

ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL

**BUILDING LOGISTICAL SPACE FOR THE ANTHROPOCENE:
A STUDY ON LOGISTICS AND GREEN LOGISTICS**

**M.Sc. THESIS
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**Department of Science, Technology and Society
Science, Technology and Society M.Sc. Programme**

Thesis Advisor: Assoc. Prof. Emine Aslı ÇALKIVİK

JUNE 2023

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**ANTROPOSEN İÇİN LOJİSTİK ALAN ÜRETMEK:
LOJİSTİK VE YEŞİL LOJİSTİK ÜZERİNE BİR ARAŞTIRMA**

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To my beloved family and my dearest friends...



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ABBREVIATIONS

3PL	: Third Party Logistics
AI	: Artificial Intelligence
AIIB	: Asian Infrastructure Investment Bank
ANT	: Actor-Network Theory
AR6	: Sixth Assessment Synthesis Report
ARPANET	: Advanced Research Projects Agency Network
BD	: Big Data
BRI	: The Belt and Road Initiative
COP26	: Conference of the Parties (26 th Summit)
CPS	: Cyber Physical Systems
CSR	: Corporate Social Responsibility
DM	: Data Mining
EV	: Electric Vehicles
FIATA	: International Federation of Freight Forwarders Associations
GATT	: General Agreement on Tariffs and Trade
GHG	: Greenhouse Gas
GLP	: Green Logistics Policies
GPS	: Global Positioning System
ICCT	: The International Council on Clean Transportation
IMF	: International Money Fund
IOT&S	: Internet of Things and Internet of Services
IPCC	: Intergovernmental Panel on Climate Change
ISP	: Internet Service Provider
JIT	: Just In Time (Inventory Management)
KPI	: Key Performance Indicator

LPI	: Logistic Performance Index
OBOR	: One Belt One Road
RFID	: Radio-Frequency Identification
SCA	: The Suez Canal Authority
STS	: Science, Technology and Society
TEU	: Twenty-foot Equivalent Unit
TMS	: Transport Management System
UTIKAD	: International Forwarding and Logistics Service Providers Association
WB	: World Bank
WCA	: World Cargo Alliance
WMS	: Warehouse Management System
WTO	: World Trade Organization

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BUILDING LOGISTICAL SPACE FOR THE ANTHROPOCENE: A STUDY ON LOGISTICS AND GREEN LOGISTICS

SUMMARY

Logistics refers to the coordination of various actors, including people, technologies, and infrastructures, to move goods and information across *space* and *time*. However, this definition oversimplifies the complex social, economic, and environmental interactions involved in the logistics process. By redefining logistics as a socio-technical assemblage, we can better understand its impacts on workers, the environment, and society at large, and develop more sustainable and equitable approaches to transportation and supply chain management.

This study aims to comprehensively examine the evolution of logistics within its historical context, scrutinizing its multifaceted interconnections in economic, technological, sociological, and political realms. By analyzing the historical development of logistics, we can gain insights into the economic, technological, sociological, and political forces that have shaped logistics as we know it today. More importantly, this historical analysis will help us to better understand the current state of logistics and the challenges and opportunities associated with green logistics. Furthermore, it seeks to re-conceptualize green logistics within the framework of Science, Technology, and Society (STS) and map its conceptual level using Deleuze & Guattari's assemblage theory. Following the perspective of STS studies, the study aims to highlight the elements that are systematically neglected by considering the stakeholders who have a say in the logistics processes. When examining the logistics processes that have become complex and intricate with the use of 3PL, 4PL, and 5PL (Fifth Party Logistics) today, it is important to note that the classical system approach proposed by understanding "the whole is greater than the sum of its parts" is insufficient, particularly in carbon emission calculations. Therefore, it is believed that using Deleuze & Guattari's assemblage theory could be beneficial in creating sustainable solutions.

In order to understand logistics, it is essential to consider the various actors involved, including workers, consumers, and other stakeholders, as well as the technologies and infrastructures that support the movement of goods. By taking a holistic approach to logistics, we can identify the ways in which it intersects with other areas of society, such as politics, economics, and culture, and develop more effective and sustainable solutions. With the aforementioned approach, this study aims to analyze the current situation of logistics inclusively and to problematize the concept of green logistics with critical approaches in the literature.

Keywords: Logistics, green logistics, science technology and society, assemblage theory.



ANTROPOSEN İÇİN LOJİSTİK ALAN ÜRETMEK: LOJİSTİK VE YEŞİL LOJİSTİK ÜZERİNE BİR ARAŞTIRMA

ÖZET

Lojistik, en genel anlamıyla, mal ve bilgi akışını koordine eden bir süreç olarak tanımlanır. Ancak bu tanım lojistik süreçlerinde yer alan karmaşık sosyal, ekonomik ve çevresel faktörleri neredeyse görünmez kılar. Çalışmanın amacı, lojistiği sosyo-teknik bir *etkileşim* olarak yeniden tanımlayarak; lojistiğin çalışanlara, çevreye ve topluma olan etkilerini daha iyi anlamak ve daha sürdürülebilir, daha duyarlı bir taşımacılık ve tedarik zinciri yönetimi yaklaşımı geliştirilmesine ilişkin literatüre katkıda bulunmaktır.

Bu çalışma, lojistiğin tarihsel bağlamda nasıl evrim geçirdiğini kronolojik bir sırayla incelemektedir. Lojistiğin tarihsel gelişimine konu olan gelişmeleri literatürdeki diğer çalışmalara paralel bir şekilde beş farklı dönemde ele almaktadır. Böylelikle, Endüstri Öncesi olarak adlandırılan dönemden Lojistik 4.0 olarak adlandırdığımız günümüze kadar olan süreç ana hatlarıyla incelenerek, bugünkü lojistik pratiklerini şekillendiren ekonomik, teknolojik, sosyolojik ve politik güç ilişkileri anlaşılır hale getirilmektedir. Tarihsel analiz, lojistiğin mevcut durumunu ve günümüzde hemen her sektörü kırılganlaştıran küresel iklim krizine lojistik sektörünün bir yanıtı olarak doğan *yeşil lojistik* pratikleri ile ilgili zorlukları ve fırsatları daha iyi anlamamıza yardımcı olacaktır. Bu bağlamda, okuyucuya, günümüzde lojistik sektöründe kanıksanan ve görünmez olarak nitelenebilecek birçok pratiğin, aslında politik bir repertuarın altyapısını oluşturan etmenleri meydana getirdiği görünür kılınmak istenmektedir.

Araştırmada, yeşil lojistik kavramı STS (Science, Technology, and Society) çerçevesinde yeniden kavramsallaştırılmaktadır. Bu kavramsallaştırma, Deleuze & Guattari'nin asamblaj (assemblage) teorisi kullanılarak yapılmıştır. Asamblaj teorisi, insan ve insan olmayan farklı unsurların bir araya gelerek oluşturduğu yapıların/sistemlerin, yapıyı/sistemi meydana getiren her bir unsurun bireysel olarak toplamından daha büyük ve daha karmaşık bir yapı/sistem oluşturduğunu öne süren teorik bir çerçevedir. Asamblajlar, mutlaka istikrarlı veya uyumlu olmak zorunda değildir. Tıpkı lojistik sektöründe olduğu gibi, çatışmalar, çelişkiler ve gerilimler de içerebilirler.

Lojistik tarihi göz önünde bulundurulduğunda, oldukça yakın zamanda ortaya çıkan *yeşil lojistik* pratiklerinden önce; lojistik gibi oldukça karmaşık ilişki ağları oluşturan bir faaliyet alanında yapılan incelemelerin birçoğu lojistik süreçlerin çevre üzerindeki etkisini yeterince vurgulamıyordu. 1995 ve 2004 yılları arasındaki 2062 araştırma metnini kapsayan Aronsson ve Brodin (2006)'in çalışmaları lojistik topluluğunda bu tutumun eksikliğini vurgulamaktadır: On yıllık bir dönemde sunulan çalışmaların yalnızca %2,2'si bu teknik alanın sosyal ve çevresel etkileriyle ilgilenmiştir. Artan rekabet ve küreselleşmenin getirdiği kırılganlıkla beraber bu yaklaşımlar pekişiyor; lojistiğin teknik anlamdaki ilerlemesine paralel bir şekilde hızla yenileniyor ve yeniden kendini tekrar etmekteydi. Süreçlerin optimizasyonu, rota ve güzergahların verimliliği ve maliyetlerin düşürülmesi gibi unsurları konu edinen araştırmaların yaygınlaştığı bir alan olan lojistik sektöründe; yeşil lojistik uygulamalarıyla birlikte çevre konusundaki farkındalık, önceki dönemlere kıyasla artış sağlamış oldu. Ancak, klasik pratikler üzerine yapılan teknik araştırmalar gibi, yeşil lojistik üzerine yapılan araştırmaların da, ihmal ettiği ya da yeterince üzerinde durmadığı bir takım unsurların halen var olduğuna ilişkin kritik çalışmalar ise ancak geçtiğimiz 10 yılda kendine literatürde yer bulabildiği görülmektedir. İhmal edilen unsurların yanı sıra, halihazırda mümkün olan yöntemlerle; ikinin üzerinde alt-işveren bulduğu karmaşık operasyonlarda; 3PL (üçüncü parti lojistik), 4PL ve 5PL gibi; karbon emisyonu özelinde yapılan ölçümleme ve/veya iyileştirme faaliyetlerinin gerçekçiliği konusundaki endişeler de bu metinde dile getirilmiştir. Yeşil Lojistik Politikaları'nın (GLP) etkililiği üzerine yapılan araştırmaların ortaya koyduğu gibi, firmaların teknik çözümlere ek olarak; yönetim organlarının yeşil lojistik politikalarını benimsemesi, çalışanlarını bu konuda bilinçlendirmesi ve devlet organlarının bu politikalara uyum sağlayan yapıları teşvik edecek bir hareket tarzı izlemesi gibi birçok farklı unsurun etkisi altında kaldığını göstermektedir. Tüm bunlar düşünüldüğünde, yalnızca teknik çözümlere odaklanmanın aldatıcı bir etkisi olabileceği de çalışma içerisinde vurgulanan noktalardan biridir.

Lojistik, çeşitli aktörleri içeren bir süreçtir ve bu aktörler arasında işçiler, tüketiciler, ulusal ve uluslararası organlar, tüzel kişiler ve paydaşları, mal ve bilgi hareketini destekleyen teknolojiler ve altyapılar yer alır. Kategorize edilerek ifade edilen bu unsurların her birinin bir ötekisiyle ilişkisinden meydana gelen yeni etkileşimlerin yeniden tüm aktörlerle ilişkisini ve buradan da oluşacak yeni ilişkiler ağını düşündüğümüzde, oldukça büyük ve karmaşık bir yapıdan söz ettiğimizi görülmektedir. Çalışmanın ana varsayımı, lojistik alanına kritik perspektiften yaklaşan düşünürlerin çıkarımlarından da destek alarak, bu alanda yapılan teknik çalışmalara ek olarak lojistiğe yönelik holistik bir yaklaşım benimsendiğinde, lojistiğin siyaset, ekonomi ve kültür gibi görece ihmal edilen diğer alanlarla da nasıl yoğun bir şekilde etkileşimde bulunduğu gözlemlenebileceği üzerinedir. Çalışma, STS perspektifini takip ederek ve lojistik süreçlerde etki sahibi olan paydaşları göz önünde bulundurarak, sistematik olarak ihmal edilen unsurları

vurgulamayı amaçlamaktadır. Bu bağlamda, lojistik üzerinde yapılan araştırmalarda yoğun bir şekilde ihmal edildiği düşünölen; (1) lojistiğın emperyalizmin yayılmacı bir aracı olarak kullanılması ve bunu devlet destekli ticari oluşumlar aracılığıyla icra ediyor oluşu, (2) lojistiğın rekabetçi yapısının sebep olduğı işçi hakları ihlalleri, (3) devletlerin jeopolitik ve jeo-ekonomik kuvvetlerini sergileyebildikleri bir alan olarak lojistiğı kullanmaları gibi konular üzerinde durulmuştur.

Çalışmada sonuç olarak, iklim değışikliğı ile mücadele konusunda yoğun bir şekilde değışim geçiren alanlardan birisi olan lojistik sektörünün, ulusal ve uluslararası organların belirlediğı politikalar doğrultusunda uyguladığı çözüm ve pratiklerin, kolektif bir yanılığa sebep olmaması adına, sistematik bir şekilde ihmal edilen diğerk problemlerin de eş zamanlı çözümüne odaklanılmasının gerekliliğine dikkat çekilmektedir.

Anahtar kelimeler: lojistik, yeşil lojistik, bilim teknoloji ve toplum, asamblaj teorisi.



1. INTRODUCTION

“If you think of Wall Street as capitalism’s symbolic headquarters, the sea is capitalism’s trading floor writ at large.”

(Henely, 2012)

Crisis in Motion: Picture this: With a team of 25 people, you embark on a voyage from China’s bustling Yantian port aboard a colossal container ship. The ship, which is built by Japanese company Imabari Shipbuilding and owned by Taiwanese Evergreen company, and Panama-flagged like foreign shipowners who wanted to avoid the stricter maritime regulations imposed by their home countries. It has boasts 400-meter deck and weighs 220,000 tons (Vessel Finder, 2023).

You were headed towards the Port of Rotterdam in the Netherlands, another one of the busiest and most renowned ports in the world with 14 million TEUs¹ transaction volume (World Shipping Council, 2023). The journey was planned to take 25 days. Over the course of 25 days, you will traverse the vast ocean, all while carrying a cargo of 18,300 TEUs (it can carry a maximum 20,124 TEUs) with an estimated value of a \$850-900 million.

Although it doesn’t seem like it, this is an ordinary journey for the ship’s experienced crew. Ordinary but still exciting - it’s a feat of engineering. After routine checks, you start your journey and proceed smoothly towards your destination. That is, until the 15th day...

On the 15th day of your journey, a violent sandstorm caused the ship to lose control and run aground in the narrow corridor of the Suez Canal, which accounts for 12% of global traffic (Lee and Wong, 2021). The incident blocked the canal entirely.

This blockage on March 23 2021, resulting in an 8.8% surge in freight prices during the six-day closure (UNCTAD, 2021). More than 400 ships were stuck or waiting at both ends

¹ Twenty-foot equivalent unit, abbreviated as TEU, is an internationally standardized inexact unit of cargo capacity often used in maritime and rail transport statistics.

of the Suez Canal (BBC News, 2021a). The transportation cost increase would ultimately be reflected in the final prices of products due to uncertainty about how long the blockade will last. Live animals on board from 20 ships that were stuck in line, with a total of 200,000 animals unable to be offloaded in a different country due to bureaucratic reasons (Kevany and Safi, 2021). This incident reignited the controversy over the transportation of live animals, which had previously been highlighted in the video footage of poor conditions that caused the death of 2,400 sheep exported from Australia to Qatar in 2018 and the death of 15,000 sheep in a similar incident near Romania in 2019 (Foster, 2018; Zaveri and Vigdor, 2020). The global chip crisis, compounded by the delay in delivery due to the accident, led to a domino effect crisis that lasted for several more months, further exacerbating the already disrupted supply chain caused by the pandemic's factory shutdowns (Stahl, 2021).

The rescue mission to free the stranded cargo ship became a global effort. In addition to the Suez Canal Authority, Svitzer, a Danish maritime operation provider, dispatched two tugboats from Port Said to join the growing fleet surrounding the ship. Boskalis and SMIT, Dutch companies specializing in dredging, sent 13 tugboats. After six days of work, the ship was finally freed (Schikker, 2021).

Crisis Aftermath: The closure of the Suez Canal does not block cargo, but rather changes its arrival date. Global ocean trade is constantly in motion. The degree of delay resulting from rerouting depends on the specific port pairs and vessel speed involved. For instance, a container ship traveling at a speed of 17 knots and passing India on its way from China to Rotterdam would require nine additional days if it took the Cape Route (Cape of Good Hope) instead of using the Suez Canal. If the ship's destination were Italy, the delay would be 13 days instead.

It is estimated that around 30% of ships those waiting on the line, approximately 120-130 vessels, chose to reroute around the southern tip of Africa, the Cape Route to continue their journeys which is about take another 12 days (Figure 1.1). In their report, the T&E group estimated that the additional emissions generated by the rerouting process could be as much as 2.6 million tonnes of CO₂. This figure is based on the assumption that the ships traveled an additional 3,500 nautical miles, burned extra fuel, and emitted an additional

80,000 tonnes of CO₂ per day (Figure 1.2). Which is equivalent to the emissions from the energy use of over 500.000 houses in the USA for a year (EPA, 2023).

This little unordinary friction had caused disruption to deliver over \$9 billion worth of goods each day which is equivalent to \$400 million worth of trade per hour, or \$6.7 million per minute (Russon, 2021). Since it had been stuck for over 6 days, approximate \$54 billion trade loss had been estimated (Samir, 2021).



Figure 1.1: Alternative routings for ship liners during Suez Canal Blockage. Retrieved from Lee and Won (2021)
Source: BBC

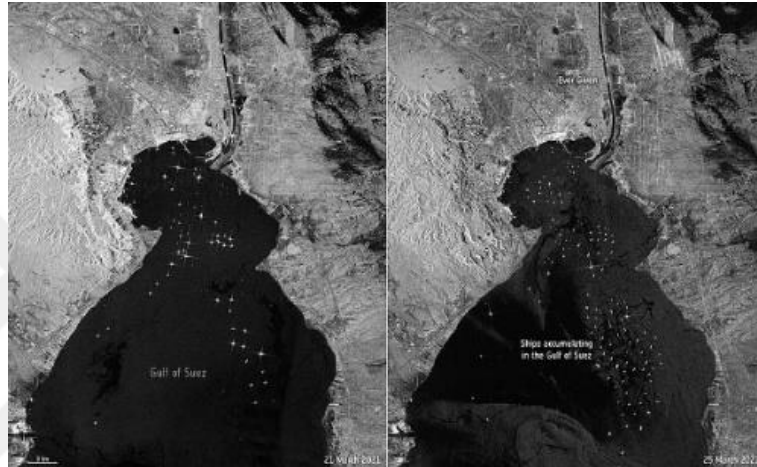


Figure 1.2: Suez Canal traffic jam seen from space (2021). Retrieved from https://www.esa.int/ESA_Multimedia/Images/2021/03/Suez_Canal_traffic_jam_seen_from_space

Ensuring deliveries are made at the right time and to the right place is not only cost-effective and environmentally friendly practice, it has become a **matter of life and death**. That is the conception of logistics operations almost today. When it comes to the world of logistics, various interconnected issues such as stock markets, climate change, border controls, animal rights, politics, and labor rights cannot be considered as separate entities. These concerns form a complex and intertwined web of problems that must be addressed collectively. It is imperative to recognize that in today's world of global trade, no crisis can be viewed in isolation as there is a ripple effect that can impact a range of industries and regions.

Today, logistics has evolved into a complex system that affects different aspects of society. While it may only represent a word on the side of trucks or online orders for some, it involves a network of infrastructures, technologies, spaces, workers, and violence that remain hidden from consumers. The management of global supply chains involves various

transactions that are political, financial, legal, and often martial, and that import themselves into society. Its impact is far-reaching and affects different sectors in various ways (Cowen, 2014a, p.3).

Therefore, it is essential to adopt a holistic approach to tackle these challenges. We must realize that our actions in one area can have far-reaching consequences in another. For instance, climate change can disrupt supply chains, which can in turn impact the stock market. Similarly, border controls can affect the movement of goods and services, leading to economic and social upheaval.

1.1 Problematization Of Logistics And Green Logistics: Crisis In Motion

There is a definition of logistics operation that is adopted by leading professionals and institutions working on this field and also find a place in the academic literature. This definition is called the *7R's of Customer Service in Logistics* and as follows: “the logistical task consists in providing the *right* amount of the *right* objects at the *right* place, in the *right* quality to the *right* time at the *right* cost” (Rushton et al., 2017, p.35; Rutner and Langley, 2000). Like this common definition, we can observe that experts working on logistics both in sectoral studies and in academia often talk about technological terms, calculations, efficiency and control when describing logistics. Apparently, neutral and technical considerations such as *operational efficiency* and *pragmatic standards of performance* seem to prevail in the domain of logistics (Mezzadra, 2016).

Today, when we try to trace any product we bought, even in our smallest shopping, it is very likely that it comes from thousands of kilometers away from where we are. This is made possible by the combination of many ‘right’ elements in the supply chain. This coordination requires harmonizing the pace and timing of labor across various locations and situations, all while dealing with the unique social, individual, and political circumstances that arise around the world. Logistical process involves managing these diverse elements in order to achieve a smooth and efficient flow of goods and resources on a global scale.

The complexity of modern supply chains are staggering, with products and components moving seamlessly across borders, oceans, and continents. The scope of logistics encompasses everything from raw materials sourcing to manufacturing, packaging, storage, transportation, and distribution. Logistics enables the creation of products and services that people rely on every day, from food and clothing to electronics and medical supplies.

The COVID-19 pandemic has brought much attention to the logistics industry, as many countries have struggled to maintain a steady supply of essential goods, such as medical supplies and food, due to disruptions in the global supply chain. This has highlighted the critical role that logistics plays in our daily lives and the economy as a whole. Probably, without logistics, the modern society we know today would not exist as it does.

But the benefits of logistics do not come without costs. The environmental impact of logistics is significant, with emissions from transportation and energy consumption contributing to climate change. The social costs of logistics include issues such as congestion, noise pollution, and accidents, which can have negative effects on the quality of life in urban areas (Digiesi et al., 2017; Hensher and Puckett, 2004). Moreover, the logistics industry is characterized by high levels of competition and pressure to reduce costs, which can lead to exploitation of workers, bad environmental practices and poor working conditions (Jaffee and Bensman, 2016).

Logistics can be redefined as a socio-technical assemblage that involves the coordination of various actors, including people, technologies, and infrastructures, in order to move goods and information across space and time. From a socio-technical perspective, logistics is not just a technical process, but also a social and political one, shaped by power relations, cultural norms, and economic forces (Chua et al., 2018; Cowen, 2014a, p.11; Mezzadra, 2016; Mezzadra and Neilson, 2013, p.viii). By conceptualizing logistics as a socio-technical assemblage, we can better understand its impacts on workers, the environment, and society at large, and develop more sustainable and equitable approaches to transportation and supply chain management.

Recognizing the drawbacks of logistics, it is essential to find solutions that can minimize the negative impact of logistics on the environment and society. The logistics industry has

recognized the importance of sustainability, and many companies are taking steps to address the environmental impact of their operations (McKinnon et al., 2015, p.216). For instance, businesses are adopting sustainable practices such as reducing energy consumption, minimizing waste, and using eco-friendly transportation options (Murphy and Poist, 2000).

One area of logistics that has gained increasing attention in recent years is green logistics. Green logistics involves the use of environmentally friendly practices and technologies in order to reduce the environmental footprint of transportation and supply chain management. While green logistics paints a *fantasy of logistics* with the potential to significantly reduce the negative impacts of logistics on the environment, it also raises important ethical and economic considerations, such as the potential for exploitation of workers in the supply chain, and the increased costs associated with the use of more sustainable technologies (Cowen, 2014a, p.203). This thesis aims to explore the inclusion of green logistical practices within global supply chains. As shown in Figure 1.3, these practices have a primary objective of minimizing the environmental impact caused by logistics operations, including greenhouse gas emissions, noise pollution, and waste generation. By emphasizing a balanced development approach that encompasses the economy, society, and the environment, green logistics activities stand apart from traditional logistics practices that primarily focus on cost reduction (Bajdor, 2012; Dekker et al., 2012).

