change (Pane-Haden et al, 2009). The whole Planet is affected as a result of the release of waste, use of materials

and pollutant gases caused by industrial production processes. This new era is known as Anthropocene; “a proposed geological epoch dating from the commencement of significant human impact on Earth's geology and ecosystems, including, but not limited to, anthropogenic climate change (Wikipedia, 2020).

Climate Crisis and Global Warming is the most important common disaster on the Planet today. Industry revolutions presented the giant greenhouse gas emissions to the atmosphere, accelerated by the consumption of fossil fuels for the global energy need. Coal, Petroleum and natural gas is still not only the main source of energy globally, but also the main resource of man made global warming unfortunately. The world is almost 1°C warmer than the beginning of Industry 1.0 because of the thickening of the atmosphere by greenhouse gases as carbon and methane. At the end of this century the rise of temperature is calculated as 4 °C in the worst case scenarios, which can be visualized as droughts, forest fires and all kinds of extreme weather events (Madran, 2020). In the 1980s and 1990s the release of pollutant gases in the air did cause ozone layer depletion. In addition, the lives of many living creatures were endangered as a result of the atomic bombs used during World War II and the radioactive pollution that was released due to the disaster in Chernobyl. On the other hand, underground coal fires, which are frequently experienced in countries such as China, America and Australia, pose a risk to our planet and human life (Stracher, Glenn, 2010). In addition, there is an electronic waste dump in China where electronic devices are dismantled and precious metals are separated (Li et al, 2011: 2528). In different parts of the world, there are garbage dumps spread over wide geographies where plastic and other wastes are located, and they cause considerable pollution. Another example is waste discharged from a company producing aluminum in Hungary causes poisoning to people. Also, recently, environmental disasters caused by oil wells in the Gulf of Mexico pose a global risk. These examples show us that environmental disasters occur along with industrialization, which forms the basis of production and consumption. The continuation of industrialization by developing itself can only be possible with applications based on sustainable development. Otherwise, resources will end and all living things in nature will be affected by these problems. Therefore, industrialization

should only be transformed and developed according to the principles of sustainable development paradigm.

In order to understand the concept of sustainable development, the importance of sustainability and development concepts should be touched upon. Because these two concepts came together and formed the concept of sustainable development that adds a new perspective to a new subject. The concept of sustainability without development and development without sustainability is meaningless (Sachs 2009: 28). Sustainability can be defined as the situation in which the ecosystem and society, or any system that continues more generally, can maintain itself without consuming its basic resources (Gilman, 1992). In other words, sustainability is the need to change our lifestyle in order to develop and support living conditions indefinitely (McMichael et al, 2003:1919). In this case, it will only be possible to find a balance between personal or social needs and the capacity of natural resources (Choi and Ng, 2011). On the other hand, when we look at the concept of development, we see that the concept is handled by different disciplines. In general, it resembles concepts such as growth, structural change and development, industrialization. Today, the content of the concept has been expanded to include not only economic but also social, political and cultural growth and development.

The concept of sustainability, which has started to be discussed on a global scale, has become the solution of the main problems of the world such as climate change, environmental pollution, increase of carbon emissions, depletion of resources, biodiversity loss, pollution of water and destruction of water resources. The approach of the United Nations (UN) on the subject is being expanded day by day and the scope of the objectives is handled from a more holistic perspective. Thus, within the scope of Sustainable Development, it is aimed not only to ecological issues such as pollution and destruction of natural resources, but also to address economic and social issues such as human health, quality education, peace and justice.

Along with the awareness experienced today, many institutions and organizations feel the need to organize their activities in this direction and are transforming for sustainable development. In this sense, many companies publish sustainable development reports every year regarding their activities and make their transformation visible. Businesses strive to protect the climate and resources for

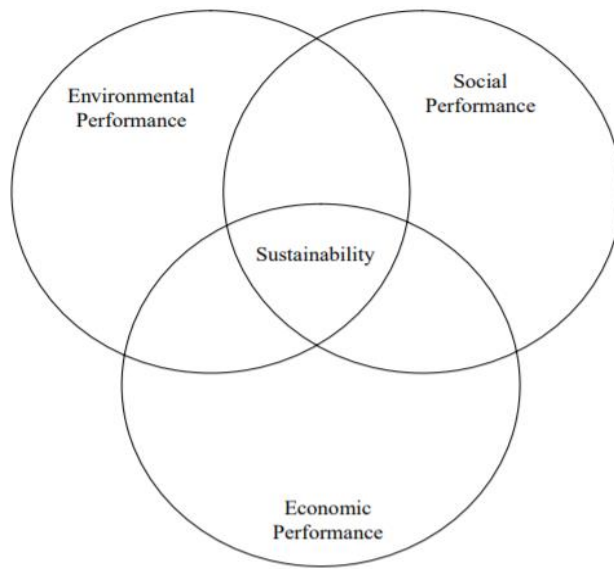
environmental and social sustainability in order to increase their competitive value in the international market (Berry and Rondinelli, 1998). Businesses can find the opportunity to open new markets for themselves and strengthen their performance in existing markets with the applications they realize within the scope of environmental sustainability (Roy, 1999).

1.2. SUSTAINABILITY AND ITS DIMENSIONS

The definition of sustainability has evolved from the past to the present, reaching a wider meaning and has a holistic approach. It is important for individuals to be able to achieve the economic developments they target without destroying the resources while living. In this sense, individuals must both maintain their lives in harmony with the environment and without harming the environment, and also ensure their economic relations by making the necessary resource consumption planning. This is why the concept of sustainability covers different dimensions. At the United Nations World Summit, sustainable development was discussed in three dimensions: economic, environmental and social (UN, 2005: 12).

At this point, the idea of Triple Bottom Line was put forward by Elkington in 1998 in order to balance the economic, environmental and social goals simultaneously (Carter and Rogers, 2008: 365). In this idea, it is emphasized that sustainability can be achieved at the intersection point by achieving the 3-dimensional goals in a balanced way. This balance is very important to achieve sustainability in a truly healthy way.

Figure 1: Sustainability: The Triple Bottom Line



Source: Carter, C. R., & Rogers, D. S. (2008). A Framework Of Sustainable Supply Chain Management: Moving Toward New Theory. *International Journal Of Physical Distribution & Logistics Management*, 38(5), 360–387. <https://doi.org/10.1108/09600030810882816>

In the following section, 3 dimensions of sustainable development will be explained. Since the perspective of the thesis will be done through the logistics sector, although all dimensions will be discussed, its environmental effects will be discussed more.

1.2.1. Economical

When we first look at the economic dimension, it is possible to say that businesses and nations aim to increase their profitability and achieve sustainable growth by using resources efficiently (Soubotina, 2004). World resources are limited, and it is important to use resources carefully and turn to renewable resources when necessary while performing economic activities. In addition, companies need to make sustainable decisions in order to sustain their existence and increase their profitability in the long term. In this sense, companies need to pay attention to many details from the raw materials they use while producing, to their energy consumption, to meeting their equipment needs. Thus, they can achieve sustainable growth by minimizing their financial calculations, increasing their profitability. In addition, it is important for

companies to keep their internal and external debt balances in balance for a long time. Economic indicators set by the United Nations Conference on Sustainable Development are outlined: Economic sustainability is discussed under the themes of economic structure and consumption and production patterns. Economic structure, economic performance, trade and financial situation were examined, and the data was focused on the gross national product. Similarly, material and energy usage and waste management studies of companies are emphasized in the theme of consumption and production patterns (UN, 2007).

Table 1: CSD Theme Indicator Framework - Economic

ECONOMIC		
Theme	Sub-theme	Indicator
Economic Structure (2)	Economic Performance	GDP per Capita
		Investment Share in GDP
	Trade	Balance of Trade in Goods and Services
	Financial Status (33)	Debt to GNP Ratio
		Total ODA Given or Received as a Percent of GNP
Consumption and Production Patterns (4)	Material Consumption	Intensity of Material Use
	Energy Use	Annual Energy Consumption per Capita
		Share of Consumption of Renewable Energy Resources
		Intensity of Energy Use
	Waste Generation and Management (19-22)	Generation of Industrial and Municipal Solid Waste
		Generation of Hazardous Waste
		Generation of Radioactive Waste
		Waste Recycling and Reuse
	Transportation	Distance Traveled per Capita by Mode of Transport

Source: United Nations. (2007, October). Indicators of sustainable development: guidelines and methodologies. Retrieved from <https://sustainabledevelopment.un.org/content/documents/indisd-mg2001.pdf>

Companies to achieve economic stability in their long-term plans should examine the costs in supply chain processes with the help of the logistics sector. (Pullman et al., 2009: 46). In addition, activities such as recycling applications, waste management issues, use of renewable resources will contribute to economic sustainability as they will minimize costs (Carter and Rogers, 2008: 377). In order to minimize costs, transformation of storage techniques in a way that consumes less energy and implementation of sustainable packaging practices will contribute to the process (Varsei, 2016: 412). In addition, considering the transportation dimension,

ensuring fuel savings by making appropriate route planning will contribute to economic sustainability as well as to the environment.

1.2.2. Social

According to the social sustainability dimension, it is important to ensure the long-term social welfare in countries and to manage each individual so that they have the right to live above the poverty line. At the same time, it is possible to direct the individuals who make up the society to be sensitive to the environment and to meet their consumption needs with this awareness. Thus, both individual and social welfare and awareness can be maintained (Yavuz, 2010: 66). In addition, social sustainability aims to ensure equality in income distribution, effectiveness in the provision of social services such as health and education, gender-based equality, and political participation (Harris, 2001). When considered in general terms, social sustainability necessitates meeting the needs such as shelter, food supply, access to clean water and employment, which are essential for living. In the Johannesburg Declaration of Sustainable Development published in 2002, subjects such as re-evaluating the production and consumption patterns of the countries, reducing and eliminating poverty were included under the aim of social sustainability (Kalyoncu, 2005). In the Social Sustainability dimension includes responsibilities such as labor practices, good working conditions and human rights, which overlap with Social Responsibility 8000 standard, The International Labor Organization and social life cycle assessment objectives (Varsei, 2016: 414).

Social indicators set by the United Nations Conference on Sustainable Development are outlined: Social sustainability has come to the fore mainly with the themes of equality, health, education, housing, security and population. Issues such as the ratio of the population living below the poverty line of the society, unemployment rates and gender equality constitute the sub-subjects of the equality theme. Under the theme of health, issues such as nutritional status, mortality rates, hygienic conditions and health services of the society were included. On the other hand, the theme of education has been brought to the fore regarding the literacy level of the society. Finally, in other themes, living space per person is under the theme of housing right;

crime rates of the society were examined under the theme of security and population growth rates under the theme of population (UN, 2007).

Table 2: CSD Theme Indicator Framework – Social

SOCIAL		
Theme	Sub-theme	Indicator
Equity	Poverty (3)	Percent of Population Living below Poverty Line
		Gini Index of Income Inequality
		Unemployment Rate
	Gender Equality (24)	Ratio of Average Female Wage to Male Wage
Health (6)	Nutritional Status	Nutritional Status of Children
	Mortality	Mortality Rate Under 5 Years Old
		Life Expectancy at Birth
	Sanitation	Percent of Population with Adequate Sewage Disposal Facilities
	Drinking Water	Population with Access to Safe Drinking Water
	Healthcare Delivery	Percent of Population with Access to Primary Health Care Facilities
		Immunization Against Infectious Childhood Diseases
		Contraceptive Prevalence Rate
Education (36)	Education Level	Children Reaching Grade 5 of Primary Education
		Adult Secondary Education Achievement Level
	Literacy	Adult Literacy Rate
Housing (7)	Living Conditions	Floor Area per Person
Security	Crime (36, 24)	Number of Recorded Crimes per 100,000 Population
Population (5)	Population Change	Population Growth Rate
		Population of Urban Formal and Informal Settlements

Source: United Nations. (2007, October). Indicators of sustainable development: guidelines and methodologies. Retrieved from

<https://sustainabledevelopment.un.org/content/documents/indisd-mg2001.pdf>

When social sustainability is examined in terms of logistics sector applications, it is seen that many companies try to improve their activities in supply chain processes in terms of social sustainability (Andersen and Skjoett-Larsen, 2009: 82). However, it is still possible to say that it is not implemented as effectively as other sustainability dimensions. The applications of the social sustainability dimension in the enterprises are mostly employing women, fair wage distribution, and providing equal working opportunities to all employees. In addition, improving the decision-making processes of companies and improving the business models they use set an example for social sustainability. At this point, this dimension of sustainability is mostly related to the managerial side of the businesses, not their operations. In addition, considering the security theme, which is one of the social sustainability themes we mentioned earlier, it can be said that companies can develop various practices in subjects such as child

labor, discrimination, regulation of working hours and occupational safety. Carter and Jennings (2002: 164) talked about the concept of “logistical social responsibility” in detail and proposed a framework in which social issues such as security, human rights, quality of life, ethics, diversity, society and charity were emphasized.

1.2.3. Environmental

Sustainability studies have mostly started to find solutions to environmental problems that emerged after the Industrial Revolutions. In order to ensure a healthy environment, the correct use of non-renewable resources, and to reduce environmental damage caused by production, activities were led by developed countries. Although 3 different dimensions of sustainability are considered, more environmental dimensions come to the agenda and are discussed more.

When we look at the definition of environmental sustainability, it is mostly focused on the sustainability of natural resources. At this point, the definition of environmental sustainability includes the titles "renewable resources", "non-renewable resources" and "environmental pollution" (Daly, 1991). Environmental sustainability is important in creating awareness in societies regarding the conscious use of natural resources and simultaneously protecting the ecosystem. Therefore, considering sustainability from an environmental perspective, giving importance to biological diversity will make the subject more holistic.

A sustainability index is prepared in order to reveal the progress in environmental sustainability in a concrete way. In this index sale, the progress of countries on this issue can be measured and shared with the world public at the meetings held on the subject (Saisana, 2014). In the 21st century environmental strategy determined by the OECD, 4 basic elements have been emphasized (OECD, 2001: 6):

1. Regeneration: Renewable resources should be used efficiently without losing any feature.
2. Substitutability: The use of non-renewable resources should be planned and replaced with renewable resources as much as possible.

3. Assimilation: The substances that harm the environment should be kept at a level that nature can absorb and, if possible, be reset.

4. Preventing irreversible impacts: It should be ensured that the factors causing environmental pollution are reduced and the ecosystem gains resilience by preserving its integrity.

Environmental indicators set by the United Nations Conference on Sustainable Development are outlined: Atmosphere, soil, ocean and seas, coasts, water, and biodiversity. At this point, it was emphasized that in order to protect the atmosphere, issues such as reducing air pollution, protecting the ozone layer, and greenhouse gas emission climate change should be addressed. It has been stated that for the protection of soils, it is necessary to focus on the regulation of arable land, control of chemicals used in agriculture, the intensity of trees being cut, desertification and urbanization. In addition, the control of waste and fishing times and rates should be addressed to protect the oceans and seas. It was also stated that the use rates of groundwater resources should be examined regarding water consumption and water pollution, which are one of the most important issues. Finally, for the protection of biological diversity, issues such as the control and proportion of protected areas and the conservation of species were emphasized (UN, 2007).

Table 3: CSD Theme Indicator Framework – Environmental

ENVIRONMENTAL		
Theme	Sub-theme	Indicator
Atmosphere (9)	Climate Change	Emissions of Greenhouse Gases
	Ozone Layer Depletion	Consumption of Ozone Depleting Substances
	Air Quality	Ambient Concentration of Air Pollutants in Urban Areas
Land (10)	Agriculture (14)	Arable and Permanent Crop Land Area
		Use of Fertilizers
		Use of Agricultural Pesticides
	Forests (11)	Forest Area as a Percent of Land Area
		Wood Harvesting Intensity
	Desertification (12)	Land Affected by Desertification
Oceans, Seas and Coasts (17)	Urbanization (7)	Area of Urban Formal and Informal Settlements
	Coastal Zone	Algae Concentration in Coastal Waters
		Percent of Total Population Living in Coastal Areas
Fresh Water (18)	Fisheries	Annual Catch by Major Species
	Water Quantity	Annual Withdrawal of Ground and Surface Water as a Percent of Total Available Water
	Water Quality	BOD in Water Bodies
Biodiversity (15)	Ecosystem	Concentration of Faecal Coliform in Freshwater
		Area of Selected Key Ecosystems
	Species	Protected Area as a % of Total Area
		Abundance of Selected Key Species

Source: United Nations. (2007, October). Indicators of sustainable development: guidelines and methodologies. Retrieved from <https://sustainabledevelopment.un.org/content/documents/indisd-mg2001.pdf>

Considering environmental sustainability in terms of the logistics sector, issues such as design, production, purchasing and transportation of products become important, especially in logistics processes. At this point, basic problems such as greenhouse gas emissions released into the air during transportation, waste generation, energy and water consumption come to the fore in all supply chain processes (Varsei, 2016: 413). The carbon dioxide emission resulting from the use of energy in the world is 60%, and approximately 25% of this rate is related to transportation (International Energy Agency, 2020). In this sense, transportation, which constitutes the most basic process of logistics, has a very important place in environmental sustainability. As an economic paradigm sustainable development and its evolution will be discussed in the following chapter.

1.3. SUSTAINABLE DEVELOPMENT IN THE HISTORICAL PROCESS

The issue of environmental problems that started to be questioned with the Industrial Revolutions and the concern that resources may be depleted in the future have made the issue of sustainability important. Likewise, it has become important to maintain the economic growth and development provided by technological developments and mechanization in these years in a healthy way. Especially, due to the increase in production that emerged through the rapidly settling capitalist world order after the Second World War, rapid consumption of resources and unfair distribution of income were in question. Therefore, with the increase of awareness on the subject, various reports were prepared, and conferences were held under the leadership of the UN. Thus, global scale solutions for resource management and environmental risks have been sought. The United Nations Stockholm Conference held in 1972 was the first meeting to discuss environmental risks. This meeting formed the basis for environmental problems discussed internationally. With the 29 declarations that came out at the end of the meeting, general lines on environmental issues were determined, and they created the basis for the discussion of the concept of

sustainable development for the next process (Rao, 2000: 8-9). Thus, the conference has become a guide for the future on issues such as the use of renewable resources and taking necessary measures to ensure the balance between environment and economy. In 1979, the First Climate Change Conference was held in Geneva, with the focus of climate change research. Establishment of the United Nations World Commission on Environment and Development (WCED) was established in 1984 for all countries of the world to adopt the global development plan and environmental protection issues (Klarin, 2018:6).

With the Brundtland Report published in 1987 (WCED), the topics of discussion were expanded, and the concept of sustainable development was addressed in a holistic way by adding the economic development dimension. In this way, it was emphasized that cooperation on an international scale is required for sustainable development (Strange and Bayley, 2009: 24). Although there is still no common definition for sustainable development worldwide, it is accepted that the first definition of sustainable development has been made with this report (Goodland and Ledec 1987 :2). Also, in 1990, the second World Climate Change Conference was held. Thus, the Global Climate Change Monitoring System was developed to monitor the developments regarding climate change (Klarin, 2018:6). Rio Summit held in Brazil in 1992 is also an important meeting for greenhouse gas and sustainable development discussions. In this conference, the human right to live in harmony with nature was emphasized and the scope of the concept was expanded. In the document called Agenda 21 adopted at the conference, it was brought up to study the concept in different fields. Thus, the concept of Sustainable Development has been expanded to include different issues such as agriculture and rural development and settlement (Bozlağan, 2005:1020). Agenda 21 document that the responsibility lies primarily with the governments, but that the public and non-governmental organizations will also be involved and cooperate in the process. In the same period, the 5th Action Plan was created by the European Union in order to include local governments in the process. The most important feature of the Plan, published under the title Towards Sustainability, is that it is the first program to see local governments as government partners (Bozlağan, 2005: 1021). The United Nations countries that came together in 1997 to take more concrete steps in Japan signed the Kyoto Protocol. As a result of

this protocol, developed countries were expected to reduce their greenhouse gas emissions by at least 5% below 1990 levels in the period between 2008-2012 (Prado-Lorenzo et al., 2009). In this sense, the protocol emphasizes that industrialization and businesses have an important impact on climate change and environmental responsibilities (Albino et al., 2009). Turkey also has signed a protocol in 2009 to combat environmental problems on a global scale and to take part in this process (Binboğa, 2017: 213).

In 2002, the World Sustainable Development Summit was held in Johannesburg. In the action plan put forward at the end of the summit, the practices to be carried out in the name of global sustainable development were included. In this sense, topics such as reducing environmental pollution, use of scarce resources, re-evaluation of production and consumption models are discussed (Bozlağan, 2005: 1025). By 2009, the Third Climate Change Conference was held. In this conference, it was aimed to predict possible disasters in a timely manner by the previously developed global monitoring system. Then, in 2012, the Sustainable Development Goals determined at the Rio Summit were renewed and issues related to the green economy were put on the agenda (Klarin, 2018:6). In 2015, the United Nations Sustainable Development Summit was held. As a result of this Summit, goals for development were determined until 2030. In the same year, the UN Climate Change Conference COP21 was held in Paris to reduce greenhouse gas emissions and prevent global warming (Klarin, 2018:6).

1.4. SUSTAINABLE DEVELOPMENT GOALS

The Sustainable Development Goals came into force in January 2016 and will guide UNDP policy and funding for the next 15 years. Sustainable Development Goals are based on defining global priorities and goals, and countries should work on this subject until 2030. With the 17 objectives determined, countries are called upon to act in cooperation on fundamental issues such as climate change, equality and justice, economic stability, sustainable production and consumption. The 17 goals are expected to guide countries in order to provide future generations with a sustainable living space (UN, n.d.)

Figure 2: Sustainable Development Goals



Source: United Nations, (n.d.) Department of Economic and Social Affairs

Sustainable Development Retrieved March 20, 2021 from <https://sdgs.un.org/goal>

Looking at the goal titles in general, certain advanced technologies are used to achieve almost all goals. In this sense, we encounter advanced Industry 4.0 technologies at the solution point of this process, which is questioned by industrialization and seeking solutions. Almost all sectors apply transformation policies in conjunction with Industry 4.0 technologies in order to achieve their sustainable development goals. When the goals are examined, it can be seen that each goal is basically related to Industry 4.0 technologies. For example, looking at the first goal, "No Poverty", we can look at the contribution of the software industry to the economy of India as an example. India, whose welfare level is not very high has become a huge giant in the industry which is software technology developed by developed countries. In the last 5 years, information technology has grown almost 6 times in India and has made a great contribution to the Indian economy (Sahoo and Nauriyal, 2014: 39). Smart agricultural practices are used to increase productivity in agriculture with the second target of "Zero Hunger" practices. Industry 4.0 technologies are used in many processes such as soil analysis, spraying and post-harvest storage and distribution. Thus, by changing the production methods, product efficiency can be increased and more production can be achieved with less cost. In addition, in order to achieve the 10th goal titled "Reduced Inequalities", the necessary technological infrastructures are completed and access to the internet is an example for countries that cannot access the internet yet. Elon Musk aims to provide low-cost

high-speed internet to all over the world with the global satellite-internet project named Starlink (Starlink, n.d.) These examples can be replicated for other goals. However, in this thesis, the relationship between Industry 4.0 and Sustainable Development stands out the most, goals of 7, 8, 9, 12, 13, 14 and 15 will be explained.

While examining the Sustainable Development Goals, it is necessary to mention the picture that emerged with the virus called Covid-19, which emerged in Wuhan, China's industrial region in the last days of 2019, and gained a global dimension after a short time. Due to the spread of the epidemic to almost all countries of the world and the number of deaths increasing day by day, various measures have been taken all over the world. On March 11, 2020, the World Health Organization declared this epidemic as the "Covid-19 Pandemic". As a result of the harsh measures taken, it is seen that the global economy is badly affected by the disrupted business and international trade. Many sectors such as tourism, transportation, energy, industry, agriculture and banking have been interrupted by the epidemic. Many businesses have started to apply the home-working system by looking for a new business model. Many companies had to shut down during this period and some companies were downsized. Many processes from production to consumption had to evolve into a different dimension. While the worldwide epidemic affected the global economy badly, on the other hand, it started a fallow process for the improvement of nature. It has been observed that in many countries, primarily in China, as the industrial activities decrease with the pandemic, greenhouse gas emissions, which are considered to be the main responsible for global warming, continue to decrease. Thus, it has been observed that air pollution has decreased in many places. In addition, when looking at the epidemic from a different perspective, the importance of having the necessary technological equipment and infrastructures came to the forefront with the transition to the working from home model. Many companies have had to follow their business follow-ups online over the internet. In addition, digital sales increased during this period due to people staying home. In this sense, it has become clear that technological developments are also needed to overcome the epidemic. Undoubtedly, it will be possible to see both the economic, sociological and environmental effects of the pandemic process in terms of sustainability in the short and long term. For this reason,

these effects of such an important event will be discussed separately in the following sections within the scope of Sustainable Development Goals.

1.4.1. Energy, Economy And Industry

Three of the objectives to be examined in the study will be explained under this title. Regarding the energy issue, Goal 7: Affordable and Clean Energy will be explained. Concerning the economy, Goal 8: Decent Work and Economic Growth will be examined. Regarding industry, Goal 9: Industry, Innovation, and Infrastructure target will be discussed. While explaining the goals, firstly the problems related to the goal will be explained and then the solutions to be done for this problem will be mentioned. In addition, the current effect of Covid-19 will be examined for each goal.

1.4.1.1. Goal 7: Affordable and Clean Energy

"Affordable and Clean Energy" aims to meet the energy needs of all individuals in a safe and sustainable manner at reasonable prices. For this reason, it is included as a goal defined by the United Nations among the Sustainable Development Goals. With the definition of clean energy as a goal, we can say that it is the aim of seeking solutions to some problems. We can express the starting point problems in defining this goal as follows. Current energy patterns are the main reasons of the Climate Crisis and Global Warming.

Problem 1: Environmental Damage

Energy use, one of the indispensable needs of daily life, is increasing day by day. As in the general needs of society, enterprises also use energy in almost all processes such as operating machines, in-house lighting, warehouses, etc. Workplaces constitute one of the most energy consuming places in the world. For example, considering the logistics sector, apart from the energy used in the business building, the fuel use of the vehicles during transportation and warehousing is also in question. As a result of all this intense energy use, we face a big problem of climate crisis and global warming. Since the Industrial Revolution, it has been observed that the energy

obtained from fossil fuels increases the carbon level in the atmosphere (Peynirci, 2020: 12). The use of energy obtained from coal is shown as the starting point of the carbon dioxide level accumulated in the atmosphere (Yılmaz and Özdağoğlu, 2020: 164). Today, energy use is increasing day by day due to the increase in both the enterprises and the population, and the rate of toxic gases released into the atmosphere is increasing rapidly. Fossil fuel based energy model is the one and only problem creating many extreme weather events, disasters, droughts and fires.

Solution 1: Preferring renewable energy sources

In order to solve the above-mentioned problems, the use of clean energy sources such as wind, solar, water, geothermal etc. should be encouraged. It has been emphasized that environmental problems will be reduced by using renewable energy sources. It has been observed that renewable energy sources have 20 times lower greenhouse gas emissions per Kwh than coal-fired power plants (National Renewable Energy Laboratory, 2013).

Many companies engage in activities related to the use of clean and renewable energy and set targets for themselves. Many companies operate in the field of clean energy. Vestas, NestEra Energy, Suzlan Group and PowerSolar companies can be shown as examples of these companies (Yılmaz and Özdağoğlu, 2020: 176). Undoubtedly, the transition processes of companies to clean and renewable energy will be more possible and easier with innovative technologies. In this sense, companies can make clean energy activities more possible by using Industry 4.0 technologies. The products of Tesla company, which stands out with technological developments, can be shown as an example at this point. Standing out with the production of electric cars and energy storage, the company offers an alternative to classical solar panels with the product named 'Solar Roof Tiles' launched in 2017 (Tesla, n.d.). As a different example, clean energy can be produced using solar energy with products known as 'smart windows' (Service, 2018). On the other hand, many countries contribute to energy production by establishing solar fields in their cities. The best example in this field is China. China is the country with the largest solar panels field in the world and is taking important steps towards developing energy policies with the use of technology (Baraniuk, 2018)

Transition to clean energy is of great importance in the transportation sector, which has a great impact on greenhouse gas emissions with energy use. In this sense, we can say that logistics companies have started to take steps in this direction. While electric vehicles are shown as an alternative in road transport, it has been a matter of building ships that move using wind and solar energy in maritime transport. Skysails company in Germany has established the "kite wind ship" system for cargo ships to ensure more efficient energy use of large ships. Skysail technology aims to reduce fuel consumption and emissions by using towing kites to bring the ship forward (Skysails-group.com). Wallenius Wilhelmsen's E / S Orcelle, also known as the world's first zero-emission ship concept, uses various green technologies to create a system that does not emit any emissions into the atmosphere. Sails, solar panels and wave energy converters are used to meet the energy needs of the ship (Laxmi, 2017). Autonomous ship studies are carried out on the seaway, as well as on the autonomous vehicles on the road. Yara Birkeland, built in Norway, can be made autonomous by navigating the boat traffic and anchoring alone in the port, using GPS, radar, cameras and sensors it has (Skredderberget, 2018). The project, which has been suspended for now, is expected to continue in the coming years.

Arkas Holding conducts many case studies in green logistics activities. The company, which invested in Euro 5 vehicles by renewing its vehicles on the road, applies methods that will save fuel by using its ships at an economical speed. In addition, the 'Arkas Forest' sets an example for environmentally friendly practices by supporting the proliferation of wooded areas. In the future, the company continues its projects aimed at reducing waste at ports, reducing carbon emissions resulting from electricity and fuel consumption, and preventing global warming. In addition, it has projects for the use of renewable energy by supporting the ceilings with solar energy in its warehouses. Another innovative step is that it emphasizes that environmental activities can be increased with investments in information technologies. In this sense, it evaluates all kinds of technological products and software to be used in the company within this scope. For example, Arkas provides its employees with PCs with an infrastructure operating with lower processing power. The IT infrastructure using Microsoft Terminal Server indirectly reduces the CO₂ emission caused by the energy

production required for the same number of PCs, thanks to its low energy consumption (Arkas, 2020).

Another example of a worldwide known logistics company is Deutsche Post DHL. With the environmental protection program called DHL "GoGreen", more than 60 percent of the group's worldwide electricity needs are obtained from renewable sources. With the GoGreen program, Deutsche Post DHL applies technologies to reduce carbon emissions by taking measures focused on transition to sustainable energy sources ("clean energy") as well as technologies that will reduce energy consumption ("low energy"). With the Industry 4.0 technologies used in this direction, uncontrolled vehicle movements are regulated with vehicle tracking systems, while carbon emissions are minimized thanks to the traceability of all vehicles. Vehicle tracking systems are used not only in the vehicles owned by DHL, but also in the vehicles of the suppliers that receive service regularly. DHL Supply Chain makes many infrastructure and technology investments for more efficient use of the energy used in all its facilities. The company aims to reduce all emissions related to logistics to zero net by 2050. (Eschmeier, 2017).

