UNIVERSITY OF PIRAEUS

DEPARTMENT OF MARITIME STUDIES

MASTER OF SCIENCE
in
SHIPPING

DRY PORT LOCATION SELECTION – CRITERIA AND IMPACT ASSESSMENT

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Diploma Thesis
Submitted to the Department of Maritime Studies of University of Piraeus as part of the requirements for obtaining a Postgraduate Diploma in Shipping Management

Piraeus
November 2021

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The approval of the Master's Thesis by the Department of Maritime Studies of the University of Piraeus does not imply acceptance of the author's opinions.

ACKNOWLEDGEMENTS

At this point, I would like to thank all those who have contributed to the completion of this Master's thesis. Completion of the Master's thesis would not have been possible without the valuable assistance of the members of my dissertation committee, Professor Eftratios Papadimitriou and Assistant Professor Ioannis Lagoudis, whom I would like to thank for their generous and tireless assistance throughout the preparation of the thesis. I would also like to thank the members of the University of Piraeus who are responsible for the electronic services. Without their assistance, especially during the pandemic of COVID-19 when the physical presence was not feasible, most of the data used for this thesis would not have been found. Finally, I would like to thank all of my professors during these special years of Master program who successfully tried to introduce us the shipping world and make us experts of the maritime and transportation industry.

Above all, I would like to thank my supervisor, Professor Maria Boile, as this Master's thesis could not have been completed without her continuous assistance, support, guidance, constructive feedback, patience and encouragement. It has been an absolute privilege to be able to prepare my Master's thesis under her supervision, as her exceptional character and outstanding academic work are unparalleled.

This Thesis is lovingly dedicated to my parents Konstantinos and Ioanna, and to my brother Argyris.
Without their love and support this project would not have been made possible.

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ABSTRACT

The aim of this thesis is to present the role of large scale freight facilities, such as dry ports, in accommodating global trade; and to conduct a Systematic Literature Review based on publicly available information from scientific studies. Furthermore, the development of large-scale freight facilities by implementing different investment models is examined, with an emphasis on Public-Private Partnerships and the associated benefits. Different cases from three important trade regions (Europe, US, Asia) have been selected and analysed. The major topic addressed in this thesis is the location determination problem. For this reason, criteria found in the pertinent literature have been selected and synthesized to create a decision-making framework. The framework focuses on two primary criteria, while also considering additional support criteria. The location of facilities, such as "duisport" in Germany and Khorgos Gateway Dry Port in Kazakhstan, is examined from a logistics, economic, and environmental perspective not only due to their size and status but also because of their importance in global supply chains. The benefits deriving from a wisely located inland facility are described at the end of this document.

Keywords: dry ports, logistics, freight transport, location selection, supply chain

ΠΕΡΙΛΗΨΗ

Σκοπός της παρούσας διατριβής είναι να παρουσιάσει το ρόλο των εμπορευματικών κέντρων, και κυρίως των dry port, και να συγκεντρώσει πληροφορίες από επιστημονικές πηγές σε μία διευρυμένη συστημική βιβλιογραφική ανασκόπηση. Στη συνέχεια εξετάζονται διάφορα πιθανά επενδυτικά μοντέλα που βρίσκουν εφαρμογή στην ανάπτυξη τέτοιων εγκαταστάσεων, με έμφαση στις Συμπράξεις Δημοσίου και Ιδιωτικού Τομέα (ΣΔΙΤ). Μία σειρά από εγκαταστάσεις ανά τον κόσμο (Ευρώπη, ΗΠΑ, Ασία) αναλύονται, καταλήγοντας στη σημαντικότητα του προαναφερθέντος μοντέλου και στα πλεονεκτήματα που αυτό προσφέρει. Στη διατριβή εξετάζεται επίσης το πρόβλημα επιλογής της βέλτιστης τοποθεσίας των dry ports. Για το σκοπό αυτό παρουσιάζεται ένα πλαίσιο αξιολόγησης αποτελούμενο από κριτήρια που αντλήθηκαν από την υπάρχουσα βιβλιογραφία. Το πλαίσιο αυτό αποτελείται από κύρια και δευτερεύοντα κριτήρια, το κάθε ένα με τη δική του σημασία και βαρύτητα. Τα κριτήρια αυτά εφαρμόζονται στην ανάλυση των περιπτώσεων των εγκαταστάσεων του Duisport και του Khorgos Gateway Dry Port, που αποτελούν δύο από τα μεγαλύτερα και σημαντικότερα εμπορευματικά κέντρα του παγκόσμιου εμπορίου. Αναλύονται τα οφέλη από τις εγκαταστάσεις σε ότι αφορά στην Εφοδιαστική, την Οικονομία και το Περιβάλλον.