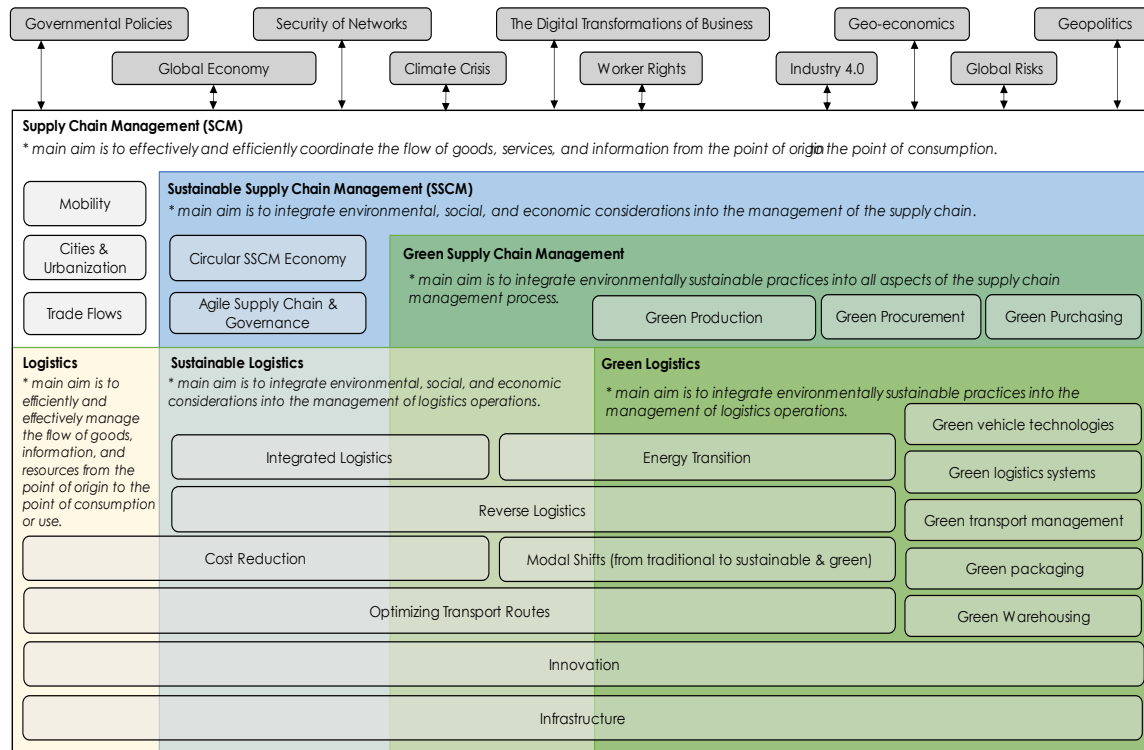


Figure 1.3: Limited scope of supply chain and logistics applications and external factors affecting these applications. While creating the figure, Tüzün Rad and Gülmez (2017; Fig.2), Paksoy et al. (2021), Jazalry, (2020), Jazairy et al. (2021; Fig.2) were taken as a basis.

In addition to environmental concerns, the logistics industry also faces social challenges. Exploitation of workers and poor working conditions are significant issues that need to be addressed. It is essential to ensure that logistics systems are designed and implemented in a way that is socially responsible, and that takes into account the needs and perspectives of all stakeholders, including workers and local communities.

Science and Technology Studies (STS) offer valuable insights into the challenges and opportunities associated with logistics systems. By examining the social and cultural dimensions of logistics technologies, STS perspective provide insights into the challenges and opportunities associated with their implementation. For instance, Assemblage Theory, which emphasizes the interconnectedness of social, technological, and material elements within a system, can help to identify the complex relationships between different elements of the supply chain. By examining how these elements interact and affect one another,

Assemblage Theory can provide insights into how to optimize logistics processes and improve efficiency.

Moreover, STS studies can also help to identify the barriers and opportunities associated with the implementation of new logistics technologies. By examining the ways in which different actors and stakeholders interact with logistics systems, STS studies can provide insights into the cultural and social factors that influence logistics systems. Furthermore, STS studies offer valuable insights into the challenges and opportunities associated with logistics systems, and can help to ensure that logistics systems are designed and implemented in a way that is both efficient and socially responsible.

While logistics is often discussed as either something inherently economical or purely technical; how can logistics be understood as a political driver and what are the implications of this for contemporary supply chain capitalism? The findings of this study will be relevant to researchers and industry professionals interested in understanding the political and social dimensions of logistics and supply chain capitalism. Ultimately, the study aims to contribute to a more sustainable and socially responsible future for logistics and supply chain management.

1.2 Purpose of the Study, Research Question and Motivation

The main question of this thesis is: *How has the historical development of logistics led to the emergence of green logistics, and do green logistics practices fulfill our expectations for more sustainable and equitable transportation and supply chain system, from a science and technology studies (STS) perspective?*

To answer this research question, we will examine the historical context of logistics and its evolution towards a more sustainable and environmentally friendly approach. We will explore the reasons why green logistics is preventing it from meet our expectations, despite its potential benefits for reducing the negative impacts of logistics on the environment and society.

One possible explanation for the failure of green logistics is the lack of political will and economic incentives for its implementation. Companies may be hesitant to invest in more sustainable technologies and practices due to the higher costs associated with them, and governments may be reluctant to regulate the industry for fear of stifling economic growth. Additionally, the complex and global nature of logistics makes it difficult to coordinate and implement sustainable practices across different regions and industries.

Another factor contributing to the controversial nature of green logistics is the limited scope of its definition. By focusing solely on the environmental impacts of logistics, we may overlook important social and economic considerations, such as worker exploitation and income inequality. Therefore, it is important to take a multidisciplinary approach to logistics that considers the many different factors that shape it, including politics, economics, technical availability and culture.

In the context of sustainability and sustainable transportation, the concept of green logistics is often used to address environmental concerns in the logistics industry. However, this approach presents a limited understanding of logistics as a whole. To truly address the complex issues facing the logistics industry, a multidisciplinary approach is required. This approach should take into account not only environmental concerns, but also economic and social factors, as well as the interplay between these factors. By taking a comprehensive and integrated approach to logistics, we can create truly sustainable systems that meet the needs of both present and future generations.

To address these complex issues, we must take a holistic but systematic approach to logistics that recognizes its social, economic, and environmental impacts, and develops sustainable and equitable solutions that serve the needs of society as a whole. By doing so, we can create a more just and sustainable transportation and supply chain system that benefits everyone, not just a select few.

1.3 Methodology

This study will employ a Science and Technology Studies (STS) approach to analyze the relationship between logistics, economy, states, geography, war, technology, environment, society and climate change. Historical analysis is critical in contextualizing current debates around logistics and green logistics. The field of logistics involves tangible and visible actions, but also involves a layer of complexity that requires a thorough examination of its history and underlying factors to fully understand. So, the study will examine the historical development of logistics, from its origins to the present day, with a particular focus on the emergence of environmental concerns in the twentieth century. By examining the historical context, we aim to gain a better understanding of the ways in which logistics have been shaped by economic and political systems over time.

The methodology of this study will include a detailed examination of primary and secondary sources. Primary sources will include historical documents, government reports, and industry publications. Secondary sources will include previous studies and reports to gain a better understanding of the current state of the logistics industry. We will use a variety of sources to examine the historical development of logistics, including academic literature, industry publications, and government reports.

The sources collected will be analyzed thematically to identify key themes and patterns relating to the historical development of logistics and its relationship to environmental concerns. The findings of this study will be presented in a detailed report that will provide a comprehensive overview of the historical and contemporary relationship between logistics and green logistics.

Through this methodology, we hope to gain a comprehensive understanding of the historical and contemporary relationship between logistics and green logistics. The results of this study will identify opportunities for future research and policy interventions for the logistics industry to reduce its environmental impact. Ultimately, we aim to contribute to a more sustainable future for logistics, the environment, and society as a whole.

1.4 Theoretical Framework

This work is mainly a study of assemblage theory. Assemblage theory is a theoretical framework that focuses on how different entities, including both human and non-human elements, come together to create larger, emergent structures that are more complex than the sum of their individual parts (Buchanan, 2021, p.42). In order to prepare a study about logistics, it was necessary to view logistics as a system in which multiple agents work together with multiple networks where all entities in this system are equally important.

Before elaborating on what assemblage theory means, I would like to differentiate it from another similar concept. In this study, assemblage theory has been preferred over actor-network theory, another framework that is widely used in STS studies developed by French sociologists Bruno Latour. Actor-network theory (ANT) and assemblage theory are both theoretical frameworks that focus on the ways in which entities (human and non-human) interact and shape one another. While there are some similarities between the two frameworks, they are also distinct in their approach and concepts.

ANT emphasizes the role of actors (both human and non-human) and their interactions in shaping the social world. ANT seeks to understand how networks of actors (including objects, technologies, and institutions) are formed and how they shape social practices, institutions, and knowledge (Latour, 1996).

Assemblage theory, on the other hand, emphasizes the ways in which entities (both human and non-human) come together to form emergent entities that are more than the sum of their parts. Assemblage theory emphasizes the importance of the relationships between entities and the ways in which these relationships are constantly changing and evolving (Buchanan, 2021, p.28).

While both ANT and assemblage theory focuses on the relationships between entities and emphasize the importance of non-human entities, assemblage theory tends to be more focused on the emergent properties of these relationships, while ANT tends to be more focused on the role of actors in shaping these relationships.

Assemblage theory is a theoretical framework that was developed by Gilles Deleuze and Félix Guattari, originally presented in their book *A Thousand Plateaus* (1980). It focuses on understanding social, political, and cultural phenomena as complex networks or "assemblages" of heterogeneous elements, such as objects, bodies, ideas, and institutions. (Deleuze and Guattari, 1987).

Assemblages are dynamic and constantly changing, and they are not reducible to their individual parts. Instead, they are defined by the ways in which their constituent elements interact with each other, forming connections, relations, and flows. These interactions are not predetermined or fixed, but rather emerge through ongoing processes of negotiation, adaptation, and experimentation. Assemblages are also not necessarily stable or harmonious, but can contain conflicts, contradictions, and tensions (Buchanan, 2021, p.50; Frewer, 2017, p.119).

Assemblage theory has been used to analyze a wide range of phenomena, from urban landscapes to social movements to scientific knowledge production. It offers a way to understand the complexity and contingency of social reality, and to think beyond traditional binary oppositions such as subject/object or individual/society.

In terms of logistics, even if we express phenomenon in its simplest form as the transportation of a product or service from one point to another; Due to the fact that the transported thing must be something separate from the logistics service itself, it has to be intertwined with at least another sector other than itself as a *raison d'être* (reason for being). This makes it necessary to evaluate any logistics activity from more than one interrelated disciplinary frameworks. In addition to this interaction, fauna and flora including sea, air, land, railways or pipelines, which are the platforms where logistics activities are carried out; or, if the transmission of information is concerned, the ocean habitat with fiber optic cables and the exosphere layer with artificial communication satellites should be included.

1.5 Structure of Text

This master's thesis is composed of four chapters, with the first two providing background information for the rest of the study. The introduction chapter establishes the general framework for the entire work, outlining the study's purpose and the main research question to be answered in order to achieve that goal. Additionally, the introduction chapter includes a statement of the study's motivation, as well as insights from the theoretical framework, methodology, and limitations.

In the second chapter, a historical analysis will be conducted by using to understand the development of green logistics practices over time. In the meantime, studies that are important for understanding the period and the historical process will also be mentioned as well as the literature review. The chapter will be examined through two sub-headings in itself, and when the chapter ends, the historical evolution of logistics will be completed in a chronological sense. At the end of this chapter, it is aimed that the reader can look at the current debates from a broad perspective.

Building on the first two chapters, the third chapter aims to interpret the findings and the various meanings of logistics in today's world.

In the final section, the practical outcomes of the last phase of the logistics evolution within the STS framework will be explored. Additionally, potential areas for further research will be discussed.

2. BUILDING LOGISTICAL SPACE FOR THE ANTHROPOCENE: HISTORICAL & CONCEPTUAL BACKGROUND

Logistics has evolved from being something only the military was interested in until the first half of the 20th century to one of the most important KPI (Key Performance Indicator) and business strategy to steer a company towards an efficient flow. As a result, what you're about to read about today's logistics could be obsolete by tomorrow. But at least we can try to look back its roots and briefly explore its evolution.

Currently, the logistical process in corporations is a result of the continuous issue of the capitalist system - the mismatch between production and distribution. Companies tend to produce more goods than what consumers want or need, which leads to overproduction. The challenge is to find ways to sell all the goods produced, and logistics analysts strive to do this effectively to avoid overstocks and understocks. By doing so, they can manage costs, expedite the system's cycle time, and improve customer service (Bonacich and Wilson, 2008, p.4).

In recent decades, the logistics industry has undergone significant changes and innovations that we named *logistics revolution*. The logistics revolution refers to the significant changes and improvements that have taken place in the field of logistics happened in the 1960s because of things like free trade agreements and deregulation. It led to companies being able to reduce their inventories and transport costs, and this in turn made the prices of products go down. These changes have been possible and driven by a combination of technological advancements, global economic shifts, and changing consumer demands. And it had a major impact on the way that businesses and organizations operate and deliver their products and services today (Bonacich and Wilson, 2008, p.36).

Some of the key features of the logistics revolution include the use of advanced technologies such as automation, artificial intelligence, and the internet of things (IoT), as well as the integration of various modes of transportation, including air, land, sea, rail and combined modes like multimodal, and intermodal (Amr et al., 2019; Wang, 2016). Since 1990s, there has also been a trend towards greater efficiency and sustainability in logistics,

with a focus on reducing waste and minimizing the environmental impact of transportation and storage via using *reverse distribution* practices. This long-term orientation caused the emergence of *green logistics* (Rodrigue et al., 2008). Green logistics refers to the practice of minimizing the environmental impact of logistics operations through the use of sustainable practices and technologies. This includes reducing energy consumption, minimizing waste and pollution, and promoting the use of alternative modes of transportation. Green logistics has become increasingly important as concerns about climate change and the need for sustainable business practices have grown.

However, as is often the case, what was good for business was bad for workers. The logistics revolution helped move manufacturing jobs to places like the global South, where workers are often paid low wages and have very insecure jobs (Bonacich and Wilson, 2008, p.27).

The logistics revolution had a major impact on the global economy and changed the way that goods and services are produced, distributed, and consumed. It has also led to the development of new business models and the emergence of new players in the logistics industry, as companies seek to take advantage of the opportunities and challenges presented by these changes. And at this point today, logistics is considered as one of the major factors for the effective sustainability of any company (Rushton et al., 2017, p.173). But, in its simplest form, *moving stuff* does not sound like a fancy concept. As consumers, we do not just stop and think about the complex web of processes that must occur before we can carry out anything as basic as filling up our car with gas. Or how the product that I am ordering right now will be with me over a night. Or by going one step further to question on those who do not reach us; “*what is the politics of logistics where Amazon doesn't deliver to our doorstep*” (Schouten et al., 2019)? Only when an order doesn't arrive on estimated time we do start paying attention to complex sets of supply chains. This is because consumer expectations in the field of logistics are very high and the existing rhythm is always accepted as an uncompromising standard (Christopher, 2022, p.45). There are sets of infrastructural processes whose existence are difficult to recognize, but whose absence we feel severely. Just like the internet. As the internet connects people and devices around the world and enables the transfer of data and information, logistics

involves the use of complex networks, systems, and processes to connect people, organizations, and resources, and to facilitate the flow of goods and services. Both logistics and the internet rely on a combination of technology, infrastructure, and human expertise to function effectively and efficiently. However, the internet is largely decentralized and it is not controlled by any one organization or individual, while logistics is typically managed by companies and organizations that are responsible for planning and coordinating the movement of goods. With the help of communities like The Equitable Internet Initiative (EII) you can even set up your internet service provider (ISP) in your own garage when you are not satisfied with your ISP (DCTP, 2017; Freethink, 2018; Motherboard, 2017). But you can't build up your own logistics network by yourself. Because the establishment of an effective logistics system requires huge infrastructural investments such as highways, bridges, railways, ports, warehouses and so on. Investments and planning of this magnitude, which cannot be dealt with on an individual basis, are made by organizations such as states, international organizations, multinational companies, and non-governmental organizations on behalf of individuals. That is precisely why, when it comes to logistics, the boundaries between power, economy, and politics become blurred, as expressed by Keller Easterling's concept of 'extrastatecraft' (Easterling, 2014, p.62). Logistics is an umbrella term for integrating various elements such as transportation infrastructure, ecosystems, assets, and labor; with production, transmission and, consumption systems through extensive cybernetic data management tools (Chua et al., 2018). This allows for the expansion of territory, sociality and ecology within the *extractive machine of supply chain capitalism*. That's exactly why, as Deborah Cowen put it in her eye-opening book, “*logistics is an industry and assemblage that is at once bio-, necro-, and antipolitical and it is not a simple story of securitization or of distribution*” (Cowen, 2014a, p. 4).

Today, the logistical performance of a country has become one of the main indicators that we use to measure the integration, adaptation and “*friendliness*” of countries to the global economy. With the Logistic Performance Index (LPI), published by the World Bank (WB) every two years between 2010-2018 and after 5 years 2023, it was aimed to reveal the strengths and weaknesses of countries in terms of logistics. With the evaluation of this network over 6 different indicators over 160 countries; states, international organizations,

investors with capital in the private sector were guided. You can see the best ranking countries and Turkiye comparison between 2023 and 2018 in six different criteria in Figure 2.1. The report published by the World Bank claimed that this sector generates a global turnover of 4.3 trillion dollars with extensions (Arvis et al., 2018).



Figure 2.1: Logistics Performance Index (LPI) by World Bank (2023). Retrieved from, World Bank, <https://lpi.worldbank.org/2023>

So, what do these values mean about a country? Who is defining and measuring efficiency in logistics operations, and what values and interests are driving these definitions? Or, how does the desire for seamless efficiency become a new mode of technocratic rule, and what are the political and social implications of this shift?

LPI prioritizes efficiency over other factors such as social and environmental impacts. This reflects a particular set of values and priorities that may not be shared by all stakeholders involved in logistics operations. For example, communities affected by the construction of logistics infrastructure may prioritize issues such as environmental protection or social justice over efficiency. This highlights the need for a more comprehensive approach to measuring and evaluating logistics performance that takes into account a wider range of values and perspectives. According to Chua (2019)'s *Revue Periode* reading guide on logistics, the desire for seamless efficiency exemplified by logistical systems thinking has extended from strict applications to supply chain movement to a generalized mandate for corporations and states alike. Logistics has

become a new mode of technocratic rule as it shapes the desirability of coordinated complexity, making the day-to-day management of financial and commercial circulation the central task of government. The smooth movement of supply chains becomes a central priority of the state and capital, with policies prioritizing efficient distribution treating all threats to the system as equivalent, regardless of their political valence. As labor and social forces seek to block the mobility of flows through strikes, blockades, and other disruptions, they are seen as threats to be secured, which sanctions a social war on workers and ordinary citizens. The political and social implications of this shift are the prioritization of capital accumulation over human life, as Chua (2019) points out in her logistics reading guide, “*the dispossession and exploitation of poor and working people in terms of their relationship to economies of supply; and the use of technological domination and surveillance as forms of control over populations*”.

In the study of logistics, to better understand these complex relationships mentioned above, it is common to categorize developments based on the impact of technology on logistics and the impact of logistics on the industry. By doing so, researchers are able to identify key trends and changes within the field over time. These categories provide a useful framework for analyzing the evolution of logistics and understanding its role in shaping various industries.

To ensure that the next section of this thesis is easily understandable for the reader, the same categories used by researchers in the field of business will also be utilized (see Table 2.1). This approach will help to provide a clear and concise analysis of the various developments in logistics and their impact on the industry. By using these established categories, the reader will be better equipped to understand the nuances and complexities of modern logistics systems and their place within the broader scope of business and industry. In the next chapter, the historical development of logistics will be summarized, highlighting the three major revolutionary steps it went through before reaching Logistics 4.0. Additionally, *Green Logistics* is explored as an extension of this development:

1. **Pre-Industrial Era:** This period spans from the beginning of human civilization up until the mid-18th century, before the Industrial Revolution began to transform

the way goods were produced, transported, and distributed. During this time, logistics was primarily concerned with the movement of armies and the provisioning of food, water, and supplies to support military campaigns, as well as the transportation of goods through trade routes and merchant networks. However, logistics practices were generally less organized and less efficient than they are today, due to the limited technological and infrastructure advancements of the time.

2. **Logistics 1.0:** During the late 19th and early 20th century, the transportation industry witnessed a significant rise, particularly with the introduction of steam-powered ships and trains that gradually replaced traditional modes of transportation. This phase was characterized by the mechanization of transportation and the increased use of containers for the transport of goods, which facilitated the movement of goods in a much more efficient and cost-effective way. The use of containers made it easier to load and unload goods, which led to a reduction in the time and cost associated with transportation. The late 20th century marked a significant increase in transportation capacity, which further propelled the growth of the transportation industry. This increase in capacity eventually culminated in the mass transportation era, which saw the advent of large-scale transportation systems capable of moving goods and people in vast quantities across long distances (Paksoy et al., 2021, p.20). This period was marked by a significant shift in the way transportation was perceived, and it paved the way for the growth and development of the transportation industry as we know it today.
3. **Logistics 2.0:** The second phase was characterized by the automation of handling systems, which was made possible by the advent of electric power, the implementation of mass-production manufacturing techniques, and the automation of container handling. This phase saw the replacement of conventional warehousing with automated loading and unloading systems, as well as sorting and warehousing systems. Electrically powered machines began to handle the

majority of the work, and the rise of container ships changed how cargo was handled in ports.

Logistics 2.0 revolutionized the way goods were handled and transported, making the process more efficient and cost-effective. The automation of handling systems allowed for faster loading and unloading times, reducing the time and cost associated with transportation. The use of electrically powered machines for handling cargo also made the process more environmentally friendly, as it reduced the need for manual labor and increased efficiency. The rise of container ships in ports further added to the efficiency of logistics, as it allowed for larger quantities of goods to be transported at once. Overall, Logistics 2.0 played a significant role in the growth and development of the logistics industry, paving the way for further advancements in the field.

4. **Logistics 3.0:** Logistics 3.0, the third phase, was introduced in the 1980s with the implementation of logistics management systems. This phase was characterized by the use of computers and information technology (IT), leading to the systemization of logistics activities. Integrating IT systems into logistics, such as Warehouse Management Systems (WMS) and Transport Management Systems (TMS), significantly increased automation and logistics management capabilities.

The integration of IT systems into logistics during Logistics 3.0 enabled companies to manage their supply chains across multiple countries and regions, adding globalization to the equation. Automation and logistics management capabilities also significantly increased during this phase. As a result, logistics activities became more efficient and cost-effective, leading to a significant transformation in the industry.

5. **Logistics 4.0:** The future of logistics is being shaped by the adoption of advanced technologies such as the Internet of Things and Internet of Services (IoT&S), Artificial Intelligence (AI), and Big Data/Data Mining (DM). These technologies are being used to optimize and automate logistics processes via Cyber Physical

Systems (CPS) and cloud computing, according to Wang (2016) and Amr et al. (2019) (Amr et al., 2019; Wang, 2016).

These advanced technologies are part of Logistics 4.0, which is the current era of logistics. The integration of these technologies into logistics processes allows for even more efficient and effective management of goods and supply chains. The use of IoT devices and sensors in logistics enables the tracking and monitoring of goods in real-time. AI algorithms can analyze data from these devices to optimize routes, reduce delivery times, and improve warehouse management. Big Sdata analytics can help identify patterns and trends in logistics data, enabling companies to make better decisions and improve their operations. Cloud computing also plays a significant role in Logistics 4.0. It enables the storage and processing of large amounts of data, making it easier for logistics companies to manage and access their data from anywhere. Logistics 4.0 is a developing logistics model that can interconnect entities, machines, physical objects, goods, and enterprise resources through the use of sensors, devices, and the Internet within supply chains. This model can promote more efficient production and distribution systems that have garnered interest from stakeholders due to its potential for high-performance supply chains.

Table 2.1: Summary Table of Historical Evolution of Logistics. While creating the table, Paksoy et al. (2021; Fig.3), Wang, (2016; Fig.1), Tang and Veelenturf (2019), Boulila (2019), and the infographic prepared by the German Research Center for Artificial Intelligence (DFKI, 2021) were taken as a basis.