Mediterranean Shipping Company (MSC), another large company in the industry, invests in low-carbon technologies and remediation programs to reduce environmental damage. The company's fleet improvement program achieved a 13% reduction in CO₂ emissions per transport between 2015-18. In addition, MSC is investigating the usability of hydrogen as an alternative energy source and fuels derived from it as a possible fuel source for container transportation (MSC, 2019). Many more companies are implementing projects that improve environmental programs by using innovative technologies. Investments are made in technologies necessary to implement environmentally friendly practices both in the world and in the local sector.

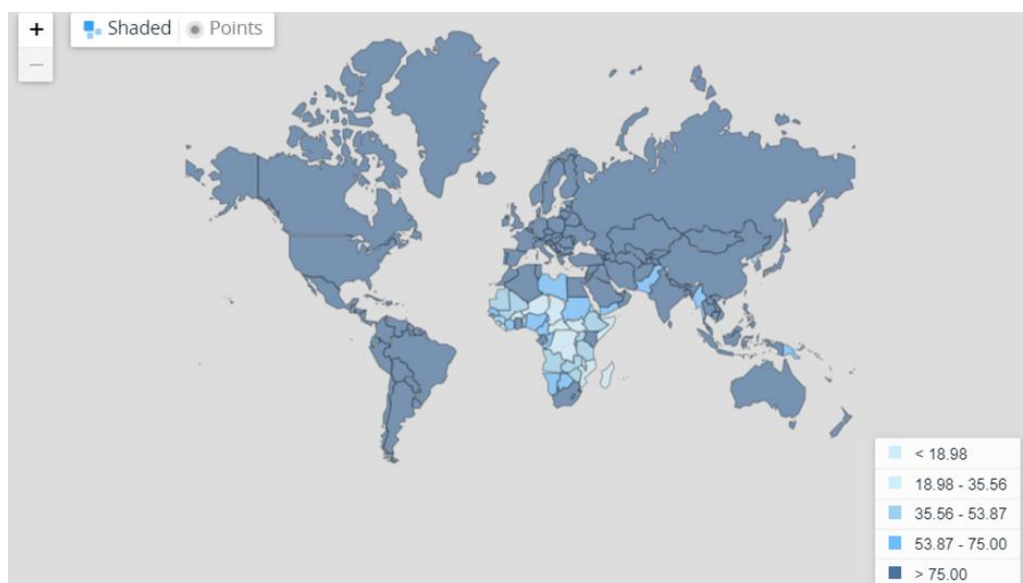
This issue is on the agenda in the academic world as well as in practice. When the literature is reviewed, it is seen that there are many studies on the effect of renewable energy use on emissions. In their study, Bento and Moutinho (2016) reached the findings that renewable energy reduces CO₂ using the data of Italy. Ito (2017) found that renewable energy production had a reducing effect on CO₂ emissions as a result of his study with the data of the 2002-2011 period of 42 countries. Likewise,

Chen et al. (2019) tested the years 1980-2014 with their study in China and found that renewable energy production reduced CO2 emissions. In another study, renewable and non-renewable energy sources were analyzed using basic contribution analysis, geometry series expansion and structural path analysis, and it was concluded that the environmental impact of renewable energy sources is lower than non-renewable energy sources (Hung, 2010). All these are just a few examples in the wide literature. When examined in more detail, it can be seen that there are many similar studies. These studies also show that there is an inverse proportion between renewable energy and emission emissions, and it may be possible to reduce emission with the increase in the use of renewable energy.

Problem 2: Access to Energy

Another problem that is addressed for the purpose of clean and accessible energy is the unequal access to energy in all countries of the world. The fact that energy access is still more restricted in some countries is another goal to find a solution. In this sense, it is seen that the population, which is mostly concentrated in Sub-Saharan Africa, has limited access to electricity. The access rate, which was 34% in 2010, could only reach 47% in 2018. With this ratio, it shows that 20 countries, 14 of which are in Sub-Saharan Africa, still do not have access to electricity (World Bank, 2020).

Figure 3: World Energy Access Rate Map



Source: The World Bank. (2020). 7 Affordable and clean energy. Retrieved February 4, 2021, from <https://datatopics.worldbank.org/sdgoalatlas/goal-7-affordable-and-clean-energy/>

Solution 2: Investing in projects to ensure equitable energy access

Many projects are created and investments are made in these projects in order to provide equal energy access to all countries globally. Equitable access to energy is aimed with the implementation of projects developed especially for countries that have no access to energy.

The energy team within the IIED is one of the organizations that handles such projects so that sustainable energy access can provide equitable access to the poorest populations. The team takes a number of initiatives to reduce poverty and ensure socio-economic development. In the projects they carry out, they conduct in-depth case studies on a country basis. They conduct their research in many parts of the world, especially in Africa, Asia and Latin America. Many of its projects are financed by the European Union. Some of the case studies are as follows: research report for the energy sector in Uganda, case studies on how to implement electricity projects in rural areas in Nepal, Peru and Kenya, research on renewable energy potential and applicability in Nigeria (Best,2021).

Another case study is continued by the World Bank. Since 2010, the World Bank has provided more than \$ 5 billion to work for energy access of countries with almost 70 projects in more than 35 countries. With these resources provided, there have been major developments in access to energy in many countries recently. Bangladesh, for example, has used off-grid solar systems and main grid development with the terrestrial cooperative program. Also, in Bangladesh, the establishment of 1.4 million solar home systems was financed by the World Bank. Vietnam and Ghana have shifted the focus to expanding networks. In China and India, the focus is on various technologies and business models, both in and independent of networks. On the other hand, 700,000 household solar energy systems were installed in Kenya with a flexible payment plan and pay as you go model. This model was later used in different countries in Africa (WB,2020).

As in the examples above, the global access problem related to clean energy is tried to be solved by supporting it with many projects. Many countries have reached

energy access thanks to these projects. However, it is still necessary to continue the developments and make the necessary technological investments by transferring more resources.

Covid-19: Affordable and Clean Energy

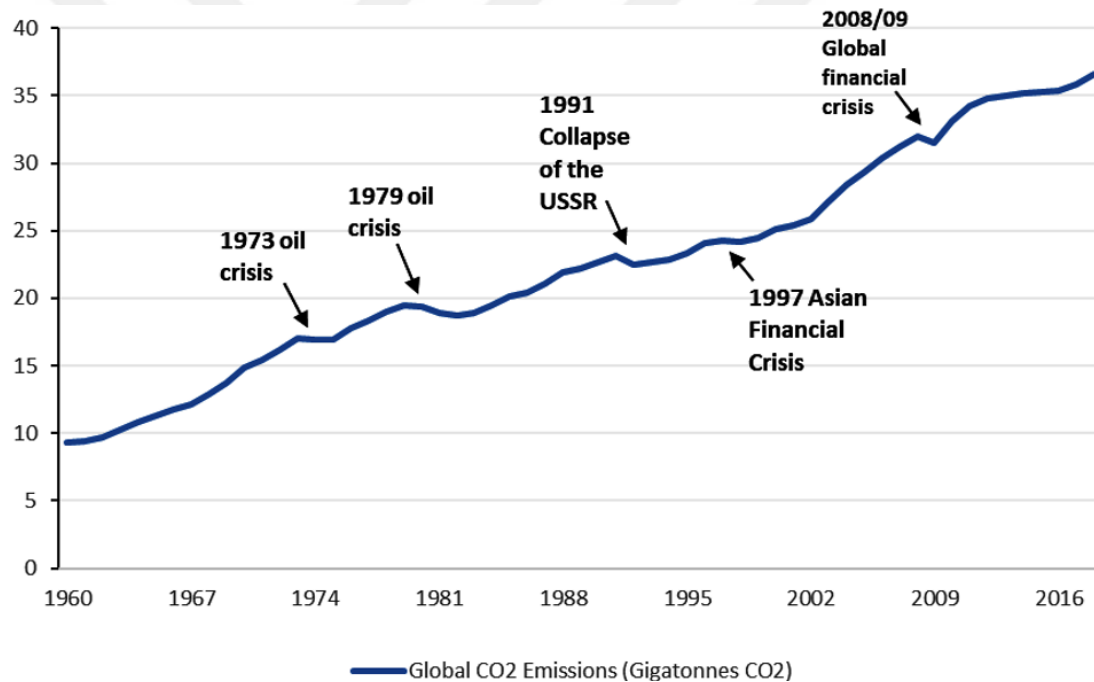
The worldwide pandemic has had an impact on many sectors in the short and long term. The energy sector has also been among these sectors and has received its share from the effects of the pandemic. Since the use of energy is an indispensable element of all sectors and daily life, with the spread of the pandemic, there have been differences in energy use above industrial activities and daily life.

During the global recession caused by the pandemic, many large companies had to suspend production. In addition, companies decided to employ their employees with a home-based working model and preferred to partially close their offices. The amount of intensive energy consumption used in production lines has decreased with the stopping of production. On the other hand, with the transfer of works in offices to homes, the use of energy used for needs such as lighting and computers in offices has also decreased. However, with the home-working model, the rate of energy use at home has increased partially this time.

Another impact affecting the energy sector has been through transport. Because, with the domestic and international travel restrictions imposed to prevent the spread of the epidemic, international flights were stopped, and restrictions were imposed on domestic flights. In addition, with the restriction of intercity travel, road travel has decreased. On the other hand, domestic travel companies also canceled their flights or had to reduce them to a minimum. Passenger transport is responsible for approximately 40% of final oil demand and 15% of the global economy. It is thought that this change in behavior related to transportation can be perceived as a transition phase to more sustainable transportation behaviors for the future, if the governments take conscious and determined steps in this regard (IEA,2020). In addition, due to the cessation of production and economic stagnation, transportation rates have decreased in the transportation sector. The service sector is perhaps the most affected by the epidemic because it is stated that the sector levels have dropped to the levels of the 1990s (UNCTAD,2020). Undoubtedly, this reduction has a great impact on fuel

consumption and greenhouse gas emissions. It was stated that the reduction in greenhouse gas emissions in 2020 was more than the 1979 Oil crisis, 2008 financial crisis and even World War II, which had global effects (PIK, 2020). However, it is thought that there will be no long-term impact on climate change if the emission rates decrease significantly with the cessation of industrial activities and the decrease in fuel consumption. While making this assumption, the great crises experienced in the past are taken as a reference. For example, although the 2008 financial crisis affected a temporary emission reduction, it was observed that the emission release continued to increase rapidly afterwards. Therefore, there should be a permanent decline in the long term (OECD, 2020).

Figure 4: CO₂ Emissions and Past Economic Crises



Source: Global Carbon Atlas. (2020). Retrieved from <http://www.globalcarbonatlas.org/en/content/welcome-carbon-atlas>

Another issue to be mentioned in this regard is oil prices. Because the oil price in April was priced at minus 40 dollars for the first time in history. The reason for this is that the increasing oil supply in the market due to the disputes between Russia and Saudi Arabia was not met due to the pandemic and the demand decreased very sharply (BBC, 2020). Another impact has been on the renewable energy sector. China, which

is the leading country in the production of wind and solar energy equipment, has prevented the production and export of renewable energy equipment due to the halt of its production activities (IEA, 2020). Considering all these effects, it can be said that the effects of the pandemic caused by Covid-19 on energy are quite high.

1.4.1.2. Goal 8: Decent Work and Economic Growth

For this purpose, it is stated that in order to achieve sustainable economic growth, full and productive employment should be equal and decent work for all. In line with this purpose, it is necessary to take the necessary activities to reduce unemployment and improve the quality and conditions of existing jobs for employees to work in humanitarian conditions without any discrimination between women and men.

Problem: Working environment and job opportunity without the definition of "Decent Work"

People acquire certain fundamental rights and freedoms when they are born. However, unfortunately, the place where people live and the economic and social conditions of the region determine the functionality and real existence of these fundamental rights and freedoms. When viewed around the world, unfortunately, it is seen that there are inequalities between developed and developing societies in all respects. In this sense, people need to work at the most basic level in order to survive and meet their needs. Therefore, unemployment and the lack of decent work manifests itself most in developing and less developed countries.

Today, many people are still unemployed. As of 2020, the global unemployment rate is 5.42% (Statista,2020). Countries with more unemployment can be predicted to be underdeveloped or developing countries. It is observed that unemployment rates are lower in countries where the economic situation is relatively good. Another problem is that although many people have job opportunities, unfortunately they still do not have suitable working conditions. For example, many employees still work long shifts and receive low wages in return. On the other hand, the hardware working conditions in the workplaces are unfortunately still insufficient

in many businesses. However, while job opportunities are still provided today, unfortunately, crimes such as slavery and forced labor human trafficking continue in some underdeveloped countries. In addition, situations such as gender discrimination, child labor, long working shifts and poor working conditions persist in many workplaces.

When working life is considered from a holistic perspective, there is a direct proportion between enterprises and countries adopting efficient working principles and using innovative technologies and achieving sustainable economic growth. With this goal, it is essential to create decent job opportunities and to make this situation sustainable by showing economic growth in more efficient and better conditions.

Solution: Transformation of working conditions and jobs in the concept of "Decent Work"

In Article 23 of the Universal Declaration of Human Rights published by the United Nations in 1948, it was stated that everyone has the right to be fair and to be protected against unemployment (UDHR, 1998, Article 23). In addition, the International Labor Organization (ILO) used the concept of "decent work" for the first time in 1999, and this concept was determined as a universal goal. The concept is generally defined as "a productive job in which the fundamental rights of individuals are protected in working life, providing a fair income and social protection for families" (ILO, 2008). In addition, freedom and equality for all individuals without discrimination, men and women. In the "Declaration of Social Justice for Fair Globalization", which was created by the ILO in 2008, this concept includes creating sustainable employment in institutional and economic terms, social security and protection (Anker et al. 2003: 151).

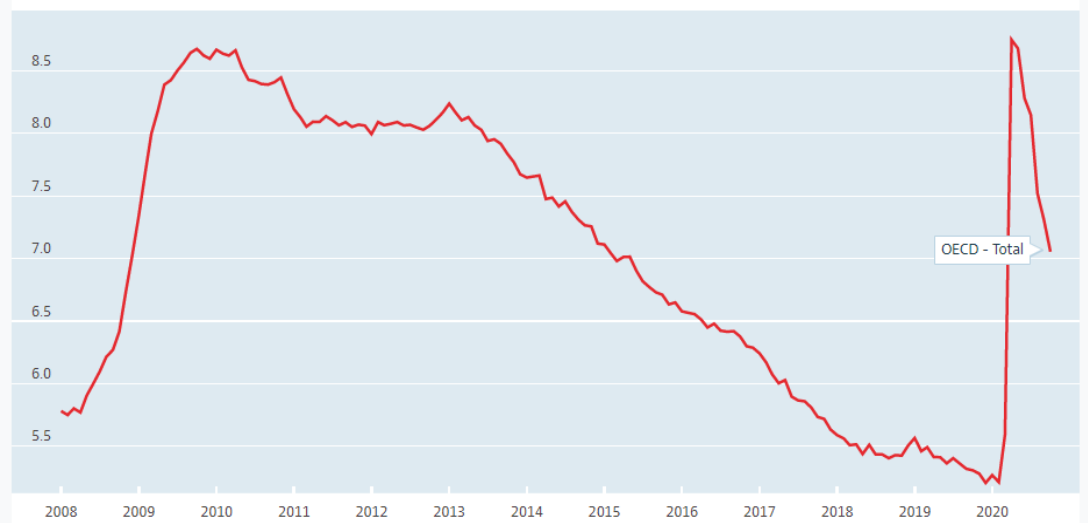
When we look at the practices in business life, it is seen that improvements have been made in many areas within the scope of the concept of "decent work". For example, DHL firm stated that the logistics sector is the backbone of economic development and that it offers job opportunities to approximately 550,000 employees. Introducing themselves as one of the largest employer companies in the world, the company states that they offer working conditions suitable for the concept of decent work. With their strategic partners, SOS Children's Villages, they aim to create and

empower young people with poor socio-economic status (DHL, n.d.a). In addition, another international shipping company, MSC, received the OHSAS award with its 18001 certificates for the implementation of health and safety standards (MSC,n.d.a.). Also, companies attach importance to the number of female employees in the employment they create. On the other hand, companies review the shift system regulations in order to improve the working conditions of the workers. Another regulation is about improving the working conditions of the employees of the companies and providing the necessary suitable living conditions to their families. Many companies now take-out private health insurance for their employees and their families. In addition, in order to increase the competence of its employees in their work, it regularly provides its employees with training opportunities in their fields. In this sense, apart from the 2 sample companies we have given, many companies show a lot of developments on the subject.

Covid-19: Decent Work and Economic Growth

This is the area where the recent pandemic situation has perhaps the most impact. Because with the pandemic, many companies have decided to stop production or must shrink due to the economic recession. Undoubtedly, this situation unfortunately affected the companies as well as the employees. Because many employees lost their jobs during this period. In addition, companies working from home by taking the decision to work flexibly also caused their employees to carry out problematic business due to insufficient technological infrastructure. These employees had to create a working environment that was not suitable for them in the home environment and difficulties such as difficulties in communicating with other employees also occurred. The table prepared by the OECD below shows how the unemployment rate jumped with the pandemic. Unfortunately, the unemployment rates, which have improved steadily after the 2008 world economic crisis, have increased rapidly due to the pandemic. In OECD countries, unemployment is expected to reach nearly 10% at the end of 2020 from 5.3% at the end of 2019 and rise to 12% if a second pandemic wave hits (OECD,2020).

Figure 5: Unemployment Rate



Source: OECD. (2020). Employment Outlook 2020 Facing the jobs crisis. Author. Retrieved from <http://www.oecd.org/employment-outlook/2020/>

It is a matter of curiosity how many companies that are closed due to the pandemic and companies that adopt the flexible working system will follow in the future. However, many companies may be in favor of maintaining the flexible working system as it reduces costs. In general, the loss of workforce and the global economic recession unfortunately have a negative impact on global economic development. In my opinion, the area where the pandemic has the most negative impact on the path of sustainable development has been the goal of "decent work and economic growth". The International Labor Organization (ILO) has warned that almost half of the global workforce may be livelihood strains due to the damage to the livelihoods of workers due to the continued decline in working hours. ILO Director-General Guy Ryder stated that the protection needs of the world's more vulnerable workers will become even more urgent due to the employment crisis that has spread with the impact of the pandemic (ILO, 2020)

1.4.1.3. Goal 9: Industry, Innovation, and Infrastructure

One of the 17 sustainable development goals that are aimed to be achieved by 2030 is "industry, innovation and infrastructure". The basis for this purpose is to provide environmentally friendly and clean production and services by providing the

necessary infrastructures in order to achieve more effective and efficient processes in all sectors with an innovative understanding. For this reason, it is possible to create processes based on time, energy and labor productivity by adopting environmentally friendly technologies and using these technologies in the industrial sector with less input and consuming less energy. For this purpose, focusing on how industry and infrastructure, which are the main pillars of sustainable economy, will be cleaner and environmentally friendly, it is investigated how necessary innovations and appropriate technologies affect the process.

Problem: High resource consumption and environmental damage due to industry and infrastructures not being sustainable and digital inequality between countries and industrial infrastructure inadequacies

Due to the increasing population in the world and the increasing needs accordingly, the development and growth of the production and service sectors has become necessary. Unfortunately, more production is needed to meet the increasing consumption need. More production means more resource consumption. For this reason, unfortunately, the increasing needs of people bring along rapid resource consumption. Because the increase in energy consumption, raw material consumption and labor consumption, which are the basis of production, will unfortunately lead to the depletion of resources in the long term and the damage to the environment will increase day by day. It is very important to use infrastructure investments and innovative technologies to ensure economic growth and development. Unfortunately, in areas where innovative environmentally friendly technologies are not used and the necessary infrastructures are not established, the rapid consumption of resources and the damage to the environment will increase rapidly. For this reason, it is necessary to transform the technologies used in industries with innovative and environmentally friendly technologies and to increase their efficiency levels. This is an important step for sustainable development as it will bring permanent efficiency and profit in the long run.

On the other hand, equal access to knowledge and know-how is important for all societies to grow and develop. What is needed to make the necessary improvements in the industry and to manage the process more efficiently is to invest in

environmentally friendly and innovative technologies and to create appropriate infrastructures. However, adopting and implementing innovative technologies can be costly in the short term. For this reason, unfortunately, there is still a lack of technological infrastructure in many countries of the world. Because many countries cannot invest in innovative technologies due to financial insufficiency. In order to ensure sustainable development in its fullest sense, this technological progress gap between developed countries and developing countries should be filled.

Solution: Creating necessary infrastructures by investing in innovative technologies

Achieving economic growth, which is one of the main goals of sustainable development, can only be achieved by attaching importance to R&D studies, increasing industrial and infrastructure investments, and using innovative environmentally friendly technologies. For this reason, necessary investments should be made in this direction in order to experience technological transformation. Because with the investments made in innovative technologies, the processes in the enterprises can be improved, the use of resources can be controlled, and maximum benefit can be achieved in a shorter time.

What is meant by sustainable industry and infrastructure is to achieve maximum output with less input and to increase productivity. However, while doing this, it is necessary to minimize the damage to the environment by using the resources effectively. In this sense, while maintaining the productivity and profitability situation, the damage to the environment will be reduced and taken under control. In order to achieve this situation, technological transformation must be done in companies. Today, when it comes to technological turn, Industry 4.0 technologies come to mind. Businesses can benefit from Industry 4.0 technologies in all their processes in order to increase their productivity. When we look at how and where Industry 4.0 technologies are used in enterprises, we can see that with programs such as ERP, SAP, LOGO used in the work tracking of employees, RFID and IoT technologies used in warehouses that enable energy and raw material controls, automation and robotic systems used in production, autonomous vehicles used in the distribution phase.

With robotic systems used in the production phase, it is possible to increase productivity and thus reduce costs. With the use of robots, processes can be carried out more effectively because the disruptions, errors and dangers that occur when people do repetitive tasks will be eliminated by robots and work safety and productivity will increase (Kiesler and Hinds, 2004). In addition, with IoT technology, the working status of the machines, the production stages of the products, and even the control of the raw materials in the produced product can be achieved and a coordinated follow-up process can be carried out for the supplier, manufacturer and customer (Kagermann, 2014). In addition, business and technical processes can be combined with smart factories and cyber-physical systems used (MacDougall, 2014). On the other hand, since digitalization and the use of smart networks will enable processes to be carried out more effectively and efficiently, Industry 4.0 technologies create an important advantage for sustainable production (Stock and Seliger, 2016). In the following sections, the advantages and effects of Industry 4.0 technologies are examined one by one on a technology basis, so not much detail is given in this section.

In the statement made by Scott Sureddin, CEO of DHL Supply Chain North America, he stated that investments were made in some technologies selected in the research conducted by the innovation teams within DHL. This investment, which aims to digitize DHL Supply Chain, includes technologies such as augmented reality, robotic process automation, and the internet of things. The company aims to improve the service it provides to its customers by eliminating complex processes thanks to its investment in these technologies (Westerville, 2018).

Unfortunately, there are no equal industrial and infrastructure conditions in all countries of the world. The UN states that digital technologies are a great potential benefit for the economic and social development of countries. In this sense, it has created a support program for everyone to be able to access the internet, access information and technology. Within the scope of this support program, it aims to support these countries with the Technology Bank established for the benefit of the least in addition, the Technology Bank currently focuses on improving access to scientific publications and data in 12 countries, including Bangladesh, Bhutan, Liberia, Nepal, Rwanda (Utoikamanu, n.d.) In addition, with the "Climate Competitive Industries" initiative created by the World Bank, it carries out studies to combine the

competitiveness of industries in developing countries in the global market, the costs of enterprises, and environmental impacts with sustainability practices. The scope of the studies consists of 3 main topics: eco-industrial parks, sustainable supply chains and climate resistant industries (World Bank Group, 2016)

Covid-19: Industry, Innovation, and Infrastructure

The impact of the recent pandemic has been deeply felt in the industry. Because, unfortunately, worldwide production and service activities have come to a halt. At this point, it has been seen once again with the pandemic that technological transformations are of great importance. Because there will be no need to stop factories where robots are operated instead of humans and are suitable for remote management. Thus, even if people do not work, processes can be managed remotely with the remote control of machines, as they have the necessary technological infrastructure. In addition, thanks to the technological infrastructure of companies that apply flexible working model, many employees have been able to continue their work by working from a different place outside the workplace.

1.4.2. Production and Logistic

Under this title, Goal 12: Responsible Consumption and Production, which is related to production from logistics processes, as well as Goal 14: Life below Water and Goal 15: Life on Land, which are also closely related to transportation, will be examined. While explaining the goals, firstly the problems related to the goal will be explained and then the solutions to be done for this problem will be mentioned. In addition, the current effect of Covid-19 will be examined for each goal.

1.4.2.1. Goal 12: Responsible Consumption and Production

Production and consumption are needed to meet all the needs people meet in order to survive. Looking across the world, we see that the ways we produce and consume goods and resources are ecologically linked to our carbon footprints. The "responsible production and consumption" behavior adopted with this goal is also a

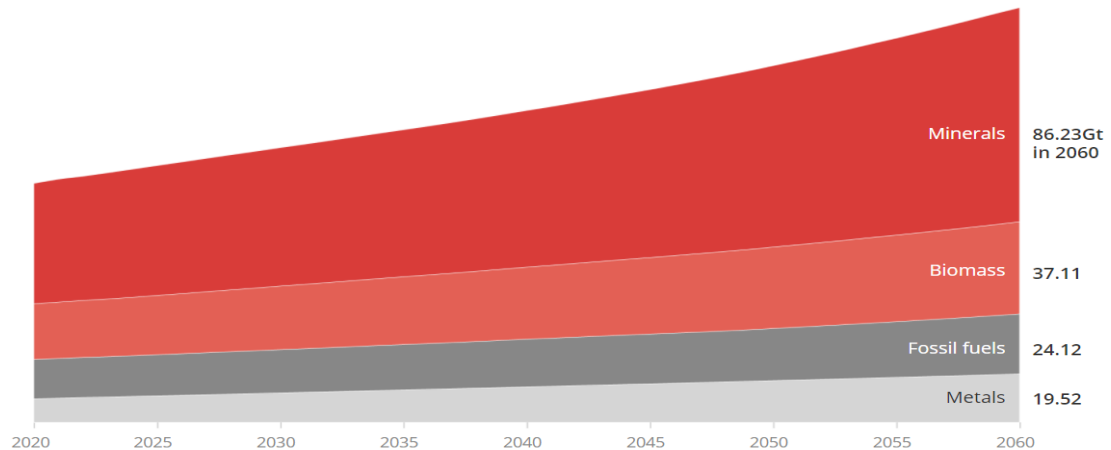
responsibility that enterprises should adopt in production and consumption in general. Along with this goal, the focus is on objectives such as efficient use of resources, reduction and control of waste quantities, reduction of carbon footprint, and recycling.

Problem: Traditional production and consumption patterns are not sustainable

With the increase of the population day by day and the development of industrialization, more production and consumption has begun to be needed to meet daily needs. In fact, unfortunately, people's consumption-oriented behaviors have strengthened as they turn to things out of need. Unfortunately, a conscious and sustainable production-consumption behavior cannot be mentioned as a result of the societies' focusing only on purchasing in the traditional consumption understanding and the uncontrolled production made to meet this demand. The attitudes adopted by businesses while running their activities determine how much damage the company harms the ecological balance. For this reason, enterprises should pay attention to many factors such as resource consumption, waste management and recycling planning in production and post-production processes.

When considered globally, it is seen that unsustainable production and consumption behaviors are more common in industrialized countries (UN, 1992). In the report published by the United Nations Economic and Social Council in 2019, it was emphasized that worldwide material consumption and material footprint per capita have increased rapidly. The use of materials is expected to increase with the projected population growth of 3 billion by 2050 and high economic growth. According to World Bank Atlas, the global material use is projected to increase by 15% by 2030 and by 75% by 2060 to reach 167 billion metric tons (OECD,2019).

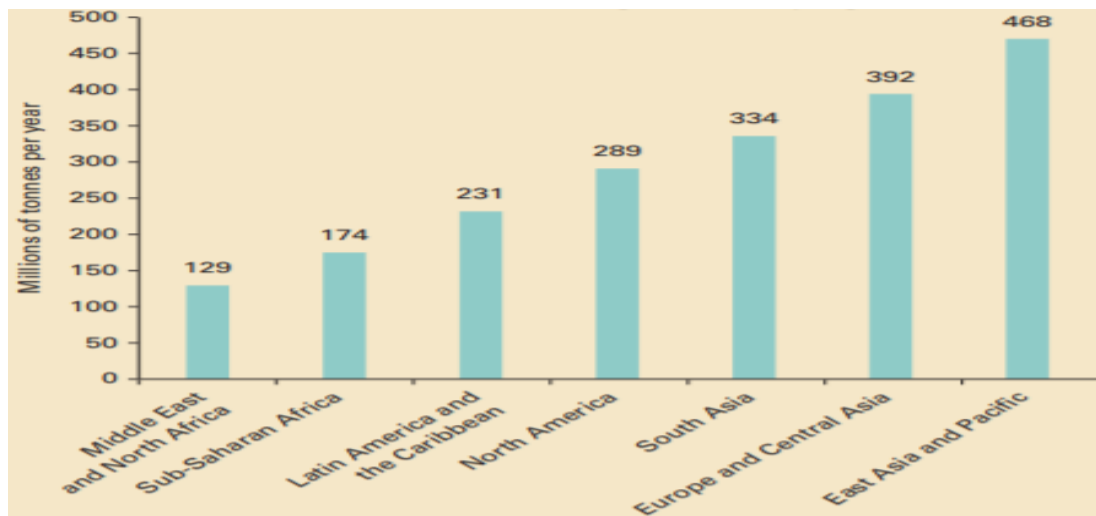
Figure 6: Global Materials Use in Gigatons



Source: OECD (2019), Global material resources outlook to 2060: economic drivers and environmental consequences, OECD Publishing, Paris, <https://doi.org/10.1787/9789264307452-en>

Wherever there is material production and use, the amount of waste increases proportionally. Until 2050, waste production is expected to increase significantly from 2.01 billion tons today and 3.40 billion tons of waste will be generated annually. While more than half of these wastes are composed of food and plastics; Other important waste products are materials such as paper and cardboard, glass, metal, rubber. Considering the logistics processes, there is waste management in many areas such as packaging of materials, stocking and inventory management. A large amount of waste can occur, especially due to the plastics and cardboards used during the packaging of the products. The waste generation capacity of developed and high-income regions is higher (Kaza et al, 2018). Regarding the amount of waste, another issue is food waste. When considered regionally, it is seen that especially in North America, food waste is 10 times more at the consumption stage compared to Sub-Saharan Africa and Europe. In low- and middle-income economies, wastes occur during food processing and storage stages due to lack of infrastructure, whereas countries with higher income levels experience more food waste at the consumption stage (Braich et al, 2020)

Figure 7: Waste Generation by Region



Source: Kaza, S., Yao, L., Bhada-Tata, P., & Woerden, F. (2018). What a waste 2.0: What a waste 2.0 (Urban Development). The World Bank. Retrieved from <http://hdl.handle.net/10986/30317>

Solution: Transforming consumption and production processes

In today's world, production and consumption processes are also in a transformation. Responsible and environmental awareness of all processes has become important for both the consumer who meets a material need and for the enterprises that provide the production and service of those materials. Now, customers are not only interested in purchasing a product, but also in how that product is produced in the background. Customers' demand for only products and services in the market has now turned into a "sustainable product and service" demand. This awareness in customers and the danger of extinction of natural resources and the deterioration of the ecosystem have made it necessary to transform all supply chain processes in enterprises (Tully and Winer, 2014). With the adoption of sustainable development understanding in enterprises, more effective focus can be focused on improving economic, environmental and social performance (Pusavec et al, 2010).