Λέξεις-κλειδιά: dry ports, logistics, επιλογή τοποθεσίας, εμπορευματική μεταφορά, εφοδιαστική αλυσίδα

DEFINITIONS

In this opening section some key terms are defined, to facilitate further reading and support broader understanding of the thesis. The terms logistics, supply chain, transportation mode, intermodal and multimodal transportation, seaport, dry port, freight, freight village, competitive advantage and opportunity cost are defined.

Logistics

The process of planning, implementing, and controlling procedures for the efficient and effective transportation and storage of goods including services, and related information from the point of origin to the point of consumption for the purpose of conforming to customer requirements. This definition includes inbound, outbound, internal, and external movements.

Source: Council of Supply Chain Management Professionals (CSCMP Glossary)

Supply chain

Starting with unprocessed raw materials and ending with the final customer using the finished goods, the supply chain links many companies together. The material and informational interchanges in the logistical process stretching from acquisition of raw materials to delivery of finished products to the end user. All vendors, service providers and customers are linked in the supply chain.

Source: Council of Supply Chain Management Professionals (CSCMP Glossary)

Transportation mode

Transport mode refers to the way in which passengers and/or goods can be transported. Transport modes for both passengers and goods may include: rail, maritime (sea), road, inland waterways, air.

Source:https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:

Intermodal transportation

Intermodal transportation is a combination of two or more modes of transport in order to move cargo from a place in a country to another place at a different country. The main characteristic of intermodal transport and the biggest difference to multimodal transport is that every part of the process is contracted with a different provider.

Source: https://container-xchange.com/blog/multimodal-intermodal/

Multimodal transportation

Multimodal transport (or combined transport) is per definition a combination of at least two or more different modes to move cargo from a place in one country to another country. The main characteristic of multimodal transport is that even though it includes various modes for transportation, it still falls under one single bill of lading. That means the carrier is fully liable for the entire carriage even though it is performed by different modes of transport such as Air, Rail or Sea.

Source: https://container-xchange.com/blog/multimodal-intermodal/

Seaport

A seaport is a facility for receiving ships and transferring cargo to and from. Seaports are usually situated at the edge of an ocean or sea, river, or lake. Ports often have cargo-handling equipment such as cranes (operated by stevedores) and forklifts for use in loading/unloading of ships, which may be provided by private interests or public bodies. Harbor pilots, barges and tugboats are often used to safely maneuver large ships in tight quarters as they approach and leave the docks. The terms "port" and "seaport" are used for ports that handle ocean-going vessels, and "river port" is used for facilities that handle river traffic.

Source: http://info.jctrans.com/jcnet/news/pn/20148142059447.shtml

Dry Port

A dry port is a port that is away from the sea. It is more inland and connected to a seaport with either a paved road or railway. Dry ports are terminals where cargo brought over on ships is transshipped. These inland ports often include storage facilities for a massive quantity of goods and are used for customs clearance of those goods

Source: https://container-xchange.com/blog/dry-ports/

Freight

Goods being transported from one place to another.

Source: Council of Supply Chain Management Professionals (CSCMP Glossary)

Freight Village

A freight village is a defined area within which all activities relating to transport, logistic and distribution of goods, both for national and International transit are carried out by various operators. A freight village must also be equipped with all the public facilities to carry out the above mentioned operations. In order to encourage intermodal transport for the handling of goods, a freight village must preferably be served by a multiplicity of transport modes (road, rail, deep sea, inland waterway, air).