Time Period	Logistics Paradigm	Industrial Paradigm	Key Business Characteristics (Logistics Perspective)	Objective (Logistics Perspective)	Descriptive Usage (Logistics Perspective)
∞ - 1800s	Pre-Industrial	Manual Labor			Traditional transportation and warehousing.
1800 – 1900	Logistics 1.0	Industry 1.0 (Mechanization)	Logistics activities was inseperable from war efforts and colonial activities.	Basic transportation and distribution	At first, human body, animals, water and other natural sources. Later, steam engine, railway network, steam ships.
1900 – 1950s					
1950-1960	Logistics 2.0	Industry 2.0 (Electrification)	Concepts taken to independent business function after WWII.	Profit maximization	Use of computerized systems and barcodes to improve efficiency. Electric power, automatic warehousing and sorting, mechanization and automation of port cargo handling.
			Limited to warehousing & transportation. First developments of the total cost of logistics operations.		
1960-1980			This era was known as fragmentation era. Companies began trading one cost for another. Outsourcing. Kanban & just-in-time.	Cost reduction	
1980-1990	Logistics 3.0	Industry 3.0 (Digitalization)	This era was known as consolidation era. Inventory management.	Customer service	Use of supply chain management softwares to improve communication and transparency. First reverse logistics & reverse distribution applications were used. Warehouse management systems, transport management systems, information technology.
1990-2000			A Technological advancement. Quick response & enterprise resource planning (ERP). Better material requirements planning.	Internal Integration	
2000 -2010			Advancing globalization leading to efficient logistics solutions & gaining competitiveness.	Total integration	
2010- ∞?	Logistics 4.0	Industry 4.0 (Cyber-Physical Systems & IoT)	Autonomous & electric vehicles	Global Integration	Use of the Internet of Things (IoT), RFID systems, artificial intelligence, cyber-physical systems and big data analytics to optimize and automate logistics processes.

2.1 Pre-Industrial Era: The Roots of Logistics (∞ - 1800)

The history of organized movement of things dates back to ancient times when people first started organizing the *transportation* of goods from one place to another. Which that makes logistics as old as human history. It's an intertwined history in which wars, imperialism, exploitation, slavery, revolutions, development and trade coexist (Tepić et al., 2011).

The distribution of resources across different parts of the world helped to define the supremacy of one particular civilization in the production of certain commodity groups (Braudel, 1992a, p.337; Diamond, 1999, p.55). The exchange of goods between different societies was first developed as a way to enable civilizational interaction. The Mediterranean civilizations were the first to establish this type of exchange. In the early days of human civilization, the transportation of goods was primarily carried out by muscle power. Humans and animals such as mules, horses and donkeys were used (Tepić et al., 2011). Apart from exchange, there was a need for the transportation and distribution of resources from one point to another for various activities. In ancient Egypt, for example, the Pharaohs relied on a system of movement of goods to support the construction of the pyramids, canals and other monumental projects. This system included the procurement and transportation of building materials, as well as the management of food and other supplies for the huge number of slaves and workers (David, 2003, p.49). In ancient Greece, the city-state of Athens developed a calculation based complex transportation system (which is called, *logistikós*, “accounting”) to support its military campaigns and trade endeavors. That system included the construction of roads, ports, and warehouses, as well as the establishment of a network of suppliers and merchants. Even if advance planning was possible, supplies and equipment were dispatched to the settlements along the route before the army advanced. They also used slaves and animals to carry minimal supplies and equipment with them. The Greeks were also innovative in their use of maritime logistics, with the development of the trireme, a fast and maneuverable warship powered by three banks of oars which is far more advanced technology than other single row oars of its time. These types of logistics systems, mostly, had some typical solutions that blended the advantages and disadvantages of the geographical location.

During the Roman Empire, logistics reached new heights of sophistication, with the development of a professional corps of *logistics* officers responsible for the procurement, transportation, and storage of supplies. They were quite conscious and prepared about the extent to which they could provide support to troops. They overcame technical inadequacies with punctual planning. (Lazenby, 1994) Vegetius, in his *De re militari*, the only Roman military instruction that has survived to the present day, expresses how the ability to access resources will make a difference: "...the main and principal point in war is to secure plenty of provisions for oneself and to destroy the enemy by famine. Famine is more terrible than the sword." (Norman, 2021; Vegetius, 2021).

At its peak, the Roman army had 30 legions, or approximately 150,000 warriors. With auxiliary soldiers, some believe the Roman army had well over a million soldiers (Lloyd, 2013). In the Roman Empire, logistics officers were responsible for the procurement and distribution of supplies and resources to the military and civilians. They were responsible for ensuring that the army had adequate food, water, and equipment, as well as coordinating the transport of these supplies to where they were needed. Logistics officers in the Roman Empire were known as *praefecti praetorio* or *praefecti annonae*. The *praefecti praetorio* were responsible for the logistical support of the imperial military and the *praefecti annonae* were responsible for the procurement and distribution of food and other supplies to the civilians. Roman logistics officers played a crucial role in the success of the empire, as they were responsible for ensuring that the army had the resources it needed to carry out its campaigns. They also helped to maintain the stability of the empire by ensuring that the civilian population had access to adequate food and other supplies. The Romans also established a system of relays, a postal service (*Cursus publicus*, "the public way"), in which fresh horses were made available at regular intervals along major roads, allowing couriers to travel long distances quickly (Jongman, 2003).

The Silk Road (or the Silk Routes) will be perhaps the oldest and most appropriate formation that we can give an example of today's logistical networks in ancient times (Andrea, 2014). It is basically a network of trade routes that stretched from eastern China to the Mediterranean. These trade routes consisted of approximately 6,500 km (4 thousand miles) which continued to be used widely until the Conquest of Constantinople, 1453.

This trade route, which will lose its ancient importance with geographical discoveries, was used to transport a wide variety of goods, including silk, spices, and other luxury items (Beckwith, 2009, p.26). The route was not only an important trade artery, but also served as a cultural exchange, allowing the exchange of ideas and technologies between East and West. The Silk Routes, at some point, became the first global cultural phenomenon, as the entire network of trade routes connected people and cultures from different parts of the world. The name was originated from the word ‘Seres’ which means ‘the land of silk’ in Ancient Greek. They used *Seres* to pointed out today’s China because was produced only in China at that time because of the special technique.²

The first leg of these routes was created when Han Dynasty came into contact with the Greco-Bactrian Kingdom³ in the west (the widest limits reached by the kingdom can be seen in Figure 2.2 at below), imported their *huge war horses* to fight against their nomadic rivals Xiongnu, who used smaller and weaker local breeding horses in China. Using the power he gained with foreign trade, he defeated his powerful neighbor rivals over and over (Figure 2.3). This success encouraged Emperor Wu to consider what else could be gained through trading with the West, and the Silk Road was established in 130 BCE (National Geographic Society, 2022).

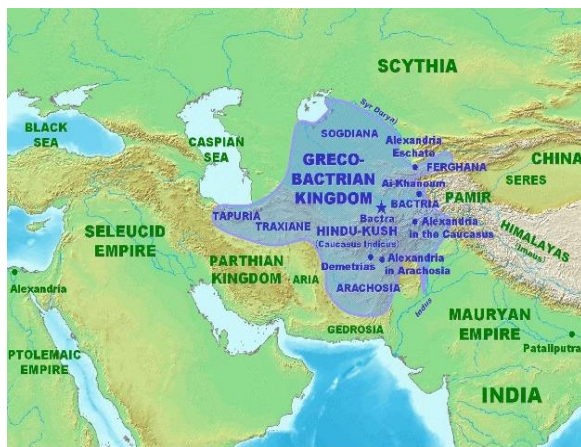


Figure 2.2: “Map of the Greco-Bactrian at its maximum extent, circa 180 BC”. Sève, M. (2007, January 26) Retrieved from, <https://commons.wikimedia.org/wiki/File:Greco-BactrianKingdomMap.jpg>



Figure 2.3: Han Empire (130 BCE). TimeMaps. (2022, September 5) Retrieved from, <https://timemaps.com/civilizations/the-han-dynasty-of-ancient-china>

² The name was given by the German geographer and traveler, Ferdinand von Richthofen, in 1877 CE.

³ A city founded by another great logistician Alexander the Great for the accommodation of wounded soldiers in his army. Over time, the Macedonian soldiers who remained there intermarried with the indigenous populace forming a new the Greco-Bactrian culture which flourished under the Seleucid Empire following Alexander's death.

There were many different feudal lords and kingdoms along the routes, as it traversed difficult terrains such as the Gobi Desert and the Pamir Mountains. On these routes, just as commodities were traded, works of arts, science, architecture, ideas, languages, philosophies, religions and inventions were spread among different cultures (Liu, 2010, p.2). Between these exchanges, China meets Buddhism from the West (India) and Europe meets the gunpowder and the paper which they will lead to the beginning of a new eras. After the Invasion of The Mongols, all control was achieved by a single state. They were ruthless but they were allowed the development of trade routes under their dominion by allowing people of different religions to coexist. That era was named as Pax Mongolica, Mongol Peace (1250–1350). Although this topic still sparks debates in the academic world (Askew, 2017), what is important for us is not the factors that led to this period, but rather the fact that international trade with logistics practices could be observed in early civilizations in practical terms. While traveling across Asia's wide steppes, one would come across people of various faiths, including Buddhists, Muslims, Shamanists, and Christians. These people coexist and work with Mongols who follow their traditional religion (De Graaf, 2018).

During that period, the success of this type of logistics relied heavily on the tradesmen who played a crucial role as the main trade facilitators and stakeholders. The distance between one trading point or market and another would have required the construction of stop-over locations or trade districts where traders could rest and store their goods safely. European travelers, including famous traveler Venetian Marco Polo, were able to travel to China and back during the Pax Mongolica period. Polo went on to write a chronicle about his journeys in faraway regions, which fascinated the European public. The success of Pax Mongolica was due to its efficient trade routes (as shown below Figure 2.4), but these same routes also led to its downfall in the mid-1300s. The bubonic plague, also known as the Black Death, originated in central Asia and quickly spread westward, facilitated by the same trade routes that had made Pax Mongolica successful (Hudson, 2014).



Figure 2.2: Silk Road (1350s AD). Retrieved March 3, 2023, from China Travel Service & Information Center LTD. (n.d.). http://chinatravel.co.uk/EN/Silk_road03.htm

In the rest of the world at the Middle Ages, logistics continued to evolve, with the development of trade fairs, guilds, and other institutions that facilitated the exchange of goods. The growth of semi-global trade during this period also led to the development of more advanced transportation technologies. The first step was to switch from using oxen to horses. This was followed by advancements in horse breeding, harnesses, horseshoes, wheels, carts, and bridge building. The increase in the number of mills and weirs also impacted river navigation (France, 2006, p.193). During this period, logistics was also crucial to the operation of feudal systems, with lords and vassals relying on complex networks of stewards, bailiffs, and other officials to manage the procurement and distribution of supplies. This system of logistics was essential to the maintenance of power and order within feudal societies (Haldon, 2006, p.41).

In the 15th and 16th centuries, logistics was primarily focused on the transportation of goods by land and sea. During this time, European explorers and traders were seeking new routes to Asia and the Americas, and logistics played a crucial role in the expansion of trade routes and the exchange of goods between different regions. After the Ottoman Empire blocked the Asian trade routes to Europe, explorers emerged for the discovery of new trade routes. The main goal of the Ottoman Empire was to destroy the domination of

Venice and Genoa over the Mediterranean, which was worked. But Spain and Portugal were determined to replace Venice and Genoa (Parry, 2010). Around 1480s, with the invention of the new ship type called the *Caravel*, Portugal and Spain begins maritime explorations. Portugal took its chance along the African coasts in search of new trade routes. from the south coast; Spain sailed west. The main aims of these explorations for two parties were to open a new sea route to the Indies (modern India), from where come spices and to regain access to luxury products blocked by the Ottoman Empire (Parry, 2010).

In 1484, Christopher Columbus, a Genoese navigator living in Lisbon, proposes to the Portuguese king to try reach Asia by sailing west. According to his calculations, Cathay (China) and Cipango (Japan) are close enough for the crossing to be feasible. Portuguese king rejects his offer and Colomb tries his luck with rival queen of Castile (one of the powerful states of the Iberia region besides Aragon and Leon). In 1492, the Queen decided to support the exploration when conditions were right. Colombus started his journey. After 36 days into the unknown they reached an island. Colombus convinced he has reached the Indies, so he names the local people as *Indians*. He seeks to find the empire of the Great Khan, as recorded in Marco Polo's writings. But, in fact he was met local Taino people.⁴ And so, unwittingly, The New World discovered by him (Armesto, 2006, p. 204; Parry, 2010, p. 29).

In the early modern period, with the discovery of the New World, the expansion of European empires led to the development of more complex logistics systems. European powers such as Spain (eventually Crowns of Castille and Aragon was united as Spain in late 15th century), Portugal, and the Netherlands established extensive trade networks and built infrastructure, such as roads and ports, to support the movement of goods (Braudel, 1992b, p. 168). The growth of global trade also led to the development of new forms of transportation, such as sailing ships and steamboats. These technologies allowed for the efficient movement of goods over long distances and facilitated the growth of global trade. Trade and commerce continued to grow in the 17th and early 18th centuries, logistics became more complex and sophisticated. The first product considered to be produced with

⁴ A historic indigenous people of the Caribbean.

a *global supply network* was *rum* (Bossart, 2021; “Rum Production in the Caribbean”, 2021). That was done in the 18th century by importing slave labor from West Africa to the Caribbean to grow sugarcane, which was originally coming from India. The molasses from this sugarcane was then shipped to different parts of the United States to be turned into rum. Some of the drink was made in the United States of America, but a lot of it was bought and sold all over the world. The distillation of rum was one of the biggest industries in early America. In order to develop and sustain like these large sugar, cocoa, and cotton plantations, and mines that require a large workforce in America, European merchants left for the African coasts where they buy slaves. These are transported to America to be sold in the mines or on the plantations. The average life expectancy of these traded slaves was 7 years (National Museum of African American History & Culture, 2021). The ships then return to Europe loaded with precious metals and luxury goods. This model became so profitable that the slave trade exploded, as did piracy, which flourishes in the Caribbean. Stefano Harney and Fred Moten, American scholars, have argued that the Atlantic slave trade played a key role in the development of modern logistics (Harney and Moten, 2013, p.92). During the Middle Passage, which was the transportation of African slaves across the Atlantic, the challenge was to efficiently store and control the slaves. The authors suggest that this experience influenced the development of modern logistical systems that are used to manage commodities in contemporary global trade.

At the beginning of the 16th century, England began to rapidly grow in sea trade. However, the Spanish Empire's colony ships were attacking English merchant ships. This led Queen Elizabeth I to support the famous sailor Francis Drake on circumnavigation of the world in a single expedition from 1577 to 1580 (Martin and Parker, 2022, p.99). Drake attacked Spanish ships on the coast of South America to weaken the Spanish Empire's naval power and ensure the safety of English sea trade. He returned to England in 1580. Drake's world tour remained a great heroic story in the eyes of English sailors. However, these attacks against the Spanish Empire increased tension between England and Spain. The Spanish Empire prepared a large fleet called "Armada" to threaten English sea trade. But the famous naval battle where the English Navy, led by Drake and other captains, defeated the Spanish Armada became a turning point in English history (Martin and Parker, 2022, p.510).

This victory led to the rise of the English Navy and increased England's power in world sea trade. The British East India Company played an important role during this process. The company was founded on December 31, 1600, by Queen Elizabeth I and was initially established to control the spice trade in India. However, over time, the company controlled all of East Asia's trade and became an *empire* that extended from India to China over 258 years (Braudel, 1992b, p. 434).

The British East India Company played a major role in English sea trade and increased England's power in world trade. However, the company was also involved in the slave trade like rival empires. The company used its ships, especially from India to Africa, to engage in slave trade (Barrow, 2017).

When we evaluate the British East India Company in terms of logistics practices, it performed quite impressively. The company was able to collect materials from all over the world and transport them to England by sea in a faster and more efficient manner. The company relied heavily on its network of agents to gather intelligence about local markets, political conditions, and other factors that could affect its operations. This information was then used to make strategic decisions about trade and logistics operations (Barrow, 2017, p.102). The company's fleet of ships was one of the largest and most advanced in the world, with ships of various sizes and capabilities designed for specific types of cargo. The company also built a network of roads and other transportation infrastructure to move goods across land. During this process, the company's ships and ports laid the foundations for modern logistics practices. Additionally, the company's colonies in the British East Indies helped increase England's production of tobacco, cotton, and other products (Barrow, 2017). The line separating economic and military activities, which cannot be clearly expressed even today, still remains thin in logistics operations and the operation of the infrastructures connected to these operations, as it was in those days (Barrow, 2017; Grappi and Neilson, 2019; Stepputat and Hagmann, 2019). However, the so-called logistics revolution will still be an important threshold.

In the 18th century, Adam Smith, a political economist wrote *The Wealth of Nations* in 1776. Two years after the *Boston Tea Party*. The *Wealth of Nations* helped to develop important groundwork to the conceptions of modern logistics. He started with questions

about how economic value is created and how people's needs are met (Braudel, 1992c). His perspective based on the balance of supply and demand, would later be called the "classicists" in economics. Smith's ideas and views were phenomenal; however, he did not imagine what would happen next. During the Industrial Revolution, workers in industrialized countries changed from being farmers to factory workers very quickly. This transformation had a big impact on the distribution of the labor force across different economic sectors. For instance, in 1810, 84% of the U.S. workforce was involved in agriculture, compared to just 3% in manufacturing (Paksoy et al., 2021, p.3). However, the manufacturing market share grew to 25% by the end of the century, while the agriculture market share gradually decreased to 8%. As of today, the agriculture market share is only 10.5% in United States. The Industrial Revolution had a big impact on people's lives, education, business organization, government practices, and more (Economic Research Service, 2023).

During the same time period, the word "logistics" began to be used more broadly to refer to the planning and coordination of the movement and distribution of goods and materials in general, not just in military contexts. The modern use of the term "logistics" can be traced back to the work of Baron Antoine-Henri de Jomini, a Swiss general, who wrote extensively about logistics and systematic attempt to define the principles of warfare in the early 19th century. In his *Summary of the Art of War* (1838) he dedicated a chapter about logistics which he called "Logistics, or the Practical Art of Moving Armies". He is credited with developing the concept of logistics as a distinct field, and his writings influenced the development of modern logistics principles and practices (Farahani et al., 2011, p.5). The term "logistics" has its roots in the Greek word "logistikos," which means "calculating" or "reasoning." However, while the word "logic" comes directly from Greek, "logistics" took a longer route. It first appeared in French as "logistique," meaning "the art of calculating," and then made its way into English. The term was derived from the French military rank of "Marechal de logis" and was used in military contexts to refer to the planning and coordination of the movement and supply of troops and equipment (Klaus, 2012; Tepić et al., 2011). Although Jomini's book did not receive much attention at the time of its publication, a few years later its English translation entered the generic courses and literature used in American military schools. Thus, "logistics" became a common term

in military language as referring to the science of military support services like transport and supply for the troops. During this period, the great and respected commanders and armies were distinguished by their logistical capabilities. General George Washington, one of the founding fathers and considered the greatest general of the United States, made detailed logistics plans for the troops under his command. According to him, to feed 15,000 soldiers for a year, the army would require 100,000 barrels of flour and 20 million pounds of meat (Valley Forge National Historical Park, 2009).

This attention to logistics was not unique to General Washington, as logistical planning has been a critical aspect of military strategy throughout history. The ability to move troops and supplies efficiently and effectively has been a key factor in determining the outcome of battles and wars.

2.2 Logistics 1.0: New Markets, Extraction & Wars (1800-1950)

In the late-18th to early-19th century, the world would witness a revolution in industry. Three innovations developed in this century will set the stage for *The Industrial Revolution*: James Watt's steam engine (1769), the spinning machines of Arkwright and Crompton (1769, 1775), and Henry Cort's reverberatory furnace (1784) (Braudel, 1992c, p. 566; Chandler, 1980). The growth of international trade and the development of new technologies, such as the steam engine, the rail network, and the telegraph, contributed to shaping the field of logistics and the industry. By the early 19th century, logistics had become an essential element of economic growth and development. Fossil fuels, such as coal, replaced traditional power resources like human and animal power, as well as other *limited* energy sources like wind, water, and wood fires. Coal became a major energy source that led to drastic improvements in industrial processes, making them more affordable and efficient. These developments allowed for the efficient transportation of goods and information over long distances.

The impact of these developments was not limited to industry, but also affected social life. With the invention of the steam machine and the mechanization of the weaving loom, craftsmen became workers (Braudel, 1992c, p. 544, 1992b, p. 241). The growth of an

urban middle class and working class, as well as the emergence of an industrial proletariat in Great Britain, was a result of the establishment of factories and industrial towns. This transition was fueled by the restructuring of international trade routes, which turned Britain into the world's workshop through the use of new coal-powered factories. (Paksoy et al., 2021, p.4). With reverberatory furnaces and the power of industrialization, they perfected iron and steel techniques, making the British the largest exporter of iron in the world. The steam engine and iron revolutionized transportation - the first railroad line linked the textile factories of Manchester to the port of Liverpool, where shipments of American and Indian raw cotton arrived. Steamships progressively replaced sailing ships on the sea. Advancements in transportation also benefited communications - steamships and railroads could carry letters. The expansion of transportation networks and the development of new modes of transportation, such as the railroad, allowed for the rapid movement of goods and people, leading to the growth of global supply chains and the development of modern logistics systems (Paksoy et al., 2021, p.341).

Also, ensuring the security of mobility on logistics channels had now become one of the tasks undertaken by the armies of nation states. The early modern period also saw the development of new logistics practices, such as the use of *bills of lading* to document the movement of goods and the establishment of warehouses and other storage facilities. This document, which is both a legal and administrative record, not only contains information about the shipment that is shared with carriers, but also serves as a documentation trail that safeguards the rights of the shipper. These innovations helped to improve efficiency and reduce costs within logistics systems (Chandler, 1980).

In 1854, France obtains permissions from Egypt to build a canal linking the Mediterranean to the Red Sea. The Suez Canal Company was established by Ferdinand de Lesseps, a French diplomat, with the goal of constructing the Suez Canal (Bonin, 2010). Such a canal had already been built in ancient times by the Pharaohs (or Darius the Great, a bit controversial topic), but had disappeared by the 8th century (Modi, 1917, p.14). Almost 8 centuries later, the canal was the scene of another unsuccessful attempt as Sokullu Mehmet Pasha's project to reach the Indian Ocean in order to revive the lost Mediterranean trade power, which he could not realize due to the expensive cost of construction. After 15 years

of work, In 1869, the Suez Canal is inaugurated, and makes it possible to travel the route to India in 60 days on a steamship, compared to six months with a sailing ship via Africa. In 1884, following expeditions to inland Africa, European countries met in Berlin (The Berlin Conference) to distribute Africa among themselves and regulate the process of colonization. As a result, the African peoples were subjected to domination and their resources were exploited. (Griffiths, 1995, p). Today, The Suez Canal carries about 12% of the world's trade and about 30% of the world's container traffic. It moves over a \$1 trillion USD worth of goods each year (The New Zealand Embassy in Cairo, 2021).

Similarly, in 1904, the United States buy the abandoned construction site for an inter-oceanic canal in between the North and the South America continents from France. The canal would considerably shorten the maritime route between the Pacific and Atlantic oceans. In 1914, ten years later, the Panama Canal is inaugurated. With this new key passageway controlled by the United States. Today, The Panama Canal carries about 12% of the world's container traffic (Rosenberg, 2019).

In 1890, Alfred Marshall (b.1842, d.1924)'s book on *Principles of Economics* is an outstanding early contribution on the question of how value can be created. Marshall stated that "man cannot create material things" and claimed that the economic activity of making things "serviceable" and valuable to people is about "movement," "arrangement," and "rearrangement," not creation of things (Marshall, 1890, p.53). Marshall provided an alternative definition of '*how economic value is created*' that had been tried to be defined by Adam Smith in the previous century. Contrary to the general view that value creation is synonymous with production, these concepts, which were put on the basis of value creation by Marshall, constitute the most basic functions of logistics today.

By time of the early-20th century, the world was hosting a war of a magnitude that it had never encountered before. The First World War (WWI) marked a turning point in the history of logistics, with armies relying on complex supply chains to sustain their operations. The logistical challenges of the war were vast, as the fighting took place across Europe and involved millions of soldiers and civilians – *total mobilization* (Millett, 1945). The logistics systems of the major powers played a key role in the outcome of the war, as the conflict was fought on an industrial scale and required a massive mobilization of

personnel and resources. The rapidly expanding railway network in order to carry large troops ammunition, food and medical supplies to the soldiers in the trenches and to support the artillery units. The armies of the time relied heavily on railroads to transport troops and supplies, and the destruction of rail lines and infrastructure caused major problems for both sides. In addition, the use of new technologies, such as tanks and aircraft, required the development of new logistical systems to support them. Out of the different approaches that developed during this period, the British and American systems, proving more effective than others by winning this *trench war*.