Focusing on energy efficiency alone is insufficient to reduce carbon emissions, one of the major environmental problems (Herring and Sorrell, 2008). In order for the Sustainable Development objectives to be implemented, it is important that production and consumption behaviors act in equal proportion and have an integrated structure (Lozano et al., 2015). The scope of "Sustainable Consumption and Production" is a

combination of life cycle analysis and a wide variety of practical cycles such as cleaner production, ecological efficiency, transformations in consumption patterns, recycling of materials, energy saving (Lebel and Lorek 2008).

Resource efficiency in businesses can be increased with the adoption of innovative technologies. Businesses are now focusing on technological transformation in order to minimize the damage caused by their production processes to the environment with their awareness of sustainability (Woo et al, 2013). It is possible to see the environmental benefits of technological transformation in both consumption and production areas (Hellström, 2007). Industry 4.0 technologies have changed the way businesses and production are conducted in terms of procedures, methods and applicability (Shpak et al, 2019). Stock and Seliger (2011) stated that Industry 4.0 technologies create great opportunities for industrial processes in enterprises to be within the scope of sustainability. It is possible to reduce the use of resources with advanced green production technologies and reduce carbon emissions with recycling-oriented studies (Hızarcı-Payne and İpek, 2020: 286). In the Environment Program of Kuehne + Nagel, waste management is given great importance. The company aims to increase the recycled waste rate by 75% in all its processes and to reduce the use of plastic to zero. Likewise, they stated that they have adopted an environmental program that includes all recycling, treatment and disposal activities, and content definitions and labeling on products. In addition, the company stated that it is trying to actively control and reduce its water footprint institutionally in order to reduce water consumption (Kuehne + Nagel, 2019).

Covid-19: Sustainable Consumption and Production

With the recent pandemic, there have been changes in the scope of "responsible consumption and production". Especially the production processes in the enterprises were negatively affected by this situation. In addition, in quarantine processes, which are generally taken as one of the methods of preventing the epidemic, the duration of individuals staying at their homes has increased and consumer behavior has also been affected by this process. Within the scope of responsible production, many companies have changed their shift regulations in order to protect their employees, switched to a flexible working model, and rearranged common areas such as office, dining area,

production area in their enterprises in a way to pay attention to social distance. In addition, many companies started to produce masks in order to meet the mask demand needed due to the epidemic, and even some large companies such as Mango and Apple donated masks (Mango, 2020). Tofaş has carried out studies on different subjects such as supporting equipment, intubation cabin production, biological sampling cabin to prevent the epidemic (Tofaş, 2020).

These behaviors, which should be considered within the scope of responsible production, in the presence of a global epidemic, they implement practices by temporarily transforming existing production systems in order to provide a social benefit by considering the health of the public. Considering the changing consumer behavior, it was seen that with the announcement of the quarantine process, which was one of the measures taken in the early days of the pandemic, people experienced panic and they stocked food and hygiene products in their homes with this panic. However, with the learning and planning of the process later, this panic state left itself to more planned and conscious consumption. In addition, due to the possibility of Covid-19 contamination, many people have ended their consumption of ready-made food and their habits of eating outside, except packaged foods.

1.4.2.2. Goal 14: Life Below Water

Oceans and seas are indispensable sources of life for the future of the world. It contains many creatures from single-celled organisms to blue whales, the largest creature on earth, provides a source of food for humans, at the same time, many people can be employed through aquatic life, in addition to these, it has a great effect on regulating air and therefore climate. In this sense, the 14th Sustainable Development goal is the title of "life below water" in order to raise awareness on many issues such as protecting marine and coastal ecosystems, reducing pollution in ocean and sea waters, preventing overfishing, preventing damage to biodiversity.

Problem: Pollution of the oceans and seas, overfishing, deterioration of marine and coastal ecosystems

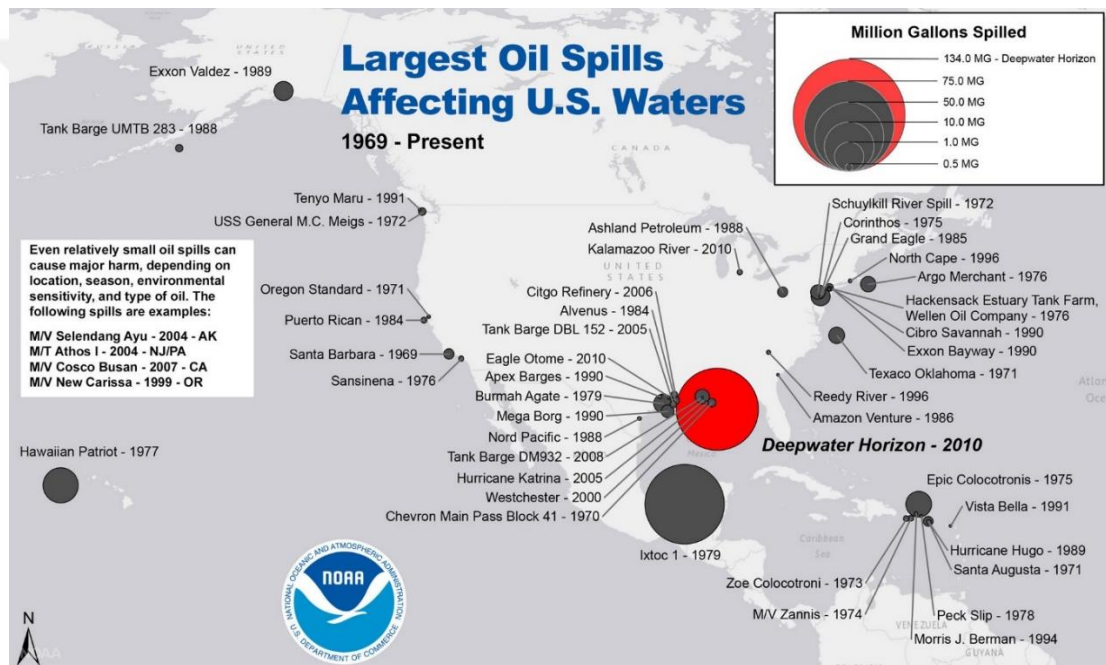
Oceans and seas, where they find both food sources and employment opportunities for a significant part of the population of the world, unfortunately faced many dangers due to man-made reasons. Considering that the world population is expected to reach 9.7 billion by 2050, we can see that the oceans and inland waters have a very important place for future food security (FAO, 2016). Unfortunately, oceans and seas, one of the main sources of life in our lives, are struggling with some problems today. If we consider these problems:

First, we can look at the pollution in the oceans and seas. It has been stated that 80% of the pollution in the seas is caused by terrestrial applications such as pesticides in agricultural irrigation, nutrient pollution, plastic waste, waste from sewage, activities in ports (UNESCO, n.d.a.). The magnitude of the pollution, especially caused by plastics, reaches dimensions that can be symbolized as the 7th continent in the world. It can be said that plastic waste is concentrated in direct proportion to consumption in urbanized areas with more population. Microplastics, which are formed by the separation of plastic waste into particles smaller than 5mm, also pose a danger to the food chain. It has been observed that 236,000 metric tons of microplastics are mixed into the oceans every year (Sebille et al., 2015).

Some of the reasons related to pollution are related to maritime transport. In the shipments made in 2019, 84% of the volumetric cargoes are made by sea. This is to show that the volume of shipments made by seaways has increased 20 times more (T.C. Ulaştırma ve Altyapı Bakanlığı, 2020). This increase in maritime transport directly affects the pollution in the seas. Ballast waters, bilges, petroleum and its derivatives and chemicals and solid wastes from ships play an active role in pollution. With the increase in maritime transportation, oil transportation started to be provided by tankers. The risk of accidents in oil transportation also poses great danger to the seas. When viewed in this sense another factor that plays a major role in pollution of the oceans and seas is oil spills. The Deepwater Horizon oil spill, known as the Gulf of Mexico Oil spill, is the largest oil spill in oil industry history. After 87 days of an explosion at a British Petroleum (BP) offshore oil rig that took place in the Gulf of Mexico in 2010, barrels of oil leaked from the closed oil well into the Gulf of Mexico.

In total, 205.8 million gallons of leakage occurred after 87 days. As a result of the accident, the habitat of endangered species of whales, sea turtles and migratory birds on the Gulf of Mexico Coast, a vital wintering and resting spot for more than 70% of waterfowl, was also greatly endangered (Guillot,2010). In recent years, similar oil accidents have been experienced in many parts of the world from the American coasts to Europe and the Turkish Straits and have caused enormous environmental disasters. The picture prepared by the National Oceanic and Atmospheric Administration (NOAA) shows the largest oil accidents in American waters.

Figure 8: Largest Oil Spills Affecting U.S. Waters



Source: NOAA, (2020). Oil spills. Retrieved from https://www.noaa.gov/image_download/36005?itok=4aNa6qYR

Fish, which play an important role in the functioning of the ecosystem, are also very important for human nutrition and livelihood. It is the primary food source for about 1 billion people and also around 60 million people are employed by sea fishing (Tidwell and Allan, 2001). In WWF's Living Planet Index, it has been observed that many fish species are in danger of extinction due to overfishing and climate change, and 95 percent of the fish stocks are declining due to overfishing, especially in the Mediterranean. Jambeck et al. (2015), it is stated that developing economies are the

most polluting. As a result of the study, it was stated that 83% of 4.8-12.7 million tons of land-based plastic waste dumped into the ocean from 192 coastal countries originates from 20 countries. These countries are: China, Indonesia, Philippines, Vietnam, Sri Lanka, Thailand, Egypt, Malaysia, Nigeria, Bangladesh, South Africa, India, Algeria, Turkey, Pakistan, Brazil, Burma, Morocco, North Korea and United States (Mohit, 2021). In a study by Lebreton et al. (2017), it was stated that between 1.15 and 2.41 million tons of plastic waste are transferred from rivers to the oceans every year, the main elements of which are again population density, plastic waste and production density.

Another point on the subject is coral reefs that are important for biodiversity. Many fish species provide food and habitat thanks to coral reefs. Unfortunately, over a third of all coral species are currently threatened with extinction due to overfishing, climate change, etc. Massive bleaching caused by rising temperatures in the Caribbean and the Great Barrier Reef in Australia has destroyed large coral reefs. Another problem is the acidification of oceans and seas. The oceans and seas have the largest solar energy harvesting capacity in the world. Increasing greenhouse gas emissions have also been to cause overheating in oceans and seas. Due to the extreme heat absorbed by the oceans and seas, more carbon dioxide accumulates in the waters, causing acidification. This endangers the calcium needs of many shellfish living underwater. Therefore, the ecological balance in marine systems is endangered due to the increasing heat in the oceans and the life of living things becomes vulnerable (Braich et al, 2020).

Solution: Raising awareness and investing in projects to keep waters clean

Considering the problems mentioned above and the consequences of these problems, it becomes evident that the most effective measures should be taken. It is necessary to create a great awareness and take action on the issue, both for individuals, governments and companies. There are many studies on the solution on a global basis. As an example of these, the Waste Free Oceans (WFO) movement, which started in Europe and later adopted by different countries, is doing a lot of work to prevent pollution in the oceans and seas. In Turkey "Happy Fish" it is a project carried out by name. In addition, the wastes collected from the sea are separated and recycled ones

are recycled, and those that are not suitable are used as fuel in cement factories. When we look at other studies by the WFO movement, some of them are as follows (PAGEV, n.d.):

- Establishment of plastic waste management facilities on the coasts managed by public or private enterprises
- With the cleaning systems to be established, it should be ensured that the oceans, seas and rivers with pollution are cleaned and trainings on beach cleaning
- Conducting waste water treatment works
- Recycling-oriented classification of waste at ports

In addition, the Ocean Cleanup environmental organization, established in the Netherlands, has developed a floating barrier technology to clean plastic pollution in the oceans and prevent waste from rivers before reaching the ocean. With the application developed, it is expected that 50% of the Great Pacific Garbage Patch could be cleared within five years. Placing the system fleets in the ocean is aimed to remove 90% of ocean plastic by 2040. It meets the energy needs of the system from wind and waves, and also lights and all electronic systems used work with solar energy. In addition, through the algorithms used, optimum placement locations are determined, and the systems are enabled to roam autonomously. The real-time telemetry used provides controls such as the performance and progress of the systems. In this respect, it can be said that the process is made easier and sustainable with technology (Ocean Cleanup, n.d.).

Also, another project is the seabin project carried out by two people from Australia. Working like a vacuum cleaner in water, the device is made of recycled materials and floats in the water, allowing the waste to fill its reservoir. The filled chamber can be emptied and used again. In this way, garbage in the sea and oceans can be collected. A seabin device can collect up to 90,000 plastic bags and 16,500 plastic bottles per year. It can also collect large plastic items as well as cans, cigarette butts and microplastics up to 2mm (Seabin Project, 2019).

Of course, considering the global dimension of the problem, it is necessary to increase these and similar examples and additionally, applications should be made in the sectoral sense. When we look at the measures that can be taken with a wider perspective, it is possible to say the following (SDG Compass, 2016).

- Review of all processes to reduce the environmental impact of products produced

- Justification of information about the use of chemicals and materials used in the packaging process of products

- Increasing resource efficiency in production processes and increasing recycling rates by evaluating waste amounts

Another point is the acidification of the seas, which increases due to the increasing amount of carbon dioxide in the atmosphere. As a solution to this problem, carbon emissions, especially caused by maritime transport, should be reduced. When we look at the examples in this field, it is seen that many international companies are in a transformation by making technological investments in this sense. For example, MSC Company is expanding its fleet with low carbon footprint with MSC Gülsün class ships that it has created to protect oceans and seas. These ships introduced in 2019 set an example for energy efficiency. In addition, the company has developed pioneering practices regarding the use of biofuels that help reduce the carbon footprint. Blends containing up to 30% biofuel are routinely in Rotterdam. It also pays attention to the use of clean hydrogen for decarbonisation of maritime transport (Broom, 2020). Another example is UPS company. The firm's practices to provide fuel savings on land and air, invest in the use of alternative fuels in its vehicles and reduce carbon emissions come to the fore. In addition, the company has certified its services by The CarbonNeutral Company under the name of UPS carbon neutral transaction. This certificate is given to organizations whose CO₂ emissions are measured and whose emissions are reduced to net zero according to their own protocols (UPS, n.d.a).

Covid-19: Life Below Water

The measures taken regarding the Covid-19 epidemic, which affected the whole world, curfews, restriction of production activities, the period of stagnation in the transportation and industrial sector undoubtedly caused many environmental impacts. When considered in terms of Sustainable Development Goals, sea pollution was positively affected by the restriction of sectors affecting the oceans and seas, such as transportation, tourism, maritime transport, fishing and seafood, while on the other hand, employment-related losses were experienced (UNCTAD, 2020).

Thanks to the measures taken, the presence of people in nature has decreased and this situation has also manifested itself in the seas. It has been observed that many water birds such as flamingos, seagulls and cranes have returned to these areas. With the decrease in sea traffic, it has enabled many sea creatures to roam more easily (Bar, 2020). On the other hand, according to the data announced by the World Tourism Organization, 2020 was a very bad year in terms of global tourism. According to the UNWTO World Tourism Barometer, the decrease in international travel is more than 11 times the loss in the 2008 global economic crisis when considered in terms of export revenues (UNWTO, 2020).

1.4.2.3. Goal 15: Life on Land

Following the importance of oceans and seas that we explained in the previous section, terrestrial life is as important as oceans and seas for the healthy living and ecological balance of living things. From this point of view, some existing problems should be addressed and resolved for the sustainability of terrestrial life. In order to solve the problems that will be explained in detail below, the 15th goal of the Sustainable Development Goals is "Life on Land". For this purpose, it is aimed to produce and apply global solutions to existing problems in order to protect the ecological balance.

Problem: Deforestation, Land Degradation, Biodiversity Reduction, Desertification

Forests, which make up 31% of the world's soils, are an indispensable source of life for all living things in nature. Forests, which are habitats for land creatures, are home to more than 80 percent of animal, plant and insect species living all over the world (UN, SDG 15). At the same time, forests, which are food and beverage stores for living things, are also a source of oxygen for our ecosystem.

Unfortunately, the destruction of the forests, which are the source of all these benefits, and a lot of problems arise due to deforestation resulting from wrong practices. It is seen that forest areas have been destroyed as a result of applications based on many reasons such as fires that broke out for various reasons, policies to

expand agricultural areas, road and building construction, acid rain, climate change, mine exploration works. On the other hand, another factor causing trees to be cut down and deforestation is the infrastructure works carried out to develop cities. Due to trees cut down for infrastructure works such as roads, bridges, etc., living space will be destroyed and carbon emissions will increase. In addition, many forest areas are being destroyed due to mining research. In addition to these, the increase in the population, the economic policies of the countries, and the fact that forests are seen as only wood / timber resources indirectly cause deforestation (Chakravarty et al., 2012). The reasons for deforestation vary from region to region.

Solution: Prevent damage to forests and lands

In solving the problem, it is important that people, governments, and businesses act together and carry out environmentally sensitive practices. Looking at the solutions to the problems, some of the steps that can be taken regarding deforestation, which is the most basic problem and is a source for other problems, are as follows:

Ecological road and bridge constructions and wildlife crossings can be investigated to prevent damage to forests and lands, especially due to infrastructure works such as road and bridge construction. Thus, the life and property safety of both wild animals and people in traffic can be ensured. Wildlife passages generally include under and overpasses, tunnels, tunnels for amphibians, fishways, and green roofs for birds and butterflies. The aim is to protect the life of living things in all of them. Wildlife passages, which were first built in France in the 1950s, were later built in many European countries. The longest ecoregion viaduct, 800 m long, is located near Crailo, Netherlands (Özbirinci, 2016).

In addition, the Forest Stewardship Council, which was established in 1993 as a reaction to the destruction of forests, is based on objectives such as the correct use of forest products, setting standards and auditing institutions worldwide. With the FSC certificate, it certifies the use of forest products without damaging the ecological processes, the use of forest products in a way that does not disturb the natural life and the qualities that support a sustainable use. With this document, businesses take steps to protect the ecosystem in their products with any forest product content (Ekolojist, 2018).

Unilever Group has many applications in this sense. The company requires its suppliers to implement the Sustainable Agriculture Rules in order to protect biodiversity. In addition, as a sustainable paper and cardboard packaging policy, it aims to ensure that all paper and cardboards are suitable for recycling (Unilever, 2018). Again, Tetrapak company aims to prevent illegal tree cutting by ensuring that the cartons are procured from permanently protected forests. Carrefour became an active member of the Consumer Goods Forum in 2020 with the aim of reducing deforestation to zero (CDP Policy Brief, 2018).

Against fires that pose the greatest danger to forests, solutions have been started to be produced with today's technology. It is possible to be aware of fires in forests with distributed systems with nodes that transfer information to the central station to obtain information about the environmental conditions with wireless sensor networks (WSN) and to process this information. Yan et al. (2016) aimed to detect different combustion stages in real time with the use of this technology and artificial neural networks in their studies. In addition, with the Intelligent Forest Capsule Fire Prevention Solution developed by NetOP Technology, the data obtained through the sensors are processed with the use of artificial intelligence, aiming to ensure the detection of fire risks in advance. It is also possible to measure temperature, carbon dioxide and smoke in forests with these capsules (Detaysoft, n.d.) In addition, with the use of technologies in agricultural lands, it is possible to increase agricultural productivity, to ensure soil and product management, to use resources more economically and to reduce environmental damage, which is known as smart agriculture. It is a technique that provides soil and product management for people and minimizes the damage to the environment with more economical use of resources. It is possible to avoid waste of resources with the use of improved information and control systems.

Covid-19: Life on Land

Natural habitats and forests, which are degraded by man, are an intervention to the habitats of other living things. As a result of these interventions, as people enter the habitats of other creatures, they have to interact with creatures that cause diseases but do not leave their own space. For this reason, pathogens specific to animal species

have started to spread to humans (Noponen, 2020). 75% of newly emerging infectious diseases are caused by animals (Kappelle, n.d.) Virologist Prof. According to Yan Xiang, we are getting closer to wild animals due to the destruction of wildlife by man, and this situation makes us vulnerable to the viruses found in them. Likewise, according to David Hayman, professor of infectious diseases at Massey University in New Zealand, the infection risks of interventions and damage to natural habitats are increasing due to population growth (Shield, 2020). With Covid-19, many factors such as precautionary measures, quarantine practices, restrictions, new model working patterns are an opportunity for people to rethink. In this way, it can be understood how important nature is and deserves great respect (Noponen, 2020).

The 2020 year of the "International Biological Diversity" day, which was established within the UNs to protect and develop natural life for a sustainable world, was celebrated with the theme "nature is the solution". In addition, it is mentioned for the first time with online campaigns within the scope of the measures to combat the Covid-19 epidemic. In order to overcome the epidemic and take precautions against similar future dangers, many commitments such as the management of medical and chemical waste used in nature, reduction of carbon footprints, protection of nature and biodiversity must be made (Kappelle, 2020).

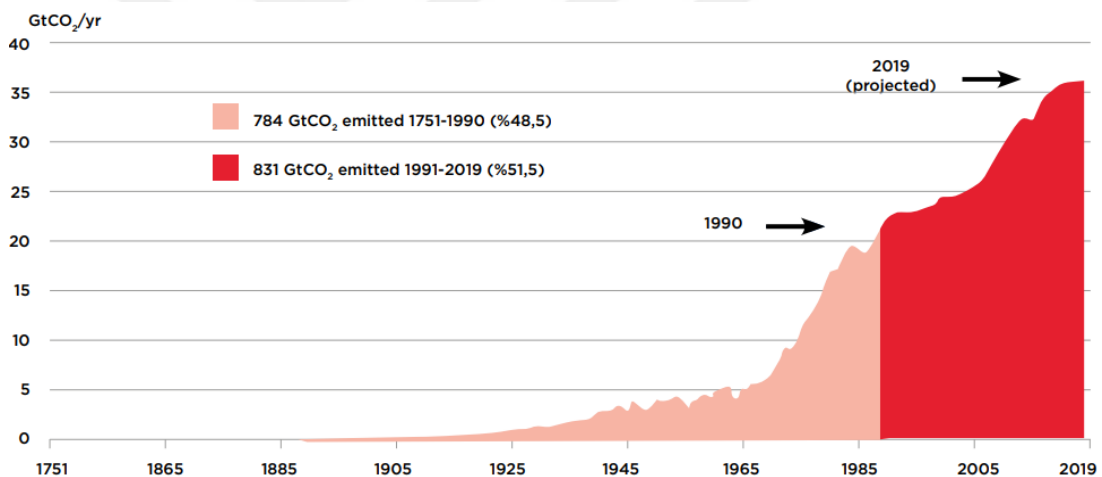
1.4.3. Climate Crisis and Logistics

Under this title, together with the Goal 13: Climate Action goal, the reasons causing the climate crisis and what needs to be done to solve these problems will be discussed. In addition, the impact of the logistics industry on the climate crisis will be analyzed. Finally, the current effects will be discussed by looking at the relationship between the climate crisis and Covid-19.

1.4.3.1. Goal 13: Climate Action

One of the biggest problems of today is undoubtedly climate change. It is stated as the most urgent goal among all goals. Especially after the Industrial Revolutions, due to the increase of the population, the release of many gases to the air and the increase in global average surface temperature, changing weather events, precipitation patterns, rising sea levels, warming and acidification of the oceans, droughts are a global affecting nature and human life (Madran, 2020: 298). With "Climate Action", which is one of the most urgent goals globally, it aims to transform the production and daily life activities of companies and therefore people by making emission reduction plans in a way to reduce their carbon footprint.

Figure 9: Increase in Global CO₂ Emissions Since The Industrial Revolution



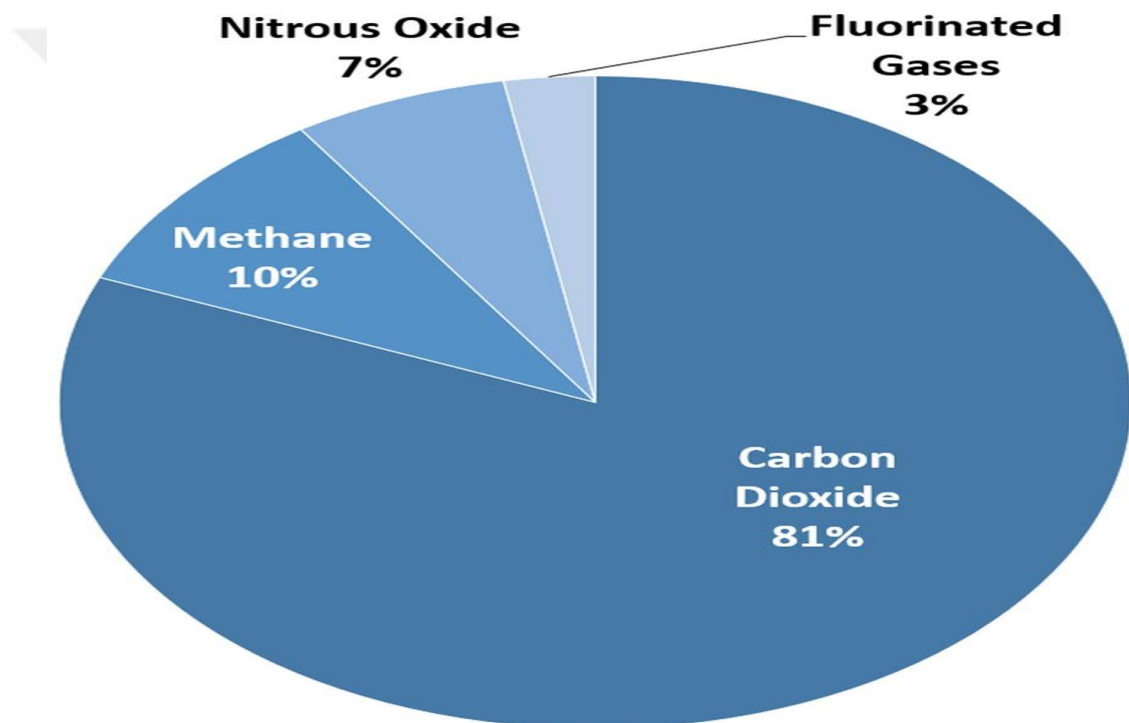
Source: Stainforth, T. (2020, April 29). More than half of all CO₂ emissions since 1751 emitted in the last 30 years. Retrieved <https://ieep.eu/news/more-than-half-of-all-co2-emissions-since-1751-emitted-in-the-last-30-years>

Problem: Global Warming / High carbon emissions and the thickening of the atmosphere accordingly

Climate change is seen by the UN as the greatest threat to sustainable development. At the same time, the World Economic Forum identified the issue as "a serious existential risk for the world" (Reyes, 2017). So the situation is really critical. One of the first concepts that comes to mind when it comes to climate change is undoubtedly the concept of "global warming". This concept can be explained as the

increase in average temperatures measured on land, sea and air throughout the year. It produces gases that cause global warming, such as carbon dioxide, methane and nitrogen oxides, which are produced as a result of burning fossil fuels used to generate electricity (Shahzad, 2015). The reason for the temperature increases in question is the fact that gases such as CO₂, CH₄, N₂O, which are released into the atmosphere in high amounts after the industrial revolutions, remain in the atmosphere for a long time and more sun rays are trapped in the Earth. This warming causes negative climatic and geological effects on the world (Madran, 2020: 300).

Figure 10: Overview of Greenhouse Gas Emissions in 2018



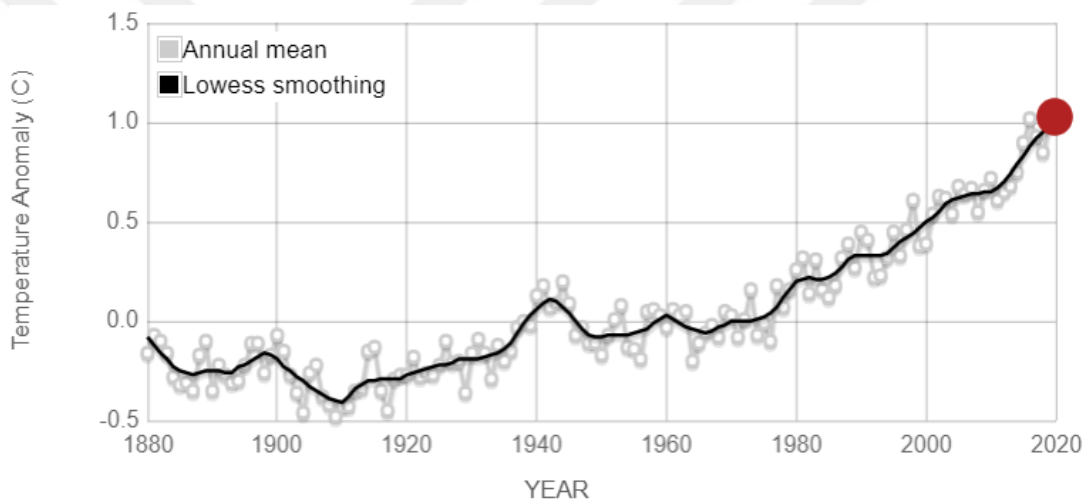
Source: US Environmental Protection Agency. (2020). Overview of greenhouse gas emissions in 2018 [Graph]. Retrieved from <https://www.epa.gov/sites/production/files/2020-04/gases-by-source-2020-caption.jpg>

When we look at the amount of emissions arising from logistics, the emission of the whole transportation sector constitutes 21% of the total emissions. This corresponds to approximately one-fifth of the global carbon dioxide (CO₂) emission amount. Within the transport sector, the mode with the highest carbon emission is road transport. Road transport accounts for 15% of total CO₂ emissions. Much of this is

due to passenger cars - cars and buses - contributing 45.1%. The other 29.4% comes from trucks carrying loads. The type of transport that has less impact on emission is rail transport. Rail transport accounts for only 1% of emissions from transport. Transporting materials such as water, oil and gas through pipelines also has an effect of 2.2% (Ritchie, 2020).