Source: https://unece.org/3rd-meeting-12

Competitive advantage

A competitive advantage is an attribute that enables a company to outperform its competitors. This allows a company to achieve superior margins compared to its competition and generates value for the company and its shareholders. A competitive advantage must be difficult, if not impossible, to duplicate. If it is easily copied or imitated, it is not considered a competitive advantage.

Source:https://corporatefinanceinstitute.com/resources/knowledge/strategy/competitive-advantage/

Opportunity cost

Opportunity costs represent the potential benefits an individual, investor, or business *misses out on* when choosing one alternative over another.

Source: https://www.investopedia.com/terms/o/opportunitycost.asp

1. INTRODUCTION

Global containerized trade has witnessed significant increase since the mid-50s when the container industry officially started its operation. Consumer needs played a key role during the years especially when e-commerce became available to most of the countries. In addition, manufacturers, in order to reduce their operating expenses have moved to Asian countries where the labour force is much cheaper than in Europe or the US. As a result, most of the finished goods are produced there and transferred via the ocean to the markets. This fact, along with the increasing size of containerships, which has reached historical high levels at over 23,000 TEUs, create congestion problems that terminals need to face, especially during peak-periods.

Since the global financial crisis of 2009, maritime transportation rates have been increasing annually. Furthermore, according to Statista[1] the trend of containerization not only will not stop, but it will gain bigger share in the next few years, as Figure 1.1 clearly depicts. In 2020, the pandemic of COVID-19 hit the world, and this is the reason of the sharp reduction in port throughput during the onset of the pandemic. However, based on the prediction made for the years 2021-2024, global trade will strongly rebound the loss of the pandemic as digitalization facilitates, more than ever, e-commerce transactions. Currently, the demand for shipping is high, prices are driven by a commodity boom and ports around the world are experiencing severe congestion. With a predicted annual port throughput of almost one billion TEU by 2024, the supply chains, ceteris paribus, would be stretched more than ever before.

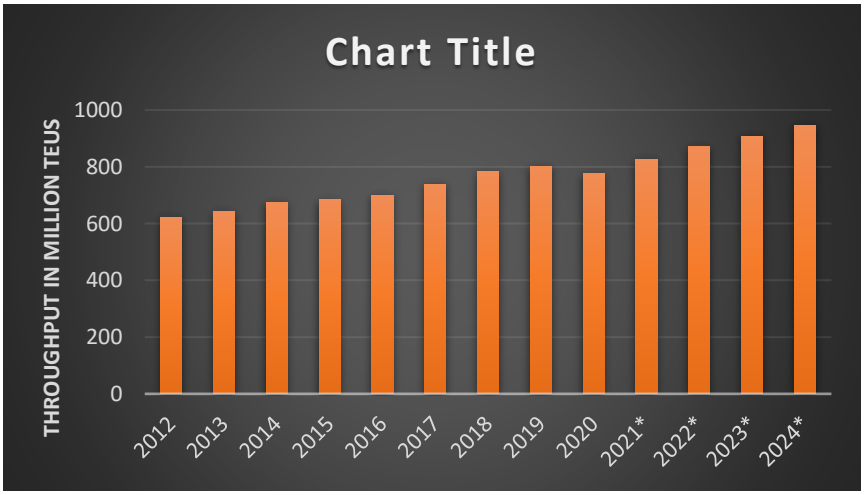


Figure 1.1: Total annual throughput (in TEUs)
Source: Statista

[1] https://www.statista.com/

As Yuen and Thai (2015) noted, liner shipping can be represented by four key quality dimensions: reliability, speed, responsiveness and value, which relate to customer requirements for speedy, safe, and low-cost delivery of their goods. But how could these be achieved when ports struggle due to severe congestion problems and supply chain networks have no available capacity left?