The distribution of food and other supplies was also a major challenge, as the fighting often disrupted traditional supply lines. This led to the creation of new systems for the procurement and distribution of supplies, including the use of convoys and the establishment of supply depots. The logistical challenges of WWI also extended to the medical care of the wounded. The development of new and more effective weapons, such as machine guns and poison gas, led to a large number of casualties, and the medical systems of the time were ill-equipped to handle the influx of wounded soldiers (Millett, 1945). This led to the development of new medical practices and technologies, such as the use of field hospitals and mobile medical units.

The Interwar period (1918 to 1939) was relatively brief, but it saw many significant social, political, and economic changes around the world. Petroleum-based energy production and associated mechanization resulted in the prosperous *Roaring Twenties*, a period of social and economic mobility for the middle class. The early twentieth century industrial structure and supply networks were heavily impacted by a world with good transportation but relatively underdeveloped communications. Automobiles, electric lighting, radios, and other modern amenities became widespread among developed-world populations. The telephone was invented in 1876 by Alexander Graham Bell, but the first transatlantic call between London and New York took place in 1926 (O'Dell, 2005). Production is now centralized at transportation hubs, and *Fordist* production lines were used to mass-produce goods (Paksoy et al., 2021, p.37). As mass production increased, it became difficult for individual customers to specify their requirements. The supply chain responded by standardizing products. Henry Ford (b.1863, d.1947) responds to the comment that

customers can request more vehicles if they are in different colors: "Customers can buy the vehicle in any color they want. Any color so long as it is black" (Ford and Crowther, 1922, p.31). The era's indulgences were followed by the Great Depression, an unprecedented global economic downturn that severely harmed many of the world's largest economies.

In the United States, following the civil war and WWI with the struggle against racism, a travel guide called "The Negro Motorist Green Book" was published in 1936 by Victor Hugo Green (b.1892, d.1960), a postman who lived in Harlem. This guide was intended for African American customers during the segregation era in the United States. It contained a list of shops that welcomed African American customers, but it was also a fine example of a commercial logistics planning document (Dillette and Benjamin, 2022). The Green Book was published in four issues between 1936 and 1963, until the Civil Rights Act of 1964, a comprehensive US legislation aimed at ending discrimination based on race, color, religion, or national origin, was put into effect.

The importance of logistics was further highlighted during The Second World War (WWII), when the success or failure of military campaigns often hinged on the ability to supply troops with the necessary weapons, ammunition, and other supplies (Kress, 2016). The logistics systems of the major powers were put to the test during the war, with some, such as the German system, proving highly effective, while others, such as the Japanese system, struggling to keep pace. With the inclusion of panzers and planes on the battlefield in the Second World War, it served as a dynamo carrying all the supplies needed.

One of the key challenges of logistics during WWII was the need to transport large quantities of supplies and equipment over long distances, often in difficult or hostile environments. This required the use of a variety of transportation methods, including ships, trains, trucks, and aircraft. In addition, logistics planners had to take into account the availability of ports, railheads, and other transportation infrastructure, as well as the need to protect these critical assets from enemy attack. The successful management of logistics was crucial for maintaining the momentum of military operations and for ensuring that troops had the supplies and support they needed to continue fighting. Another major challenge of logistics during WWII was the need to maintain and repair

equipment, as well as to replace lost or damaged equipment. This required the establishment of repair and maintenance facilities, as well as the procurement and distribution of spare parts and other supplies (Coakley and Leighton, 1943, p.484; Kress, 2016, p.49). This meant the establishment of a modular supply system; which would form the infrastructure of the revolutionary inventory management system *just-in-time* production in the next decade.

Logistics were not included in the scientific disciplines until the mid-20th century. Because, the integration of different scientific fields was not possible until a philosophical platform was developed that could meet the demands of the modern production and distribution systems. However, this was done by developing systems with the greatest degree of integration of different scientific disciplines.

2.3 Logistics 2.0: The Invisible Revolution ^{5 6} (1950-1980)

After WWII, logistics played a significant role in the reconstruction of Europe and the rebuilding of economies around the world. In the years following the war, logistics systems were established to support the movement of goods and materials to support economic recovery and growth. Logistics was originally a military concept that played a supporting role in enabling military strategy. However, with the rise of modern states and petroleum warfare, logistics became increasingly important to the success of campaigns, leading to a reversal where logistics began to define military strategy (Cowen, 2014a, p.3). The business community absorbed the expertise, and terms like "industrial logistics" and "business logistics" were taught in boardrooms all over the world. This included the development of transportation infrastructure, such as roads, bridges, ports, and airports, as well as the establishment of logistics networks to manage the flow of goods and materials. Biggest challenges of logistics in the post-war period was the need to rebuild and modernize transportation infrastructure that had been damaged or destroyed during the war. This included the repair and construction of roads, bridges, and other

⁵ In her book, "Ninety Percent of Everything," Rose George defines the logistics industry as "invisible," pointing out its almost invisible status compared to the largest companies, despite its income level being nearly the same.

⁶ The term "logistics revolution" was first coined by Bonacich E and Wilson JB (2008) in *Getting the Goods: Ports, Labor, and the Logistics Revolution*. Ithaca, NY: Cornell University Press.

transportation infrastructure, as well as the development of new technologies and systems for managing the flow of goods and materials. In addition to transportation infrastructure, logistics systems were also established to manage the distribution and storage of goods, as well as the tracking and monitoring of shipments. This included the development of new technologies, such as computerized inventory systems and advanced transportation management systems, to improve the efficiency and effectiveness of logistics operations. Over time, the scope of logistics has expanded beyond just technology and physical product flows to include strategic and organizational elements as well. (Paksoy et al., 2021).

Many sources, especially those in the logistics industry, claim that American entrepreneur Malcolm McLean invented the container in 1956. However, Marc Levinson argues in his book “The Box”, that McLean's true contribution to containerization was not the metal box or the ship, but a managerial insight. This is because containerization had already been in use in North America and Europe for several decades before McLean's first ship set sail (Levinson, 2016, p.xii). But we know that the first commercial attempts were made in the late 1950s, regardless of who the invention of the container would be attributed to. Until the standardization with the containers, goods were shipped depending on the type of cargo and the mode of transportation. Common methods are *loose cargo* and *break bulk*. What they have in common is that they both require a lot of manpower, cause loss of space and the loading times are long. The old methods were expensive as well as time consuming. The handling charges at the port were almost half of the transport costs. In addition, damage to cargo and theft was very common in the old methods. But in containers like this it would not be as easy as before. With standardization of containers, its automatically eliminated wasted space in ships and cut unloading time by up to 3 weeks. The Ideal X, a converted war surplus WW2 tanker carried the first standard containers from Newark to Houston became the first commercial container ship using standardized steel containers. The Ideal X, a shipping vessel, was approximately 160 meters long and 9.1 meters wide. Its estimated capacity was around 96 TEUs, which is a standard unit term in logistics. The introduction of the shipping container revolutionized cargo transportation by enabling seamless movement between road, rail, and sea. This innovation was a critical factor in the development of modern multimodal and intermodal

shipping methods. (Paksoy et al., 2021). It also significantly altered the nature of port cities across the world. Both ships and ports were redesigned to handle containers. In the 1960s and 1970s, American railroads strongly opposed the adoption of containers (Levinson, 2016, p.348). Longshoremen needs for handling drastically down in port cities while machinists are needed. This phenomenon would later be called “*containerization*”.

Containerization had a major impact on Asian economies, but it was initially introduced to the region through military means. In the 1960s, the US government began to rapidly increase its military presence in Vietnam, but the country's primitive transportation infrastructure made it difficult to sustain the military force. Malcolm McLean promoted the use of containerization, which allowed the US to transport large quantities of military supplies by ship to Vietnam (Levinson, 2016, p.238). This made it possible for the US to maintain a well-equipped military presence in Vietnam despite the challenges posed by the country's limited infrastructure. Without containerization, it would have been difficult for the US to sustain its large military presence in Vietnam. Containerization enabled the US to feed, house, and supply the 540,000 military personnel who were in Vietnam by the start of 1969. The use of containerization in the Vietnam War demonstrated the potential for the technology to revolutionize transportation and logistics on a global scale. As shown in the Figure 2.5, the volume of container ships has expanded tremendously since the invention of the container. In 2023, MSC's Loreto, with a capacity of 24,346 TEUs, surpassed Ever A Lot, which held the title of the world's highest capacity container ship and was completed in 2022.⁷ MSC's Loreto can theoretically carry 48,692 passenger cars at a time.

⁷ In 2022, Ever Alot - the largest container ship in the world - had a capacity of 24,004 TEUs. It is owned by Evergreen Marine (*the company that owns Ever Given too*). The Ever Alot is 399.99 meters long, 61.5 meters wide, can cruise at 22.6 knots, and is operated by a crew of around twenty-five on China-to-Europe routes. You can get more information from these sites:

(1) <https://www.porttechnology.org/news/ever-alot-breaks-record-for-worlds-largest-containership/>,

(2) <https://www.vesselfinder.com/vessels/details/9893955>,

(3) https://www.marinetraffic.com/en/ais/details/ships/shipid:6991950/mmsi:352001259/imo:9893955/vessel:EVER_ALOT

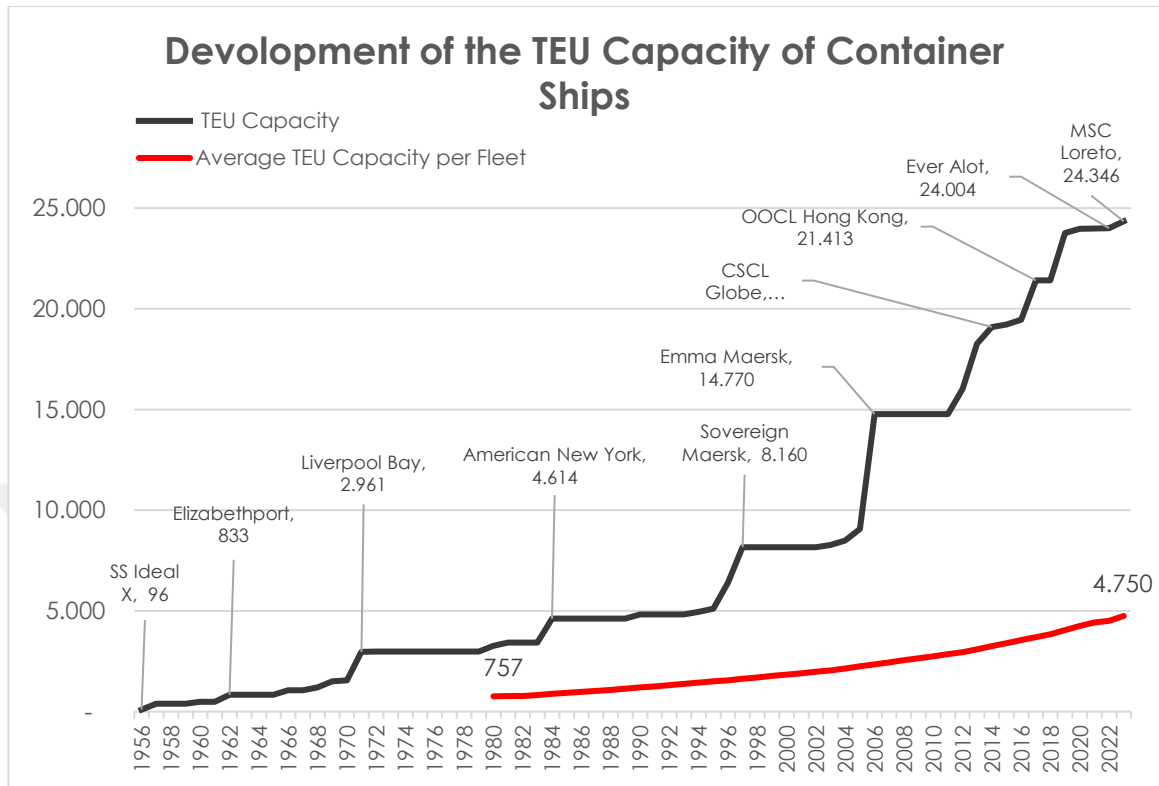


Figure 2.3: “The development of the TEU capacity of container ship - largest container ships by year”. Sources: Allyn International (2023) and MarineTraffic (2023) - reusable under Creative Commons BY-SA 4.0 intl license

The invention of the shipping container brought about a significant change in the way commodities were transported across oceans and how labor was organized in docks and ports. It is an iconic symbol of the new paradigm of logistical mobility. The concept of "supply chain," which involves the management and organization of component supplies for industrial production, is also closely tied to logistics and frequently associated with the shipping container (Haugen, 2019; Levinson, 2016, p.361). The container image, which is widely recognized as a symbol of productivity and efficiency, has now served as the inspiration for like software tools as internal container-oriented cluster-management system like Kubernetes. With Kubernetes, you can group your applications into containers and run them using the Docker engine to ensure that they perform as intended (The Linux Foundation, 2023).

So, thanks to the Vietnam War the shipping container gain its importance today in the world. It is important to keep in mind this military genealogy of modern logistics, and this is because the military origins of logistics continue to haunt its development. This kind of link between logistics and the military is often emphasized in critical understanding of the

present (Chalfin, 2019; Chua et al., 2018; Cowen, 2014; Mezzadra and Neilson, 2019, p.68).

The private sector's interest in logistics and the concept of supply chain, which was made possible with the spread of the necessary minimum technological infrastructure has now started to find a place for itself in the academic literature and in the conversations at the board of directors of multinational companies. Studies conducted during this period considered logistics as a system engineering/analysis technique that is often used to solve inventory and distribution problems. These business texts adopt a technical and economic perspective on logistics, viewing it as a tool that can be used to increase capital accumulation, rather than trying to understand them as contested processes with social and political implications. The conclusions reached by many of the studies put forward were as follows: When businesses understand the concept of total cost of distribution and apply *integrated distribution management* practices well, they can increase their profitability considerably (Cowen, 2014a; La Londe et al., 1976; Mentzer et al., 1989).

With the combination of containerization and development of the information technologies caused the next shift in supply chain networks (Paksoy et al., 2021, p.20). Improved communication meant that it was possible to specify exactly which parts and products were needed.

Containerization meant that these parts and products could be transported cheaply and delivered quickly. When we add a more sensitive planning and a good operational process to the benefits provided by the containerization, "just-in-time" delivery emerges. Just-in-time (JIT) inventory management, basically, aims to minimize inventory by only producing and delivering goods as *when they are needed*. The main idea behind JIT is to create a production system that removes any activities that do not add value to the final product or allow for the uninterrupted flow of material, essentially eliminating wasteful and costly elements in the production process. The goals of JIT are closely tied to logistics and distribution and have been adapted accordingly (Paksoy et al., 2021, p.202; Rushton et al., 2022, p.74).

Implementing JIT principles in production can lead to several benefits, including lower inventory costs, reduced lead times, increased efficiency, and improved quality control.

By eliminating wasteful activities, JIT helps to minimize the time and resources required for production. This, in turn, reduces inventory costs and frees up space in warehouses and production facilities. JIT also helps to reduce lead times by streamlining the production process and ensuring that materials and products are delivered just in time to meet demand (Rushton et al., 2022, p.264).

Although the conceptual infrastructure and technologies related to the supply chain were originated mainly in the US, it was Japanese companies that figured out how to use them to change the way production works. They call this process "*lean production*". A more flexible and reduced the need inventory capacity for the end-product and it replaced the traditional, Fordist assembly line-based production system (Paksoy et al., 2021). This decentralized network-based production process has been developed over many years. The first application method of JIT and lean production developed the Toyota Production System between 1948 and 1975. The production system known as "The Toyota Way" originated from a methodology focused on daily improvements and the motto "good thinking, good products." It has since become renowned worldwide. Although the effects of practical applications on employee motivation have been criticized, today we know that these type of production is quite efficient for the electronics industry and very effective in other sectors like chemistry, textile, shoes, and industrial machines manufacturing (Mehri, 2005; Persoon et al., 2006).

With these major iterations, logistics and production, previously thought of as clearly separate operations, have become even more intricate. Prior to the so-called "logistics revolution," the term used to describe this field was "physical distribution," which referred to the organization of different economic activities within a single firm. The main concern for managers at that time was minimizing costs after production. The approach minimizing costs *after production* was predicated upon a firm boundary that distinguished production from distribution: First, there was production, which was the real matter, where value was added; and then there was physical distribution, where value was not thought to be added. Since it was not considered possible to add value in physical distribution, the main problem for managers and organizers was to minimize costs, which also meant

minimizing the time needed for distribution (Brennan, 2021; Mezzadra, 2016; Mezzadra and Neilson, 2019, p.145; Watts, 2019).

However, in the 1960s, the concept of logistics shifted to focus on adding value across circulatory systems. This was a radical departure from the traditional view of logistics as just physical distribution. Logistics was now interested in how value could be added throughout the entire supply chain, from production to consumption. This new paradigm allowed for the blurring of the boundary between production and circulation, as value could now be added not only in production but also in circulation. This shift in focus from physical distribution to logistics was a kind of revolution from the point of view of capital also. This new paradigm was crucial for the infrastructural skeleton of capitalist globalization, which relies on the efficient movement of goods across borders. Without the new mobility paradigm brought about by the logistics revolution, the operations of inventory giants like Amazon and Walmart would be literally unconceivable, and the same could be said for globalization in general (Cowen, 2007, 2014; Mezzadra and Neilson, 2019, p.45).

Theoretical and international political developments that were not directly related to logistics were now also shaping the future of logistics. With revolutionary technological developments especially in the information and logistics sector caused the effects of *globalization* and *neoliberalism* to be felt very intensely all over the world. Although we can trace the beginning to the 1960s, the logistics revolution gain its momentum as a result of a number of political factors, including attacks on the welfare state, deregulation, and increased international free trade that began in the 1970s and continued to increase its influence in 1980s (Bonacich and Wilson, 2008). The two biggest names in the political spectrum that would contribute to this acceleration were running their states in the 1980s: Ronald Reagan in the United States and Margaret Thatcher in Britain. The key idea during that time, was to enable the market to function without any interference from the government, both locally and globally. This model was called neoliberalism outside of the United States, and it came to be known as the “Washington consensus” because the United States pushed it so hard to other countries via international organizations such as the

International Monetary Fund (IMF) and the World Bank (WB) (Emmerij, 1997, p.48; Sheppard and Leitner, 2010).

2.4 Logistics 3.0: Business Logistics & Supply Chains (1980-2010)

With the growing effects of globalization and liberal economy, the advancements in the field of information technology (IT) were gaining speed and showing their impact on logistics technologies, both directly and indirectly. The integration of IT systems, such as Warehouse Management Systems (WMS) and Transport Management Systems (TMS), significantly improved the automation and management capabilities of logistics (Paksoy et al., 2021). With these theoretical and practical developments, the tracking and control mechanism in the logistics process is strengthened and the presence of logistics in the economic field begins to be increasingly felt.

Globalization and neoliberalism have had positive effects such as creating new markets and opportunities for politicians and the business world to evaluate. However, they have also had negative effects that cannot be ignored. The pursuit of economic growth and the expansion of international trade can come at the expense of environmental concerns (Foster and Magdoff, 2011). For instance, if we need to illustrate within the logistics sector, when a company outsources manufacturing to countries with weaker environmental regulations it can lead to increased pollution in those countries. Additionally, the transportation of goods around the world can contribute to *greenhouse gas emissions*.

The greenhouse effect was discovered in 1820s when Joseph Fourier (b.1768, d.1830), a French physicist, noticed that the Earth's temperature was warmer than expected given the amount of solar radiation it received (Fleming, 1999; Mikhaylov et al., 2020). He hypothesized that the Earth must be retaining some of the heat it receives from the sun. In the late 1850s, John Tyndall confirmed Fourier's hypothesis by conducting experiments that identified certain gases, such as carbon dioxide and water vapor, as being especially effective at trapping heat in the Earth's atmosphere (Hulme, 2009).

After a century, between the 1970s and 1990s, individual studies on climate were carried out instead of joint studies contributed by many scientists under the supervision of organizations like the United Nations, such as the Intergovernmental Panel on Climate Change (IPCC, est. 1988) that exists today. While a group of researchers meticulously studied carbon dioxide emissions using newly developed methods, they concluded that the increase in carbon dioxide in the atmosphere would cause global *warming* in the long run. Another group examined aerosols and suggested that the world's climate *cooled* from the 1940s to the 1970s, leading them to conclude that global cooling awaited us (Peterson et al., 2008). In December 1972, climate researcher Reid Bryson addressed the American Association for the Advancement of Science, comparing the current state of scientists' knowledge of climate change to the old metaphor of blind men describing an elephant. Fortunately, according to a study published in 2008, between 1965 and 1979, 44 scientific papers predicted warming, 20 were neutral, and only 7 predicted cooling. Therefore, even at that time, the majority of scientists were forecasting warming even though predictions of cooling received more media attention (Peterson et al., 2008). To some extent, we know that we were in the Anthropocene period and that this order we created would have a comeback for us. But we still haven't reached a consensus on what form and extent this will be.

Carl Sagan (b.1934, d.1996), who testified to Congress on climate change in 1985, expresses his belief that we need to act quickly in the face of this problem with these words (Sagan, 1985):

“...The power of human beings affects, control and change the environment is grow as our technology grows. At present time we clearly have reached the stage where we are capable both intentionally and inadvertently to make significant changes in the global climate and in the global ecosystem. [...] Because the effects occupy more than a human generation there is a tendency to say that they are not our problem. Of course; they are nobody's problem! Not on my tour of duty, not on my term of office; it is something for the next century, let the next century worry about it. But the problem is that there are effects, and greenhouse effect is

one of them, which have long time constants. If ypu don't worry about it now it's too late later on and so in this issue as in so many other issues we are passing on extremely grave problems for our children when time to solve the problems if they can be solved at all is now."

The conclusions of the experts, who started to make long-term predictions about the future for the first time after the two world wars, were often pessimistic. Reports and books about humanity's uncertain future have appeared regularly over the years. In 1972, The Limits to Growth (LTG) study was published by a group of Massachusetts Institute of Technology (MIT) system analysts. The study was commissioned by Club of Rome (est. 1968), which is a non-profit organization of business leader and intellectuals whose focused on having critical discussions about important global issues. The study takes a somewhat Malthusian⁸ approach.

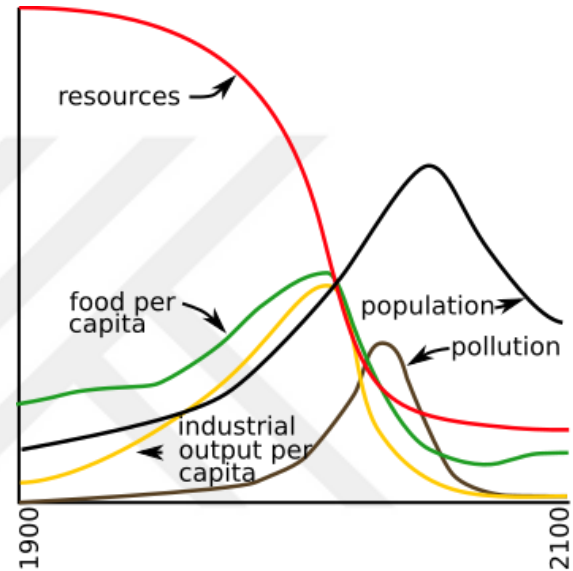


Figure 2.4: "The world standard model" described in The Limits to Growth, 1972 Source: Meadows et al. (1971)

But it does not make a simple calculation based on only logarithmic and arithmetic functions like Malthus. They used, what they called *World3* model (Figure 2.6). Which is used a relatively complex model that included population, food production, industrialization, pollution, and consumption of non-renewable natural resources parameters into the equation to simulate the consequence of interactions between the earth and human systems (Meadows et al., 1971, p.21). Many people criticized LTG as soon as it was published. Most of the critics found the MIT data pessimistic, emphasizing the variability of parameters such as the 'resource' of the model, and stating that some calculations led to false findings (Jahoda et al., 1973). LTG was raised awareness of the finite nature of Earth's resources and the need for sustainable development. The study also

⁸ Thomas Robert Malthus (b. 1776, d. 1834), argued that it is pointless for humans to have infinite hopes for social happiness since the population will inevitably grow faster than the means of production if it continues at the same pace as it did. Population growth will occur at a faster rate in a geometric progression while the means of subsistence will only increase in an arithmetic progression at a slower rate.

led to changes in government policies and corporate practices. For example, the United States government established the Environmental Protection Agency in 1970, and many companies began to adopt more sustainable business practices.