It can be said that global warming has reached record temperatures in the last 10 years and warming has continued to increase since 2001. 2019 went down in history as the second hottest year of the last 140 years, after 2016 (NASA's Goddard Institute for Space Studies (GISS)).

Figure 11: Global Land-Ocean Temperature Index



Source: Goddard Institute, (2020). National Aeronautics and Space Administration Goddard Institute for Space Studies, GISS surface temperature analysis(GISTEMP). Global Land-Ocean Temperature Index. <https://climate.nasa.gov/vital-signs/global-temperature/>

Increasing temperature with global warming brings along forest fires, increased desertification, irregular rainfall, and flood disasters. At the same time, it is observed that global warming and melting of polar glaciers caused sea levels to rise. With rising sea levels, there is a risk of flooding many countries. It has been observed that the sea level has increased 15-20 cm in the last 20 years. Another effect of global warming is seen as the increase of diseases by making it difficult to maintain homeostasis on the human body (Akin, 2006).

From 2010 to 2019, more than 1.3 billion people were affected by extreme weather events such as floods, drought, heat and cold weather, and needed emergency assistance (Ricciardi et al, 2020). When we look at the factors that cause greenhouse gas emissions, the first thing we come across is energy consumption. Energy consumption is responsible for as much as 73% of human-induced greenhouse gas emissions worldwide. In the energy sector, most of the emissions arise from heat and electricity generation. Following the heat and electricity generation, transportation, manufacturing and construction sectors come. Since the 1990s, industrial processes have increased by 174%, transportation by 71%, manufacturing and construction by 55% and stand out as the fastest growing greenhouse gas emission sources (Ge and Friedrich, 2020).

Solution: To take action to combat climate change and its effects.

The solution can be explained in a single sentence. To take action to combat climate change and its effects. Reducing and preventing global warming caused by the increase in the emissions of greenhouse gas emissions as a result of the above-mentioned and human-induced practices can be possible by changing and transforming human activities.

One of the first important steps taken in the process of climate action is the "Intergovernmental Panel on Climate Change (IPCC)" established in 1988 with the support of the United Nations Environment Program and the World Meteorological Organization. The purpose of the panel is to create scientific information on issues related to human-induced climate change (IPCC, n.d.) Another important step taken regarding the execution of the process is the Paris Agreement, which was signed in 2015 and entered into force in less than 1 year. With the agreement, it is aimed to limit the global temperature increase to 2 degrees above the level before the Industrial Revolution, and 197 countries have signed (Madran, 2020: 299).

It is a known fact that a considerable part of greenhouse gas emissions is generated by industrial activities. For this reason, when the solution is focused, the most fundamental point will be the awareness that occurs in the enterprises and the transformation of all kinds of activities in this direction. A low-carbon economy is required for a sustainable growth-oriented economy. For the targeted sustainable

economy, new business models, innovations and technologies are the main factors affecting the transformation of companies. The willingness of companies to act for climate change is also important to their survival and reputation in the global market, and so the situation also has a commercial issue. It is seen that investors with assets worth many trillion have signed up to climate-related actions and commitments such as the UN's Responsible Investment Principles (PRI), Montreal Climate Commitment, Fossil Fuel Withdrawal Commitments and Portfolio Decarbonization Coalition (Global Compact, n.d.a).

Transformations in company operations are of great importance towards "climate action". In this sense, companies' transformation activities include increasing their energy efficiency, reducing their carbon footprints in product and service processes, and acting with this awareness in all operations and supply chain processes. Countries need to transform in this sense and take action for decarbonization (Levin & Lebling, 2019). Transformations are needed in all sectors, small and large, in order to combat climate change. In this sense, many measures can be taken, such as choosing renewable energy sources, electrifying the transportation sector, making more sustainable agricultural practices, protecting forests, and focusing on producing less waste (Ge and Friedrich, 2020).

As of 2018, the Carbon Disclosure Project, which is a global platform, is an international non-governmental organization based in London, which is described as the most comprehensive environmental initiative. Through the platform, it is possible to reach risk data on issues such as climate change, water, forest, and city sustainability in the world. The platform is seen as a "secondary stakeholder" to increase the accountability of enterprises regarding climate change (Arenas, Lozano and Alberada 2009).

On the other hand, different climate actions are also taking place that make a big impact around the world and increase the awareness of many people. For example, 15-year-old Greta Thunberg took a sit-in in front of the Swedish Parliament in the summer of 2018, initiating a new process in the discussions on climate change / crisis and related activism. "School Strikes for Climate", which he pioneered, and it was a form of action that took place in many parts of the world with the participation of six-degree students. With this trend, thousands of children support them by not attending

school every Friday. He wants to get everyone to take action for the climate with this action of the children. In this sense, it goes on strike every week in the Netherlands, Belgium, Switzerland, Germany, Scotland, Ireland and Australia (Yildirim, 2020). The emphasis on the need to handle climate debates more strongly in the sociological field, which is tried to be explained with the concept of "Green Modernity", is also realistic in this direction (Beck, 2010).

The transformations of companies that have relatively more impact on climate action than others are very important. At this point, if we give an example to the transformation activities of businesses, we can say that international companies lead the way. For example, MSC has been investing heavily in low-carbon technology for years to achieve its goals of decarbonizing sea transportation. In partnership with South Pole, the world's leading developer of emission reduction and renewable energy projects, MSC offers clients access to climate action projects that improve life and nature for communities around the world. MSC leads major investments in sustainability and minimizing the environmental impact of fleets with its Carbon Neutral Program (MSC, 2020, June 15).

Another example is the applications of DHL, one of the big companies, in international logistics. DHL invests in many climate protection projects to offset greenhouse gas emissions. Adopting the climate-neutral "GoGreen" perspective in its services, the company makes sure that all projects comply with the "VER Gold Standard" at least. Since 2016, the new Fairtrade Climate Standard has also been approved in its own independent projects in Lesotho, and it is the first project of its kind to comply with this standard. Aiming to reduce all logistics-related emissions to zero by 2050, some of the targets set by 2025 are as follows (DHL, 2017, March)

- To increase our carbon efficiency by 50% compared to 2007 levels.
- The aim is to beautify people's lives at home and at work by using environmentally friendly collection and delivery solutions such as bicycles and electric vehicles for 70% of our first and last customer services.
- To ensure that more than 50% of our sales consist of Environmentally Friendly Solutions.
- To ensure that 80% of our employees receive GoGreen expert certification and are involved in our environmental and climate protection activities.

A different example is ARKAS logistics company, which has achieved significant reductions in carbon dioxide emissions with the changes made in all processes, from low-sulfur fuel to speed optimization, from transition to fuel-efficient ships to choosing the appropriate route, with the goal of sustainability for many years. Container transportation company to make appropriate efforts to improve environmental performance and representing 84 percent of world container transport CCWG (Clean Cargo Working Group) members, the group stands out as the first and only member in Turkey. Arkas Line continues to develop new projects to reduce fuel consumption and consequently carbon and sulfur emissions by addressing operational issues in this context. By choosing to use Low Sulfur Fuel oil instead of IFO 380 in all the ships it operates, it carries out environmentally friendly processes both in its investments and within the scope of regulations. With the new generation eco-design ships it adds to its structure, it is possible to save a lot of energy thanks to its machine features and hull design (propeller and steering systems). Arkas Line signed an industry-academy collaboration to minimize the carbon footprint in maritime transport, which is responsible for 3.3% of global Greenhouse Gas (GHG) emissions. It has implemented the "Mini-Chip" project. Mini-Chip, which offers an innovative Decision Support System for load carriers in order to reduce fuel consumption, minimize carbon footprint and reduce costs with the project, is important as a simulation setup (Arkas, n.d).

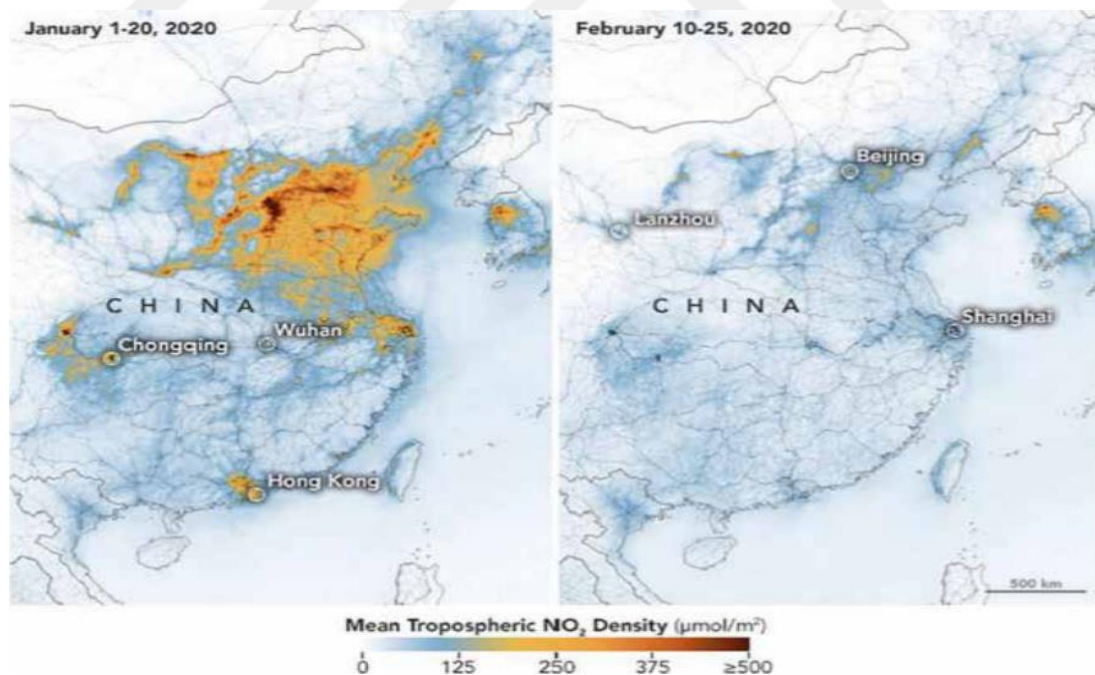
Covid-19: Climate Action

2020 has been a critical year for climate action, five years after the Paris Agreement. The year 2020 started with forest fires in Australia, one of the most striking consequences of the climate crisis in recent years. started. 18 million hectares of forest area with delayed burning corresponds to 14% of the forest-covered area in the continent (UN Environment Program, 2020). The second critical event that hit the year after the great climate crisis was Covid-19. So much so that the epidemic that started in China spread all over the world in a short time and became a global epidemic. From the perspective of Covid-19, although they seem to have a different structure with the climate crisis, they can be defined as different aspects of the same global

ecological destruction (Malm, 2020). Because the measures taken locally in both crises alone do not have long-term effects and a global measure and action plan is required.

It can be said that the Covid-19 epidemic has created the awareness of taking measures quickly in societies. Because, in order to prevent the spread of the pandemic, the restriction of industrial activities, closure of stores, and changes in consumption habits caused a decrease in greenhouse gas emissions. Especially in China and Italy, the air was observed to be cleaned dramatically, according to the Copernicus Atmosphere Monitoring Service, with China's restrictions on industry and traffic, air pollution decreased by about 20-30 percent in February. With the measures taken in the latest analysis by Carbon Brief, China " It is stated that, due to a 40 percent reduction in production, it has reduced approximately one-fourth of carbon emissions since February (Myllyvirta, 2020). This ratio is important as China is the country that emits the greenhouse gases most causing climate change due to its dependence on fossil fuels and coal.

Figure 12: Variation in the Concentration of NO₂ in China During the COVID-19 Lockdowns



Source: Gautam, S. (2020). COVID-19: air pollution remains low as people stay at home. *Air Quality, Atmosphere & Health*, 13(7), 853–857. <https://doi.org/10.1007/s11869-020-00842-6>

However, all these effects are thought to have a short-term impact on emissions. In order for Covid-19 measures to become effective for climate action and to reduce emissions in terms of sustainability, all measures should be continued in the long term. Jeremy Wilks, a space and environment correspondent for Euronews, claims that the amount of greenhouse gases people emit into the atmosphere each year is too high for this one-time drop to take effect. (Wilks and Ging, 2020). I still think that the Covid-19 epidemic is a guide to people and companies on a global scale to understand a more conscious lifestyle. The experience of the pandemic is very important in terms of both measures taken and learning how to behave against epidemics. All the practices we have learned in the short term have transformed to a great extent, if not for everyone. If the awareness experienced can be continued after the pandemic, and if measures are taken hand in hand in a fast, stable and global way for climate change, as in the pandemic, solutions will be obtained for the climate crisis.

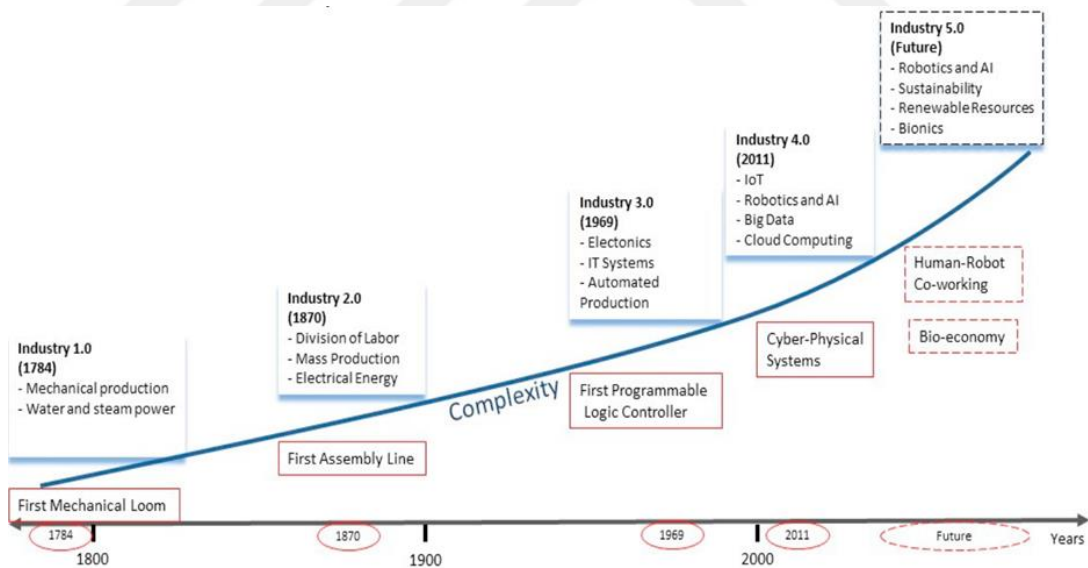
CHAPTER TWO

INDUSTRIAL REVOLUTIONS

2.1. HISTORICAL DEVELOPMENT OF INDUSTRIAL REVOLUTIONS

Societies have developed and changed with two major events. The agricultural revolution that took place in 8,000 BC and the industrial revolutions that started in the 18th century caused changes in the practices of human life. Societies that have settled with the agricultural revolution have faced the problems of storing the products obtained in different conditions and transporting them to different places. Every step taken to find solutions to these problems has contributed to the change and development of communication and transportation activities. In the following section, the historical process of industrial revolutions after the agricultural revolution will be briefly explained.

Figure 13: From Industry 1.0 to Industry 5.0.



Source: Demir, K. A., Döven, G., & Sezen, B. (2019). Industry 5.0 and human-robot co-working. *Procedia Computer Science*, 158, 688–695.
<https://doi.org/10.1016/j.procs.2019.09.104>

2.1.1. Industry 1.0

Covering the mid-1700s and the 1830s, Industry 1.0 led to the transition from manpower to machine power as a result of two key elements: the invention of the steam engine and railway construction (Schwab, 2016). Steam machines have been used especially in the textile field. The reason for this is the development of weaving technologies in this period. In the same years, spinning machine technologies developed. Considering all these developments, it can be said that the effect of weaving looms to this period is quite high.

With the use of steam machines as energy sources, mass production became widespread, product variety increased, and small workshops were replaced by factories. People living in rural areas during the agricultural revolution experienced a transition to urban life with the industrial revolution and urbanization increased in this period. With the mechanization process experienced in the 1st industrial revolution, production has become practical. As a result, it was possible to export the produced products to different countries. On the other hand, since there is a need for new raw materials for increased production, raw materials have been searched for from different countries. The supply of raw materials from different countries was done by steam trains and ships. Thus, steam-powered trains and ships have created logistical resources that will contribute to the development of transportation vehicles (Drucker, 1994: 37, 38). The process started with the invention of the steam engine and continued with the development of maritime and rail transport. George Stephenson, who worked on steam locomotives during this period, explored the first locomotive. As a result of the studies made faster, the locomotives factory was established in 1823. In the same way, steam power was started to be used in maritime transportation with the steamer made by Robert Fulton in 1807(Andaç, 2019: 5). Thus, it is possible to transport products faster. With the increase in transportation and international trade, the Industrial Revolution started to spread to other countries besides England (Andaç, 2019: 11). This development process, which initially led to an increase in production, also affected its development in transportation. Trade relations between countries have increased with the development of procurement of goods and raw materials between countries. Thus, the 1st Industrial Revolution spread to Europe and the Americas beyond England.

On the other hand, with the 1st Industrial Revolution that affected the commercial and economic structure, living conditions also changed. Especially the increase in production caused environmental problems with the change of small workshops by factories and the migration of the peasant population to the city. Especially with the use of coal and the spread of railways, air pollution problems have increased. Increased use of basic resources such as waste caused by the factory, rapid migration, and pollution, such as water, are the problems that remained in the background in this period.

2.1.2. Industry 2.0

In this period, progress has been made based on previous developments. The increase in production in the previous period brought about productivity and cost calculations in this period. Thus, steel, oil, chemical materials and electric energy sources have been used to increase productivity and produce cheaper instead of steam and coal (Kayapınar, 2017: 4). With the power of electricity, which has more power than steam power, more and cheaper production has started. Electrical energy was used in automobile assembly lines especially in this period and it was introduced to mass production in the world. In this process, the "Fordism" movement developed by Henry Ford left its mark on the period and led to the expansion of mass production. (Şahin, 2019: 6). The mass production in the automobile sector has led to the development of the road network. Thus, in addition to rail and sea roads, Roadway have also developed in this period (Eğilmez, 2017). The railways developed in the first period were made faster and more efficient with the use of new power supplies in this period. In 1897, Rudolf Diesel invented diesel engines and emerged from the use of electric locomotives (Halton, 1982: 6). Steel used in shipbuilding in the Second Industrial Revolution brought about the construction of larger and more efficient ships (Mokyr, 1998: 227). As a result, there has been a decrease in freight rates in this period due to the decrease in transportation costs (Halton, 1982: 6). Thus, transportation has become cheaper over long distances.

In this period, the increase in mass production and the development of transportation networks have led to an increase in trade relations and competition.

Thus, many countries of the world have established and developed commercial relations with each other.

The electricity used in this period provided resources from fossil fuels such as coal, and the production and use of electricity caused environmental problems to grow. The wastes generated by steel, petroleum and chemicals used to increase efficiency have caused greater destruction in the environment. In addition, the areas used for land roads that developed during this period affected the environment negatively. Since renewable energy sources were not used yet, rapid consumption and pollution of natural resources were in question.

2.1.3. Industry 3.0

Technological progress has been made in response to the needs of the Second World War after the Second Industrial Revolution. The experience gained as a result of the needs in the field of automatic control during the war has led to the development of information and electronic technologies in the countries. Thanks to the transistors invented in this period, the use of electronics in every field has been achieved. The production of transistors in this sense is one of the important steps for the 3rd Industrial Revolution (Sercan, 2019: 18). Following this development, the first commercial computers in the world were introduced and the use of computers became widespread (Gordon, 2012: 11). Through the first CNC (Computer Numerical Controller) machines produced in 1952, it was possible to integrate software and machines with each other (Özdoğan, 2017: 13, 15).

Looking at the developments in logistics, the “cargo handling automation” process has been experienced since the 1960s. Therefore the development of communication technologies in this period brought about automation (Ekincioğlu, 2019: 14). In 1969, with the development of programmable logic-based PLCs, automation in production was started (Kayapınar, 2017: 4). Thus, automation and information technology (IT) have been two important elements that highlight this industrial revolution. Thus, much more mechanical, practical and small products have started to take place in daily life.

Thanks to the rapidly developing technologies, while increasing the production and profitability, daily life became easier, on the other hand, existing environmental problems continued to increase rapidly. In parallel with the increasing consumption, the desire to produce more and faster caused the depletion of natural resources more rapidly. However, unlike the previous 2 revolutions, awareness of these problems increased and renewable energy sources were emphasized with the 3rd Industrial Revolution (Rifkin, 2014: 57-60). During this period,. concentrated on renewable energy sources such as solar energy, wind energy. At the Copenhagen Climate Change Conference held in 2009, sustainable growth and the negative effects of fossil fuels on the environment were discussed, so renewable energy sources became important for the industries (Jänicke and Jacob, 2009: 2-10).

2.1.4. Industry 4.0

All the developments from the 1st Industrial Revolution to the 4th Industrial Revolution supported and triggered each other. The 4th Industrial Revolution, which is mostly used in conjunction with the Industry 4.0 concept, was first introduced in 2011 at the Hannover Fair, the world's largest industrial fair in Germany. In 2012, a working group was formed by the government in Germany and works for "The High-Tech Strategy Report " were initiated. Within the scope of this project, issues such as reduction of carbon emissions, establishment of environmentally friendly and smart cities, use of alternative fuels, transition to smart grids were taken as basis (Klitou, 2017). Industry 4.0 integrates cyber physical systems, the Internet of Things and smart factories; the creation of a digital value chain that enables the communication of products, business partners and the business environment in a holistic framework (Kagermann et al, 2013). Industry 4.0 consists of internet-based, cyber-physical systems that can process and transfer large data (Schlechtendahl et al., 2014). Cyber-physical systems integrate production facilities, warehouses and logistics processes to form a digital network (Wang et al., 2016). In this way, businesses will be able to work in a more integrated way and provide greater and more intensive information flow between manufacturing-based and subsidiary processes (Banger, 2017: 21). This

process includes a number of technologies for intelligent products that integrate nested digital and physical processes (Hermann et al., 2015).

The Industry 4.0 perspective aims to create smart factories with self-managed processes. Thus, it is based on the establishment of systems capable of integrating the internet and physical objects and performing data exchange. As a result, it will be possible to significantly control resource use, eliminate complexities in the production, storage and distribution cycle of products, and increase productivity (Wan & Zhou, 2015: 136). At this point, the concept of Industry 4.0 will be able to develop solutions not only to renewable energy sources, but also to the problem of resource consumption by controlling all processes in the supply chain in order to develop sustainable development which was the subject of concern in the previous industrial revolution. Industry 4.0 covers the changes needed to achieve this sustainability (Wang et al., 2016)

2.1.4.1 Industry 4.0 Technologies

Industry 4.0 is a process consisting of some technological components like other revolutions. There is more than one view regarding the classification of technologies. Dalenogare et al. (2018) classify Industry 4.0 technologies as additive manufacturing, artificial intelligence, big data and analytics, blockchain, cloud, industrial internet of things and simulation. There are also views that group technologies into physical and digital technologies. Physical technologies are thought to mainly involve layered manufacturing (Gibson et al., 2014), and digital technologies are mainly related to cloud computing, block chain, big data analysis and simulation, information and communication technologies (Liao et al., 2017). Schwab (2016), examined technologies in 4 main groups in his book and under the title of digital technologies; He explained Information Technologies, Blockchain and Distributed Ledger technologies, Internet of Things. Secondly, he explained Artificial Intelligence and Robotics, Advanced Materials, Additive Manufacturing and Multidimensional Printers under the title of "Redefining the Physical World". Thirdly, in the title of "Changing People"; Biotechnologies, Neurotechnologies, and Virtual and Augmented Realities. Finally, with the title of "Integrating the Environment", he discussed Energy

Production, Storage and Transmission, Geoengineering and Space technologies. As can be seen, there are different opinions about the grouping of technologies in the literature. Therefore, it is not right to set any group restrictions on technologies. With this understanding, in this section, the technologies that are thought to be used most in relative practice will be explained by compiling from many sources.

2.1.4.1.1. Cyber Physical Systems (CPS)

Cyber Physical Systems, in its simplest definition, are systems that link physical tools with virtual information systems (Lee, 2006:1). CPS uses communication devices such as multiple sensors and actuators to achieve this integration. The data and information obtained through the sensors are collected. The collected data is transmitted to cyberspace via the Internet and processed with certain algorithms. The processed information is converted to the necessary commands and transmitted to the actuators thanks to the internet of things. This ensures that the machines continue to operate according to these commands. This mechanism enables the traceability and control of the devices. (Monostori et al. 2016: 621).

CPS enables multi-faceted IT-based integration from raw material procurement to production, marketing, and distribution of products. This system makes it possible to benefit from a wide range of management and control mechanisms in all processes. For this reason, the logistics sector is also used in the processes such as storage, collection, and shipment of products. Due to the increasing logistics activities in recent years, it is important to make logistics activities compatible with technology. Thanks to CPS, it is possible to use existing infrastructures more effectively and efficiently. Faster decision-making in the tracking and control of logistics processes will be possible thanks to CPS (Hülsmann, 2014). It is dependent on the compatibility of software infrastructures with the CPS that the objects used in the logistics process need to control and make decisions with the data obtained through various sensors.

Cyber-physical Systems are used in many areas. It can be specified with its function in usage areas as providing critical infrastructure controls such as electricity and water, traffic controls, process controls, energy saving controls, environmental pollution controls (Lee, 2008; Rajkumar et al., 2010). In this sense, it can be said that

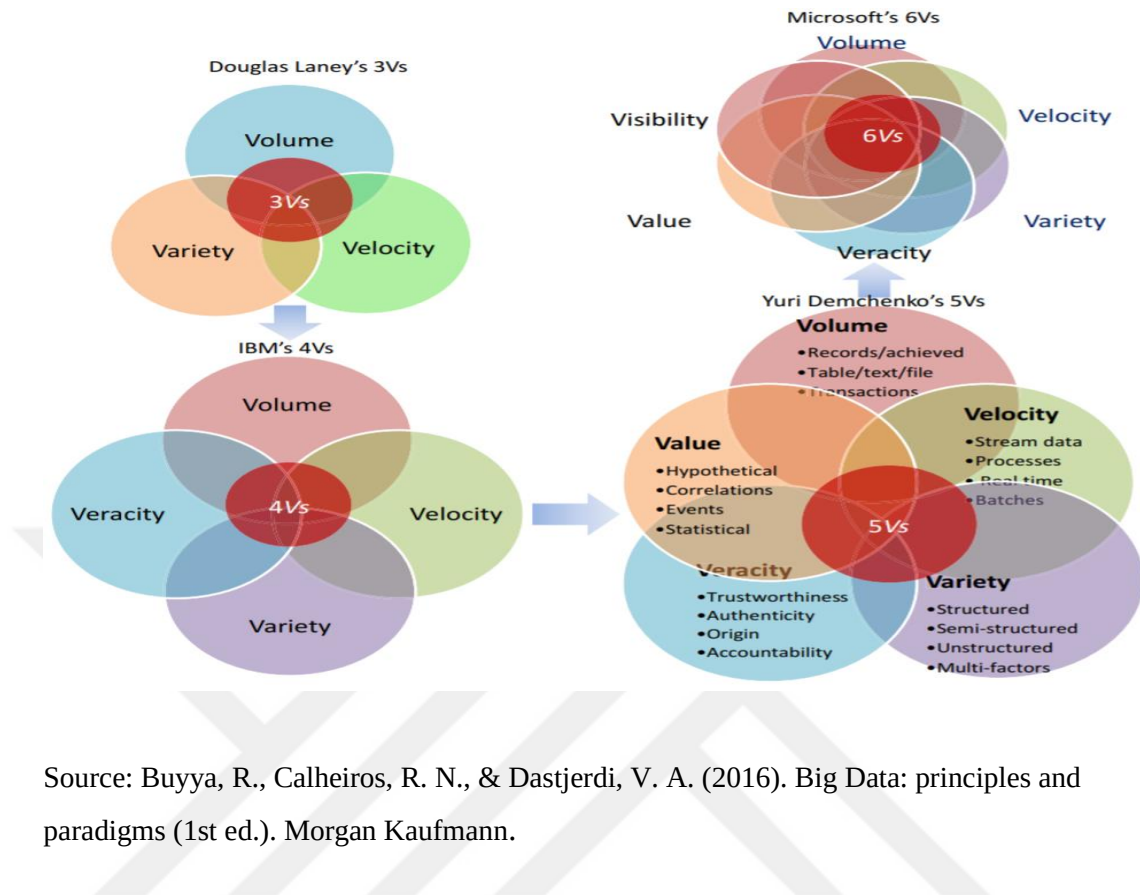
cyber-physical systems are a technology that will play an important role in sustainable development.

2.1.4.1.2. Big Data and Analytics

Before explaining the concept of big data, it is necessary to look at the concept of data. The most general definition of data is a term used for communication in the database (Harrod and Prytherch, 2005). Datas are not meaningful on their own and therefore they need to be grouped, analyzed, and associated. To convert the data into meaningful information and use it, it should be ensured that it is systematically recorded in a certain order by associating with each other. At this point, we need to talk about big data. Big data is the technology used to store and analyze very large and complex data sets. Therefore, it contributes to the development of new technologies with tools that can manage this complexity through big data (Cackett, 2013: 14).

The concept of big data has gained great importance in the 2000s. The process started with Douglas Laney's definition of big data as 3V, followed by IBM's definition of 4V. In this way, the concept of velocity, volume, and variety in the 3V concept introduced by Laney has been added to the concept of veracity and converted to 4V. Later, in 2013, Yuri Demchenko added this definition value to 5V. Finally, Microsoft added the visibility dimension to 6V of big data (Buyya et al, 2016: 7-8-9).

Figure 14: From 3Vs, 4Vs, 5Vs, and 6Vs Big Data Definition



Source: Buyya, R., Calheiros, R. N., & Dastjerdi, V. A. (2016). Big Data: principles and paradigms (1st ed.). Morgan Kaufmann.

Today, all technologies used in conjunction with Industry 4.0 require continuous data collection and analysis. In this sense, with the big data technology, enterprises can provide instant access to instant data, control and analyze this data. At this point, big data technology provides businesses with opportunities to make optimal decisions, reduce costs and improve services and products (Davenport, 2014: 7-29).