Transportation networks, seaports, warehouses, logistics centers, all have limited capacity. These facilities operate efficiently until they reach their capacity limits. Then delays occur, creating big problems across the whole supply chain, including increasing costs and inefficiencies. For instance, if seaports near a manufacturing zone struggle to handle the scheduled number of ships, inventory rates will be affected and deficit for the retailers worldwide will be created - no access to the ordered goods - which is an issue that cannot be remedied in a short period of time. The boom of the container industry during the last 10 years, along with the increasing size of vessels and shipment sizes, as well as the lack of transportation networks able to accommodate increasing traffic from major seaports, created the aforementioned logistics problems at a large scale.

Efficient transport connectivity and port hinterland facilities may provide reliable solutions to jammed ports and networks connected to them, with associated environmental, socio-economic, and logistics benefits. Congested yards and gateways translate to increased emissions in the surrounding area as trucks stay longer in and around the terminal. In addition, the development of more efficient hinterland networks leads to increased economic benefits for a region, since seaports with a well-established hinterland network have the opportunity to increase their annual throughput without investing in their physical expansion. With containers staying less time at a terminal yard, the seaport capacity increases. A key role in reducing the container dwell time at a seaport terminal, may be played by inland facilities in the port's hinterland, such as dry ports, where handling operations similar to those of a seaport take place.

Major container shipping companies, especially those which are part of the industry's biggest alliances, have been vertically integrating by investing in ports and inland terminals. This strategy started as a way to better serve their customers and gain competitive advantage against their competitors, by improving the quality of services offered and thus increasing demand for them (Sussman, 2000). Porter's cost/differentiation theory finds application in the strategic choice of the liner shipping companies to expand their network by investing in real estate. That kind of investment

almost changed the rules of the competition game providing carriers with flexibility and increased productivity.

It seems that now, more than ever before, the industry could benefit from efficient hinterland connections and strategically located inland facilities, in order to de-congest seaport terminals and reduce delays in ports in general. Multimodality constitutes a key feature of inland freight facilities, which operate as a buffer between the maritime leg of transportation and the retailers, allowing the efficient mode shift. Cargo can be transferred from rail to truck, and vice versa, and reach the receivers in a faster way. Multimodality also contributes to more environmentally friendly transportation mainly because of the wide rail use. Shipping companies following the door-to-door orientation in order to maintain a competitive position in global trade, include multimodality to eliminate the barriers the traditional networks have created.

2. THESIS PREVIEW

Globalization has changed the way consumers transact in markets, reduced barriers in terms of trade and transactions around the world and contributed in global trade recording historical high rates. The demand, especially in a microeconomic environment, changes rapidly either upside or downside, while supply needs more time to adjust, a fact that makes cargo flows unstable. Furthermore, the total containerized cargo flows have increased significantly due to several reasons, including advances in relevant technology and changes in shipper and consumer needs and preferences. Container vessel sizes increase significantly, aiming to achieve economies of scale and reduce transport cost per unit while increasing profit margin. The increase of ship sizes has significant impact on the structure of the liner shipping networks and the characteristics of port terminals.

Shippers and receivers are not only part of local and regional supply chains, but they have a strong role in global trade. Carriers cater to their needs, while seeking to optimize their services, reduce costs and increase revenues. Many ports are required to accommodate an increasing number of containers within a shorter time window, which places a stress on their capacity and increases the need for new technology implementation, or capacity expansion. Capacity limitations along with a lack of space for expansion often result in congestion in the terminal yards and gates. Furthermore, apart from the above, seaports must deal with the implications of trade imbalance with shortage or deficit of empty containers being a big problem. The rate of imports, especially in western Europe and the US, exceeds by far the rate of exports. For example, import-export imbalance in early 2021 in the port of Los Angeles hit a 4:1 ratio, which had several implications in terms of management of operations and handling of equipment shortages. It is thus crucial for seaports to become more flexible, and steadier at the same time, to cope with these imbalances.