The rapidly developing sensitive concerns of future resource consumption and environmental probes would also affect the business world. In between the 1970s and 1990s, there was an explosion of published theories on business science in academia. Although its origins can be traced back to the 1940s, the framework of *Corporate Social Responsibility (CSR)*, one of the theories that could be put into practice in the 1980s with the approach of Archie B. Carroll (1979) that brought together experts in this field. The study could be considered quite progressive for its period. And it would play a major role in the importance of green/today's logistics framework (Agudelo et al., 2019; Carroll, 1979).

In 1980, *Overshoot* by William R. Catton (b.1926, d.2015) was published. Catton was originally a sociologist. He is known for his scholarly works in environmental sociology and human ecology areas. Catton, in *Overshoot*, portrayed the Western consumer culture, “a lifestyle hyper-focused on spending money to buy material goods”, as *Homo Colossus*. This definition illustrating the extreme energy user. Catton argues that the classical economist point of view is disconnected from the realities of the physical world. Our natural resources are not infinite and their reproduction by nature is much slower than human consumption rates (endofempire79, 2008). Catton traces back relevance of such ecological concepts including the fundamental ecological principle of carrying capacity, reaction, succession, climax, food chain and dominance to understand ecological systems and ecological limits (Catton, 1980, p.3).

The World Watch Institute published the first State of the World book in 1984, followed by 33 more books until 2017. The institute was founded by Lester Russel Brown (b. 1934), an American environmental analyst. The main thesis of the first book was that the economy would grow slowly in the future. However, if the rate of depletion of oil and topsoil reserves continues, it could lead to economic and political problems (Ellington, 1985). The series examined the biggest environmental problems, as well as other critical

issues on the planet, such as urban development, global security, consumer culture, and sustainable government policies.

In 1986, The German logistician Gösta-Bernd Ihde (b.1938, d.2021) took Marshall's (1980) concept of creating economic value one step further and suggested that production itself actually means *transformation of matter* and constitutes a kind of activities of the transfer of things *in space* through transportation, *in time* through storage and warehousing and *in order* through parcelling, consolidating/deconsolidating, patterning.

In 1987, Our Common Future, also known as the “Brundtland Report”, was published by the United Nations’ World Commission on Environment and Development. The report popularized the term “sustainable development” what it described as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (United Nations and Brundtland, 1987). The publication of Our Common Future and the work of the World Commission on Environment and Development helped to create a global awareness of the need to address environmental issues and led to the adoption of Agenda 21, the Rio Declaration, and the establishment of the Commission on Sustainable Development. In 1988, Helge Ole Bergesen who was a Norwegian political scientist, suggested from a skeptical perspective on the report published the previous year that some people in the Third World see this report as being part of a Western effort to control the internal affairs of developing countries in the name of environmentalism. Which he named as ‘*green imperialism*’ (Bergesen, 1988).

Fast forwarding to today, Climate Transparency Report (2020) found that Canada is one of the worst emitters on a per capita basis. The report also found that southern nations are already suffering from the worst impacts of climate change, and that this is due to the lack of research being done in the global south. According to a study published in Nature in 2020, less research is being conducted on climate change in the global south, despite the region being highly vulnerable to the worst effects of climate change and also has the smallest carbon footprint (Callaghan et al., 2021). As shown as below in Figure 2.7, the region also has the smallest carbon footprint despite its high population. A recent study found that the Global North is responsible for most of the climate change, exactly 92 percent, on Earth (Hickel, 2020). At COP26 (The 2021 United Nations Climate Change

Conference), the Nordic and Baltic countries proposed that the World Bank should fund eco-friendly energy solutions in developing nations, including “green hydrogen” and “smart micro-grid networks”. Meanwhile, Norway continues to extract petroleum and planning to taking over the top position from Russia as the largest energy supplier for Europe (Humpert, 2023).

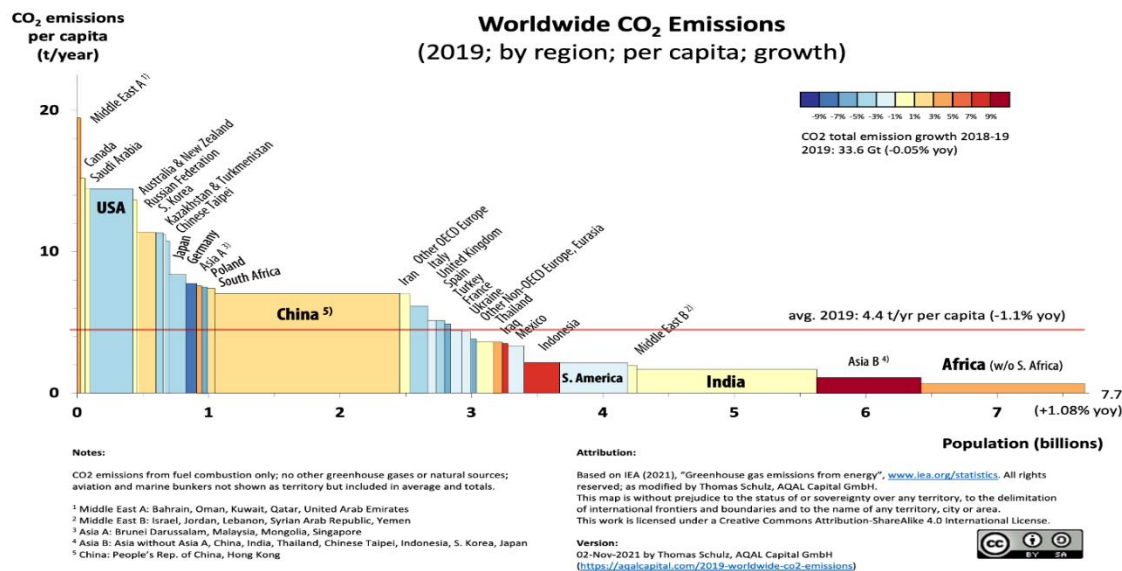


Figure 2.5: Worldwide CO₂ Emissions by region per capita (2019). Credit: Tom Schulz (October 31, 2021).

During the same period of growing concern about climate change, which became more popular than ever before, The Intergovernmental Panel on Climate Change (IPCC) was established by the United Nations in 1988. The IPCC is an internationally accepted organization that is responsible for studying the risks of climate change. They considered the leading authority on the topic. They make their findings available to policymakers so that they can take the appropriate action to protect the environment. The panel does not produce its own science. They analyze all relevant scientific papers published in the field of climate change and make clear and practical implications for politicians. They publish an extensive report almost every 6 years, including their conclusions from their analysis, their predictions, and their own findings. While the reports steer clear of being overly policy-prescriptive, they are intentionally “policy-relevant,” meaning their conclusions can easily be translated into real-world policy outcomes. This includes the natural, economic and social impacts and risks. It also covers possible response options.

Like climate change adaptation and climate change mitigation. The IPCC has three working groups and a task force, which carry out its scientific work.

World Trade Organization (WTO), was created in 1995 to replace the General Agreement on Tariffs and Trade (GATT) which had expired. After WWII, the GATT was created on a temporary basis and joined other new international institutions related to economic cooperation such as the “Bretton Woods⁹” institutions (now known as the World Bank and the International Monetary Fund; IMF) The economic protectionism was considered as one of the reasons for the WWII. Therefore, that economic agreements could protect peace between the countries. WTO is an international organization based in Geneva that supervises world trade and aim to help to reduce trade barriers between countries. It provides a framework for conduct of international trade in goods and services . The WTO tries to make trade easier with help to negotiate new trade agreements between countries. This could help to lower the prices of goods, which can beneficial for everyone. But some are skeptic about their works because it can promote the interests of large multinational corporations. They also argue that the trade liberalization the WTO encourages can lead to environmental damage and decreased living standards for people in developing countries. As of 2022, the WTO had over 164 member countries.

While the aforementioned developments were taking place in the theoretical and international political fields, the world was on the eve of yet another technological revolution. The internet was opened to the public in 1991. It is developed in the 1960s by the United States military as a way to communicate and share information between different locations. And, it was originally called ARPANET, and was used primarily by military and academic researchers. With the widespread use of the Internet by people and rapid developments in the field of transportation technology, it was realized that the internet could be used as an effective tool for logistics management and coordination. After three years, the first retail transaction on the Internet has happened already between two friends of a Sting CD. The New York Times titled this phenomenon with these words: “Attention Shoppers: Internet Is Open” (Lewis, 1994). And the e-commerce sector was

⁹ The Bretton Woods system was an international monetary system that was established in 1944. It was designed to regulate international trade and finance after World War II. Under the system, countries agreed to peg their currencies to the US dollar, which was convertible to gold at a fixed rate. The system was dismantled in the early 1970s due to economic pressures and changing political circumstances.

born, which will irreversibly affect the logistics industry, both on the consumer and operative side. After almost one year later we would witness the emergence of today's giant e-commerce corporations such as Amazon (est.1995) and eBay (est.1995).

E-commerce has transformed the way businesses and consumers interact by changing brick-and-mortar retail in the past 20 years. Online sales have increased from 0.63% of total retail sales in 1999 to 13.3% in 2021 (Page, 2022). This process, which was super accelerated with the impact of Coronavirus pandemic in 2019, has led to changes in the way goods are produced, distributed, and sold, and it has had a significant impact on the logistics industry as a whole. We can see the reflection of this acceleration in the Figure 2.8 below:

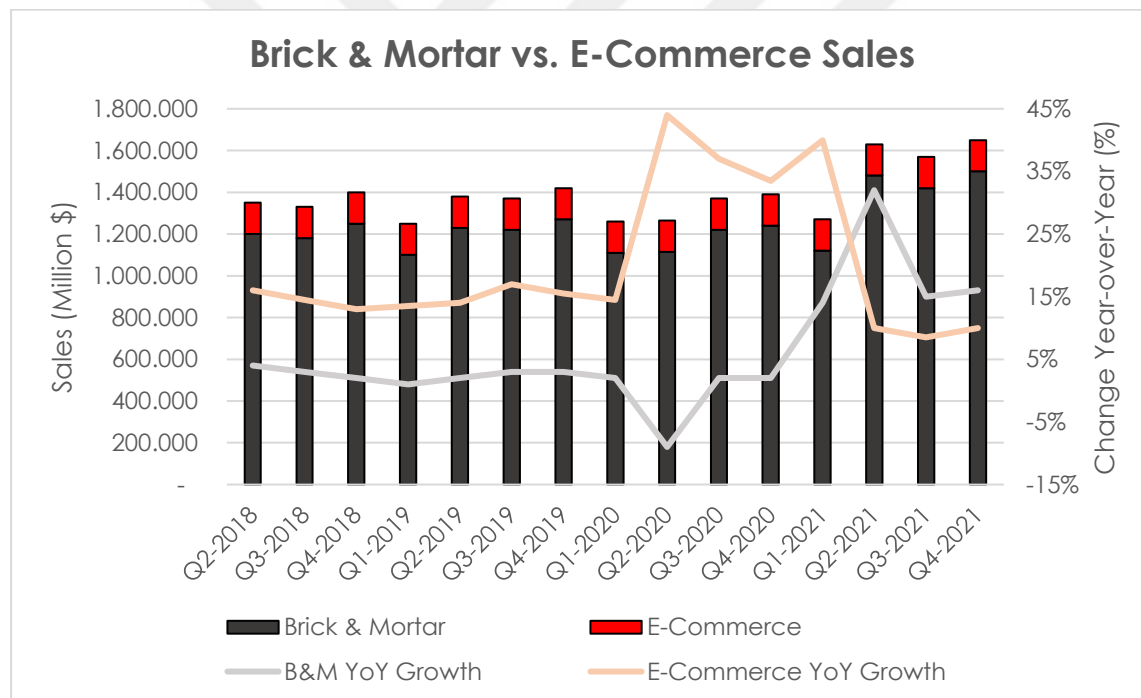


Figure 2.6: Brick & Mortar vs. E-Commerce Sales (2021). Credit: Goldberg (2022)

As the last leg of the transportation and logistics sector is now the final consumer, the developments in this field gained momentum. Two critical technologies, Global Positioning System (GPS) and Radio-Frequency Identification (RFID), became widely used in 1990s. These are very important for the follow-up of the shipments and the healthy progress of the operation processes. GPS is a satellite-based navigation system that allows users to determine their precise location and track the movement of objects (Wang et al.,

2008). In logistics, GPS is often used to track the movement of vehicles and shipments, which can help to improve efficiency and reduce the risk of delays or losses. Although, The United States military began developing the GPS system in the 1970s, and civilian use was allowed in the 1980s. The first production car with a built-in GPS navigation system was released in 1990.

RFID is a technology that uses radio waves to communicate information wirelessly. RFID tags, which can be attached to objects or products, contain information about the item that can be read by RFID scanners. In logistics, RFID tags are often used to track the movement of goods and improve inventory management. Studies in this field analyzed the use of RFID in logistics for the Internet of Things, highlighting the benefits of increased visibility of goods at the data level and reduced errors due to inventory inaccuracies. Also, explored the potential impact of RFID technologies on logistics facilities and found that they could improve productivity, but also noted the existence of significant barriers such as imperfect read rates, high system costs, and security concerns (Sun, 2012; Twist, 2005). The use of these technologies has allowed logistics companies to more accurately track and manage the movement of goods, which can help to improve efficiency and reduce costs. It has also allowed for the development of new services, such as real-time tracking of packages for e-commerce shipments. These technologies have evolved rapidly, along with new emerging e-commerce domain and end-user delivery models.

In 2005, Amazon launched a membership program called Amazon Prime, which provides its members with free two-day shipping on all eligible purchases for a flat annual fee. The program quickly became popular among customers and put pressure on other retailers to offer similar shipping options in order to remain competitive in the market. This move by Amazon not only changed the way consumers shop for products, but also revolutionized the retail industry as a whole. And created one of the major challenges of e-commerce: fulfilling orders in a timely and cost-effective manner. That is requires well organized and planned efficient logistics systems. These requirements led to the development of new technologies and practices for managing inventory, coordinating transportation, and tracking packages. One example of this is the emergence of *fulfillment centers*, which are

large warehouses that store and distribute goods for e-commerce companies. These centers are equipped with advanced technologies such as robotic and RFID systems, and automation to improve efficiency and reduce costs. Online retailers required efficient and reliable logistics networks to deliver goods to customers, leading to the development of new delivery models such as same-day and even one-hour delivery.

2.5 Logistics 4.0: Smart & Integrated Logistics (2010 - ∞)

The shift from traditional logistics to new logistics solutions is inevitable due to the challenges and opportunities presented by today's consumer behavior. Logistics 4.0 is a complex system that includes emerging technologies that work together to meet customer needs and meet the growing complexity of logistical operations. It is closely related to Industry 4.0 and the two cannot be considered separate from each other (Paksoy et al., 2021; K. Wang, 2016).

During this period, the direction of industrial and logistics developments are influenced by several factors, including growing complexity and needs in the manufacturing industry due to technological advancements, competition, international markets, and demand for individualized products with short life cycles. Industry 4.0 is viewed as a way to create supply chains that are cost-effective, adaptable, stable, and sustainable. As well as, the initiative will introduce new business models it also brings flexible mass production, optimize coordination and reduce costs. The field of logistics will undergo substantial transformations, such as enhanced material handling, real-time monitoring of material flows, and improved risk management (Hofmann and Rüsch, 2017).

According to the comprehensive studies conducted in this field, the key components of Industry 4.0, including smart factories, cyber-physical systems, the Internet of Things (IoT), and the Internet of Services (IoS). These components are closely linked and enable a decentralized, automated, and self-optimizing production process. The potential benefits of Industry 4.0 include greater efficiency, flexibility, and individualization of production, but may also lead to significant changes in employee roles and potential job destruction (Amr et al., 2019; Hofmann and Rüsch, 2017; Paksoy et al., 2021, p.353; K. Wang, 2016; Winkelhaus and Grosse, 2020).

After the cold war period, in which liberal and capitalist understanding prevailed, the factor in which states put their weight in international disputes was the power of deterrence (Lebow, 2005). In this direction, advanced and developing states created a kind of 'risk society' that is ready for any situation at any time with massive infrastructure investments. Risk society is a term developed by sociologist Ulrich Beck in the late 20th century to describe a society in which risk is the primary focus. He argues that traditional industrial societies were structured around the production and distribution of goods, but in modern times, risk has become a central concern that shapes the way society is organized (Beck, 2002, p.41). This situation led to states giving weight to policies aimed at maintaining geopolitical and geo-economic power.

Geopolitics and geoeconomics are two distinct concepts that are closely related. Geopolitics is concerned with the military, political, and human resources aspects of a state's foreign policy. It focuses on hard power elements and their influence on a country's policy. In contrast, geoeconomics is a relatively new concept that focuses on economic space, including transportation connectivity, networks, commerce, trade, investment, and financial and economic strengths. Geoeconomics concerns a nation's pursuit of strong economic performance and sustainable economic competitiveness (Yu, 2017).

Despite their differences, geopolitics and geoeconomics are closely intertwined, with the political dimension of geoeconomics strongly intertwined with the competitive economic dimension of geopolitics. For example, China's rising geo-economic power has enabled it to expand its geopolitical influence by leveraging its economic and financial power to expand its strategic and economic interests abroad. The Belt and Road Initiative (BRI), also known as One Belt One Road (OBOR) and *The New Silk Road*, is a global development strategy introduced by the Chinese government in 2013. As can be seen in Table 2.2 and Figure 2.9, it involves investments and infrastructure projects to improve connectivity and cooperation via 6 economic corridors among about 70 countries in Asia, Africa, and Europe. The BRI includes a network of roadways, railways, maritime ports, power grids, oil and gas pipelines, and other infrastructure projects. The initiative expands six economic corridors that connect different parts of the world. It is considered the core of President Xi Jinping's foreign policy. China's One Belt, One Road initiatives and the

establishment of the Asian Infrastructure Investment Bank (AIIB) have made China the center of geoeconomics and geopolitics in the region and beyond. Ultimately, while geopolitics and geoeconomics are different concepts with different meanings, they are closely related, and together they shape a nation's foreign policy and its relationships with other countries (Yu, 2017).

Table 2.2: Belt and Road Initiative corridors (routes) and their scopes.

Economic Corridor	Route Description
“The New Eurasian Land Bridge”	Connects Western China to Western Russia
“The China-Mongolia-Russia Corridor”	Connects North China to Eastern Russia via Mongolia
“The China-Central Asia-West Asia Corridor”	Connects Western China to Turkey via Central and West Asia
“The China-Indochina Peninsula Corridor”	Connects Southern China to Singapore via Indochina
“The China-Pakistan Corridor”	Connects Southwestern China through Pakistan to Arabian Sea routes
“The Bangladesh-China-India-Myanmar Corridor”	Connects Southern China to India via Bangladesh and Myanmar

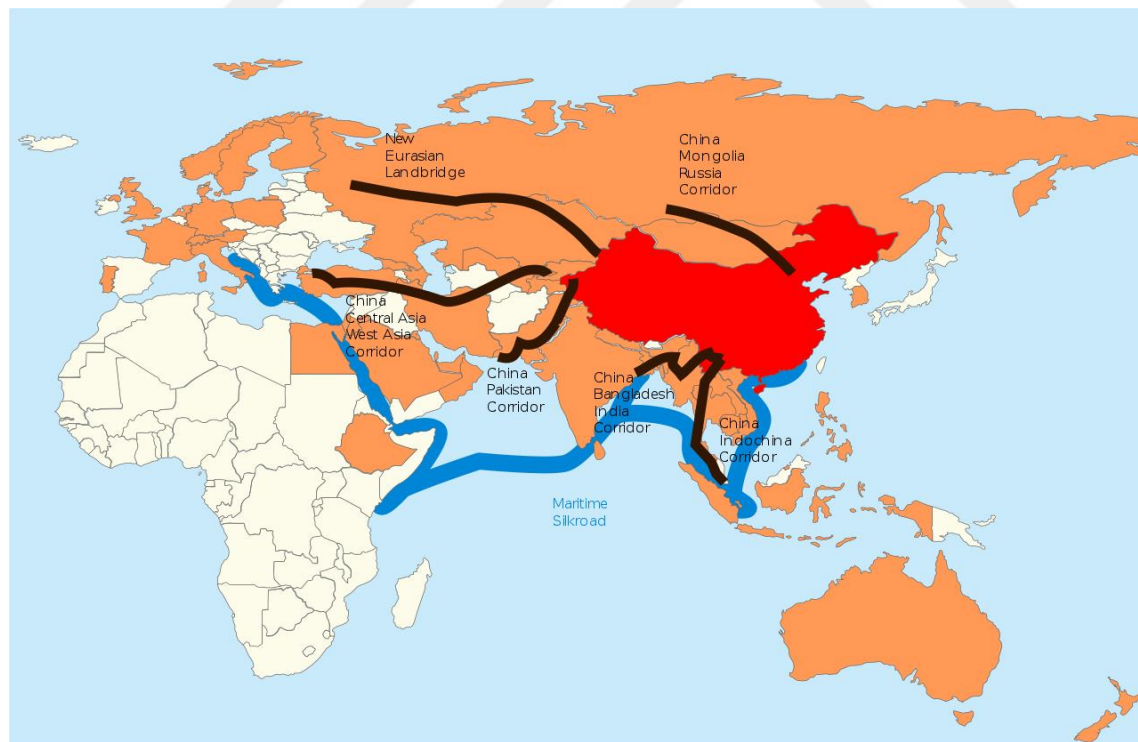


Figure 2.7: “China in Red, the members of the Asian Infrastructure Investment Bank in orange. The proposed corridors in black (Land Silk Road), and blue (Maritime Silk Road)”. Credits: Lommes (May 14, 2017). Retrieved from <https://commons.wikimedia.org/w/index.php?c>

With the China Ocean Shipping Company (COSCO)'s acquisition of the Piraeus Port Authority in August 2016 in line with the China's BRI policy, China has greatly expanded its sphere of influence. President Xi Jinping has praised COSCO's investment in Piraeus as an exemplary project. During his visit to Greece in 2019, Xi inspected the port and sees Piraeus as a crucial hub for China's fast land-sea link with Europe and for connectivity between Asia and Europe (Bali, 2022).

The US perceives the AIIB as a vehicle for China to project its economic influence across Asia and replace the Western-dominated financial architecture with a China-centric regional and international financial system. While Amazon's total carbon footprint grows 18% from 2020 to 2021 as in the previous period (it is grown 40% from 2019 to 2021) according their sustainability report (Amazon, 2022, p. 97); The US government's concerns with the AIIB include doubts about the organization's corporate governance standards, lending procedures, environmental and social safeguards, and potential to challenge the West-dominated international financial order. As a result, the US government has exerted diplomatic pressure on its close allies not to join the AIIB, although some countries such as the UK, Germany, and France have already joined the organization (Yu, 2017).

All these developments were happening quite rapidly and studies were needed on the possible effects and consequences of the use of these political agendas and new technologies. Both the 2000s and 2010s saw the introduction of new regulations related to logistics, such as safety regulations and environmental regulations. However, the 2010s saw a greater emphasis on compliance with these regulations, as companies sought to mitigate risk and demonstrate their commitment to sustainability. In 2010s, the rise of sustainability as a key concern in logistics has led to the development of eco-friendly practices such as electric vehicles and carbon offsetting.