As in many other sectors, the use of big data has become very important in the logistics sector. Big data is used especially in operational processes in logistics sector. Especially during the route planning stage for the shipment of products, big data are used in the analysis of the issues such as the calculation of traffic conditions, weather conditions and delivery orders. Thus, it provides options for which products will be sent by air, land, sea or rail and which route will be more efficient and convenient. In this case, it saves both time and fuel. In addition, information about the delivery addresses of the products also accelerates the delivery process to the correct address by verifying the geographical coordinates thanks to the big data. Through real-time analyzes, it is possible to reach the information of where the materials and vehicles are

located and to manage the delivery process by reaching the driver when necessary (Arndt, 2015). Also, Luo et al. (2017: 934) stated that certain controls are provided by using GPS data and large data analysis from vehicles to control fuel consumption and carbon emissions in vehicles.

2.1.4.1.3. 3D Printers

The first application of additive manufacturing or three-dimensional printer (3D printer) technology emerged in 1984 (Sercan, 2019:63). 3D printers are the machines that produce digital data, which is designed with the design programs in computers, by adding layers of material without the need of any tools. In recent years, three dimensional “3D” printers, one of the production tools, work as a laser or inkjet printer to convert products from digital media to a 3D object (Berman, 2012: 155). 3D printers designed with certain software and working like CNC machines in this sense contribute to the development of production activities by providing the production of even complex objects within the scope of Industry 4.0. In this sense, it makes the production of complex objects faster and easier. Machine production is carried out separately with the design and production processes combined with 3D printers. Because hardware and software tools act together (Banger, 2017: 147). 3D printers are used in many industries such as automotive, aerospace, architecture, electronics and defense, although they are still very low in the logistics sector (Özkan, 2019:35).

Thanks to 3D printers, less raw material usage is provided, thus contributing to environmental protection with the advantage of waste management (Horst et al., 2018). In addition, it reduces the cost of resources such as labor and equipment required for production, thus reducing resource consumption (Thomas et al., 2014). The production methods used in previous industrial revolutions produced a lot of waste due to the cutting, processing and conversion of the raw material to the final product. With 3D printers, zero waste is generated because the material required by the product is used and additive production is based.

2.1.4.1.4. Cloud Computing

One of the most important components of Industry 4.0 technologies is Cloud Computing. With the emergence of new technologies, Cloud Computing has replaced the wired systems with increasing data usage. In this sense, Cloud Computing provides a very important service for the collection, storage and distribution of data. Functionally, it is also defined as a service that enables online common information sharing and distribution among information tools (Ekincioğlu, 2019:24). The fact that the large data described in the previous sections will grow continuously may cause problems in the storage of the data, at which point the cloud computing service will be able to solve this problem. Because, cloud computing systems can be used in enterprises for collecting, storing and analyzing big data and thus, optimization of processes can be provided.

The cloud computing system is divided into certain groups within itself. Public cloud; is a service open to the general use of users on the internet. Private cloud; it is only available to a particular organization. Community cloud; the service is available to community members. Hybrid cloud is diversified into systems that are formed by integrating different services in addition to special services created by an organization (Yıldız, 2009: 8,9).

Rapidly increasing use of cloud information technology in many sectors, has become very important for the logistics sector. This technological service, which is one of the basic building blocks of Industry 4.0, has many advantages. Especially with cloud information systems, it is possible to reach the data of the vehicles during transportation and offer quick solutions to the transportation problems that may occur (Barreto et al., 2017: 1248). In addition, cloud computing is seen as an instrument that effectively coordinates and integrates the functions involved in logistics processes. It is possible to realize the logistic activities and to ensure the data transfers between the processes with cloud computing (Iyigün and Görçün, 2019:127). Furthermore, sharing data obtained with cloud-based platforms with customers and other business partners makes the process easier. The cloud computing system provides a more flexible and faster service because it can be provided in all areas with internet connection and with all kinds of vehicles. This situation contributes to the acceleration of the audit and

reporting processes (Yıldız, 2009:7). It provides electricity and space saving thanks to its flexible structure with cloud computing that provides access to information at any time with computers or smartphones (Öztuna, 2017: 58). Also, with the cloud storage system, businesses reduce their software costs because they can perform their corporate transactions with their software compatible with the cloud computing system (TÜSİAD, 2016: 29). Another advantage of cloud computing technology is that the backups of the stored data are done automatically on the cloud system, thus preventing the risk of data loss due to any failure or technical problem in the computers (Sercan, 2019:47).

This system, which is widely used today and provides many advantages to businesses, may cause problems in terms of information security. Businesses should therefore check all security measures when transferring information to the cloud system. In addition, it is necessary to pay attention to the fact that service providers should provide a guarantee of uninterrupted and secure service because software and hardware services are provided by a single service provider.

2.1.4.1.5. RFID

In its simplest definition, Radio Frequency Identification (RFID) is similar to label and barcode technology. It is a technology that works with reader tools to read a label placed on the products and to read these labels (Sun, 2012:107). RFID is an older technology compared to other Industry 4.0 technologies. However, with the development of Industry 4.0 technologies, it has found more usage areas and has become more common. Like other technologies, it is used in many areas for traceability and control purposes.

With a different definition, RFID is a system operated by the use of radio frequency electromagnetic fields to collect data from the labels on the objects and to identify and track the objects. RFID technology is a suitable technology for the circulation and control of products. Warehouse management, inventory control, follow-up and guidance in transportation can be made with this technology in supply chain management processes (Zhang et all, 2012: 1399).

RFID systematically consists of 3 basic components. The first of these are labels attached to products or objects. The RFID tag in question contains information about the product or object. Secondly, they are RFID interrogators that can communicate with these tags. Finally, these queryers have a backend system to the central database. It is possible to access additional information about the products through this database (Sun, 2012:107).

RFID technologies, like other technologies, are used in many fields. Regarding logistics, this technology is used in many stages such as storage, loading, transportation, delivery. RFID technology is used in warehouses, especially in processes such as controlling stocks, automating picking, tracking products on shelves, directing the placement of goods in the warehouse (Jones and Chung, 2016: 256). From a transportation perspective, it is used to quickly set up and track delivery schedules, and to track and identify delivery vehicles. In addition, this technology can be used through the labels on the pallets to define the ordering required to load materials accurately and quickly in container or truck loads. Thus, mixing of the loads and pallets in the field will be prevented and the waiting times to be experienced in the loading area can be reduced (Zhang et al, 2012: 1400-1401). In storage areas, different products or pallets can be identified by RFID technology thanks to RFID tags, thus the processes of storing, replenishment and collection of these products or pallets are accelerated (Doan, 2017:28). Traceability of logistics processes has increased with RFID technology. Stocks, orders, vehicle locations and delivery points information can be accessed at any time (Jones and Chung 2016: 242). With this technology, as labor savings will be achieved, productivity can be increased by preventing time losses caused by manual processes.

2.1.4.1.6. Internet of Things

The Internet of Things (IoT), which is mostly expressed as a concept (Bartodziej, 2016:54), is a technology that occurs when the devices that can communicate with each other meet on a common network (Lee and Lee; 2015:431). The Internet of Things (IoT) is a network of objects that communicate with each other

through radio frequency identification tags or sensors, so that objects can interact with each other to transfer data.

The IoT concept, which is one of the most important components of Industry 4.0 technologies, was introduced in 1999 by Kevin Ashton (Gokhale et al., 2018: 41). According to Ashton (2009), the internet must be a network that collects information not only from people but also from objects, so that human-caused errors can be prevented and some measures can be taken by collecting real-time data from objects. In the supply chain processes of the companies, it is possible to control the instantaneous data flows by working with the devices by communicating with each other simultaneously with the internet of things. In this way, full performance of the machines and prevention of possible errors can be provided. In addition, data such as operating performances, production speeds, error rates, how much resources they consume can be accessed (Sercan, 2019: 55).

IoT technology, which has found a new usage area with each passing day, has started to be used effectively in the processes in the logistics sector. In particular, integration of CPS and IoT technologies with the logistics sector is in a position to provide convenience in real-time tracking of material flow processes, tracking of the transportation processes of the goods and foreseeing the risks that may arise in these processes (Hoffman and Rüsch, 2017: 24).

Schwab (2016) stated that IoT technology has many advantages. It is possible to summarize these advantages as follows; Increasing efficiency in resource use, real-time information flow and cost control, security planning can be made thanks to foreseeable risks, continuous traceability as a result of providing digital connections with products, etc. It is a fact that many companies providing logistics services need fast data flows in air-land-sea and rail transport processes. Therefore, for the logistics industry utilizing IoT technology and creating supply chain processes compatible with this technology have become their primary objectives. In addition, IoT technologies that can be applied in different fields provide advantages for logistics companies that offer wider services other than transportation such as storage, packaging, and customs clearance. Storage is one of the most important parts of the logistics industry. Therefore, efficient management of warehouses is one of the main objectives of logistics companies. Efficiency in storage activities can be increased with smart

storage systems, smart racks, energy and resource usage measurements to be established in warehouses equipped with Industry 4.0 technologies (Çetin, 2017).

In addition, with the digitalization of logistics processes and the continuous flow of information provided, logistics processes can be carried out more safely, faster and more efficiently, thus increasing the productivity and profitability of businesses. As shown in the figure below, with the use of IoT technology, it is possible to increase the productivity and measurability by real-time monitoring of the products, automation and optimization of business processes, ensuring the necessary coordination used in logistics processes (Macaulay et al, 2015).

Figure 15: IoT-Enabled Capabilities



Source: Macaulay, J., Buckalew, L., & Chung, G. (2015). Internet of things in logistics. A collaborative report by DHL and CISCO on implications and use cases for the logistics industry. Matthias Heutger. Retrieved from <https://discover.dhl.com/content/dam/dhl/downloads/interim/preview/updates/dhl-trend-report-internet-of-things-preview.pdf>

In the classification by Vermes and Friess, potential areas for the use of IoT technology were identified. These areas are smart environment, smart water management, smart industry, smart production, smart transportation, smart energy, smart cities, smart buildings and apartments, smart health and smart living applications. In all these smart system applications, with the use of IoT, it is possible

to control and take measures regarding many issues. For example, thanks to smart water management, the consumption of water resources can be brought under control. In addition, with smart transportation applications, transportation conditions and fuel consumption of vehicles can be monitored and container filling levels can be controlled. With regard to the goods in transit, transport will be safer as real-time road tracking can be done. In addition, it can be automated in order to predict and prevent the failures that may occur in the development of the "connected fleet". Thanks to smart energy applications, individual and social energy consumption can be measured. In addition, waste management can be provided and traffic density can be monitored with smart city applications (Witkowski, 2017:766). Thus, with the use of IoT, the process can be managed more effectively and efficiently. In addition, conservation of resources, reduction of environmental damage and sustainability will be ensured.

2.1.4.1.7. Artificial Intelligence

From past to present, researches are conducted on how the human brain thinks, perceives and how it can make decisions. As a result of the research, it is seen that the human brain can reach meaningful results by analyzing many data. In information-based technologies, these perception and evaluation processes of the brain have guided studies for the use of machines in their functionality. Thus, technologies that are defined as artificial intelligence and which are being used in many sectors today, emerge. When analyzed within the scope of Industry 4.0, it can be said that all internet based technological components are interrelated. In this sense, artificial intelligence technology is directly linked to other Industry 4.0 technologies.

Artificial intelligence acquires descriptive and predictive inferences by imitating the natural intelligence of the human brain and analyzing the external data it collects through computers (Tang ve Veelenturf, 2019: 3). Thanks to these inferences and algorithms, machine learning emerges. Considering machine learning, the purpose of using artificial intelligence technologies is to ensure regular progress and development by controlling workflows. However, in terms of production, industrial robots are used to manage workflows with artificial intelligence technologies, and the inclusion of robots in this process is an important area for artificial intelligence

technology. In this sense, artificial intelligence plays an important role in processing and evaluating real-time data (Özkan, 2019: 38).

From the point of view of the logistics sector, artificial intelligence is developing day by day in global logistics and supply chain management and continues to provide convenience in the sector. Thanks to the real-time data obtained, many artificial intelligence technologies are utilized in order to plan routes in order to provide transportation as soon as possible by evaluating road condition and traffic density information (Sariel, 2017: 21). According to Infoholic Research (2018), with the use of artificial intelligence technology, all supply chain processes, including the logistics industry, will be automated and better services will be offered to customers. It is also necessary to talk about robots about the use of artificial intelligence in the logistics industry. The use of robots is increasing day by day in subjects that require physical power such as transportation, placement and control of products in warehouses. Thus, it is possible to create smart warehouses using artificial intelligence technologies. In addition, driverless vehicles working with artificial intelligence technology infrastructure are very important for the transportation process in the logistics industry. In summary, we can say that Industry 4.0 technologies are used interconnectedly from the beginning to the end of supply chain processes. Artificial intelligence technology, as in other technologies, provides convenience to companies in terms of customer service from order management to delivery of materials and even afterwards. Thus, maximum efficiency can be ensured as errors and failures can be prevented in process management.

2.1.4.1.8. Augmented Reality

Augmented reality is the creation of a new perception in the real world environment by animating video, sound, images and graphics with sensory input. (Öztuna, 2017: 78). The concept of augmented reality was first introduced as a result of a research by Thomas Caudell and David Mizell. The researchers have ensured that workers and technicians working at Boeing company are guided by installing a digital imager to make the cable connections on the planes correctly (Sercan, 2019:65). Thus,

the application area of augmented reality technology has become widespread thanks to tools such as wearable technologies, simulation tools and imagers.

Although the concepts of augmented reality and virtual reality seem similar, they are basically different concepts. The difference of virtual reality is that it creates virtual environments where the real world is modeled or simulated in three dimensions. But Augmented reality is realized by real-time transmission of data from the real world in a more interactive way (Somyürek, 2014: 67). For example, while getting directions with augmented reality glasses, we can see the direction information with arrows on the road. However, the navigation we use on phones is an example of virtual reality.

Today, with the development of technology every passing day, the adaptation of all sectors to this process is progressing rapidly. Many sectors use these technologies to make their processes more functional. In this sense, augmented reality technology brings improvements in the logistic sector, as well as in many sectors. The augmented reality that comes to the forefront in logistics planning and logistics activities provides contributions to the sector such as reducing costs, optimizing resources, reducing error rates and improving the process (Yılmaz and Duman, 2019:3).

When we look at the usage area of Augmented Reality in logistics; In the planning stage of logistics facilities, issues such as where and how the facility will be built and where the equipment to be used in the facility will be located can be determined with this technology to reduce costs. In addition, during the transportation of goods, this technology can be used to plan the route to be traveled, to determine the most appropriate and effective loading by defining the goods. In international trade, this technology can be used for the control and translation of documents in import/export processes that vary by country. With augmented reality technology, settlement planning in warehouses can be made easily. It allows users to easily maximize the available space of a warehouse according to the criteria of the inventory. By placing the floor plan in the physical warehouse, users can determine which placement works best and reduce the costs associated with warehouse planning (Yılmaz and Duman, 2019:4). In addition, for the optimization of packaging processes, the identification of goods, content information, packaging instructions can be displayed in real time with this technology (Mattig et al, 2016: 3).

2.1.4.1.9. Autonomous Robots

Robots; are machines that can be programmed by computers and can perform complex actions automatically. The types of robots that can communicate with their surroundings by working with artificial intelligence technology and have their own decision making mechanisms are called autonomous robots (Şahin, 2019: 15). The use of autonomous robots, one of the important components of Industry 4.0, in the industry started in the 1940s with the use of paint machines working with automatic control, and the development of industrial robots emerged in different products of robot technology (Yazıcı, 2016: 39).

The development of the first autonomous robots was made by William Gray Walter at the Burden Neurological Institute in England in the late 1940s. The autonomous robot, which has a numerically based operating system and is known as the 'Unimate' and accepted as the basis of the autonomous robot industry, was developed by George Devol in 1954. Thus, autonomous robots are being used as machines that perform more accurate, faster and cheaper actions than humans. Even jobs under difficult and unhealthy conditions for humans have been made by robots (Banger, 2017: 72).

Today, autonomous robots are used in many areas from the health sector to the production sector. It is possible with the use of autonomous robots to provide a more efficient and safe workflow in all processes from production to distribution. In this sense, the use of autonomous robots is also very important for the logistics industry. While some of the robots, which are mostly used in warehouse activities in the logistics sector, have autonomous features, some are non-autonomous robots that are guided by operators by humans. Many processes such as separation, assembly, packaging of products made in warehouses can be done by robotic systems. In addition, thanks to the sensors and sensing systems used, it can be said that automatic racking systems, along with other technologies, started to work with robot technology (Görçün,2018:362) . On the other hand, robots are also used in container loading and unloading. In the event that all of the products are not loaded or unloaded, after opening the container, the robotic system can be scanned by the contents through the transport container, taking the products in the command given to it, and putting them on the

conveyor belt. In this sense, container handling robots are very important in this process (Brock, 2016: 22-23). In addition, robots can use the cloud computing systems to evaluate the order commands they receive, allowing them to collect orders from the relevant shelves and deliver them to the shipping point (Görçün, 2018: 362). In this sense, it is possible for robots to be used in many activities such as picking, placing, loading, unloading and packing orders .

Thus, it is possible to speed up and facilitate logistic processes by using autonomous robots. With many actions that cannot be done with manpower, robots can perform safer, more efficient workflows. In addition, the fact that many logistics activities can be done by robots and the problems encountered in the processes will be prevented, thus reducing the costs. On the other hand, as a result of faster processes, time and labor savings can be achieved.

2.1.4.2. Criticism of Industry 4.0 Technologies

Industry 4.0 technologies, which affect all sectors and witness great transformations, undoubtedly bring many changes both in daily life and in the processes of businesses. New business models emerge in businesses, and many processes such as production, storage, shipping, consumption, etc. are reformed. From a sociological perspective, technologies appear in all needs of people such as education, health, clothing, etc.

When viewed globally, the state of societies, which are based on sustainable development on the one hand, and in the technological transformation described in this chapter on the other, had to be carried out in the same process. The technologies, which have many facilitating and solution elements for all sectors, have emerged as they coincide with the Sustainable Development Goals on the one hand, and on the other hand they are in conflict. In addition to the advantageous situations we have mentioned one by one while explaining the technologies in the previous section, it also includes some threats. If we look at them;

The concept of equality, which is the basis of all the Sustainable Development Goals, unfortunately becomes more questionable when considering the technological transformation. Because it is clear that technological transformation will not occur at

the same rate on the basis of world countries that unfortunately impose systemic inequality. For this reason, it is obvious that Industry 4.0 technologies, which will be the scene of great advantages for developed and rich countries, are only a dream for developing and less developed countries. For this reason, this inequality gap to be created by this worldwide transformation may unfortunately become more evident. On the other hand, Industry 4.0 technologies are considered to be irrelevant and difficult to apply for many small and medium-sized enterprises (SMEs). In many sectors, it is stated that SMEs are more disadvantageous than large companies for technological transformation (Maier & Student, 2015). It is difficult for SMEs to bear the necessary infrastructure and costs for existing equipment and processes to adapt to technological transformation (Müller, et al., 2018).

In accordance with the goal of "Decent work", which is among the Sustainable Development Goals, it is aimed to employ every person in accordance with human rights conditions. However, due to the technological transformation and increasing automation experienced with Industry 4.0, many companies now benefit from robotic systems in many areas such as production centers, warehouses, planning shipments, etc. For this reason, some jobs that were previously done by human hands are now carried out with robots and autonomous devices. Unfortunately, this situation causes some people to be unemployed by taking away the jobs they are employed in. It is thought that new advances with technological developments will cause many people to lose their jobs and social fragmentation may occur (Sanchez, 2019). On the other hand, for the use of Industry 4.0 technologies, employees' need for highly skilled employees will increase. There will be a need for existing employees to receive training in order to acquire sufficient skills, and this will create extra costs for many businesses. Therefore, it may be difficult for businesses to meet these needs and at the same time, it will be difficult to find personnel with all competencies (Bonekamp & Sure, 2015).

On the other hand, sociological and technical systems need to work together in order to implement technological transformation in a sustainable way (Davies et al., 2017). Therefore, transformation should be approached and implemented with a holistic perspective. Otherwise, polarization in existing jobs and accompanying income inequalities (Frey et al., 2016), separation of capital from labor force, technical

unemployment based on limited labor shortage (Rainie & Anderson, 2017), demographic divisions according to the ages of the people to be employed (Goodhart & Pradhan, 2017), such contradictions may arise.

In addition, the fact that every information and data can be accessed and controlled in such a transparent way in general also reveals problems in terms of security. Because with Industry 4.0 technologies such as big data and cloud computing where all data can be stored and processed, access to information will be easier. And in line with this accessibility, security systems should also be installed, but there are still gaps in this regard. As a result of information transparency, there is a possibility of many cyber security problems such as developing protection against cyber attacks and protecting know-how processes (Flatt et al., 2016).

As a result, the progress of Industry 4.0 technologies in parallel with sustainable development is important for the welfare of societies globally and for the transfer of a clean world to future generations. The effects of technologies on sustainable development goals need to be further evaluated and addressed (Bai and Sarkis, 2020). For this reason, it is important to deal with some of the problems mentioned above in a way to reach a solution and to solve them while technological transformations are taking place.

2.1.5. Industry 5.0

Looking at the industrial revolutions, it is seen that the innovations and developing technologies they bring cause various changes in societies. The technological transformation process experienced with Industry 4.0 has caused both advantageous and disadvantageous situations for companies and societies. In general, it is thought that Industry 4.0 adopts a mass production-oriented capitalist approach and ignores people, nature, in other words, sustainable development. It has been stated that it focuses on increasing the efficiency in the processes of the enterprises and ignores the human cost, which aims for optimization (Nahavandi, 2019: 3).

In addition, the issue of environmental pollution, which increased after the 2nd Industrial Revolution, has now become the leading subject of the production sector and started to be seen as an element of competition in the international market.

Although the sustainability perspective is tried to be addressed with Industry 4.0 technologies, it is thought that it is insufficient to focus on the technologies necessary for the protection of the environment and for sustainable development. For this reason, Industry 5.0, which takes human as its focal point and covers sustainable improvement, is seen as a solution (Nahavandi, 2019: 3). Thus, we can see that Industry 4.0 technologies, which are completely technical, are trying to complement the sociological dimension with the Industry 5.0 perspective. With Industry 5.0, the concept of sustainability has been emphasized based on cooperation between human and machine.

One of the biggest criticisms made to the Industry 4.0 approach, the autonomous device-oriented approach, which prevents people from their employment is expected to be eliminated with the Industry 5.0 approach. According to Østergaard (2016), Industry 5.0 is a revolution that will make people return to the factories. With the Industry 5.0 approach, a synergy between human brain power and smart systems will be created to increase the efficiency of the process. As a result of this cooperation between people and machines, a less cost-oriented approach will be adopted with more efficiency, increasing the added value of the products, and with less waste. Gotfredsen (2016) emphasizes that a more creative robotic production can be made in production with human-robot collaboration, and that this cooperation will be beneficial by stating that workers can take part in better tasks. In addition, "smart robots", which are among Industry 4.0 technologies, will take a form called "cobots", which will be aware of human existence, monitor, learn and work as a colleague. The cobots, which observe a person on any task with the camera on it, take and process the images and predict the next step of the worker. Sensors used to predict the next step of the worker will be able to help the worker where necessary by predicting the signals to be received from the human brain over a wireless communication channel (Nahavandi, 2019: 3).

Another vision of Industry 5.0, apart from the human-machine collaboration mentioned above (Johansson, 2017), is bioeconomy (Demir and Cicibaş, 2018). What is meant by this is the efficient use of biological resources in production and industrial processes and to ensure the balance between industries and the economy ecologically. It is stated by the European Commission that bioeconomy, the production of renewable biological resources and waste management and their transformation into products

such as feed, bio-based products, and bioenergy (EC, 2012). Bioeconomy is very important for a sustainable economy (Schütte, 2017). In the table below, Industry 5.0 visions created by Demir et al. (2019) and Industry 4.0 are compared (as cited in Demir and Cicibaş, 2017).

Table 4: A Comparison of Industry 4.0 and Industry 5.0 Visions

	Industry 4.0	Industry 5.0 (Vision 1)	Industry 5.0 (Vision 2)
Motto	Smart Manufacturing	Human-Robot Co-working	Bioeconomy
Motivation	Mass Production	Smart Society	Sustainability
Power Source	Electrical power Fossil-based fuels Renewable power sources	Electrical power Renewable power sources	Electrical power Renewable power sources
Involved Technologies	Internet of Things (IoT) Cloud Computing Big Data Robotics and Artificial Intelligence (AI)	Human-Robot Collaboration Renewable Resources	Sustainable Agricultural Production Bionics Renewable Resources
Involved Research Areas	Organizational Research Process Improvement and Innovation Business Administration	Smart Environments Organizational Research Process Improvement and Innovation Business Administration	Agriculture Biology Waste Prevention Process Improvement and Innovation Business Administration Economy

Source: Demir, K. A., & Cicibaş, H. (2017, October). Industry 5.0 and a critique of Industry 4.0. Presented at the 4th International Management Information Systems Conference “Industry 4.0,” İstanbul, Turkey: İstanbul University

In addition, Rada (2017) focuses on waste prevention by adding environmental values to human-machine cooperation, and focuses on sustainability, criticizing the existing digitalization with the "Industrial Recycling" approach put forward by. 4 types of waste are mentioned in "Industrial Recycling". These are as follows:

Physical Waste: Physical wastes that arise during production processes, generally in the form of garbage.

Social Waste: Refers to unused manpower and unemployed people are in this category.

Urban Waste: Refers to insufficient infrastructure and empty areas, fields.

Process Waste: It refers to situations such as overproduction, empty or incomplete filling of transportation vehicles that occur during processes such as production, storage, distribution.

In addition to these, it is thought that new employment areas will be created with the Industry 5.0 revolution. It is among the expectations that it will open many business areas such as artificial intelligence, robotic programming, and the invention of new generation production robots. It is expected that there will be no repetitive tasks in human hand jobs, and the creativity in the work process will increase with the use of different robot forms with an innovative perspective. Moreover, with Industry 5.0, numerous start-up companies will create a space that can produce software and hardware-driven robotic solutions globally. As this will strengthen the global economy in terms of both employment and income, it will contribute to sustainable development (Nahavandi, 2019: 11).

CHAPTER THREE

TRANSFORMATION OF THE LOGISTICS SECTOR IN INDUSTRY 4.0 TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT

Looking at the emergence of logistics, it is possible to say that it has a past as old as human history. With the existence of people, it has been necessary to move goods and services from one place to another due to their needs. Especially in times of war, the logistics activities required to transport the necessary ammunition to the battlefield have an increasingly important place in human life. Today, we can say that many goods and services are moved from one place to another, intercity or internationally. Due to the increasing trade volume between countries, all countries of the world carry out logistics activities in imports and exports. It is obvious that in the field of logistics, as in all other areas, there are environmental risks brought about by density and increasing volume. Therefore, it is clear that it is necessary to manage the increasing trade volume with processes in a way that will benefit sustainable development. It is up to us to evolve the logistics sector, which is associated with the destruction and consumption of natural resources in almost every process, into a more sustainable and more environmentally friendly process using today's innovative technologies.

In this part of the thesis, the communication and applications of Industry 4.0 technologies and sustainable development perspective in the logistics sector, which were explained in the previous chapters, will be examined.

3.1. CONCEPT AND IMPORTANCE OF LOGISTICS

Since it has a very old history and has gone through many different processes throughout history, there is no single definition of the concept of logistics. The concept of logistics, which was first used in the military field, started to gain a commercial meaning with the following years. International trade has gained importance with the increasing competition conditions among countries around the world and the increase in transportation facilities.

The word logistics was first replaced by the concept of physical distribution in 1967 and was used by the Logistics Management Council gathered in the United States (Bowersox - Closs, 1996: 4). In the years when the Council was established, the word logistics was used in a sense that covers all processes from the raw material starting point to the consumption point of a product. Therefore, from a general perspective, we can say that logistics actually has a broader meaning than transportation and includes processes such as order, inventory control, packaging, storage, customer service (Boone-Kurtz, 1992: 492). At this point, logistics includes the entire process of delivering to the customer at the right time, in the right place, in the conditions requested by the customer and in the right quantities. When it comes to logistics activities, a process that includes all transportation processes, information flow and storage processes between the exporting country and the importing country should be considered (Vallee, 2011: 82). With this feature, the logistics process requires complete planning.

The importance of the logistics industry throughout the world is increasing day by day. In the global market, customers now expect to reach products or services in the fastest times, in the most favorable conditions, with the best service and at the lowest prices. As international borders disappear and world trade volume increases, logistics companies focus on meeting the expectations of their customers with competitive policies. On the other hand, the progress in the logistics sector gains momentum as facilities are provided in the global market, such as cross-country customs regulations, gradually decreasing quotas, and eliminating tax restrictions.

In addition, with Industry 4.0 technologies adopted around the world, faster and more traceable logistics processes are also important in terms of meeting customer demands and reducing costs. Industry 4.0 technologies can now be used in almost all logistics processes. Thus, it becomes easier to meet the increasing expectations of the customer. On the other hand, environmental issues also come to the fore among customer expectations. The fast consumption brought about by globalization and the damage to the environment caused by the misuse of resources are among the issues that raise awareness all over the world. For this reason, customers pay attention to the product they choose and the services they receive to be sustainable and not to cause environmental problems. At this point, logistics companies are now required to pay

attention to and control the resource consumption, energy use, waste management and all other environmental issues with the technologies they use. Sandberg and Abrahamsson (2011) stated in their studies that the use of innovative technologies is effective in the increase of the importance of logistics within the scope of sustainable competition.

Various applications are carried out worldwide in order to measure the progress and success of companies in the logistics sector. At this point, it is possible to monitor the progress of countries in the logistics sector with the Logistics Performance Index (LPI) by the World Bank. The index, which was first made in 2007, was expanded in technical and scope in the following years. As of 2012, sustainable performance indicators are also included in the index. Thus, it is possible for countries to compare themselves with other countries in terms of logistics activities and to develop accordingly. The top 10 countries included in the ranking in the Logistics Performance Index in 2018 are shown in the table below (WB- LPI, 2018).