Ports are key linkages in global supply chains, handling the biggest part of cargo volumes worldwide. Container shipping companies have been ordering mega containerships with a capacity of over 24,000 TEU to achieve scale efficiencies, a trend that has major impacts in the structure of liner shipping networks, and port and terminal characteristics by creating congestion in terminals either in yards where containers are temporarily stored, or in gates where large number of trucks form queues to enter the

port. Through vertical integration, major carriers become involved in terminal operations.

In an effort to expand terminal capacity, a vertical integration strategy often involves the development of dry ports. Such facilities offer several functionalities and services, operating as a buffer for deep-sea ports, which struggle to accommodate the increasing volume of containers and large shipment sizes. One of their typical characteristics is the multimodal connectivity contributing to a reduced carbon footprint as well as to cost and time saving for shippers and receivers. A dry port may be a viable option for supply chains either for inbound or outbound logistics. The benefits derived from their implementation include social, logistics, environmental, and economic ones. Their importance for landlocked countries is also worth mentioning. Several actors can be part of global supply chains even those whose access to traditional modes of transportation, like ships, is limited.

Dry ports offer a viable solution to such problems, with notable benefits to the maritime supply chains and the port hinterlands they serve. Dry ports are inland intermodal terminals directly connected to a seaport by various modes of transport, which support the transhipment of sea cargo to inland destinations. They contribute to the minimization of port congestion while generating new job opportunities, directly or indirectly. Furthermore, they contribute to the reduction of carbon footprint and support regional development of their surrounding local areas, through intermodalism and transport network development. A dry port can adopt the role of a seaport providing similar functionalities and services. Their development and implementation derive from economic integration, from companies such as logistics providers, real estate developers, container shipping companies etc, and can provide maritime ports the ability to handle efficiently increased amounts of cargo. Such inland facilities usually offer rail and road services as well as inland waterway transport where possible. Many port authorities have been investing in dry port development, although there is strong presence of the private sector, especially in the US and in some cases in north-western Europe. A modern large-scale freight facility development must include both private and public sector involvement and support, to create a sustainable project with a competitive advantage.

Inland facilities, including both freight villages and dry ports, have gained prominence in researchers' agenda during the last decade. Many researchers have focused on dry

ports' main characteristics and services offered. For the purpose of this thesis, a pool of different freight facilities, including dry ports, from around the world has been developed and reviewed, with a selected number of them presented herein. Development policies in various regions (Europe, USA, Asia) are examined, underlining the role of public-private partnerships and the contribution of each sector to the development and operation of the facilities. The research also demonstrates the role of Public-Private Partnerships PPPs in large-scale freight facilities development initiatives. Public and private sector cooperation may assist in better streamlining the allocation of resources, risks, and rewards in large scale freight facility development projects. Furthermore, by implementing PPPs, inland ports may attract more tenants to operate in their area while collaborations with significant seaports are further enhanced. For each one of the selected cases reviewed in this paper, the physical characteristics such as capacity and area coverage, will be described. In addition, the kind of investment as well as the current developer and operator will be noted followed by the services/functions offered and the tenants which operate in the terminal. Special attention will be given to the stakeholders and shareholders of each facility. Finally, the comparative analysis will conclude on the role of each sector before, after and during the development of an inland freight facility.

This thesis also aims to present a framework that simultaneously optimizes freight village location and facilitates decision making by saving time and avoiding risks and uncertainty. Several criteria have been taken into account prioritizing distance from markets, and accessibility in terms of proximity to global networks and multimodal connectivity, based on a research conducted by Prologis (Prologis, 2016). Initiatives such as the Chinese Belt and Road Initiative and the TEN-T in Europe contribute to the upgrade of hinterland transportation and, subsequently, to the freight village efficiency. Plethora of metrics are considered with the most important to be presented, providing developers with a safe "path" to follow in order to make such a strategic decision. Special attention is also given to different modes' presence as one of the foundations the dry port concept is built on. For this purpose, a SWOT analysis for multimodality is presented.