With rapid spread of services that making itself visible directly to the consumer, such as e-commerce, consumers and businesses have become more aware of the environmental impacts of transportation and supply chain practices. Now, the courier companies that came to the door of the consumer to deliver the product had created an awareness, even if it was not intentional. So, the focus on sustainability in logistics has become increasingly

important in recent years. One key area of focus has been the use of eco-friendly transportation, such as electric vehicles and hybrid vehicles, which emit fewer greenhouse gases and other pollutants compared to traditional fossil fuel-powered vehicles. Although this trend in the industry is promising, success has not yet been fully achieved in terms of implementation. According to current research on electric vehicles and carbon emissions, while battery electric vehicles (BEVs) are considered true zero-emission vehicles due to the lack of tailpipe emissions, the actual savings in greenhouse gas emissions from EVs is questionable when the energy used to charge them comes from traditional sources of fossil fuels. The study also points out the technical, economic, and logistical barriers that hinder the expansion of EVs as a replacement for conventional vehicles (Ghosh, 2020). Logistics companies have also adopted practices such as carbon offsetting, in which they offset the carbon emissions from their operations by investing in projects that reduce or remove carbon from the atmosphere. Other sustainability initiatives in logistics have included efforts to reduce waste and improve resource efficiency, such as recycling packaging materials and using reusable containers. The goal of these efforts is to minimize the environmental impact of logistics activities while still meeting the needs of businesses and consumers.

In 2015, The Paris Agreement is the first-ever universal, legally binding global climate change agreement was adopted at the Paris climate conference (COP21). The Agreement includes commitments from all 195 countries to reduce their emissions and work together to adapt to the impacts of climate change. It was drawing a roadmap for developed countries to support developing countries in climate mitigation and climate adaptation. The treaty required countries to publish action plans that would be updated every five years. These plans would be called Nationally Determined Contribution (NDC), and each time a more aggressive course of action was expected. However, it required all countries involved in the agreement to report transparently every five years. The Paris Rulebook, commonly referred to as the operational guidelines for the practical implementation of the Paris Agreement, was agreed upon at the UN Climate Change Conference (COP24) in Katowice, Poland, in December 2018, and was finalized at COP26 in Glasgow, Scotland, in November 2021.

In the report of the IPCC, which was presented after the Paris Agreement, it is emphasized that there is an area that can be improved in the field of logistics, especially in land transport, with technological developments and improvements in planning (Intergovernmental Panel on Climate Change, 2019). Today, the transport and logistics sector is responsible for around 17% of global CO₂ emissions (Figure 2.10). If we don't take strong and effective action, the European Environment Agency predicts that by 2050, logistics will account for up to 40% of global carbon dioxide emissions.

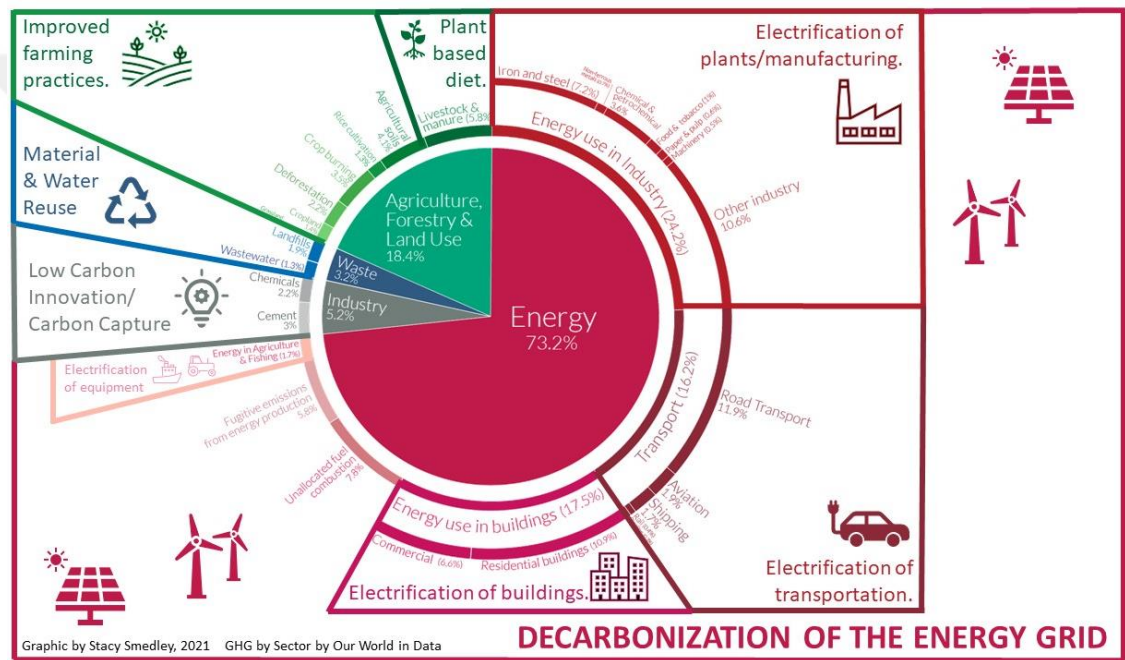


Figure 2.8: GHG emissions and proposed solutions by sector, 2016. Credits: Smedley (2021). Data retrieved and original infographic made by Ritchie et al. (2020).

As of 2023, logistics for all types of flows is a natural and fully integrated part of all types of companies' operations. It plays a crucial role in the global economy and continues to evolve and improve to meet the needs of businesses of all sizes relying on complex supply chains and consumers (Tang and Veelenturf, 2019). Logistics covers more than just transportation, it can cover various activities throughout the supply chain such as customer service, inventory management, waste reduction, order processing, and communication channels. As, Nigel Thrift's description sums this up very well. He defines logistics as "perhaps the central discipline of the contemporary world" (Thrift, 2004).

Given that logistics is so central to nature, people, technology, politics, and commerce, it is not only important for the logistics sector but also for the future of all citizens of the world that this sector, which is indispensable for almost every industry, adopts a sustainable and adaptable structure. Despite its complexity and invisibility, it is crucial that the logistics sector becomes more sustainable and adaptable. Therefore, green logistics applications seem to determine the future of logistics.

The IPCC released its Sixth Assessment Synthesis Report (AR6) on March 20 2023, which took 8 years to complete. The report is a comprehensive scientific assessment of climate change and includes findings from hundreds of scientists. The nearly 8,000-page report details the devastating consequences of rising greenhouse gas emissions, but also highlights pathways to avoid these intensifying risks. The IPCC identifies readily available, and in some cases, highly cost-effective actions that can be taken now to reduce emissions, scale up carbon removal, and build resilience. Despite the rapidly closing window to address the climate crisis, the report affirms that a safe, livable future is still possible. But our trend from implemented policies will probably get us worsened than our 2019 state as we can see in Figure 2.11 below:

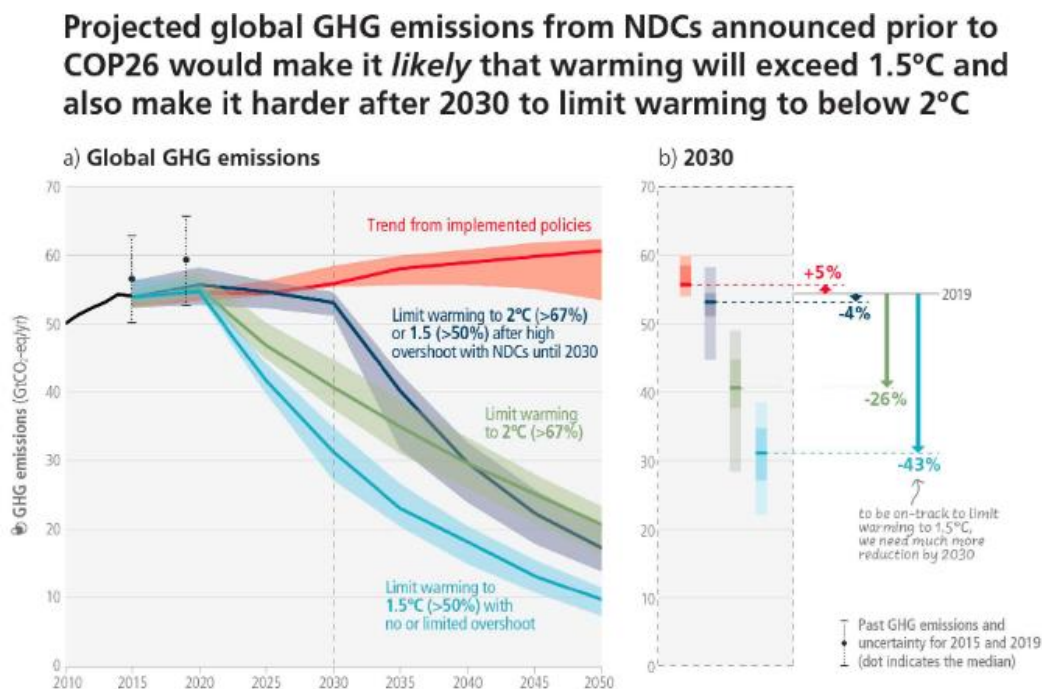


Figure 2.9: Projected global GHG emissions scenarios. Source: IPCC's Sixth Assessment Synthesis Report (AR6, 2023)

3. GREEN LOGISTICS, OR *THE FANTASY OF LOGISTICS*

According to Murphy and Poist (1995), environmental degradation was not a major concern until the 1960s. Most people believed that the environment's capacity to absorb waste and regenerate resources was infinite (Murphy et al., 1995). Expanding from its initial focus on the outbound movement of finished goods (physical distribution) to companies' entire transport, storage, and handling systems (integrated logistics). And finally, with a slightly more holistic perspective, to the interactions with businesses both upstream and downstream movement (supply chain management). This has broadened the focus of research on green logistics in terms of the operations, procedures, and connections examined. The rise in environmental consciousness, the expansion of environmental laws, and the creation of national and international standards for environmental reporting and management are all significant contextual trends that many businesses are now implementing into their corporate social responsibility (CSR) programs (McKinnon et al., 2015). The World Commission on Environment and Development, established in 1987, highlighted the importance of environmental sustainability as an international goal, leading to increased attention to environmental issues in politics and economics. The transportation industry is a significant contributor to environmental degradation (Frewer, 2017; Mikhaylov et al., 2020), and logistics was seen as a way for the industry to become more environmentally friendly (McKinnon et al., 2015). In the 1990s, there were many studies, reports, and opinions on how to incorporate environmental concerns into logistics. This decade was referred to as "the decade of the environment". Although its history dates back to the early 1990s, the period in which green logistics movement or environmentalist studies in the field of logistics will gain its momentum in 2010s. Only 45 papers out of 2,026 (2.2%) dealt with environmental issues, according to Aronsson and Huge-Brodin (2006)'s analysis of 10 different logistics, supply management, and transportation journals from 1995 to 2004 (Aronsson and Huge Brodin, 2006).

There is a strong connection between *the logistics revolution* and *green logistics*. As the advances in technology and logistics management that have occurred during the logistics

revolution have made it possible to optimize the logistics process in a way that reduces its environmental impact. For example, the use of advanced transportation management systems can help companies to plan routes more efficiently, reducing the distance that goods need to be transported and the amount of fuel that is consumed. Similarly, the use of digital platforms for coordinating the movement of goods can help to reduce the need for physical transportation and the associated emissions. The adoption of advanced technologies can support the implementation of green logistics practices and help logistics companies to reduce their environmental impact while also improving efficiency and competitiveness. Big data analytics can enable logistics companies to optimize their operations and reduce their environmental impact through real-time monitoring and data-driven decision-making. Advanced technologies can also help logistics companies to reduce their energy consumption and greenhouse gas emissions by enabling more efficient routing and scheduling, and by enabling the use of alternative fuel vehicles. In addition, the adoption of Logistics 4.0 can also facilitate the integration of environmental considerations into the design and planning of supply chain networks. For example, the use of advanced analytical tools, such as life cycle assessment and carbon footprint analysis, can help logistics companies to identify and prioritize opportunities for improvement in terms of sustainability.

Green logistics can have various definitions depending on the perspective of the researchers. It is generally defined as a sustainable approach that balances economic, environmental, and social issues in logistics operations. Some studies view it as a combination of activities involving the management of material and information mobility, reduction of carbon emissions, and making supply chain activities more environmentally friendly. On the other hand, others define it as a management approach that considers the interests of all components and ensures the sustainability of the environment while aiming for economic growth (Barut et al., 2023). The different stages of logistics operations have different sources of pollutants, and the definition of green logistics varies depending on the scope of focus. In general, green logistics aims to reduce the negative environmental impacts of logistics activities, such as high carbon emissions and disposable packages. The reason for multiple definitions is that researchers evaluate logistics from different perspectives.

Looking at the practical reasons, as concerns around climate change are rising globally, and with the arrival of some international sanctions, logistics companies have started looking for ways to reduce their carbon footprint. It is these concerns that gave birth to green logistics. As Cowen (2014) points out that the corporate fantasy of logistics includes "green" cost savings, indicating that the concept of green logistics emerged as a result of a growing concern for environmental sustainability. It is a relatively new within the concept of logistics, but rapidly evolving subject. We will refer green logistics practices as ***the practice of designing and managing the logistics process in a way that is environmentally sustainable***. It includes all attempts to minimize the ecological impacts of logistic activities. Green logistics consists on applying eco-friendly strategies that mitigate the emissions of CO₂ and other pollutants the supply chain produce. Some popular strategies include building strategically located warehouses, recycling waste, using biodegradable packaging, use of renewable energy and electrical fleets. By implementing green strategies and technology, logistics companies can make international trade a more sustainable activity. Carbon offsetting is a must and a popular form of application when it is come to action. Because, as well as various large investments, it also includes actions that can yield cost-effective results with solutions such as various route improvements, training of technicians, and minor improvements to be applied in equipment.

Logistics companies can somewhat control carbon emissions with the improvements we have mentioned above. These measures are generally referred to as 'low hanging fruit' because their applicability and return on investment are high in the short and medium term (Mckinnon, 2010). However, to what extent do these measures serve to achieve national and international targets? Will the measures taken by logistics companies be sufficient to achieve the goals set by the IPCC for 2050? Or are these measures used as a form of *greenwashing*?

Greenwashing is the practice of making an organization or product appear more environmentally friendly than it actually is (de Freitas Netto et al., 2020). This can happen when companies engage in ethical consumption or virtue signaling, but do not actually

make any significant changes to their operations. For example, a company might sell "fair trade" coffee, but continue to use unsustainable farming practices.

In the context of logistics, greenwashing can occur when companies claim to be using green logistics practices, but these practices do not actually have a significant impact on their environmental footprint (de Jong et al., 2020). For example, a company might claim to be using electric vehicles for deliveries, but these vehicles may only make up a small percentage of their fleet.

It is important for companies to take steps to reduce their environmental impact. But if we want to make progress in line with our targets, we should develop comprehensive and holistic policies rather than isolated policies focused solely on green practices of logistics.

The applications developed on green logistics in the theoretical sense are now accepted as one of the basic approaches in this field, probably because they have gained a place in the practical sense *or created a new commercial area*. At the beginning of the thesis, I mentioned the 7R description while defining the logistics. The definition of 7R has been in the book since the first edition of “*The Handbook of Logistics and Distribution Management*” in 2014 (see Figure 3.1), which is considered one of the most competent resources in the field of logistics management. In 2022, with the addition of "rights of ethics & environmental standards", 7R leaves its place to 8R (see Figure 3.2):

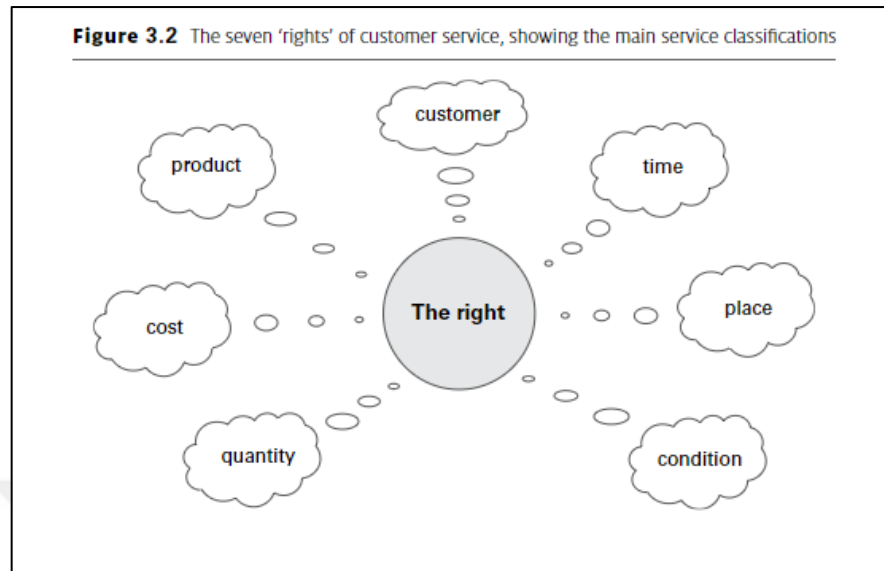


Figure 3.1: Seven 'Rights' of customer service according to 6th edition of The Handbook of Logistics and Distribution Management

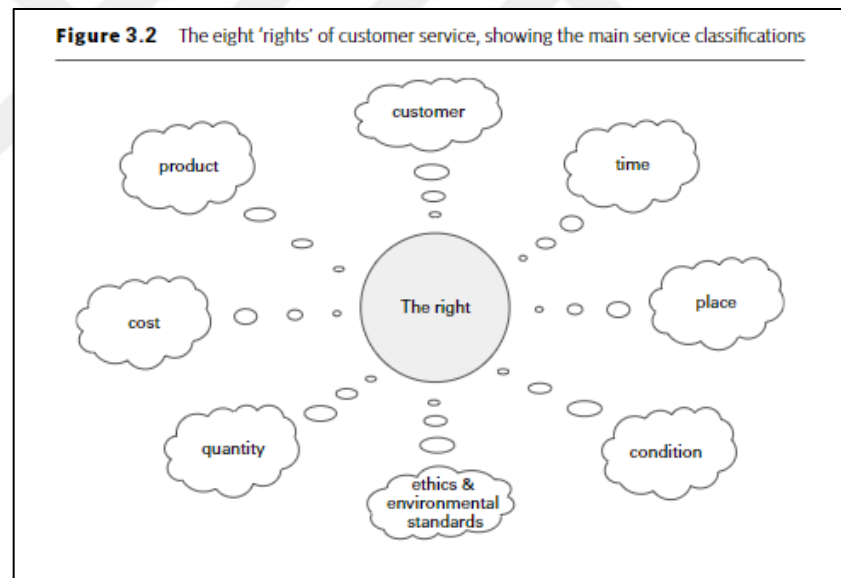


Figure 3.2: Eight 'Rights' of customer service according to 7th edition of The Handbook of Logistics and Distribution Management

It is important to gain a quick awareness in this area. Because, according to the report published by The International Council on Clean Transportation (ICCT) in 2017, **only** international shipping, if treated as a country, would be the sixth largest emitter of CO₂ in 2015 as can be seen in the Figure 3.3 below (Olmer et al., 2017):

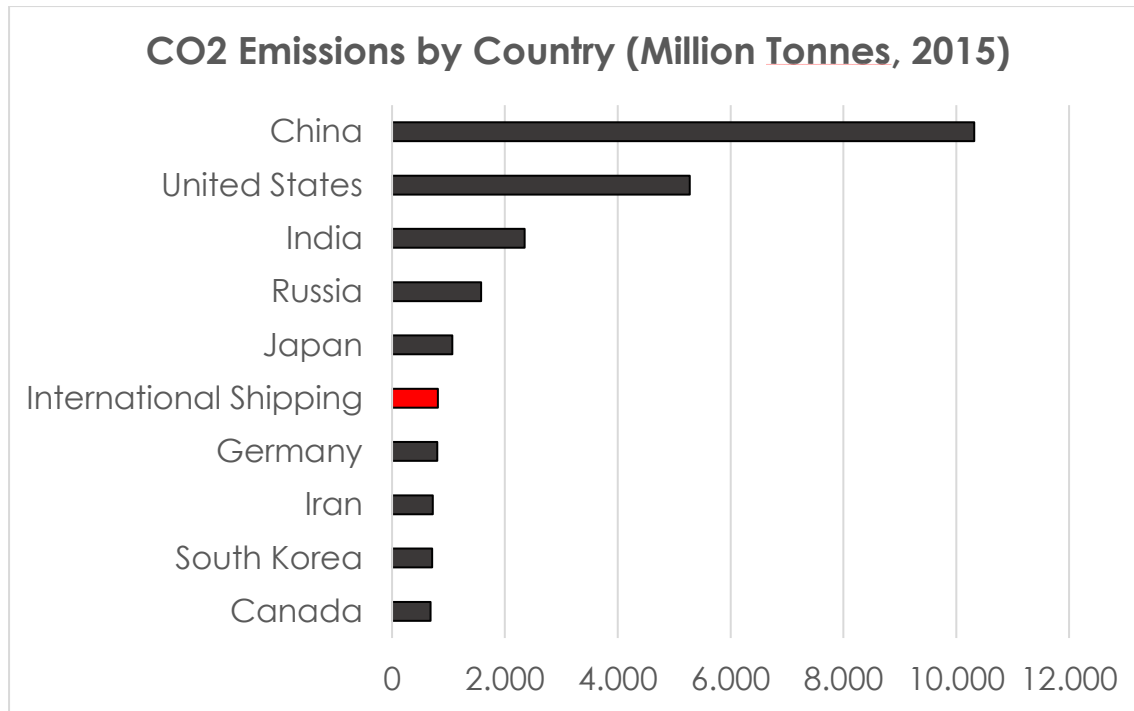


Figure 3.3: ICCT's "Greenhouse Gas Emissions from Global Shipping" Report (2017)

Considering that the improvements to be made in logistics in terms of carbon emissions will directly and indirectly affect other sectors, it is obvious how important this issue is. According to the reports prepared in 2022, the size of the global logistics market was measured as 8.4 trillion euros in 2021. In 2027, this volume is expected to exceed 13.7 trillion (Statista Research Department, 2022). The share is remarkable and the competitiveness top notch.

Although, we largely believe that the shift of logistics towards sustainability is not only a sectoral innovation but also a responsibility for the future of our planet, we are facing some difficulties in putting the developed methods and practices into practice. According to McKinnon et al. (2015), performance studies should not only focus on environmental measures, but also consider economic and social measures for a more comprehensive evaluation (McKinnon et al., 2015). Similarly, Zhang (et al. 2020) proposed the main factors that influence the effectiveness of green logistics policies (GLP) as: (1) Perfection of the GLP system, (2) green governance capacity of government, (3) level of perception

of logistics enterprises on GLP, (4) level of social supervision, (5) development level of the logistics industry.

The research finds that the effectiveness of GLP is influenced in distinct ways by various factors, and it proposes a comprehensive model that outlines the antecedents of GLP effectiveness, revealing how these influencing factors work and their internal mechanisms (Figure 3.4). Understanding these factors and their relationships will help improve the effectiveness of GLP, upgrade green logistics, and achieve green development (Zhang et al., 2020).

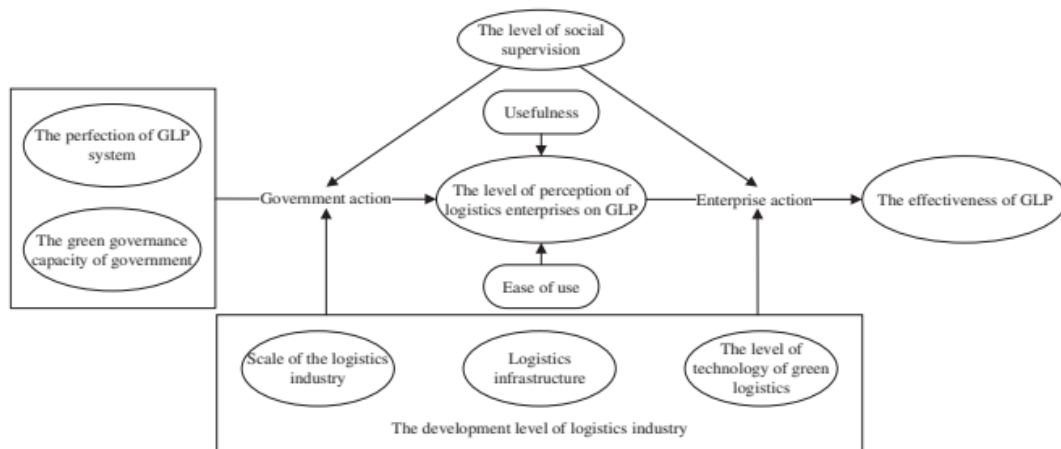


Figure 3.4: The model of influencing factors of the effectiveness of GLP. Credits: Zhang et al. (2020)

Similarly, Seroka-Stolka (2014) points that the environmental awareness of managers is one of the easiest ways to achieve standards on climate action other than pressure through legislations from states (Seroka-Stolka, 2014).