Table 5: Logistic Performans Index

Country	Year	LPI Rank	LPI Score	Customs ?	Infrastructure ?	International shipments ?	Logistics competence ?	Tracking & tracing ?	Timeliness ?
Germany	2018	1	4.20	4.09	4.37	3.86	4.31	4.24	4.39
Sweden	2018	2	4.05	4.05	4.24	3.92	3.98	3.88	4.28
Belgium	2018	3	4.04	3.66	3.98	3.99	4.13	4.05	4.41
Austria	2018	4	4.03	3.71	4.18	3.88	4.08	4.09	4.25
Japan	2018	5	4.03	3.99	4.25	3.59	4.09	4.05	4.25
Netherlands	2018	6	4.02	3.92	4.21	3.68	4.09	4.02	4.25
Singapore	2018	7	4.00	3.89	4.06	3.58	4.10	4.08	4.32
Denmark	2018	8	3.99	3.92	3.96	3.53	4.01	4.18	4.41
United Kingdom	2018	9	3.99	3.77	4.03	3.67	4.05	4.11	4.33
Finland	2018	10	3.97	3.82	4.00	3.56	3.89	4.32	4.28

Source: World Bank. (n.d.). Global rankings 2018 | Logistics Performance Index. Retrieved May 15, 2020 from <https://lpi.worldbank.org/international/global>

According to the index, countries are compared on the basis of factors such as customs, infrastructure, international transport, and logistics competence. Turkey is # 47 in the ranking and is classified among the middle-income countries (WB- LPI, 2018).

Table 6: Logistic Performans Index, Turkey

Country	Year	LPI Rank	LPI Score	Customs	Infrastructure	International shipments	Logistics competence	Tracking & tracing	Timeliness
Turkey	2018	47	3.15	2.71	3.21	3.06	3.05	3.23	3.63

Source: World Bank. (n.d.). Global rankings 2018 | Logistics Performance Index. Retrieved May 15, 2020 from <https://lpi.worldbank.org/international/global>

Recently, the applicability of the Sustainable Development Goals to the logistics sector has been discussed. Many logistics companies try to organize all processes in their businesses to suit these purposes. Thus, more functional and efficient processes can be obtained in both managerial and operational issues. Companies re-create and publish these practices every year under the title of "Sustainability Report". Thus, it offers a more transparent view towards its customers towards achieving sustainable development goals among companies. By looking at these reports, customers can clearly see the greenhouse gas emission amounts, resource consumption, waste management and recycling policies of the companies and find the opportunity to compare them between companies.

3.2. MAIN ACTIVITIES IN LOGISTICS

In this part of the thesis, the processes in the logistics sector will be explained. While explaining logistics processes, Industry 4.0 applications used in these processes and the benefits of these technologies in terms of sustainable development will be focused. In general, the functions covered by logistics management can be examined under 6 main titles; 1. Order processing, 2. Inventory management and control, 3. Storage, 4. Product handling, 5. Packaging and classification, 6. Transport (Bowersox and Closs, 1996, p.4). Also, logistics processes that are important in terms of sustainability can be listed as transportation, Inventory management and storage, information flow, purchasing and protective packaging design and reverse logistics (Dey et al., 2011: 1245). In this section of the thesis, the subject of the study, which is important in terms of sustainability, will be explained in this title order.

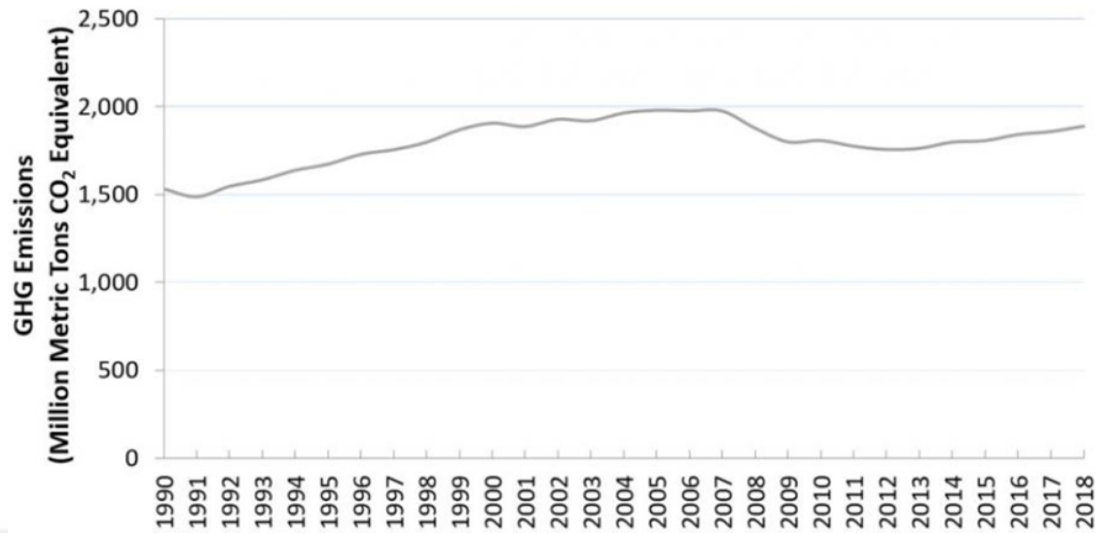
3.2.1. Transportation

Transport activities are one of the most important processes in the logistics sector. When it comes to transportation activities, the process of delivering the raw materials to the production points and the products produced to the final delivery points to be delivered to the end user is emphasized. The main activities related to transport include the way in which transportation will be carried out, determining the transportation route, and the decisions about how the shipment will be carried out (Lambert et al, 1997:25) However, from a broader perspective, transportation can be defined as the fastest and safest delivery of the right goods at the right time. Thus, when it comes to transportation activity, it is not only the process of moving goods from one place to another, but also the fulfillment of many different parameters during this process. Today, one of the most important points of transportation is that the process can be sustained with the least damage to the environment. Because the transportation process in the logistics industry is one of the processes with the most environmental damage.

In terms of logistics, transportation is generally carried out in 5 different ways. These are roadway, seaway, railway, airway and pipeline transportation. Which type of transport will be chosen may differ depending on the countries in which the trade is carried out, the urgency of the goods to be transported, and transportation costs. Today, due to various environmental problems, the issue of which transportation type is chosen has become even more important.

It is stated that there are 3 main bases of the environmental impact of transportation; It is the building of transport networks, the use of transport vehicles and the destruction of these vehicles and their parts (Wu and Dunn, 1995) . Recently, environmental problems are increasing due to these 3 main sources. As a result of the fossil fuel consumption of vehicles used in transportation, toxic gases such as CO₂ (carbon dioxide) are released into the environment and pollute the air. Also, there is pollution of the environment due to the wastes released from transportation vehicles. The figure below shows the emission emissions from transport.

Figure 16: Greenhouse Gas Emissions from Transportation, 1990-2018



Source: US Environmental Protection Agency.(n.d.a.). Fast Facts on Transportation

Greenhouse Gas Emissions Retrieved March 19,2021 from

<https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions>

At this point, it is of great importance to minimize and reduce the emission of gases to the environment in the transportation type. From this point of view, road transport is the one with the highest emission gas to nature among other transport types. In addition, there is an inefficient use of energy due to the use of internal combustion engines during transportation (Gören, 2011: 29). For this reason, it is possible that countries in the world tend to use different types of transportation every year to reduce emission gas.

Seaway transport can be shown as an alternative type of transport to roads to reduce emissions. Although seaway transport includes longer times as a delivery time, it provides the opportunity to transport high volume loads at low costs. In addition, considering its environmental damage, it has a very low greenhouse gas emission compared to road transport. International activities are also carried out to make sustainable decisions in maritime transport. In 2018, the United Nations International Maritime Organization (IMO) set its vision for reducing greenhouse gas emissions from maritime transport. According to the first strategy, it is aimed to reduce annual greenhouse gas emissions by 50% by 2050 compared to 2008 and to eliminate them completely in the longer term. In addition, the energy efficiency design index (EEDI)

requirements for ships and the carbon intensity of ships are among the targets (IMO 2018).

From the point of view of Sustainable Development, studies are carried out to reduce CO₂ emissions from energy consumption, waste management and industries within the scope of the Kyoto Protocol. Energy consumption increases due to fuel consumption, especially in developing countries. These increases bring along increases in CO₂ emission. In this sense, the Kyoto Protocol aims to reduce the greenhouse gas emissions released into the environment by using alternative energy sources (UNFCCC, n.d.a). In particular, the following measures are taken for road transport, which causes the most greenhouse gas emissions in the environment.

- Use of alternative vehicles that reduce fuel consumption
- Alternative fuel use,
- To develop various methods to make transportation networks more planned and to make traffic flow more controlled

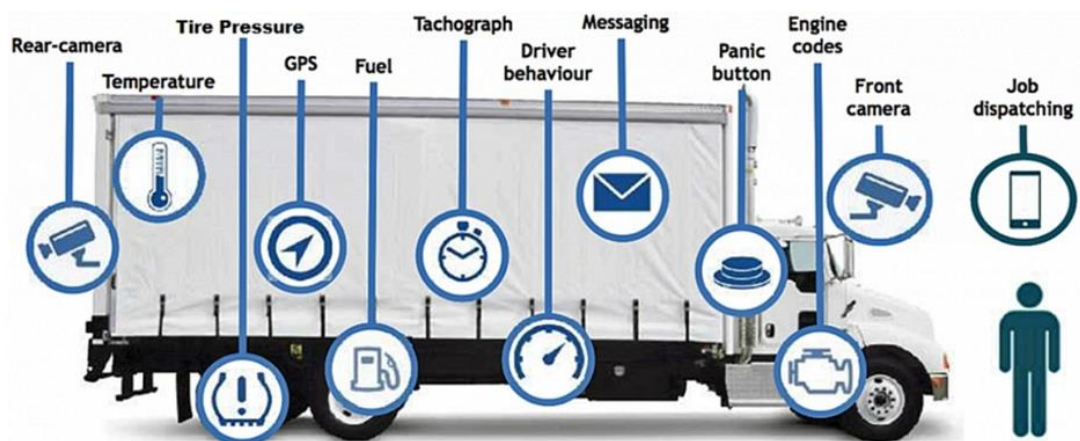
The use of new technologies is needed to take the specified measures and to develop environmentally friendly methods. With the use of Industry 4.0 technologies, it has become more possible to implement such measures. For example, autonomous vehicles and electric vehicles have started to be used today to control fuel consumption and reduce emissions. Many countries around the world are leading in this sense. For example, in China in 2017, the use of electric vehicles was promoted by promoting the introduction of electric vehicles at the "New Energy Vehicles" event. In Germany, Van Hool company has also integrated hybrid technology and electric vehicle technology into its vehicles (Snauwaert, 2017). In addition, Toyota has started to produce fuel cell trucks and generators in order to reduce emission rates (Toyota, 2020). Tesla semi-truck, an autonomous truck produced by Tesla for road transport, can be cited as an example of electric vehicles. Thus, the use of unmanned vehicles was also mentioned and it became possible to reduce the accident risks (Tesla, n.d.).

Another alternative is the use of drone technology in short distance transportation. While faster delivery can be achieved with drone technologies, it also makes it possible to reach points that are not suitable for road transport. The Government of Rwanda cooperates with companies UPS, GAVI and ZIPLINE to save the health of many people in Africa through the vaccine alliance (Etter, and Siddiqui,

2019). In this sense, drone technology not only contributes to health logistics, but also enables everyone to have the right to a healthy life in accordance with the principle of equality in sustainable development goals.

Of course, alternative means are not the only solution to take environmental measures. Because although developed countries make developments regarding autonomous vehicles, it is still not possible to use autonomous vehicles on a global basis because it is still more costly economically. Therefore, it is also possible to provide easier and cheaper facilities with different Industry 4.0 technologies. In this sense, the necessary transformation in transportation can be achieved with Internet of Things technology. With IoT technology, it is possible to access real-time data on vehicles thanks to sensors and chips installed in vehicles. Thus, it will be possible to save fuel as the fuel consumption in the vehicle can be monitored and controlled. In addition, it may be possible to arrange routes using real-time traffic data. On the other hand, since heat and light controls can be made in the vehicle, it can be ensured that the goods are kept under control and deterioration can be prevented (Philip et al, 2019). In addition, with the data received by cloud computing technology, transportation problems can be solved faster.

Figure 17: How IoT Technologies Transforms Fleet Operations?



Source: McCarthy, D. (2017, December 1). Under the hood: How iot tech transforms fleet ops. Retrieved from <https://www.fiercееlectronics.com/components/under-hood-how-iot-tech-transforms-fleet-ops>

Muthuramalingam et al. (2018), in their study, conducted a case study on Intelligent Traffic Management Systems based on IoT and big data and examined the

hardware and software components associated with the system. Thus, they tried to reveal the use of IoT and big data technologies in smart transportation systems. It is possible to make transportation processes more effective and efficient with the system called "Intelligent Transportation Systems" (ITS) (Barreto et al., 2017: 1247-1248). With ITS, better and optimized service can be achieved by providing transportation times and fuel consumption. Thus, a more environmentally friendly transportation can be provided. In addition, ITS can be used not only in road, but also in other modes of transport such as seaway, airline and rail. In the figure below, the entire communication network of ITS is shown (ETSI, 2018).

Figure 18: Intelligent Transportation Systems Network



Source: ETSI. (2018). Intelligent transport systems. Retrieved from <https://www.etsi.org/images/files/ETSITechnologyLeaflets/IntelligentTransportSystems.pdf>

It is possible to use Industry 4.0 technologies in other types of transportation as well as on the road. For example, in maritime transportation, which is the most preferred after land, sustainable applications can be found by using new technologies. Maritime transport (Binder, 2016), one of the sectors where digital transformation can be used effectively, enables more efficient use of port logistics and shipping networks with big data and advanced technology networks (Berg & Hauer, 2015). For example, two companies KVH and Kongsberg Maritime have started using IoT technology to

find solutions to problems for ships. Thanks to this system they place on the ships, they can provide data transmission and data can be accessed by operators and customers (Connors, 2020). In maritime transport, IoT-based solutions are also used to control energy and fuel use. Traceability of fuel and energy use is possible thanks to the smart meters installed on the ships, thus reducing the gases emitted to the environment by saving fuel. Hernández et al. (2020) researched IoT solutions suitable for the current needs of the maritime industry and offered recommendations on IoT systems compatible with the SMARTSEA project.

In addition, thanks to the data communication developed to ensure the integration between ships and ports, the density of the ports can be controlled. Thanks to big data and IoT technology, ships can send data to the port before they approach the port, and preparations can be completed before the ships dock. Another important issue is related to the wastes they leave to open waters due to the long transit time of maritime transport. Zuin et al. (2009) conducted research on the final treatment of ship wastes and waste management by measuring the environmental effects of wastes originating from ships at Koper Port. In addition, thanks to the sensors attached to the objects, the efficiency of the ship operation can be increased with artificial intelligence technology (Jahn, Bosse, & Schwientek, 2020). Again, thanks to new technologies, these wastes can be left in a control.

When we look at the issue in terms of the Covid-19 epidemic, which started in China towards the end of 2019 and spread rapidly all over the world, we see that the logistics industry is also highly affected. The restrictions imposed by each country to try to prevent the spread of the epidemic also affected the international trade of those countries. Due to reduced national and international trade, carbon dioxide emissions from transportation are expected to decrease by 30%. The highest rate of emission reductions is in the Russian Federation and Central Asia, and it is expected to be around 54%. Although there has been a significant decrease in other regions, it has not yet reached the level of 50% (ITF, 2020).

When compared to February of the previous year, trade rates in container transportation decreased by 8.6% as of February 2020. The decrease is more pronounced especially in Far Eastern countries. Significant reductions have also been

observed in Europe, North America and Oceania. The table below shows the decreases for different regions around the world (ITF, 2020).

Table 7: Changes in Container Trade Volume by World Region, 2020

	Change Jan 2019 to Jan 2020 (%)	Change Feb 2019 to Feb 2020 (%)
Far East	0.0	- 17.5
Europe	0.7	- 4.0
North America	- 0.3	- 7.0
Australasia and Oceania	- 6.5	- 2.8
Indian Subcontinent and M. East	3.7	6.1
South and Central America	2.4	2.8
Sub-Saharan Africa	5.4	7.4

Source: ITF. (2020, April). Global container shipping and the coronavirus crisis. Author.

Retrieved from <https://www.itf-oecd.org/sites/default/files/global-container-shipping-covid-19.pdf>

There have also been changes in the functioning of logistics processes due to Covid-19. Alternative transportation systems have been created by selecting new models that are more systematic and suitable for the conditions. At this point, the use of drones in deliveries has gained importance in order to reduce human contact due to the epidemic. The use of drones has played an important role in areas such as medical supplies, the delivery of laboratory samples, and the disinfection of public spaces, especially with the epidemic (ITF, 2020). In April 2020, the use of drones was approved by the Irish aviation authority for the delivery of pharmaceuticals and critical supplies by the drone operator Manna Aero. Also in Ghana, the well-known drone operator Zipline provides a "contactless drone delivery" service that collects Covid-19 test samples from 1000 rural areas and delivers them to laboratories (Halpin and Cairnduff, 2020).

With the discovery of the vaccine, the logistics of the vaccine has become the agenda in terms of delivering the vaccine to all countries of the world. It is clear that the vaccine, which must be transported as a cold chain, requires a great logistic service from the production facility to the delivery to the countries. Logistics suppliers that will provide the necessary conditions have become important for the transportation of the vaccine that needs a cold temperature of -80 degrees (BBC, 2020). Considering the economic levels of the underdeveloped and developing countries, issues such as the supply of vaccines and the existence of cold stores that can be stored when brought to the country are important for the Sustainable Development Goals. Because it is

important that every country has equal access to basic health needs and at this point, it is imperative to find remedial solutions for underdeveloped and developing countries.

3.2.2. Inventory Management and Warehousing

Inventory, in its most basic definition, has a meaning that indicates semi-product, raw material, spare parts or finished products in order to meet the needs of enterprises (Samanta,2015:9). Warehousing means keeping all these materials in places belonging to businesses for the purpose of protection and storage. Therefore, warehousing is very important for inventory management because thanks to warehousing, all inventories are kept ready in warehouses to be used when needed.

Since inventories are the most important cost item for businesses, it is important to carry out inventory management and warehousing processes effectively. Also, environmentally, warehousing is an important process for sustainability. With a good inventory management and warehousing, both costs and environmental damages can be reduced. Subjects such as energy use of equipment used in warehouses, process optimizations, inventory reduction programs and just-in-time systems, recycling and waste management are indispensable managerial elements of the warehousing process. If these factors are taken into consideration, both costs and environmental damage can be reduced. Prachar et al. (2014) proposed the Kanban method in their project to optimize the inventory management of companies and to reduce costs and to ensure sustainable development. What they aim with the system is to eliminate waste and improve processes by focusing on employees.

How inventory management and warehousing processes can be managed more effectively and sustainably depends on certain criteria. The first of these criteria is recycling and waste management. Because, considering the environment, industrial packaging and the management of waste are very important for both storage and ecological balance. Radhakrishnan (2015), while presenting an overview of green packaging and recycling in his study, emphasized the benefits of these two issues by examining case studies for raw materials, resources, cost and storage order. Another criteria, it is important where the warehousing areas of the enterprises are allocated. Because it is close to important points such as the port and truck park in the process of

taking the goods from the warehouse and transporting them to the delivery points is important for energy and fuel. In addition, we can list other important points other than the location where the warehouses are allocated as follows (Emmet and Sood, 2010: 135-137):

- Minimizing energy savings with planning management in warehouses
- Increasing energy efficiency by using motion sensors and timed lighting systems
- Using natural daylight if possible in warehouse lighting
- Use of heating and cooling systems to keep the warehouses at a suitable temperature
- Use of energy efficient technologies and equipment in handling processes

Thus, it is possible to optimize in terms of storage with the correct warehousing method and inventory management of logistics enterprises (Wen and Gu, 2016: 878). In this sense, the use of Industry 4.0 technologies in inventory management and warehousing processes can make an important contribution to sustainability. One of the most important reasons for resource consumption in warehouses is energy use. In order to control and minimize energy use, sensors to be used with IoT technology can control and reduce important energy use such as lighting and heat (Buntak et al, 2019). In storage, the management of operational processes is as important as the physical infrastructure. Because inventory management and warehouse relationship is managed by more operational processes such as moving the inventory into or out of the warehouse, placing it on the shelves in the warehouse, loading it on transport vehicles when necessary, and in some cases completing packaging operations in the warehouse. Industry 4.0 technologies can also be used for effective management of operational processes. For example, robot technology is used to regularly transport and place materials in suitable places in warehouses. In addition, by using smart conveyors and sorting systems, it is possible to stack the goods properly and place them on the relevant shelves in a shorter time (Lee, 2015). With RFID technologies, instant checks of goods in warehouses can be made and thus unnecessary inventory can be prevented.

Figure 19: DHL Implements Smart Warehouse Initiative



Source: DHL, (2019 July 30). Smart warehouse with internet-of-things technology.
Retrieved from <https://dhl-freight-connections.com/en/solutions/smart-warehouse-with-internet-of-things-technology/>

Shown in the figure above, an example of DHL smart warehouses, DHL Supply Chain has implemented an integrated supply chain for Tetra Pak in Singapore and implemented the first digital twin of a warehouse in the Asia-Pacific region. The warehouse is the first smart warehouse to exist as a digital twin, optimized, cost-effective, continuously fed with real-time data and mapped in real time. These digital smart warehouses, which are implemented to improve the storage and transportation processes of Tetra Pak, set an important example for the future. In addition, DHL Supply Chain has integrated physical objects such as industrial trucks with IoT in order to manage their inventories (DHL, 2019 July 30).

Also Dachser, an integrated logistics company based in Germany has decided to extend the cooperation between Fraunhofer Material Flow and Logistics Institute (IML) and DACHSER Enterprise Lab for another three years. Thus, the company aims to increase its logistics activities by focusing on digital technologies such as

autonomous vehicles, real-time positioning systems, smart warehouse systems for the Dachser network (FutureIoT, 2020).

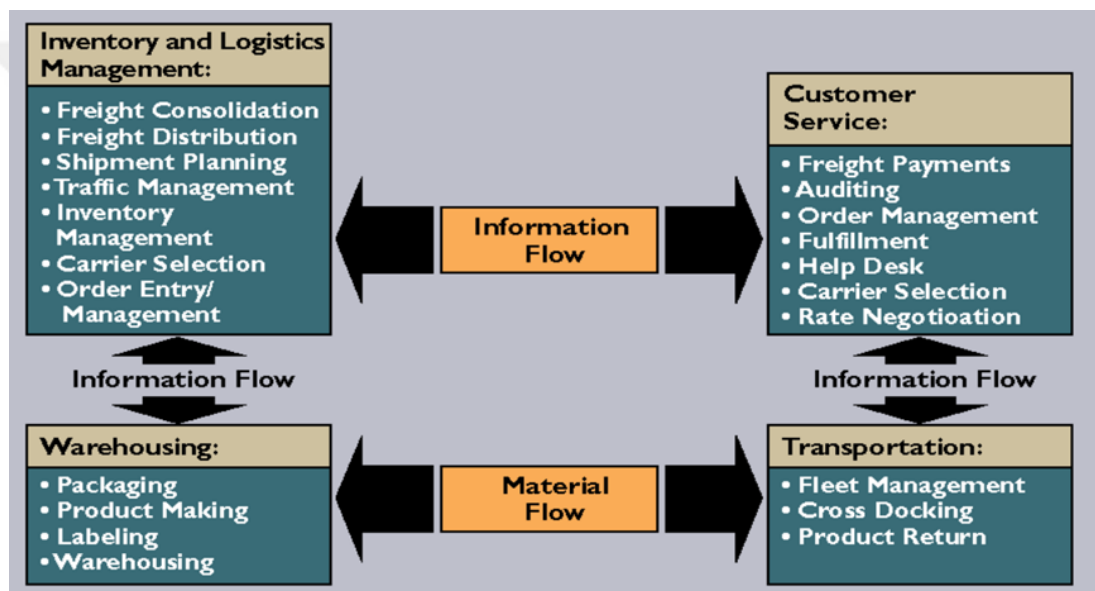
3.2.3. Information Flow, Purchasing, and Protective Package Design

One of the most important things for the efficient execution of logistics processes is the functionality of the information flow. When it comes to logistics, it is a very comprehensive process, from the supply of raw materials to the delivery of the final goods to the customer, and even to after-sales support. For this reason, it is very important to ensure an effective flow of information with suppliers, customers, even employees in the logistics processes.

Providing the flow of information effectively will increase the efficiency of the processes carried out. At this point, it should be considered that all activities should be included in the flow of information in the most basic way. Such that, for example, in warehouses, which is one of the most important areas of information flow, processes such as transportation time of vehicles carrying goods, unloading the goods and directing them to the loading area to receive new goods can be carried out more efficiently thanks to the efficient information flow. This is because “empty driving times” of the vehicles will be shortened and the emission of the vehicles will naturally be reduced (Fugate et al., 2009). In addition, information flow is of great importance during the use and supply of inventories. Taking the necessary materials in the required amount when necessary can also be determined by the correct information flow. Thus, since unnecessary material will not be purchased, inventory management will be ensured and commercial costs will be managed. In order to ensure the flow of information effectively, enterprises must have technological infrastructure. The flow of information and data can be managed using Industry 4.0 technologies such as appropriate ERP programs, cloud computing and big data. For example, all data in the warehouse can be recorded thanks to cloud computing technology and it may be possible to make the information more useful by creating the necessary conditions when requested by the relevant persons. The logistics information system can be adapted to different conditions and enables the optimization of processes. In general, it contributes to tracking inventory entries and exits, and to facilitate management in

storage and transportation processes. Since the system will always be accessible to all stakeholders of the company, all information changes are monitored instantly, thus increasing efficiency at every step in the logistics processes. Logistics Information Technologies; It consists of computer systems, computer networks, cloud systems, automatic recognition, data collection systems and data transport technologies. When the use of these technologies is adapted to the logistics activities in the entire enterprise, more efficient processes will be created, so resource efficiency will be achieved.

Figure 20: Categorization of Logistics Functions



Source: Vaidyanathan, G. (2005). A framework for evaluating third-party logistics, Communications of the ACM, 48 (1), 89-94.)

As explained in the figure above, there is a flow of information between Inventories and logistics management which include process such as entering orders, determining freight, selecting a carrier in, and warehousing which include processes such as packaging and labeling. In addition, information flow is also required between the processes in inventory and logistics management and customer services, such as the decision of the carrier, freight payment, order management. From this point of view, customer service is also in relation with transportation. On the other hand, there is a flow of material between transportation and storage. Because the materials must be collected from the warehouse in order for the transportation to be organized and

realized. All these processes take place between processes in the flow of information and material (Vaidyanathan, 2005).

With the most basic definition of purchasing, it is the supply of goods and services needed in enterprises at the desired quality at the most affordable price. We can say that the purchasing process concerns both inventory management and customer delivery, and actually it is at the basis of the logistics processes. When we evaluate the purchasing process from the perspective of sustainable development, it can be mentioned about environmentally friendly purchasing processes such as the evaluation of wastes and encouraging recycling (Min, 2001). In order to make sustainable purchasing processes, all activities such as reduction and recycling of materials should be considered (Carter and Carter, 1998: 659). When these activities are considered, it is important to prioritize not only economic concerns but also environmental issues (Green et al., 1998: 89). At this point, in order to exhibit a sustainable approach in the purchasing process, the following points should be considered (Kaynak, 2012: 22):

- Energy-saving and waste-free products
- Products with low water consumption and low resource use
- Material content suitable for recycling
- Products that create less waste
- Low cost and less environmentally damaging products in disposal and disposal processes

To carry out the purchasing process effectively, it is necessary to collect data, analyze these data and come to a conclusion. At this point, this integrity can be achieved by using Industry 4.0 technologies. For example, the processing of data entered the system and the execution of operational transactions by establishing a connection between machines can be achieved with cloud computing and big data technology. Thus, the process from the supplier to the customer in the purchasing process can be managed properly thanks to this data transfer. In addition, using cyber-physical systems, real-time controls of stocks can be made through sensors placed in the warehouses, and efficient use and management of resources can be achieved.

On the other hand, demand for products produced with environmentally friendly ingredients is also important for customers. Because recently, customers are now paying attention to the cleanness of the content and the environmentally friendly

conditions while evaluating the price and quality of the products they will buy. In his study, Woser (2016), stated that, as a marketing approach, the purchase of environmentally friendly products both pay attention to the protection of the environment and create new customer opportunities for businesses and ensure their permanence in the market. Khaleeli and Jawabri (2021), in their study, investigated how environmental awareness among consumers affects their purchasing behavior within the United Arab Emirates, and as a result, they concluded that there is a positive and significant relationship between consumers' purchasing intentions and their attitudes towards environmentally friendly products. Alamsyah et al. (2020) investigated customers' intention to buy eco-friendly products through a survey in a supermarket experienced in environmentally friendly products. As a result of the research, it was concluded that green product advertising has an important effect on the purchasing behavior of customers. In addition, it has been revealed that the development of green awareness has an effect on the purchasing behavior of customers.

The packaging process is directly related to operational activities in logistics processes. Processes such as keeping the goods in the warehouse, transportation process, and delivery to the customer determine the quality and form of packaging. On the other hand, the packaging process directly affects the environment due to the area used and the material used in packaging. For this reason, it is important that the packaging of the goods is packaged in a way that is suitable for the transportation modes and the protection of the material, but in a way that takes up a small amount of space and with recyclable materials. Some countries have taken decisions on the later recall of used packages and supported this by law. For this reason, planning for packaging has become very critical (Sarkis, 2003). Because at this point, attention is paid not to use harmful materials in packaging, to reduce waste from packaging, and to reuse the relevant packages.

Regarding the packaging process, it may be necessary to use some technologies for companies to implement more effective applications. For example, by installing smart packaging lines in enterprises, the packaging processes of the goods can be monitored, and productivity can be increased as wrong packaging will be eliminated. Thus, since a more systematic process will be followed in a shorter time, unnecessary

energy losses can be prevented and costs can be reduced. In addition, by using robots in packaging processes, the margin of error will be reduced and quality and profitability can be increased.

García-Arca et al. (2017), in their study, investigated the main elements of sustainable packaging logistics and investigated whether this understanding encourages packaging changes and innovation. The researchers, who conducted their research with an exploratory study in the Spanish toy production sector, found at the end of the study that a better sustainable performance can be achieved as a result of developing sustainable packaging logistics. Schmidt and Schmidt (2019) emphasized that packaging is important in logistics and that it should be done carefully in order to protect the products and reduce the costs during storage and transportation. In addition, they focused on sustainability in their articles, especially examining the role of packaging in logistics processes such as the transportation, storage, loading and packaging of labels. With their case study, they discussed the overseas logistics process of avocado, a food type with CO₂ emission and high water consumption. García-Arca et al. (2020), have focused their research on reimagining packaging for sustainable logistics. For this, they are based on 3 different logistics systems: palletizing, multimodal containers and package services. While designing, they focused on the selection of relevant technologies (for example, transportation and storage information on RFID tags), the size of the packages and the space they will occupy in the warehouse.