Pazirandeh and Jafari (2013) discussed whether the results of a study on the impact of “greening” transport operations on logistics efficiency and effectiveness. The study found that the paths leading from greening transport operations did not have a statistically significant impact on either logistics efficiency or effectiveness. This means that the hypothesis that greener transport operations would positively affect performance could not be supported.

However, the study also used structural equation modeling to examine indirect effects between latent constructs. The results showed that the sustainability strategy had an indirect positive significant effect on both logistics efficiency and effectiveness, mediated through the two greening transport constructs. In other words, in addition to the direct effect of greening measures on performance, the sustainability strategy also had an indirect effect (Pazirandeh and Jafari, 2013).

Some of recent works like Kurbatova et al. (2020) suggested that Many countries face challenges in balancing economic interests with environmental concerns, including unstable economies, outdated infrastructure, and insufficient development of eco-friendly industries. Solutions include investing in innovative logistics centers, improving legal culture and environmental awareness, and developing government incentives for eco-friendly businesses. International cooperation is also needed to establish a unified legal framework and enforcement mechanisms for sustainable development.

Actually, all the improvement policies and innovative solutions we discussed above starts with assuming that something exists seamlessly: measurability. Actually, measuring the full impact of logistics on the environment is not as easy as it seems.

And if that's the case: wouldn't trying to improve something we can't measure be just a *fantasy*?

3.1 The Technical Difficulty of Measuring Carbon Emission Values

The logistics sector is a provider of logistics services that handles all or some of the logistics needs of a client company, including shipping, warehousing, packaging, and information flow. Many logistics companies use 3PL (third-party logistics) service providers in their networks to meet the needs of their customers. Logistics service providers offer a wide range of services, including transportation and warehousing, that can be complemented by other capabilities, such as material management, information-related services, and value-added services. Many logistics companies have adopted innovative technologies to improve their operations, including information and

automation technologies (Lin and Ho, 2011; Sauvage, 2003). Most logistics service providers have implemented 20 or more initiatives to broaden the scope of their services in order to fully satisfy the growing demand from customers for one-stop shopping (Murphy and Daley, 2001). Many companies are realizing that customers and other stakeholders don't always distinguish between companies and their suppliers, and so they're embarking on significant efforts to establish green supply chain management initiatives (Skjoett-Larsen, 2000; Srivastava, 2007; Zhu et al., 2008). This is important because environmental management is becoming more important in the logistics industry as development speeds up. Although this seems like a positive development; the complexity of the networks here may cause us to reach misleading values in measuring.

Although tracking technologies are developing day by day, there are still many gaps in terms of measuring carbon emissions due to the complexity and multi-part structure of logistics operations. For example, when you transport goods yourself (1PL), you can measure your carbon emissions directly. However, when you use a carrier company (2PL), you have to obtain the carbon emission values from that company. If you use a third-party logistics (3PL) provider, you may need to obtain these values from one or more points. If your 3PL company is working with sub-employers (which is very likely, given that an average logistics provider works with about 20 different companies), the probability of obtaining inaccurate measurement values increases considerably. This problem only becomes more significant when you apply this scenario to 4PL and 5PL logistics operations.

Companies that are accepted as 4PL and 5PL today work with hundreds of different solution partners from many different countries and are members of huge logistics networks such as World Cargo Alliance (WCA) or International Federation of Freight Forwarders Associations (FIATA). These logistics networks charge their members a monthly fee, and in return for this fee, they provide guarantor and mediation services to business partnerships created through their own platforms.

* As the gray area increases, the level of auditability decreases in the eyes of the producer and consumer.

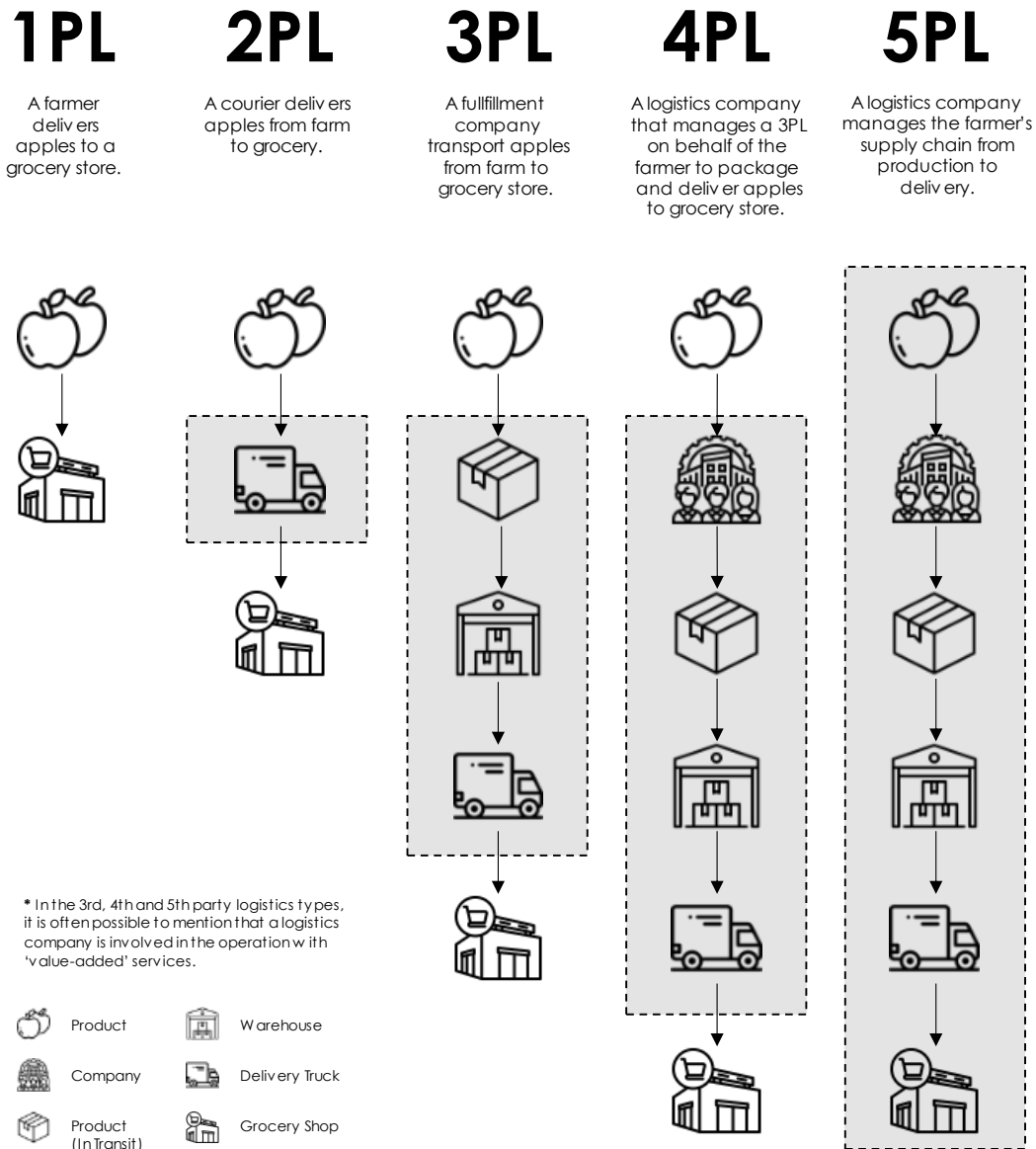


Figure 3.5: Types of logistical ecosystems as of 2023. While creating the figure, Hosie et al. (2012) and Vinay et al. (2009) were taken as a basis.

For instance, imagine you are an industrial manufacturer who needs to ship cargo to another overseas company using door-to-door delivery. You contact a global forwarding company that provides this service and agree with them to pick up your cargo from your

factory and deliver it to the destination address. From this point on, your only point of contact is the forwarding company.

The forwarding company then makes an agreement with a supplier operating in your region to collect your cargo from your factory at the specified day and time. The supplier delivers the cargo to the port to be loaded onto the ship of the shipowner company, which is another contact of the forwarding company. The shipowner company's ticket has already been provided in advance.

The cargo sets sail from the port and arrives at the destination country's port. A local supplier, coordinated by the forwarding company, picks up the cargo from the port and delivers it to the final destination address.

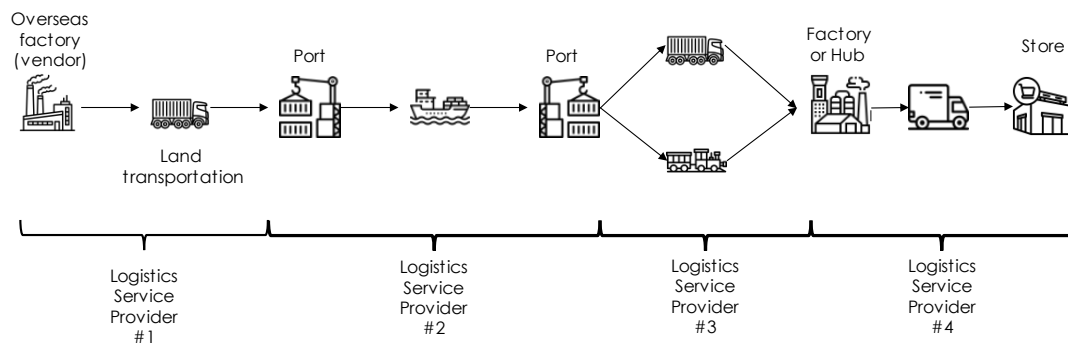


Figure 3.6: An average overseas logistics operation with multimodal/intermodal mode. While creating the figure Farahani et al. (2011; p.72), and Hosie et al. (2012) were taken as a basis.

There are several factors that can affect carbon emission measurements, including the fuel consumption rate of vehicles used for transportation, the weight of the load being transported, transportation speed and whether the route taken is within the city or not. Unfortunately, obtaining accurate data on these factors from subcontractors can be difficult and may lead to inaccuracies. Subcontractors may lack the necessary tools or expertise to measure these factors accurately, leading to incorrect data that can negatively impact the overall measurement process. Additionally, there may be other factors that are not being considered or measured, such as the use of alternative fuels or the impact of traffic congestion (Dekker et al., 2012).

This example demonstrates a successful, smooth, minimalist, and frictionless forwarding operation. It is not uncommon for the operation to deviate from the planned date and time due to supply and delivery of cargo or possible delays at the port. For this reason, almost every international port applies a free waiting time tariff of approximately two days. After that, the expected time is charged per hour. The same is true for waiting times of trucks, but this period is much shorter.

It's worth noting that the forwarding firm managing this excellent example of operation has no self-ownership. All that is needed to coordinate this type of activity is an internet network, a phone, and a contact list. Many large logistics companies have forwarding departments that they coordinate through their extensive networks and local branches. You may believe that you are working with large companies that attend environmental conferences, but unless you specifically state in your contract of carriage that you want to use a self-owned vehicle, the carrier may use a supplier without your knowledge. There are 656 companies that provide international transportation services only registered with International Forwarding and Logistics Service Providers Association (UTIKAD) in Turkey (UTIKAD, 2023). I'm not even counting the companies that only do domestic transportation.

This example highlights the complexities and challenges of measuring carbon emissions in logistics operations. The logistics sector is composed of various service providers, including carriers, freight forwarders, and third-party logistics providers, all of whom contribute to the transportation of goods from one point to another. Each provider is responsible for a specific part of the logistics chain, and the carbon emissions associated with each part must be accurately measured to determine the total carbon footprint of the operation.

However, as the example shows, obtaining accurate data on these factors can be difficult, especially when dealing with subcontractors. The measurement process may be inaccurate, leading to an underestimation or overestimation of the carbon footprint. ***This is where assemblage theory comes in***; the parts that make up the logistics operation, including the carriers, freight forwarders, and third-party logistics providers, may have different goals, values, and cultures. These parts are brought together to form a larger

whole, an assemblage, which has emergent properties that cannot be predicted by looking at the individual parts alone. In the context of logistics, the different parts of the operation may have different approaches to sustainability and environmental management, which can lead to inconsistencies in the measurement process. Therefore, it is important to consider the assemblage as a whole and understand the emergent properties that arise from the interaction of the individual parts.

The logistics sector is a complex and interconnected system, and measuring its carbon footprint accurately requires a deep understanding of the assemblage that makes up the system. By taking a holistic approach and considering the emergent properties of the assemblage, we can better understand the complexities of measuring carbon emissions in logistics operations and work towards more sustainable and environmentally friendly solutions.

3.2 The Social & Political Difficulty of Measuring Carbon Emission Values

The effectiveness of green logistics policies, which aim to reduce carbon emissions, is influenced by factors such as the green governance capacity of government, the level of social supervision, and the development level of the logistics industry (McKinnon, 2010; McKinnon et al., 2015; Zhang et al., 2020). These factors suggest that measuring carbon emission values in logistics can be challenging due to the various actors and stakeholders involved, including government agencies, logistics enterprises, and society. The implementation and effectiveness of policies and measures may also be affected by social and political factors, such as public perception and support for environmental protection, as well as government priorities and resource availability. Measuring carbon emission values in logistics requires a comprehensive understanding of the social and political context, as well as the technical and scientific aspects of carbon measurement. (Zhang et al., 2020)

Green logistics aims to reduce the negative environmental impacts of logistics activities such as high carbon emissions and disposable packages. Its goals include reducing the environmental damage caused by the purchase of energy, equipment, and materials

needed while carrying out logistics activities. To create a more environmentally friendly production process, it is necessary to use eco-friendly materials and reduce the use of disposable packaging. Additionally, pollution caused by transportation activities should be minimized by reducing the amount of polluting gases released. These goals can be achieved through the transformation of logistics activities to more environmentally friendly actions like using non-polluting vehicles, redesigning all stages of the supply chain with an ecologist approach, and implementing sustainable logistics operations including greener packaging and routing. It is also essential to implement policies to reduce emissions, encourage the logistic industry to replace its operation with carbon-free ones, and use green energy in logistics operations to improve economic development. Government policies and regulations, play a crucial role in facilitating the development and adoption of green logistics practices. Governments and companies must work together to ensure a more ecologically sensitive business environment (Balcombe et al., 2019; Barut et al., 2023).

Klaus and Müller (2012) discuss the challenges faced by logisticians in managing supply chain relationships in turbulent environments. Effective flow management requires consideration of various factors beyond physical materials and information flows, such as interpersonal relationships, coordination, governance, and contractual arrangements. Advanced supply chain management should consider four types of relationships: materials flow, information flow, social relationships, and institutional contractual and formal-organizational arrangements. Additionally, Experts should assess the level of complexity that can be managed within hierarchical organizational units and determine the most effective ways of combining loose and tight coupling mechanisms between network actors and units in the face of high uncertainty and environmental turbulence. Logisticians should apply the right incentives and controls in agent relationship networks where information is unevenly distributed, and consider externalities in complex decisions about systems architectures (Klaus and Müller, 2012). We have seen from other sources that it is necessary to combine *the right things in the right ways* when defining a good logistics operation (Rushton et al., 2022, p.32).

4. ANALYSIS & FINDINGS

Logistics usually offers a self-image that tends to de-politicize all its aspects as technical spheres. Therefore, logistics has long been considered a neutral and merely technical domain. A topic for engineers and the science of management. But today logistics is at the center of a lively field of critical studies which involves geographers and architects, anthropologists and political theorists, designers and scholars. These critical studies examine how logistics and the infrastructure that supports it are integral to the functioning of global capitalism, shaping our economic, social, and political systems by dominating environmental factors. From a critical perspective, logistics is a fundamental subject for understanding contemporary processes of organizing labor, production, distribution, and consumption (Chua et al., 2018; Cowen, 2014; Grappi and Neilson, 2019; Mezzadra, 2016).

As we see in previous chapters, logistics originated from the worlds of colonialism, slave trade, and the military, and was developed to organize, control, and manage the movement and halting of goods. By the 19th century, logistics had evolved into a distinct matrix of rationality, blending historical experiences to create a singular paradigm of efficiency, speed, and dependability. At the mid-19th century, logistics took on its modern form, establishing connections between logistics, finance, and forms of power that are still evident today.

Since the mid-20th century, logistics has evolved from a military science concerned with provisioning armies to a wide-ranging science of circulation. It is not just limited to the management of supply chains, but also “a calculative logic” and “spatial practice” of circulation that is at the forefront of the reorganization of capitalism and war. The logistics industry has not only changed the transportation of goods, but has also transformed the way space is organized, creating a universal logic of abstract flow that has led to economic and military spatial remaking. This has worsened the existing patterns of uneven geographical development and intensified long-standing processes of dispossession and exploitation (Chua et al., 2018; Harvey, 2006, p.83; Mezzadra and Neilson, 2019, p.190).

Logistics turn itself into an ideology during the 20th century, promoting the idea of a frictionless world without disruptions (Mezzadra and Neilson, 2019, p.107). The logistical ideology serves as a tool to uncover and eliminate disruptions related to labor disputes, natural obstacles, or war events. With the emergence of Toyotism, the "just in time and to the point" mentality became the all-encompassing logic behind the vision of a conflict-free world (Chua et al., 2018; Cowen, 2014a, p.56). This ideology arms itself to gain trust.

Critical scholarship on logistics demonstrates how the processes of production, distribution, and consumption have been expanded on a global scale and woven into complex spatial patterns. This has resulted in a reshaping of the relationship between manufacturing and transportation. From this perspective, logistics works through and reinforces uneven geometries of power. It facilitates and speeds up circulation in some cases, while intensifying containment and fortifying borders in others. (Chua et al., 2018; Cowen, 2007, 2014a).

Today, the concept of green logistics, similar to traditional logistics, presents itself as a depoliticized and technical field primarily driven by private companies. However, relying solely on this approach may not be sufficient to address the complex challenges we face.

By providing an example from the Suez Canal Crisis, which I earlier outlined to demonstrate the vulnerability of logistics operations, it becomes evident that focusing solely on the financial implications of the event necessitates overlooking numerous factors. However, it is important to acknowledge the presence of a multifaceted network of relationships underlying the situation.

When we analyze the Suez Canal Crisis from the perspective of assemblage theory (see Figure 4.1), we can witness the formation of novel social structures, or assemblages. As noted earlier, similar to the intermediary firms and customers within the logistics network reaching the 5PL level in the logistics network, these new assemblages have exerting a considerable influence as key players during the crisis. These relationships highlight the intricate dynamics and complexities that must be navigated to effectively tackle the challenges we encounter.

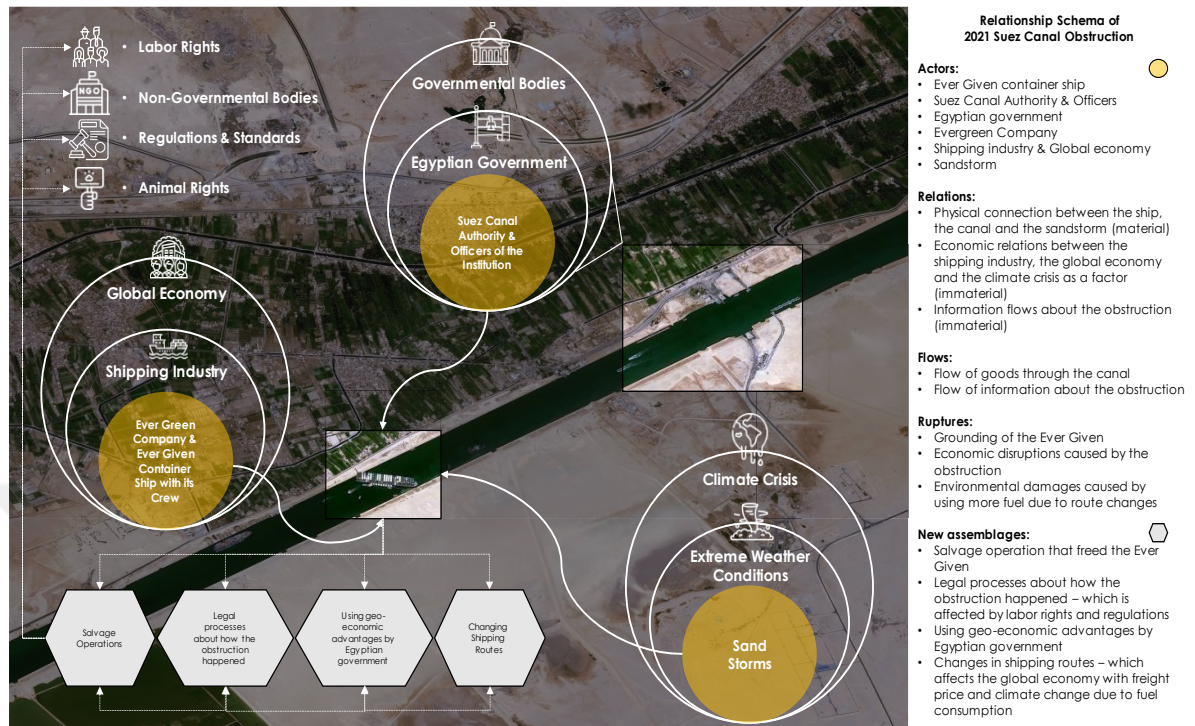


Figure 4.1: Relationship Schema of 2021 Suez Canal Obstruction. Background satellite image source: Cnes 2021, Distribution Airbus DS

It should also be noted that, in the Suez Canal obstruction, there is no negative situation directly caused by green logistics practices. However, there is an alternative cost due to a number of systematic flaws that are neglected by those LSPs who think that they can achieve improvement by concentrating only on green logistics.

When we examine the event in terms of social relations, there are some allegations made against the crew members of the Ever Given by The Suez Canal Authority (SCA). SCA claimed that the captain of the ship had entered the canal during poor weather and high winds, and that this had caused the ship to lose control and run aground. The SCA also alleged that the crew had not been properly trained in how to navigate the canal. In response, accusations were brought against the SCA side that the officers were unprepared and slow, and that they acted to protect their own interests rather than solve the problem (Chellal et al., 2021; George, 2021).

This highlights a systemic flaw within the shipping industry, where governments and profit-driven companies may prioritize cost-cutting measures over investing in adequate training and resources for their workers. The pursuit of profitability often outweighs the

importance of ensuring operational safety and sustainability. While the capacity and the size of ships has maximized to reduce carbon emissions per container transported, the number of crew remains mostly the same. The focus on increasing capacity for financial gain and prestige becomes the preferred approach for private companies. However, as we witnessed during this crisis, it becomes evident that these technical advancements should have been accompanied by a simultaneous focus on enhancing personnel training and empowerment.

Both the Evergreen company and the captain of the Ever Given were influenced by the global economic structure in their decision-making process. Although a sandstorm occurred on that particular day, which could have been a reason to pause, the captain, driven by the financial pressures imposed by the prevailing just-in-time business model in the shipping industry, chose to continue through the canal.

Furthermore, based on data from the voyage recorder, revealed a language barrier between the Arabic-speaking Suez Canal Authority officials and seafarers and the crew of Indian origin who spoke English. It is expected that a team managing such a critical operation would possess strong communication skills, and the inability to communicate in the same language even while technical investments are being made highlights the inadequacy of investment in the human resources behind the scenes.

The event also impacted global trade and highlighted the interconnectedness of economies worldwide. The disruption caused by the blockage affected numerous industries, leading to financial losses and delays in the supply chain. The social implications of such incidents go beyond individual companies and extend to broader economic and societal spheres. The demand of \$916 million by the Egyptian government from the Evergreen company following the occurrence of this incident can be considered as an indication of the enduring significance of geoeconomic policies, which often go unnoticed when evaluating the actors involved. However, when this offer was subsequently rejected by Evergreen, the amount was reduced to \$550 million, and eventually an agreement was reached for an undisclosed sum (BBC News, 2021b).

Additionally, the blockage disrupted the natural flow of marine traffic, resulting in delays and congestion. There was an irreversible extra pollution with more fuel used. These

disruptions not only have immediate environmental impacts but can also have long-term consequences for marine ecosystems and biodiversity. Considering the environmental aspects within the assemblage theory framework enables a more holistic understanding of the crisis and its broader implications.