DHL, has presented ideas on the future state of packaging in the logistics industry with the report "Rethinking Packaging". The company emphasized that in the future, in order to carry out packaging in a responsible and sustainable way, it is necessary to prefer environmentally friendly packaging materials, to make arrangements to ensure optimum placement in transport vehicles, and to focus on smart packaging solutions where products can be tracked and information can be accessed through smart technologies. Company also emphasized that it is important to raise awareness of the public on the issue of packaging waste (Heck and Ward, 2019).

The Kuehne + Nagel firm has included a contract packaging solution in its services. Thus, it aims to meet the complex demands of its customers. While serving, the company attaches importance to the use of the latest technological software,

working with local packaging providers and the use of new collaborative robots. The company enables customers to transparently monitor their products by establishing an instant connection with a solution that works with a cloud system, the porch of Nulogy, a leading contract packaging software developer. In addition, it has signed a partnership with Universal Robots, one of the leading companies in its field, for "cobot" applications to increase process optimization and efficiency. Cobots are aimed to provide efficiency in packaging processes by helping warehouse employees with packaging tasks (Nadelhofer, 2017)

3.2.4. Reverse Logistics

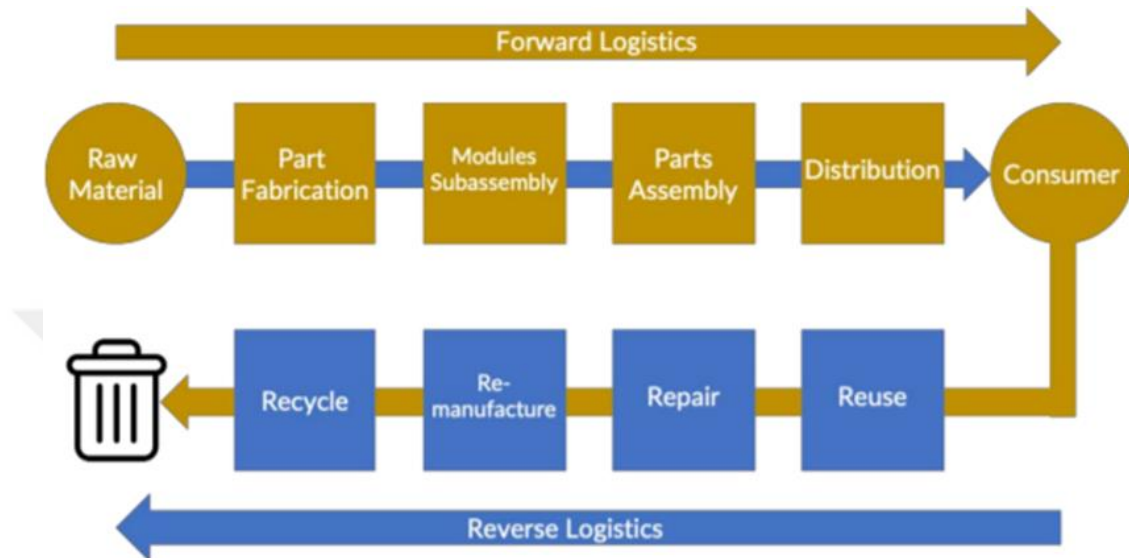
The concept of reverse logistics includes a process in which environmental damages can be reduced by methods such as reuse, recycling, and less material use in enterprises (Carter and Ellram, 1998). In other words, reverse logistics; It has also been defined as a concept that organizes the processes that include recycling, reproduction, re-sale, reuse and disposal processes in order to provide business gains (Johnson, 1998: 217).

Studies in the literature on the concept of reverse logistics highlight its environmental effects (Chakraborty, 2011; Ciliberti et al., 2008). In studies, the effects of sustainability on the economic and environmental dimensions were investigated, mostly by trying to understand the difficulties in the implementation of reverse logistics (Dowlathshahi, 2010). Companies aim to reduce environmental problems and increase the profitability of the company by reducing costs in reverse logistics applications. Because, with the reverse logistics application, businesses will be able to reduce costs in items such as raw materials, labor and energy. In addition to these, when looked at from the customer side, it will add value to businesses turning to environmental applications (Greve&Davis, 2012:5). In order for a product to be subjected to reverse logistics application, it must have one of the following reasons (Brito et al, 2002:21):

- Production-related errors
- Products returned by the customer
- Return for warranty purposes

- Return for service purposes
- Refund due to termination of use
- Refund due to lifetime

Figure 21: Reverse Logistics



Source: Carver, A., (2018), Supply chain management basic: Reverse Logistics. Retrieved from: <https://www.datexcorp.com/supply-chain-management-basics-reverse-logistics>

In the figure above, advanced logistics and reverse logistics processes are shown. In advanced logistics, materials are delivered to the customer which include the process from raw material to the final delivery. However, in reverse logistics, the process takes place by returning the materials from the customer, reuse, repairing and recycling by reproducing. Therefore, it is aimed to use resources efficiently and recycle them directly in reverse logistics processes (Carver, 2018).

Whether the products will be included in the reverse logistics application can be clarified by using some technologies and the process can be accelerated. For example, production-related errors can be detected quickly with automation systems, image processing and robotics technologies used in enterprises. In addition, information technologies can be used in the process management of returned products in order to communicate with the customer quickly and to complete the necessary steps mutually.

Jessop (2020) stated that the concept of reverse logistics includes processes such as recycling, reuse and re-distribution, repackaging of products and emphasized that innovative technologies should be used in all these processes. He also drew attention to the use of artificial intelligence to make supply chain processes sustainable and to rethink recycling. He stated that artificial intelligence technology can be used to identify possible problems in products and to order return-repair requests. It can be used to sort millions of return or repair requests to identify potential problems with products.

In order to develop reverse logistics applications, the international logistics company UPS aims to prevent waste by reducing losses in products by investing in Optoro, a technology company that works for the management and resale of returned goods, and with algorithm-based analytical applications in reverse logistics processes (Llewellyn, 2017). Another international logistics company, FedEx, aims to improve the integration of returns, status of returns and processes through its website, with the return technology it has adopted to improve return processes. In addition, it adopts solutions that facilitate the recycling, reuse, repackaging of the products taken back within the scope of reverse logistics practices (Fedex, n.d.).

3.3. LOGISTICS SECTOR IN TURKEY

Turkey has a very important location for logistics due to its strategic and geographical location. It is a corridor region due to its proximity to European countries, Middle Eastern countries and Asian countries. It is a country that is located in the middle of 3 continents and has both sea and land connections, with routes suitable for all transportation types and on important trade routes. Therefore, Turkey has the advantage of its geographical position for the logistics industry and foreign trade of the country.

When the largest share of public investment in the last 5 years in Turkey is taken by the Transport and Communications sector in 2020. If we look at the investments made to improve the logistics infrastructure in Turkey, it is possible to see examples such as Istanbul Airport, Yavuz Sultan Selim Bridge, Marmaray, ports, logistics centers, the Baku-Tbilisi-Kars Railway Line, etc. According to the

Transportation and Infrastructure Minister's stated that it has made 910 billion investment for Turkey's transport and communications infrastructure in the last 18 years (UTIKAD, 2020). Logistics sector in Turkey has a size of around 12% in GDP. While 50% of this ratio is directly obtained from the activities of logistics service providers, the remaining 50% is composed of the logistic activities within the trading companies. Considering the last 10 years, the contribution of Transportation and Storage activities to GDP is approximately 8%. There are 472 members of Turkey in the International Transport and Logistics Service Providers Association as the logistics and transport companies. Considering the preferred modes of transportation in logistics activities, although it is seen that all transportation modes are preferred, the most used transportation mode is seaway and road (UTIKAD, 2020).

Considering Turkey's foreign trade data, European Union countries rank first in exports and imports. In this sense, the European Union is an important partner for Turkey in terms of foreign trade. In this study, although the logistics sector is considered within the scope of the Sustainable Development Goals created by the UN, it is necessary to mention the European Green Deal established by the European Union. This deal is also important for the goal of a sustainable Turkey. While looking at the logistics sector in Turkey in terms of sustainability, we need to explain this agreement established by the European Union. With this agreement, the EU has created a roadmap with extensive and effective regulations in order to achieve the targets of reducing carbon emissions by 50% by 2030 and reducing carbon emissions to zero in 2050. Within the scope of the agreement, the application of "carbon border tax - carbon border adjustment mechanism" will be in question. Thus, it is planned to impose additional obligations for some goods coming from non-EU countries that do not implement the regulations regarding climate change. In addition, they announced that they will not trade with countries that have not signed the Paris Agreement in the coming years, within the scope of the EU Green Deal. The consensus that adopts a carbon-free economy model from industry to agriculture, from transport to energy will result in a reshaping of trade. Thus, attention will be paid to the carbon content of the shipped goods for the specified sectors (European Commission, 2020). It is anticipated that a tax of 30 to 50 Euros per ton will be charged from products exported to Europe, depending on their carbon content (TÜSİAD, 2020).

The European Union has a great importance in Turkey's foreign trade, so the Green Agreement has a very important place. If Turkish exports do not make arrangements in line with the EU Green agreement, there may be a huge market loss for Turkey. In addition, Turkey signed the Paris Agreement but did not pass the Parliament. Within the scope of the agreement, Turkey needs to support R&D projects towards the carbon neutral target, turn towards clean energy investments in all sectors, and transform production processes in a carbon neutral manner. The completion of these regulations will contribute to the transformation of Turkey by supporting an environmentally friendly industrial revolution process. The green consensus can be an important opportunity for Turkey on the road to sustainable development if necessary arrangements are made. The European Commission Green Consensus Call has been opened in Turkey as of September 22, 2020, and is carried out by TÜBİTAK. Within the scope of the call, it is planned to support pilot applications, innovative products, recommendations on governance of green and digital transformation, and innovation in social and value chains.

In the " Trends And Expectations In The Logistics Sector 2020" conducted by UTIKAD and Dokuz Eylül University Maritime Faculty; Regarding digitalization and Industry 4.0, 78% of the participants stated that they have implemented digital transformation applications for "software" and 61% for "customer relations". 46% invested in "Cloud computing systems", 28% in "R&D and innovation center", 9% in "blockchain" technology. In addition, they specified the technologies they think will have the most intense technological impact for the next 5 years as "big data analysis" and "robotics and automation systems". In the same research, it was seen that the participants made the understanding of sustainability more into a company policy. Regarding the improvement in energy, water and waste management processes, 37% of the enterprises were stated to have initiatives in this direction. Participants cited "Tax regulations and financial incentives (76%)", "Legal regulations (67%)" and "Certification (41%)" as the points where sustainability would benefit the most (UTIKAD and DEU, 2020).

CHAPTER FOUR

A LOGISTICS INDUSTRY CONTENT ANALYSIS REGARDING SUSTAINABILITY & INDUSTRY 4.0

4.1. THE PURPOSE OF THE STUDY

Sustainability and Industry 4.0 technologies are the most prominent of the current global issues. Many companies take important steps towards becoming sustainable, thanks to increasing global awareness. They are also already transforming their businesses with Industry 4.0 technologies. The use of these technologies in transformation for sustainability is particularly crucial for the logistics industry, as it has a key interface role in the global economy. The purpose of the study is determining the relation between sustainability efforts of the Turkish logistics industry using Industry 4.0 technologies. The focus is on whether logistics companies are actually in a transformation in terms of using Industry 4.0 technologies for sustainable development goals.

4.1.1. Research Questions

- 1) Is sustainability concerned when performing the activities of logistic companies operating in Turkey?
- 2) In what scope do the logistics companies address the Sustainable Development Goals?
- 3) Do logistics companies use Industry 4.0 technologies in logistic processes while achieving their sustainable development goals?

This study aims to investigate the connection of Sustainability and Industry 4.0 technologies. When looking at the literature background, it is difficult to find a study dealing with the cross between Sustainability and Industry 4.0 technologies in terms of the logistics sector. Due to the limited number of studies on the subject in the literature background, the thesis was edited by creating research questions within the

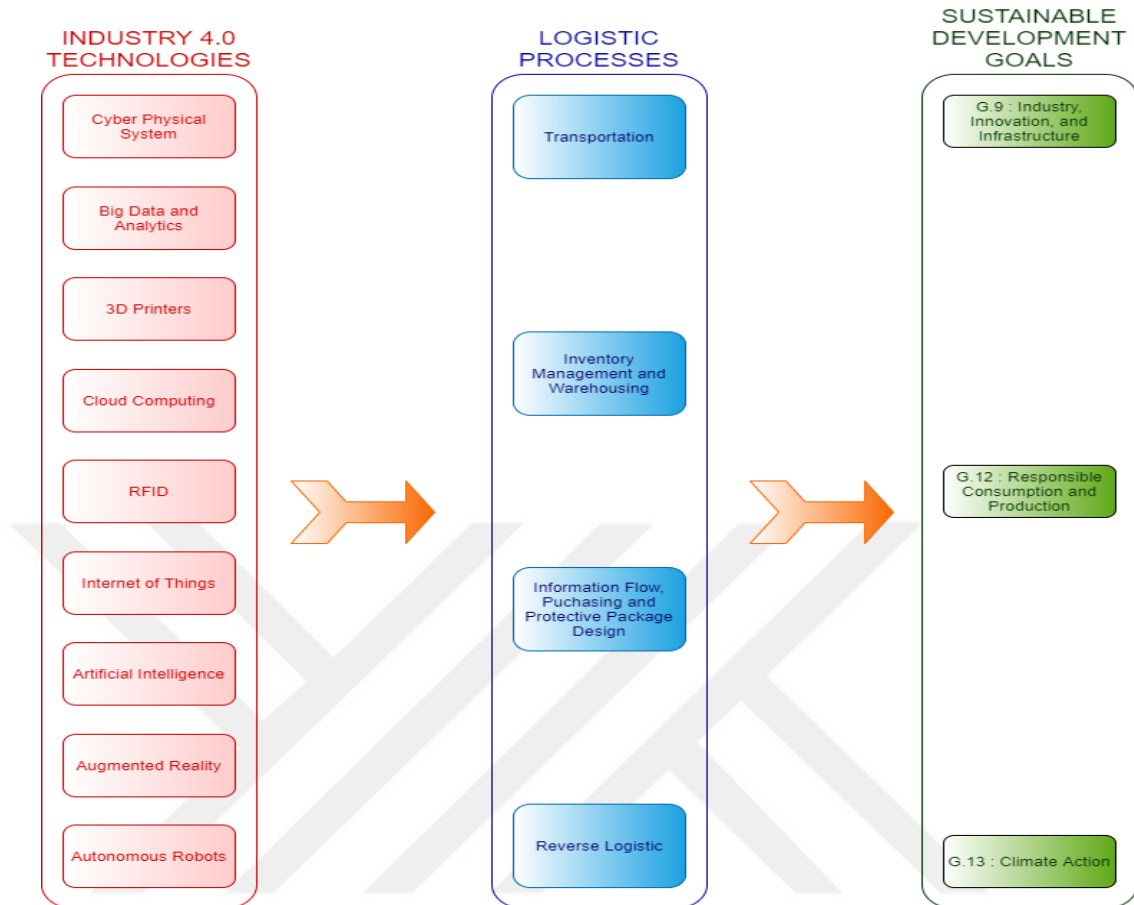
expectations of the research. In addition, since the thesis should be a qualitative study, the research questions were used to structure the thesis.

4.2. METHODOLOGY

The research methodology is very important in order to express the situation of the research in practice, in accordance with the aims and objectives of the researcher and to ensure the reliability of the research. The methodology section is the section where the study is designed and presented in accordance with the purpose of the research. When considered for this research, we can explain the design of the research as follows; the steps followed in the development of this research are as follows; In order to form the basis of the theoretical text consisting of 3 parts, the Sustainable Development Goals and Industrial Revolutions are explained in detail by scanning the literature and making citations from the literature. Then, logistics processes and main activities in terms of these two subjects are explained with examples taken from the literature and sample applications.

In the application part of the study, based on the previous sections, the existence and scope of Industry 4.0 technologies in the sustainability studies of companies in the logistics sector were investigated. International and local firms operating in Turkey were selected as population. Firstly, the sustainability reports of the selected companies were examined and if they did not have any published reports or had very few reports, the web pages, press releases and news pages of these companies were examined. During the examination, it was paid attention that the data obtained were related to the subject of the research, and those that were not eliminated.

Figure 22: Conceptional Framework



Source: Adopted from Kamble, S. S., Gunasekaran, A., & Gawankar, S. A. (2018).

Sustainable Industry 4.0 framework: A systematic literature review identifying the current trends and future perspectives. *Process Safety and Environmental Protection*, 117, 408–425. <https://doi.org/10.1016/j.psep.2018.05.009>

In the figure above, the conceptual framework of the study has been established. The use of Industry 4.0 Technologies in logistics processes such as transportation, inventory management and warehousing, information flow, purchasing, packaging and reverse logistics processes have been investigated in the conceptual framework created within the scope of the research subject of the thesis. Logistics companies operating in Turkey, in terms of Industry 4.0 technologies in order to achieve the objective of sustainable development is aimed to understand whether they are really in a transformation. For this reason, Goal 9: Industry, Innovation, and Infrastructure, Goal 12: Responsible Consumption and Production Design and Goal

13: Climate Action were selected among the Sustainable Development Goals, and the use of Industry 4.0 technologies to achieve these goals was analyzed.

4.3. TYPE OF STUDY

The research design is planned in accordance with the purpose of the research. The design used in this research is exploratory and descriptive research. Descriptive research is used to describe a feature or function of the subject under investigation, as indicated in its name. Exploratory research is generally preferred when knowledge on the subject is limited or the subject is relatively new. Exploratory research is generally more suitable for qualitative research. The reason for choosing the exploratory research type in this study is that the research subject is new and there are not many publications in the literature on the reflection of the relationship between sustainability and Industry 4.0 technologies in the logistics sector. Sustainability and Industry 4.0 issues are two different issues that gain great importance today and it is not yet fully known whether businesses adopt the use of these technologies in their sustainability approach. With this research, exploratory research type was preferred as it was aimed to discover this faint connection and gain a more concrete quality. It is also a descriptive study because of the general description of the situation.

4.4. DATA COLLECTIVE METHOD

In order to collect the data to be analyzed in the study, it was first determined which companies would be selected as sample. Companies were selected by examining in 2 groups. The first group consists of international companies operating in Turkey. The top 20 countries were selected in the Logistics Performance Index (<https://lpi.worldbank.org/>) to select companies in this group. This country is located in the Sustainable Global Reporting database it was identified international logistics companies operating in Turkey. (<https://database.globalreporting.org/search/>). While these companies were selected, companies whose report language was not English and those without GRI were eliminated. In addition, the document dates were taken as the year 2011, which is accepted as the starting date of Industry 4.0, and the sustainability

and other company reports published since 2011 were collected as data. There are a total of 9 companies evaluated in the first group. The firms chosen as the second group is selected from the local logistics companies in Turkey. While selecting local companies, the Sustainable Global Reporting database was searched and 3 Turkish logistics companies were reached. The sustainability reports of these 3 companies were collected as data. Thus, the sustainability reports of 12 companies in total were accessed from the Sustainable Global Reporting database. In the second group when choosing local companies in Turkey, International Transportation and Logistics Service Providers Association, known as the most comprehensive transport and logistics sector of civil society organizations in Turkey (UTIKAD) website of its members it was examined individually. The companies that publish sustainability reports or any press releases, news etc. related to sustainability were selected as examples ([https:// www.utikad.org.tr/](https://www.utikad.org.tr/)). There are 8 companies selected from UTIKAD. The 8 companies selected were primarily checked whether they publish sustainability reports or not. If the report was not published or if there are few reports, the relevant documents were selected by scanning the press releases, news and sustainability pages on their websites. The number of documents obtained as data related to the subject by scanning the documents is 141. The Table 8 below shows details about company selections and documents of the companies.

Table 8: Document Details of Selected Companies

	Company Name	Company found from	Document Type	Number of report	Sum of Company Page Number	Document Date Range
1.	UPS	GRI	Sustainability Report	9	1004	2011-2019
2.	DHL	GRI	Sustainability Report	9	1170	2011-2019
3.	FedEx	GRI	Global Citizenship Report	9	647	2011-2020
4.	Aramex	GRI	Annual Report	9	1625	2011-2019
5.	Kuehne+Nagel	GRI	Sustainability Report	4	209	2016-2019
6.	MSC	GRI	Sustainability Report	3	183	2016-2018
7.	Maersk	GRI	Sustainability Report	7	308	2014-2020
8.	Borusan Logistic	GRI	Sustainability Report	7	583	2012-2018
9.	Omsan Logistic	GRI	Sustainability Report	1	56	2014
10.	Mars Logistic	GRI	Sustainability Report	2	116	2012-2013
			Press Release	18	31	2015-2018
			Sustainability Report	1	28	2019
11.	Expeditors Intrenationals	GRI	Press Release	4	11	2011-2021
			News	3		
12.	DB Schenker	GRI	Integrated Report	5	1458	2015-2019
13.	Arkas (Turkey)	UTIKAD	News	5	5	2019-2021
14.	Ekol Logistic	UTIKAD	Progress Report	1	46	2016
			Press Release	26	28	2011-2021
15.	Reysaş Logistics	UTIKAD	Press Release	5	12	2011-2021
			Website (Home Page)	2		
16.	Netlog Logistic	UTIKAD	News	4	6	2015-2021
			Website (Sustainability Page)	1		
17.	Fevzi Gandur Logistic	UTIKAD	Press Release	2	3	2019-2021
			Website (Sustainability Page)	1		
18.	Barsan Logistic	UTIKAD	Website (Sustainability Page)	1	1	2021
19.	Hilal Trans	UTIKAD	Website (Sustainability Page)	1	1	2021
20.	Solmaz Logistic	UTIKAD	Website (Home Page)	1	1	2021
Total				141	7532	

Source: Created by the author

4.5. DATA ANALYSIS

Content analysis was widely used in studies that examine sustainability reports (Manetti, 2011) as an analysis method. Content analysis method; It is a research method that enables a text to be analyzed systematically and impartially and to draw conclusions from the text (Wimmer and Dominick, 2000: 135-136). While planning the content analysis method, first of all, research questions were determined, the companies that would constitute the sample were selected, and coding and analysis units were formed by creating a category system.

Goal 9: Industry, Innovation and Infrastructure, Goal 12: Responsible Production and Consumption, Goal 13: Climate Action were selected from the Sustainable Development Goals, which are explained in detail in the thesis in the determined categorization system. The reason for choosing these targets is Target 9, because it is directly related to Industry 4.0. Goal 12 was chosen because it is based on acting responsibly in all processes of the enterprises and it is thought that it can

enable an evaluation for all processes while evaluating Industry 4.0 technologies. Goal 13 has been chosen as it is indicated as the most urgent problem for the whole world. In addition, Industry 4.0 technologies have been determined as a separate category in order to understand the intensity of the use of Industry 4.0 technologies in the realization of the Sustainable Development Goals. Finally, as the sampling area of the thesis is logistics companies, the logistics processes considered within the scope of sustainability in the thesis were determined as the 5th category.

Within each category, codes related to the theme of the category were created and these codes were searched for in all documents collected as data. The codes created according to the categories are shown in the table below. ATLAS.ti 9 program was used to put this analysis into practice. All the data obtained were transferred to this program and the relevant categories and their codes were created in the program. The generated codes were searched in all files one by one, and the usage amounts of the related codes in the sentences were examined. In addition, coding matches were made for the connection of Industry 4.0 technologies and 3 targets selected from the Sustainable Development Goals, and the common use of codes belonging to both groups in sentences was examined. The common use of the codes in the Industry 4.0 technologies group individually for each target is visualized as a Sankey Diagram and the connection between them is revealed.

Table 9: Codes for Goal 9: Industry, Innovation and Infrastructure

Name	Grounded	
● ◇ Industry		1592
● ◇ Infrastructure		1488
● ◇ Landscape and Design		956
● ◇ Innovation		926
● ◇ Employment		630
● ◇ Access to financial services		25

Source: Created by the author with the program ATLAS.ti

In Table 9, while creating the Goal: 9 Industry, Innovation and Infrastructure codes, the words industry, innovation and infrastructure in the definition of the goal were especially selected. In addition to these, the sub-indicators of the UN in the related targets were examined and the concepts of landscape and design, employment

and access to financial services were selected and determined as codes. In the table, these codes are listed according to the density of occurrence in the sentences by searching through the documents loaded.

Table 10: Codes for Goal 12: Responsible Consumption and Production

	Name	Grounded	
●	◇ Waste Management		1063
●	◇ Renewable energy		914
●	◇ Recycling		739
●	◇ Productivity		613
●	◇ Fossil fuels		105

Source: Created by the author with the program ATLAS.ti

While creating the Goal 12: Responsible Consumption and Production codes in Table 10, the sub-indicators determined by the UN in the relevant goal were examined. The key words related to the subject, waste management, renewable energy, recycling, efficiency and fossil fuels, have been identified as codes. The determined codes are listed in the table above according to their densities.

Table 11: Codes for Goal 13: Climate Action

	Name	Grounded	
●	◇ Climate Change		488
●	◇ Footprint		443
●	◇ Carbon Emission		406
●	◇ Pollution		232
●	◇ Bio-diversity		186
●	◇ Global Warming		138
●	◇ Ecosystem		132
●	◇ Net Zero		89

Source: Created by the author with the program ATLAS.ti

In Table 11, the Goal 13: Climate Action codes were determined by examining the sub-indicators of the UN. The codes chosen here are climate change, footprint, carbon emission, pollution, biodiversity, global warming, ecosystem and zero waste codes, which are keywords related to Climate Action. The footprint code refers to all

footprints that affect the environment, such as carbon, material, water, etc. Likewise, the pollution code refers to all pollution such as air, water, soil.

Table 12: Codes for Industry 4.0 Technologies

Name	Grounded	
Technology		2146
Smart Technologies		302
Digital Transformation		244
Internet of Things		149
RFID		104
Augmented Reality		90
Artificial Intelligence		75
Autonomous Robots		63
Big Data		62
Industry 4.0		48
Autonomous Vehicle		44
Cloud Computing		35
3D Printers		31
Cyber Physical System		27

Source: Created by the author with the program ATLAS.ti

In Table 12, while determining the codes in Industry 4.0 technologies, the technology names explained in the second part of the thesis were selected. In addition to these, digital transformation, smart technologies, and the word technology which is used most generally, have been added as a code recently used with Industry 4.0.

Table 13: Codes for Logistic Process

Name	Grounded	
Transportation		1395
Information Flow, Purchasing and Protective Package Design		1367
Inventory Management and Warehousing		821
Reverse Logistic		102

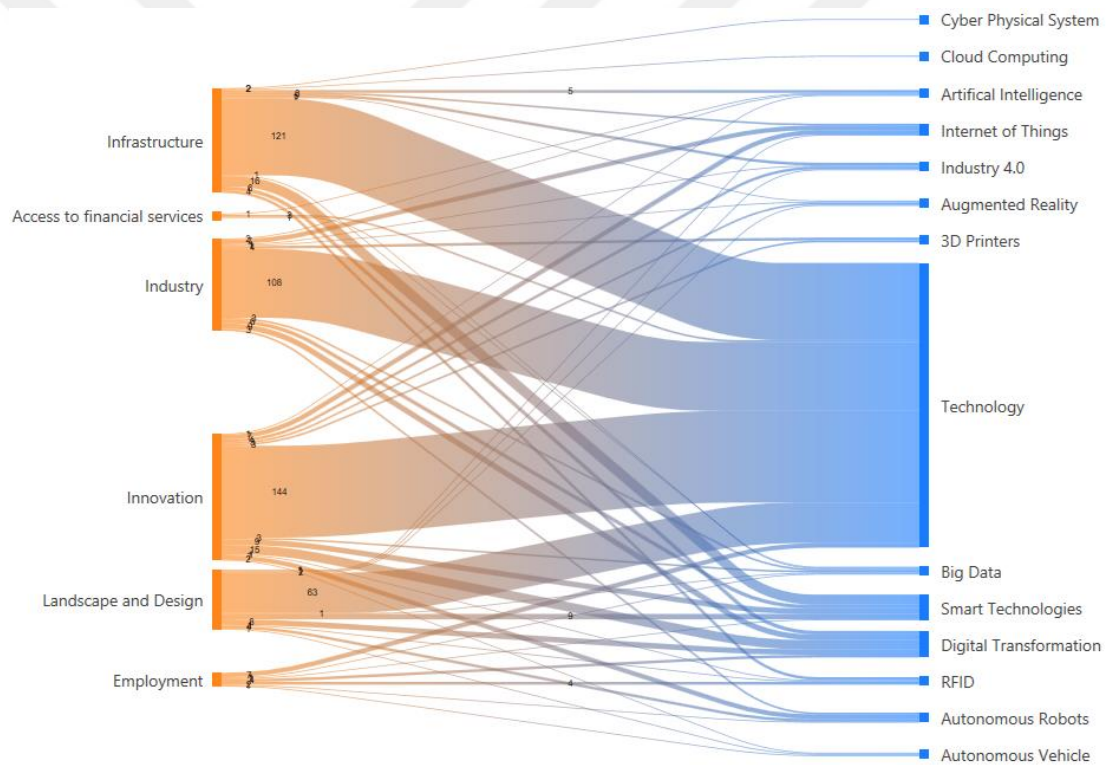
Source: Created by the author with the program ATLAS.ti

The codes in the logistics processes in Table 12 were created with the names of the logistics processes in the third part of the thesis. The aim here is to create integrity between the information explained in the theoretical part of the thesis and the codes selected in the analysis.

4.6. FINDINGS

According to the codes, in order to see the results obtained in the ATLAS.ti program more clearly and to understand the connections between the categories, a table of sentences in which the categories belonging to Industry 4.0 Technologies and the codes belonging to all other categories are common has been made in the program. Thus, it has been tried to concretize the common usage of the 3 goals, which are examined in the Sustainable Development Goals, and also the logistics processes with the codes in the Industry 4.0 technologies category.

Figure 23: Goal 9 "Industry, Innovation and Infrastructure" & "Industry 4.0 Technologies"

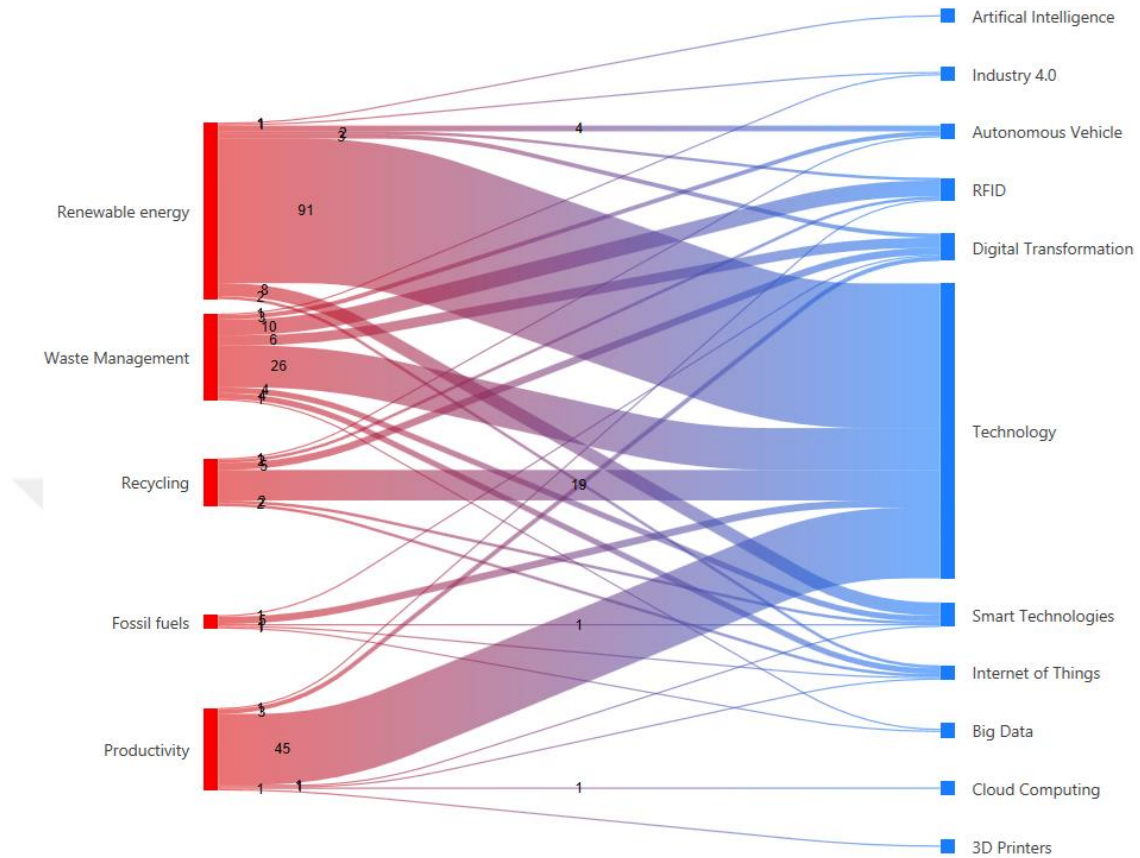


Source: Created by the author with the program ATLAS.ti

First of all, in the above figure, the Goal 9: "Industry, Innovation and Infrastructure" category and the "Industry 4.0 Technologies" category were compared. The left side of the figure is the code for Goal 9. On the right, there are codes belonging to the Industry 4.0 Technologies category. Looking at the figure, it is seen that the words Industry, innovation and innovation, which are first mentioned in the definition

of the Goal, are used extensively when making explanations about this goal. Therefore, these are the most common use codes with technology codes. Then, it is seen that the relationship between landscape and design code and technologies is intense. When looking at the codes of the technologies separately, although there are matches with the name of each technology, the great intensity has been with the "technology" code. At this point, we can say that the general perception in reports and publications is gathered on the general technology term, not on the technologies themselves. The names of Industry 4.0 technologies have not yet been classified by the industry for this purpose. The matching of the codes with the Industry 4.0 technologies themselves is 85 in total of all codes. Digital transformation and smart technologies codes are more closely matched to others. The total number of matches of the codes with the "technology, digital transformation and smart technologies" codes is 529. However, it is noteworthy that the use of each technology under its own name is very low. Although this shows that there is a relationship between the use of technologies and Goal 9, it may reflect the fact that the technologies are known by their names and their use is still very little.

Figure 24: Goal 12 "Responsible Consumption and Production" & "Industry 4.0 Technologies"

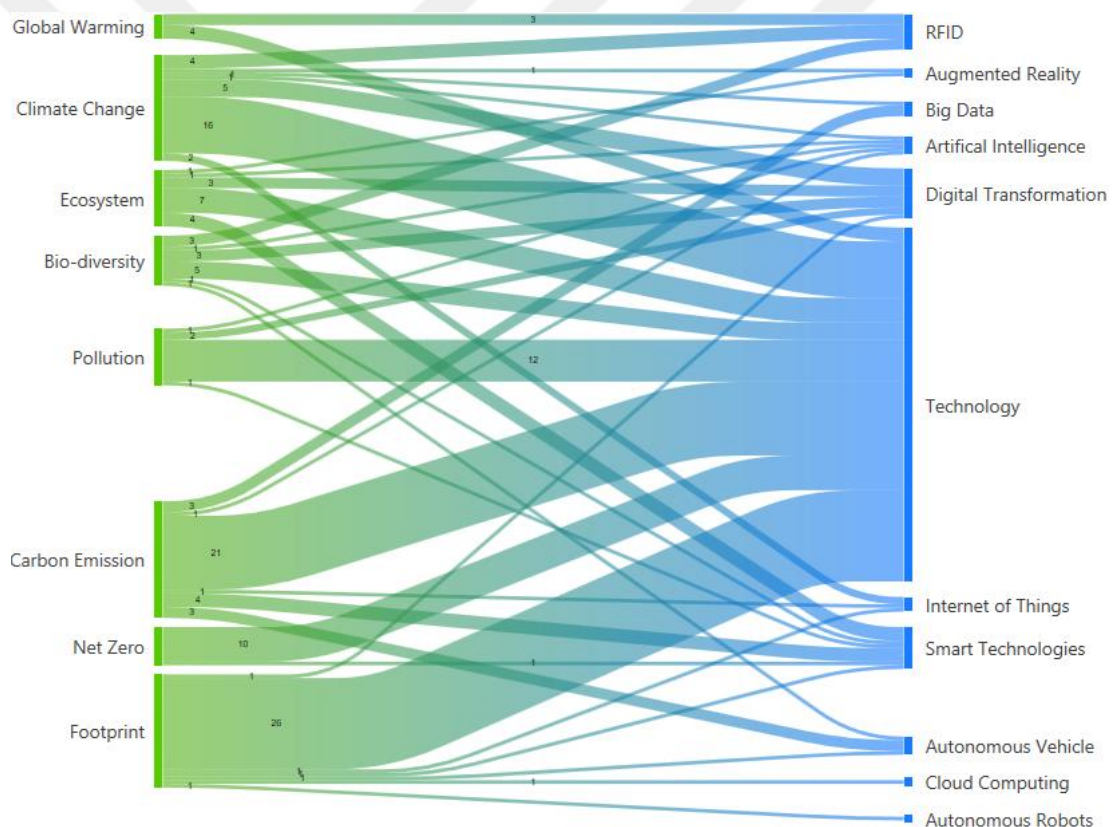


Source: Created by the author with the program ATLAS.ti

Second, Goal 12: Responsible Consumption and Production is compared with Industry 4.0 Technologies. Codes on the left side belong to Goal 12 and those on the right belong to Industry 4.0 Technologies. Looking at this figure, it is seen that renewable energy, waste management and productivity codes are used extensively. It is noteworthy that the concept of renewable energy has been used quite frequently, while the concept of fossil fuels is used less frequently. It is the "technology" code with which the codes match extensively. Following the technology code are digital transformation and smart technologies codes. The total number of matches of the codes with the "technology, digital transformation and smart technologies" codes is 220 in total. The matching of the codes with the Industry 4.0 technologies themselves is 38 in all codes. In this figure, it can be said that Industry 4.0 technologies are expressed not with their own names, but rather with concepts such as "technology, digital transformation and smart technologies". On the other hand, RFID technology has also

been found to match more than others. The reason for this can be interpreted as the high preference of RFID technologies in warehouse and inventory management in order to realize responsible consumption and production. In addition, it can be said that companies regulate their waste management policies in accordance with the law and legislation. In addition, it is possible to think that the use of RFID technology is also preferred in warehouses for cost-oriented efficiency. Another prominent technology is the internet of things. With this technology, it can be said that it comes to the fore for responsible consumption and production thanks to the controls of the use of resources such as fuel, heat and energy through sensors.

Figure 25: Goal 13 "Climate Action" & "Industry 4.0 Technologies"

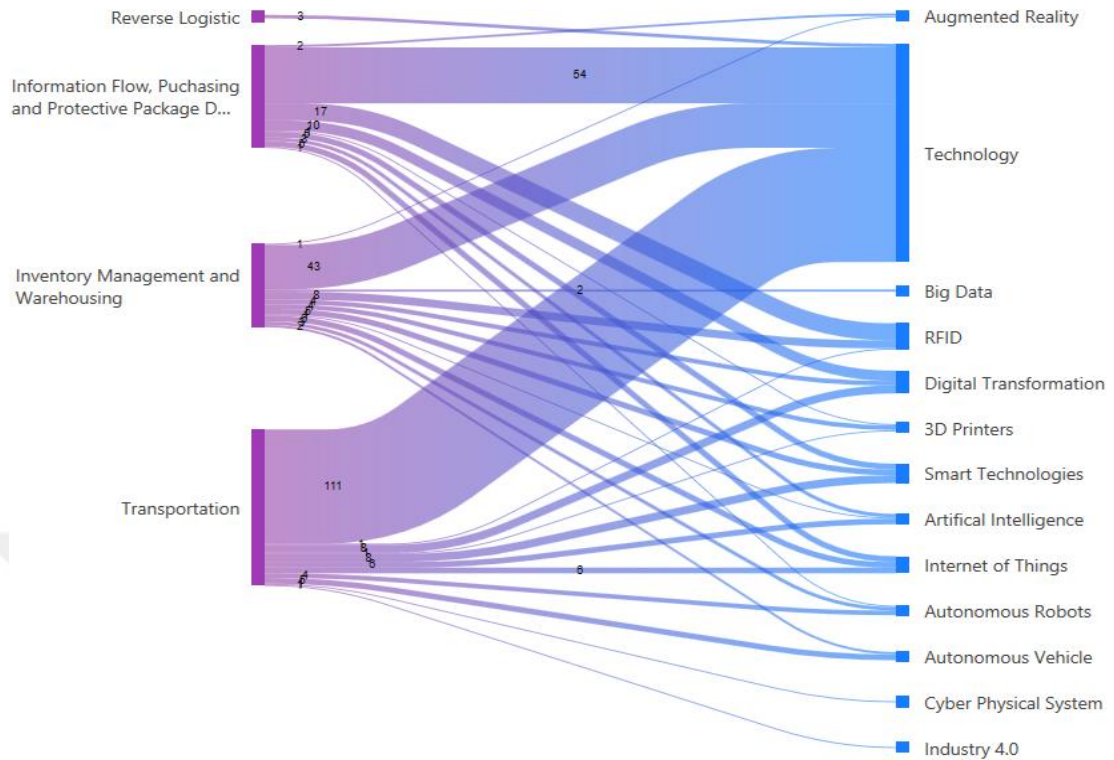


Source: Created by the author with the program ATLAS.ti

In the figure above, Goal 13: Climate Action and Industry 4.0 Technologies are compared. Looking at the figure, it is seen that the concepts commonly used to describe climate action in reports and publications are climate change, carbon emission and footprint. The most densities matching technologies belong to these concepts.

Ecosystem, pollution and biodiversity density are higher than global warming and zero waste concepts. From here, it can be thought that the zero waste target is relatively low, although the companies include sentences about carbon emissions in their publications. When we look at the connections of the relevant codes with technologies, we have seen a match with the most intense "technology" code here, as in the previous 2 targets. Digital transformation and smart technologies follow. The total number of matches of the codes with the "technology, digital transformation and smart technologies" codes is 127 in total. The matching of the codes with the Industry 4.0 technologies themselves is 38 in all codes. The striking point here compared to the previous figures is that compared to the first 2 figures, it is seen that technology names are used more intensively on their own. It seems that especially RFID technology matches quite intensely. Robots and cloud computing technology seem to have the least match compared to all other technologies. The reason is that as the robotic Turkey from requiring the high cost is not yet very common and can be interpreted as the cloud is less use of information technology as well. In addition, another striking point in this figure is that while the concept of Industry 4.0 is a little overtaken in the previous 2 figures, no matches were seen in the codes related to Goal 12 in this figure. It is noteworthy that the concept of Industry 4.0 is not used, although technology names are used more frequently than other figures. Nevertheless, it is actually within our expectation to see Industry 4.0 technologies taking place in the discourse of the sector with their own names.

Figure 26: "Logistic Process" & "Industry 4.0 Technologies"

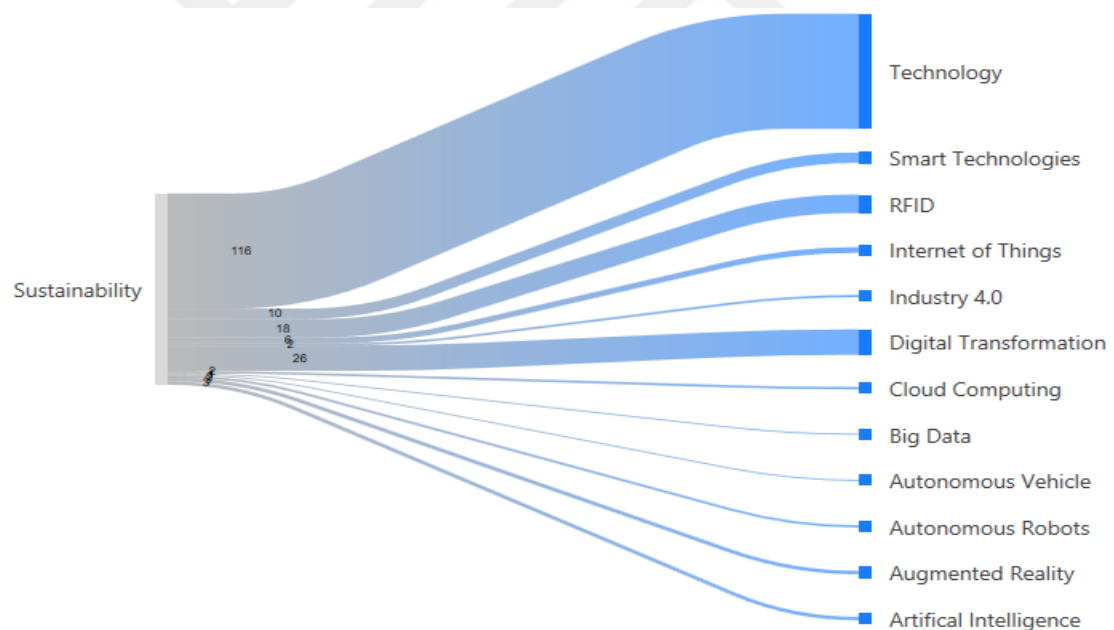


Source: Created by the author with the program ATLAS.ti

After looking at the joint use of Industry 4.0 Technologies with 3 of the Sustainable Development Goals, the connections of the processes in the logistics sector with Industry 4.0 technologies were examined. In the above figure, there are the processes of the logistics sector on the left and the codes belonging to the Industry 4.0 category on the right. In the figure, it is seen that all without the reverse logistics are matched intensely. The most connected process with technologies is transportation, and the code with which the transportation process matches the most is the "technology" code. It also matches the majority of other codes. The striking point here is that it has very little match with the code of "autonomous vehicles" associated with transportation. Use of autonomous vehicles in Turkey results here may not yet be drawn widespread. In the other codes such as inventory management, warehousing, information flow, purchasing and packaging, the most intense match was with the "technology" code. The total number of matches with the technology code is 211. Here, it is seen that there is an intense match with the RFID code, especially in the "information flow, purchasing and packaging" code. RFID has 17 matches with this

code. The reason for this may be that these technologies are preferred especially during processes such as labeling and barcoding used in the packaging part or when materials are found from the warehouse. Another striking point in the figure is that the matching with the Industry 4.0 code is only in the transport code. Because in connection with Industry 4.0, the understanding of Logistics 4.0 has been produced. However, there is very little match for 4.0 within the scope of logistics processes. This may be the case that the Industry 4.0 revolution is still used in all processes with a general definition as technology. Looking at the figure, it can be thought that companies use the transformations in the Industry 4.0 revolution with the definition of "technology" instead of naming them one by one. Because, overall, the total matching with the "technology, smart technologies and digital transformation" codes is 251. However, the number of matches of Industry 4.0 technologies with their names is 80 in total.

Figure 27: "Sustainability" & "Industry 4.0 Technologies"

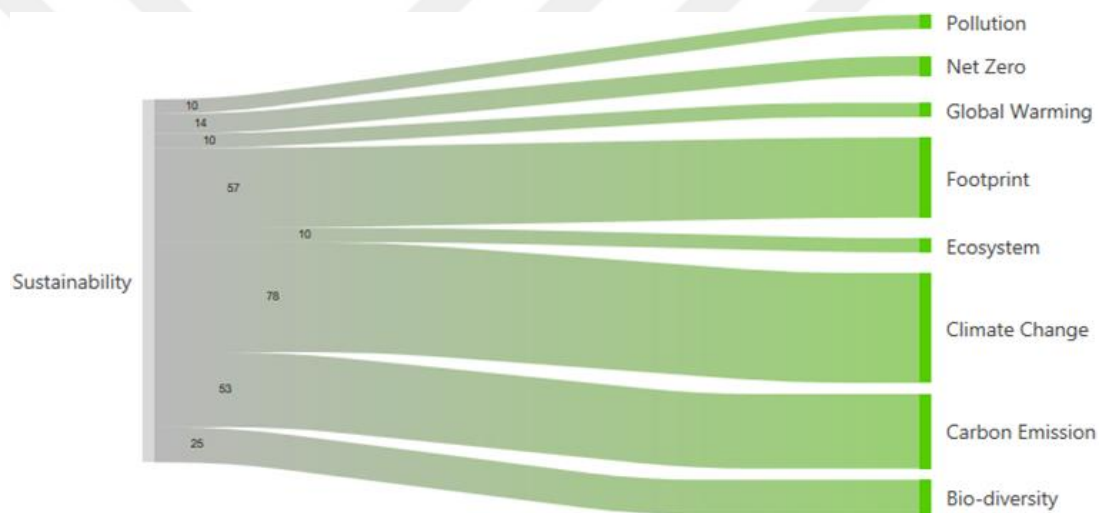


Source: Created by the author with the program ATLAS.ti

In the figure above, sustainability and Industry 4.0 technologies are compared. Here again, as in the figures commented above, a general picture prevails. The most intense match was with the "technology" code. Later, it is seen that the definition of "digital transformation" is used extensively with sustainability. The total number of matches between the sustainability code and "technology, smart technologies and

digital transformation" codes is 152. It can be said that RFID technology has a more intense match with the word sustainability with 18 matches, as in the above figures compared to other technologies. Here, it can be thought that RFID technology is preferred because it is more cost-effective and older than other technologies. Although it is seen that they match with other technologies, it is seen that the density is low. We can interpret this situation as the relationship between sustainability and Industry 4.0 technologies is not mentioned extensively in the publications of the companies. When we look at the Industry 4.0 code and sustainability match here, it is seen that there are 2 matches and this number is very few.

Figure 28: "Sustainability" & "Climate Action Codes"



Source: Created by the author with the program ATLAS.ti

On the other hand, in the figure above, sustainability and the codes of "climate action", which is stated as the most urgent aim by the UN, are compared. It is seen that sustainability matches most with climate change, carbon emission and footprint codes. The less use of the concepts of ecosystem, biodiversity and global warming, which are the old uses of Climate Action, may indicate that the sector is doing it with a new perspective in its discourse on sustainability. In addition, although the sector has started to use new concepts in "climate action", it is seen that it has not yet fully spread the discourse of zero waste.

4.7. LIMITATIONS AND SUGGESTIONS

The area of focus of the study consists of 2 basic parameters. One of them is sustainability and the other is Industry 4.0 technologies. In this sense, these 2 fields have a very large literature and perspective in themselves. In accordance with the subject of the thesis, these two areas were limited and focused on certain points of the subjects in order to examine the subject more deeply and to analyze it better. In addition, the focus of the subject, collected over logistics companies in Turkey as a selected sample, the study aimed to look at a more basic area.

During the study, some difficulties were encountered. In the methodology part, the sustainability reports published by the companies and the publications on the websites of the companies that do not have reports were analyzed. In order to see the practices of companies related to the sustainable development goals, which is the starting point of the study, it was aimed to examine only the sustainability reports. However publishing sustainability reports in Turkey are very few for logistics companies. For this reason, press releases, news and announcements pages on the websites of logistics companies that do not have reports were examined. While doing this examination, it was aimed to start from 2011, which is accepted as the beginning of the Industry 4.0 revolution, so the 10-year archive scan took a lot of time. Examining the publications and collecting those related to the main subject of the study has been a factor that increased the difficulty in the application part of the study. After collecting all relevant documents, since ATLAS.ti program used for the analysis of these documents is English, when searching for words in publications uploaded in Turkish, the related words option cannot be used, so the results obtained are only on the basis of the searched word for Turkish documents and find the words manually. This limited the results of the data obtained in the study. In addition, since the document scan other than the report made about the study is examined on the website, if there is a document published after the date of collection, it will not be included in this study.

Considering the recommendations regarding the study, more research is needed in order to examine the intersection of two globally important issues in more detail and to reveal their examples in different fields. Sectoral studies to address the issue from different angles may be more enlightening for the relevant sectors. In addition,

quantitative research methods can be used in addition to content analysis in the application part, and more concrete results can be achieved.



CONCLUSION

Businesses around the world have great responsibilities in order to solve global problems in line with the 17 Sustainable Development Goals determined by the UN. Businesses that have a certain impact on the emergence of problems in many goals are trying to transform in order to solve these economic, ecologic and social problems. This transformation focuses on improvements and efficiency in all processes of companies. With its many processes, the logistics sector has a direct impact on sustainability issues. For this reason, the logistics sector must transform in line with the 17 goals discussed. It is inevitable to use today's Industry 4.0 technologies for transformation to occur. Businesses now aim to increase their efficiency by optimizing these technologies in many processes. Today the main aim of the Industry 4.0 technologies has to be providing efficiency in the operations and more important than this, to change the direction of the performance to for the sustainability of all type of companies.

In order to achieve sustainable development, enterprises must fulfill their social, economic and environmental responsibilities. In the international market, it is very important that these responsibilities are presented transparently and that companies share their performances, especially with customers and stakeholders. In this sense, it is very important for businesses to publish sustainability reports in terms of protecting their brand values in the international market, improving business reputation, and transparently revealing the performances of the enterprises. In most countries it is mandatory to publish the sustainability report, however, in Turkey companies prefer to prepare sustainability reports voluntarily. During the data collection phase for the study, it was seen that many large local companies in the logistics sector did not publish the sustainability reports, unfortunately. As an example, 7 out of 20 selected companies which are local companies within this research do not have a sustainability report. Therefore, businesses in the logistics sector should be encouraged to publish sustainability reports. In this respect, the international companies operating in Turkey provide good leadership to the local companies on their way to sustainability reporting.

As a general result of the content analysis, it can be defined that there is a weak but clear discourse about connection of Industry 4.0 technologies and sustainable development goals in Turkish logistics industry. However, the analysis results showed that the industry discourse has not yet facilitated the names of Industry 4.0 technologies. As an example, the discourse always uses the concept of "technology" for all kinds of applications in the companies. For example, for Goal 9 Industry, Innovation and Infrastructure, the total number of the codes with Industry 4.0 technologies is only 85, although the total number of matches with the "technology, digital transformation and smart technologies" codes is 529. In addition, although the goal is related to the industry, it is matched only 1 with the Industry 4.0 code. It was 11 times that the Industry 4.0 code was matched with all codes in Goal 9. This situation shows that the sector discourse has not yet used Industry 4.0 technologies even in the industry, innovation and infrastructure. Looking at Goal 12 Responsible Consumption and Production, the total number of matches with the "technology, digital transformation and smart technologies" codes is 220 in total, while the matching of the codes with Industry 4.0 technologies is only 38 for all codes. On the other hand, RFID technology has also been found to match more than others. The reason for this can be interpreted as the high preference of RFID technologies in warehouse and inventory management in order to realize responsible consumption and production. In addition, it can be said that companies regulate their waste management policies in accordance with the law and legislation. In addition, it is possible to think that the use of RFID technology is also preferred in warehouses for cost-oriented efficiency. On the other hand, for Goal 13 Climate Action, the total number of matches for the codes "technology, digital transformation and smart technologies" is 127, while the matching of codes with Industry 4.0 technologies is only 38 for all codes. Here, a better fragmented distribution is seen compared to the other figures. In addition, another striking point in this figure is that while the concept of Industry 4.0 is a little overtaken in the previous 2 figures, no matches were seen in the codes related to Goal 12 in this figure. It is noteworthy that the concept of Industry 4.0 is not used, although technology names are used more frequently than other figures. In the comparison of the "Logistic Process" & "Industry 4.0 Technologies" codes discussed in another figure, the technology code was matched 111 times with the transportation code. This

situation shows us that the most important process of logistics is still considered as transportation and its technologies are mostly used in transportation. From this point of view, it seems that the concept of technology is a general concept for the sector, it is not fragmented to the Industry 4.0 details. Within the field study it has been hardly identified a relation between Industry 4.0 applications and sustainability. Businesses are still at the beginning level in the use of Industry 4.0 technologies on the road to sustainability. The use of Industry 4.0 technologies in the logistics sector has not yet reached the maturity level, so the effect of Industry 4.0 technologies on sustainable development goals is still quite weak. Nevertheless, the use of the concepts of smart technologies and digital transformation in the industry's discourse indicates that there is a development in this long way sustainability.

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APPENDICES

Appendix 1: Data Sets of Chapter Four Figures

Figure 23: Goal 9 "Industry, Innovation and Infrastructure" & "Industry 4.0 Technologies"

	3D Printers Gr=31	Artificial Intelligence Gr=75	Augmented Reality Gr=90	Autonomous Robots Gr=63	Autonomous Vehicle Gr=44	Big Data Gr=62	Cloud Computing Gr=35	Cyber Physical System Gr=27	Digital Transformation Gr=244	Industry 4.0 Gr=48	Internet of Things Gr=149	RFID Gr=104	Smart Technologies Gr=302	Technology Gr=2146
Access to financial services Gr=25	0	1	0	0	0	1	0	0	0	0	0	0	0	3
Employment Gr=630	0	0	0	2	1	1	0	0	4	0	0	4	1	7
Industry Gr=1592	4	2	1	3	0	3	0	0	9	1	7	0	6	108
Infrastructure Gr=1488	0	5	1	0	0	1	2	2	6	5	3	4	16	121
Innovation Gr=926	3	1	3	7	2	3	0	0	15	4	7	1	9	144
Landscape and Design Gr=956	0	0	2	4	1	1	0	0	8	1	1	1	9	63

Figure 24: Goal 12 "Responsible Consumption and Production" & "Industry 4.0 Technologies"

	3D Printers Gr=31	Artificial Intelligence Gr=75	Augmented Reality Gr=90	Autonomous Robots Gr=63	Autonomous Vehicle Gr=44	Big Data Gr=62	Cloud Computing Gr=35	Cyber Physical System Gr=27	Digital Transformation Gr=244	Industry 4.0 Gr=48	Internet of Things Gr=149	RFID Gr=104	Smart Technologies Gr=302	Technology Gr=2146
Fossil fuels Gr=105	0	0	0	0	0	1	0	0	1	0	1	0	1	5
Productivity Gr=613	1	0	0	0	0	0	1	0	3	0	1	1	1	45
Recycling Gr=739	0	0	0	0	1	0	0	0	5	0	2	2	2	19
Renewable energy Gr=914	0	1	0	0	4	0	0	0	3	1	2	2	8	91
Waste Management Gr=1063	0	0	0	0	3	1	0	0	6	1	4	10	4	26

Figure 25: Goal 13 "Climate Action" & "Industry 4.0 Technologies"

	3D Printers Gr=31	Artificial Intelligence Gr=75	Augmented Reality Gr=90	Autonomous Robots Gr=63	Autonomous Vehicle Gr=44	Big Data Gr=62	Cloud Computing Gr=35	Cyber Physical System Gr=27	Digital Transformation Gr=244	Industry 4.0 Gr=48	Internet of Things Gr=149	RFID Gr=104	Smart Technologies Gr=302	Technology Gr=2146
Bio-diversity Gr=186	0	1	0	0	1	0	0	0	3	0	0	3	1	5
Carbon Emission Gr=406	0	1	1	0	3	3	0	0	0	0	1	0	4	21
Climate Change Gr=488	0	1	1	0	0	1	0	0	5	0	2	4	0	16
Ecosystem Gr=132	0	1	1	0	0	0	0	0	3	0	0	0	4	7
Footprint Gr=443	0	0	5	1	1	0	1	0	1	0	1	0	1	26
Global Warming Gr=138	0	0	0	0	0	0	0	0	0	0	0	3	0	4
Net Zero Gr=89	0	0	0	0	0	0	0	0	0	0	0	0	1	10
Pollution Gr=232	0	1	0	0	0	0	0	0	2	0	0	0	1	12

Figure 26: "Logistic Process" & "Industry 4.0 Technologies"

	3D Printers Gr=31	Artificial Intelligence Gr=75	Augmented Reality Gr=90	Autonomous Robots Gr=63	Autonomous Vehicle Gr=44	Big Data Gr=62	Cloud Computing Gr=35	Cyber Physical System Gr=27	Digital Transformation Gr=244	Industry 4.0 Gr=48	Internet of Things Gr=149	RFID Gr=104	Smart Technologies Gr=302	Technology Gr=2146
Information Flow, Purchasing and Protective Package Design Gr=1367	1	3	2	1	0	0	0	0	10	0	5	17	5	54
Inventory Management and Warehousing Gr=821	4	1	1	3	2	2	0	0	4	0	6	8	5	43
Reverse Logistic Gr=102	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Transportation Gr=1395	1	6	0	4	5	0	0	1	8	1	6	1	8	111

Figure 27: "Sustainability" & "Industry 4.0 Technologies"

	3D Printers Gr=31	Artificial Intelligence Gr=75	Augmented Reality Gr=90	Autonomous Robots Gr=63	Autonomous Vehicle Gr=44	Big Data Gr=62	Cloud Computing Gr=35	Cyber Physical System Gr=27	Digital Transformation Gr=244	Industry 4.0 Gr=48	Internet of Things Gr=149	RFID Gr=104	Smart Technologies Gr=302	Technology Gr=2146
Sustainability Gr=4258	0	3	3	2	1	1	2	0	26	2	6	18	10	116

Figure 28: "Sustainability" & "Climate Action Codes"

	Bio-diversity Gr=186	Carbon Emission Gr=406	Climate Change Gr=488	Ecosystem Gr=132	Footprint Gr=443	Global Warming Gr=138	Net Zero Gr=89	Pollution Gr=232
Sustainability Gr=4258	25	53	78	10	57	10	14	10