Despite all this, if we examine Evergreen's website, we can observe their 11-step action plan aimed at promoting green logistics efforts.

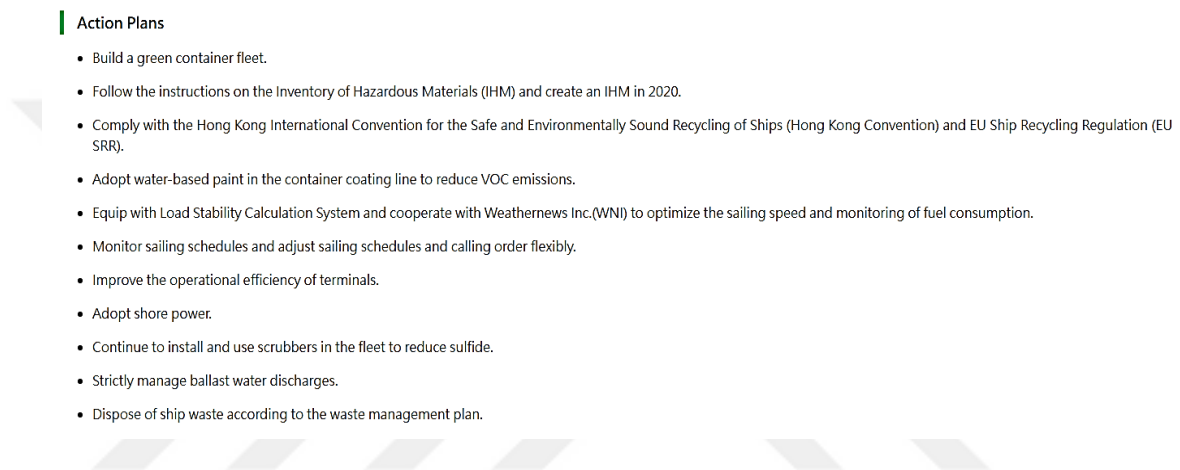


Figure 4.2: Environmental Policy & Commitment by Evergreen Line. Evergreen Marine Corp. (2021b)

The company's performance and target report, specifically the 2021 Evergreen Sustainability Report Chapter 3 on Green Shipping (Evergreen Marine Corp., 2021a), provides valuable insights on how they improve their workflow and equipment to contribute their sustainability targets. Although the data presented in the report showcases significant improvements, it should not be overlooked that they only mention The Suez Canal incident on page 39 of the report, in the customer relations section.

According to Chua et al. (2018), critical approach to logistics is characterized by three core commitments: (1) "a rejection of the field's self-depiction as an apolitical science of management, with a commitment to highlighting the relations of power and acts of violence that underpin it"; (2) "an interest in exposing the flaws, irrationalities, and vulnerabilities of logistical regimes"; and (3) "an orientation toward contestation and struggle within logistical networks." Overall, logistics is facing new types and levels of

opposition, but it is still possible to challenge the status quo, explore alternative logistics approaches, and move beyond the current supply chain capitalist system.

Using Deleuzean assemblage theory, the logistical paradigm of the post-18th centuries can be viewed as a complex and dynamic network of interconnected entities and processes that work together to enable global power operations. This approach helps us recognize the complexities involved and emphasizes the need for a multidimensional solution. To address the challenges of green logistics effectively, it is imperative to foster collaboration between private companies, regulatory bodies, and stakeholders to prioritize safety, sustainability, and the well-being of both humans and the environment. We can't think logistics or green logistics as a separate entity. While this paradigm may seem efficient and reliable, a critical approach reveals some troubling aspects of this network.

1.1. Logistics as a Tool of Military Expansionism & Profit-driven Private Corporations

The 21st century is characterized by a complex network of entities and processes that enable global power operations. This network, however, also facilitates the projection of power and the imposition of imperialistic agendas. This can be seen through the lens of logistics, which can be put into action as *extrastatecraft* through intense power relations fueled by both state and private companies. Aside from the military origins of logistics that we have explained in detail in previous sections, there have also been recent cases where logistics has emerged as an integral function of military forces. One example of this is the direct use of logistics in military operations.

A prominent example is the 2003 invasion of Iraq, which highlights how the assemblage of logistics, military, and political entities can lead to the projection of power and the imposition of imperialistic agendas on vulnerable populations. The logistical system enabled the US military to rapidly move troops, supplies, and equipment into Iraq (Lofgren, 2007). However, it also facilitated the destruction and devastation of the country, leading to the displacement and suffering of its people.

An example of private companies, such as DHL, being involved in post-war rebuilding efforts raises important ethical questions about the relationship between logistics, finance, and forms of power. The reliance on these companies to provide essential services, such as the delivery of critical supplies and equipment, highlights the neoliberal logic of post-war reconstruction, where profit-driven entities are increasingly favored over the state. Officials from DHL announced their plan to invest in Iraq immediately after the lifting of sanctions, stating: "The fact we are able to establish services almost the minute sanctions are lifted is testament to the resourcefulness of our people" (Scoop News, 2003).

Cowen (2014) discusses the transformation of a former military detention camp, Camp Bucca, in Iraq into a logistics city, Basra Logistics City. The camp was the largest U.S. detention camp in Iraq and was infamous for detainee abuse. The transformation of the camp into a logistics city was seamless, and the site was repurposed as a logistics city dedicated to processing goods and oil for transnational corporations. The Northern Gulf Partners, based in New York, will be operating the logistics city on the site for forty years. The company and its investors will not have to pay any corporate taxes or fees for a period of 10 to 15 years as they set up one of the largest centers for corporate petroleum logistics in the world. (Cowen, 2014a).

It is important to note that logistics produces its own spaces. The production of space by logistics is inherently capitalist in nature. However, this capitalist production of space is confronted with powerful tensions and conflicts between spaces of capital, especially logistics spaces, and political spaces. These conflicts arise from the competing interests of profit-driven corporations and communities impacted by the social and environmental consequences of logistics operations.

David Harvey (b.1935), a prominent Marxist geographer and social theorist, has extensively written about urbanization, space, and political economy. In his book "Spaces of Global Capitalism: A Theory of Uneven Geographical Development," he argues that with the emergence of global supply chains, companies are now optimizing the flow of goods and information across vast distances using sophisticated logistical systems and technologies, resulting in vast networks of warehouses, distribution centers, and

transportation infrastructure, which he refers to as “physical landscapes” (Harvey, 2006, p.91).

Harvey believes that these *logistical landscapes* have significant implications for the organization of space and the distribution of power within the global economy. They have the potential to create new forms of uneven development, with some regions and cities benefiting from the growth of logistical activities while others are left behind. Additionally, Harvey suggests that logistical landscapes may give rise to new forms of labor exploitation and social inequality, as workers in the logistics sector often have precarious and low-paying jobs (Harvey, 2006, p.90).

Furthermore, the involvement of private companies in the logistics network raises concerns about accountability and transparency. The profit-driven motives of these entities may clash with the interests of those who are affected by their operations. This highlights the need for greater regulation and oversight in the logistics industry.

1.2. Logistics as a Tool of Suppression of Labor & Extraction of Nature

The unlikely story of a steel box that changed world trading system. Between 1950 and 2010 global shipping tonnage has increased at a rate nearly three times that of world population growth. Modern ships have become like mobile warehouses traveling along predetermined routes between countries of production and consumption.

In fact, as tried to be shown in the previous section, the logistics revolution that started in the 1950s has transformed the world we live in, from changing how goods are manufactured and transported, to altering the way we shop and consume, to influencing the design of our cities and urban spaces. The rise of e-commerce and global supply chains has made logistics an essential component of the digital age, allowing for goods to be shipped across the world with unprecedented speed and efficiency (Levinson, 2016, p.355). However, along with these technological advancements come questions about the environmental and social impacts of the logistics industry, such as the carbon footprint of transportation and the exploitation of low-wage workers in global supply chains.

Containerization has changed the logic of shipping by reducing the costs of loading and unloading, making it more economical to load bigger and bigger ships. This has favored large shippers (importers) over smaller ones because shipping full containers simplifies the shipment enormously compared to less-than-container load (LCL) which requires consolidation of smaller loads and intermediaries who take their cut. Large shippers can fill containers, and their huge volume can push down the cost of transportation, allowing them to gain other types of preferential treatment. Additionally, containerization has led to the rise of intermodal transportation, which has shifted power from the ports to the steamship lines, enabling them to choose the ports they would use based on criteria other than natural hinterland. This process has resulted in overcapacity among some ports and has led to a tendency toward concentration where the big ports get bigger and the small ports lose market share (Bonacich and Wilson, 2008).

As these developments spread over a long period of time and were taken for granted, systematic blindness occurred. Because of that, critical studies of logistics have become increasingly important in understanding the complex and often hidden systems that underpin our global economy. These conflicts can be mitigated through the development of sustainable logistics practices and policies that prioritize the well-being of both corporations and communities. By prioritizing sustainable logistics practices, profit-driven corporations can work towards reducing the negative consequences of their operations on communities and the environment.

The logistics industry places a significant emphasis on surveillance and control, particularly in tracking workers' movements. Cowen (2014) discussed the expansion of efforts to track the laboring body and the development of tracking technologies have made the laboring body's movements visible to the management. The logistics industry aims to accelerate production and distribution systems and ensure secure supply chains, often utilizing securitization methods. Workers' physical bodies are subject to techniques of managerial discipline and control due to concerns about an undisciplined workforce. Various forms of securitization are used to target workers' bodies, including biometric data for security credentialing, surveillance through cameras and maps, and the threat of physical harm from security forces. Moreover, some technologies of "electronic

governance," such as Google's "Map Coordinate," allow employers to track mobile employees in real-time, which has an impact on the spatial and temporal existence of bodies, refining them through a "positive economy" of time that seeks the maximization of efficiencies (Cowen, 2014a).

From the perspective of the blurring boundary between production and circulation, the development of logistics has engendered new relations between the two. Amazon and Walmart are examples of this new relationship. The implications of these new relations between production and circulation are significant for both capital and labor. In the past, distribution was completely subordinated to production. But today, iconic corporations like Walmart and Amazon are confronted with a completely different situation. Their operations would be unthinkable without the logistical global stretching and reshaping of supply-chains. Logistics is a crucial condition for the existence of Amazon and Walmart. Nowadays, supply-chain operations often tend to exercise command over processes of production. This is a dramatic reversal of the traditional situation we associate with capitalism, particularly industrial capitalism. In many cases, production is subordinated to supply-chain operations and distribution, which also means circulation. Anthropologist Anna Tsing (2009) shows how Amazon and Walmart push costs back to producers, allowing them to use any method they want to keep prices at a minimum, which often involves eliminating labor and environmental standards. Although production is crucial and must be performed, how it is performed is, at the end of the day, irrelevant. What is more crucial for companies like Amazon and Walmart is the logistical capacity to synchronize diverse modes of production along the supply-chain, which Tsing refers to as "*piracy*". Piracy, describes "the relation between logistical supply-chain operations and their surrounding economic and social environments as an extractive relation" (Tsing, 2009). This synchronization of diverse labor regimes and modes of production along the supply-chain opens up a critical angle on logistical operations. An extractive moment characterizes the working of logistics today, as well as other capitalist operations, such as finance (Cowen, 2014b).

Labor struggles in logistics, be it in ports or in the so-called gig-economy, are innovative precisely because logistics prompts innovations in the organization of labor and radically

disrupts established statutes and rights. These disruptions in established statutes and rights can lead to both exploitation of workers and new opportunities for organizing and



Figure 4.3: Amazon workers on synchronized global strike. From top left-to-bottom right: (1) one of the posters prepared for the protest; (2) protestors from the USA; (3) protestors from India; (4) another one of the poster prepared for the protest.

advocating for labor rights within the logistics industry (see Figure 4.3). Like factories, ports that now employ thousands of workers together can also become the scene of worker strikes, as seen in the UK's busiest port, the Felixstowe Port. Of the 2,500 workers at the port,

1,900 are unionized workers who protested against the low wage increases they received despite rapidly rising inflation rates by intermittent work interruptions (Bloomberg Television, 2022; The Independent, 2022). After two intermittent strikes, they settled for an 8.5% increase, up from the protested 7%, and a one-time extra payment of £1,000 (BBC News, 2022). At CJ Logistics, one of Korea's largest LSP companies, 1,700 unionized workers (out of a total of around 20,000 workers) went on strike for 63 days due to the low wages and poor working conditions that resulted in the deaths of 16 workers between 2020 and 2021 (Korea Now, 2021). The strikes ended with the agreement of both sides that better working conditions be provided and lawsuits against striking workers be dropped (Dong-woo, 2022).

Similarly, technology-supported tracking applications that aim to increase efficiency, companies' presence on social media platforms within the scope of PR activities, and accessibility policies bring together worker groups that would be difficult to unite and act together without modern communication technologies. During the 2022 Black Friday week, Amazon workers in 40 different countries protested wage increases of 7% despite inflation rates averaging around 11% and difficult working conditions under the slogan #MakeAmazonPay (CNBC Television, 2022; Sweney, 2022).

These examples highlight the potential for labor struggles within the logistics industry, particularly in ports and the gig economy, to challenge established laws and structures. The disruptive nature of logistics operations can create both opportunities for advocating for labor rights and exploitation of workers. Additionally, the use of technology to optimize efficiency and track workers can also bring together worker groups that were previously difficult to unite and organize. The new frontiers of logistical development, essentially associated with the process of digitalization, enable and shape new forms of organization of labor. They blur the distinction between life and work within the dystopic frame of a 24/7 productivity regime. The 24/7 productivity regime of logistics challenges traditional labor laws and structures, leading to innovative forms of labor organization that blur the boundaries between work and personal life. The digitalization of logistics is a driving force behind these innovative labor practices.

The logistics industry's contribution to greenhouse gas emissions and climate change, as highlighted by the recent IPCC Sixth Assessment Report, also underscores the need for addressing labor issues within the industry. The report identifies readily available and cost-effective actions that can be taken to reduce emissions and build resilience, but their successful implementation will require cooperation and coordination with workers and labor unions.

In conclusion, labor struggles within the logistics industry have the potential to challenge established laws and structures, create new opportunities for advocating for labor rights, and have implications for the global economy and society as a whole. The use of technology to optimize logistics operations and track workers also brings together worker groups that were previously difficult to unite and organize. Addressing labor issues within the industry is crucial for building a sustainable and just future.

1.3. Logistics as a Means of Legitimizing Regional Domination

When we look at the analysis studies for the Suez Canal Blockade case in 2021, many of them make some common conclusions by referring to the researches put forward in the past decade (Lee and Wong, 2021). One of these common points is that alternative solutions should be produced for routes that can turn into a bottleneck at any moment, such as the Suez Canal. The Northern Sea Route (see Figure 4.4) stands out as the most optimal of the suggested alternative routes for Asia-Europe trade (Lee and Song, 2014; Liu and Kronbak, 2010). Northern Sea Route (NSR) runs through the Arctic Ocean between the North Atlantic and the Northern Pacific. According to Lee and Song in their work at 2014, the container traffic is forecasted to reach about 29,000 TEU in 2015 and around 3 million TEU in 2030. The share of the NSR would be 1.6 percent in 2015 and 64.1 percent in 2030 under the condition that the sailing cost through the NSR stays at the same level with the cost of the SCR (Lee and Song, 2014). In line with this prediction, in 2022, approximately 1.36 million TEUs used this route (Melkadze, 2023).



Figure 4.4: Potential route for arctic shipping.
Source: The Economist (2018). Data retrieved from Economic Possibilities of Shipping Through Northern Sea Route (Lee and Song, 2014)

In a recent study, two climate scientists from Brown University collaborated with a legal expert from the University of Maine School of Law to forecast how the future regulation of shipping routes may be impacted by the melting of the Arctic Ocean ice. They predicted that by 2065, the Arctic's navigability will have significantly improved, opening up the possibility of new trade routes in international waters, which would diminish Russia's influence over trade in the region while simultaneously lowering the carbon footprint of the shipping industry (Lynch et al., 2022).

The number of container ships traveling the Arctic maritime routes (see Figure 4.5) will increase the amount of melting and black smoke. This, in turn, will affect the polar habitat. Although recent studies suggest that investments and

regulations to be made in this region are to protect the

habitat, what will prevent countries that want to have a say in this new conjuncture from harming the environment? Especially when it comes to countries with relatively weak environmental regulations, such as Russia, which is already the dominant commercial power on this route, and China, which gave life to the Belt and Road Initiative project.

Annual volume of cargo transportation through the Northern Sea Route (NRS) in Russia from 2011 to 2022
(in million metric tons)

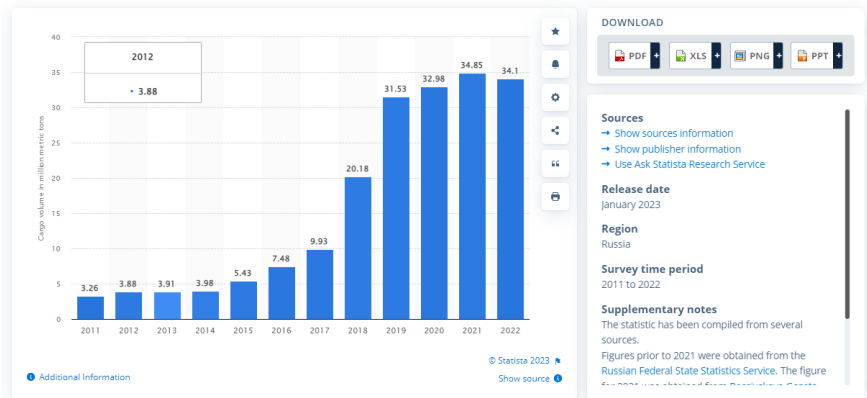


Figure 4.5: Annual volume of cargo transportation through NRS in Russia from 2011 to 2022. Source: Melkadze (2023)

5. CONCLUSION

Slavoj Žižek (b.1949), a Slovenian critical philosopher and culture critic known for his unconventional perspectives, argues that woke culture paradoxically allows individuals to maintain a state of ignorance despite its intention to raise awareness (Žižek, 2023). According to Žižek, practices such as *ethical consumption*, *virtue signaling*, or making symbolic gestures like *buying a coffee* to eliminate poverty, create a false sense of personal righteousness while failing to address the deep-rooted systemic injustices and exploitations inherent in our capitalist consumer lifestyles. These practices can give individuals a misleading sense of achievement and moral superiority, leading them to believe they are actively contributing to positive change while neglecting the underlying structural and systemic issues that perpetuate social and environmental injustices. This allows individuals to relieve their guilt through a narrative of being a savior, while still participating in and benefiting from the very systems they claim to oppose.

For instance, buying a coffee to "eliminate poverty" may be seen as a form of ethical consumption, but it may not effectively address the underlying economic inequalities and exploitative labor practices prevalent in the coffee industry. Similarly, applying this mindset to the logistics industry suggests that solely focusing on individual actions or profit-driven practices of private companies, without considering the broader systemic implications, may be inadequate in addressing the challenges posed by the climate crisis and the urgent need for sustainable logistics practices.

To address the climate crisis, it is crucial to go beyond individual actions and embrace systemic changes within the logistics industry. This may involve implementing sustainable transportation methods, optimizing supply chain networks to reduce carbon emissions, and promoting circular economy principles to minimize waste, as well as, reassessing the economic and political interests of countries on a global scale, implementing policies that encourage private companies to fulfill their responsibilities towards nature and not to ignoring labor rights violations in the logistics sector.

This thesis aimed to redefine logistics as a socio-technical assemblage, and analyze its historical development and contemporary challenges in a very wide area. Although the main approach is through STS, methods such as thick description, systematic analysis, and qualitative data analysis have also been used as tools. By taking a holistic approach to logistics, it was hoped that we can better understand its impacts on workers, the environment, and society at large, and develop more sustainable and equitable approaches to transportation and supply chain management.

The initial section problematizes logistics through a case, which serves as a foundation for the subsequent sections. The second section takes a closer look at the historical development of logistics, exploring the impact of technological advancements, socio-cultural phenomena, and literature of the period. By doing so, the reader is provided with a broad understanding of the factors that have contributed to the current state of logistics.

I believe this approach to this topic is important. Because climate crisis, which is the reason for the practical existence of green logistics, is one of the biggest crises of our era. It may even be considered the biggest problem when considering the effects that will leave for future generations from us. Based on the studies released by international

organizations that are the subject of the thesis, there is still a possibility for us to adapt to the climate crisis and achieve sustainable living if every state, organization, and individual does their part. However, these practices can only be directed if they are transparent, measurable, and traceable enough. If your focus is on a complex structure such as logistics, where different stakeholders are involved, a good analysis must be made to understand the behavior of each factor. After this stage, new solution opportunities can be evaluated and implemented.

The STS perspective allows one to be critical of science history and challenges notions such as the linear progression of science history. It is neither linear nor all progression. There are many factors in this history of how things circulate and why. Assemblage theory provided valuable insights into the complex relationships between different elements of the supply chain. By examining how these elements interact and affect one another, we gained insights into how to optimize logistics processes and improve efficiency. Moreover, STS studies can also help to identify the barriers and opportunities associated with the implementation of new logistics technologies. By examining the ways in which different actors and stakeholders interact with logistics systems, STS studies can provide insights into the cultural and social factors that influence logistics systems.

The principles of logistics involve concepts such as time, place, and utility, and the purpose of logistics is to ensure that products reach their intended destination so that people can have access to what they need. Logistics has the potential to improve people's lives and even inspire a movement towards a more sustainable future. To achieve this, we need to significantly transform the infrastructure we have built worldwide.

As the end point of this entire logistics evolution, the task that the green logistics paradigm should undertake not be limited to resolving the paradoxical relationship between environment and logistics. It should be evaluated from a much more inclusive and holistic perspective and its practices should be developed in this direction. Rather than a practice in which only environmental factors are emphasized, a system should be created that can prevent the practices to be carried out in the interests of the states and companies that have a voice in the international arena.

6. FURTHER DISCUSSIONS

In the process of writing this thesis, there are several key topics that I find particularly interesting and worth exploring further.

One area that deserves more attention is the gendering of logistics, which could shed light on the ways in which this industry privileges certain groups over others. The gendering of logistics is an area that has not received as much attention as it deserves. The logistics industry is often seen as a male-dominated field, and this perception has contributed to the underrepresentation of women in the industry. By examining the gendered nature of logistics, we can gain a better understanding of why this industry is less accessible to women, identify discriminatory practices and policies, and develop strategies to promote gender equity in the industry. I hope that, when we focus on this issue, we will reach a different interpretation of the existing workers' rights violations. This could lead to more diverse and inclusive work environments, as well as better outcomes for all stakeholders in the logistics value chain.

Interpreting logistics as an 'invisible power' is another area that has the potential to yield valuable insights. As I have stated many times in my thesis, logistics is often seen as a technical and operational function, rather than a social and political one. However, logistics has the power to shape our society and economy in profound ways, from determining the location of factories (and the social life that will develop around it) and warehouses to influencing the flow of goods and services across borders. By examining logistics through the lens of Foucault's definition of "power", we can gain a deeper understanding of how logistics operates as a system of control and how it reproduces existing power relations. This could lead to more critical and nuanced analyses of logistics, as well as more effective strategies for challenging its power dynamics.

Another area that logistics and climate change, viewed through the lens of 'hyperobjects', could offer an innovative and thought-provoking approach to this topic. By exploring how hyperobjects like global warming and oil impact logistics, you could provide a unique perspective on the challenges and opportunities facing the logistics industry in the face of climate change. The logistics industry is a significant contributor to greenhouse gas

emissions, and the effects of climate change are already being felt across the industry. By examining logistics and the climate crisis relationship through the lens of hyperobject, we can better understand the ways in which these two phenomena are interconnected and how they shape each other. This could lead to more effective strategies for reducing emissions and building resilience within the logistics industry, as well as more comprehensive approaches to addressing the climate crisis as a whole.

Finally, exploring Harvey's uneven geographical development theory in the context of development theory could yield valuable insights into the ways in which geographic factors shape development. The logistics industry plays a significant role in shaping the spatial organization of the global economy, and the uneven development of logistics infrastructure can have profound implications for economic growth and social welfare. By examining Harvey's theory in the context of logistics, we can gain a better understanding of the ways in which logistics shapes economic development and identify strategies for promoting more equitable and sustainable forms of development.



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