The case of "duisport" trimodal terminal is examined, where containers are transferred by rail, road, and inland waterways contributing to regional economic and social development, job opportunities, collaboration with seaports and to environmental

protection through the reduction of carbon emissions by reducing truck miles travelled. Khorgos Gateway Dry Port also constitutes an instance of well-located freight village exploiting other developments under the Belt and Road initiative. Both freight villages are established in close proximity to important economic corridors, a fact that renders them part of an extended global trade network and directly connected with the most important markets worldwide.

This thesis is developed along three parts. The first part presents preliminary information as well as a Systematic Literature Review, which examines scientific studies referring to dry port and freight village development. Functions of inland facilities, the importance of freight villages and dry ports, networks of freight facilities and associated benefits are also included. The second part is oriented in giving a financial and economic perspective of a dry port project, presenting development models, including Public-Private Partnerships. Selected cases from three major regions (Europe, the US, Asia) are analysed. Finally, the third part focuses on the main topic of this thesis; the dry port location selection. A SWOT analysis and a process for prioritizing the location selection criteria is presented. The location selection framework and the selected criteria are examined and tested through the context of duisport and Khorgos Gateway Dry Port cases. The thesis document concludes with a summary of the benefits of a well-located inland facility as well as key points derived from the study.

3. SYSTEMATIC LITERATURE REVIEW

Following a systematic literature review (SLR), pertinent literature has been selected and classified as presented herein. Several papers from different periods have been considered, to expand SLR's range and reinforce its objectivity. To begin with, a description of the current situation in global trade as well as in terminals around the world offers a good overview of the problems that supply chains must deal with. The presentation of inland facilities, including dry ports, is filling the gap between the problem and the solution followed by the underlining of their need in the context of the networks which include them. Connectivity is a major factor concerning most of the researchers worldwide. In addition, the different types of dry ports are presented based on several studies and different criteria. The importance of location in large scale freight facilities and the impacts of a good choice strengthen the need for creating a comprehensive and integrated framework. Finally, the different development models and the actors involved in the process are presented, focusing on the coexistence of both factors during the panning phase.

The volume of international trade and freight transport worldwide has witnessed fast growth in recent decades. Specifically, according to the 2020 UNCTAD Review of Maritime Transport, in 2019 the European ports handled over 810 million TEUs. Li et al. (2011) noted that these increased flows pass through seaports to the hinterland, creating congestion in a port's gateway as well as delays in customs clearance. Furthermore, maritime terminals are often suffering by lack of space for potential expansion. Many researchers, such as Othman et al. (2016), have noted that a container seaport is incomplete without inland freight facilities. Monios (2011) noted the importance of vertical integration, either forward or backward, in the supply chain and underlined that the role of ports has changed to comprise a nodal point in the logistics chains. Ports need to be more active in extending or even maintaining their hinterlands. Deep-sea ports, according to Flämig and Hesse (2011), seek economies of scale because of globalization, which increases the quantity of cargo by reducing the distances, as Tadić et al. (2019) noted. Supply chains, traditionally, were strongly dependent on the maritime leg of transportation. According to the 2020 Review of Maritime Transport, players across the whole supply chain are equal and once something goes wrong, the whole chain must deal with it. The flows of cargo, especially containerized, have been increasing rapidly through the last decades, creating congestion and inefficiencies.

Freight village and dry port implementation cases demonstrate that the existing port infrastructures can handle significant increases in the volume of cargo, in collaboration with such inland facilities. Roso (2007), Khaslavskaya and Roso (2019), Boile and Theofanis (2017), Boile et al. (2013) observed that dry ports have become a solution to increase seaport productivity due to the movement of containers via high capacity means to and from seaports to achieve an effective supply chain solution in the hinterland as well as in the entire transport chain. According to Fazi and Roodbergen (2018), a dry port constitutes operational buffer as it helps to avoid demurrage and detention. Their purpose is not to compete with a seaport, but to increase its services and to reduce demand for using coast border lands, as Dorostkar at al. (2016) mention. Haralambides and Gujar (2011) characterized dry ports as inland equivalents of maritime terminals. Several definitions for dry ports have been reported by different authors such as Li et al. (2011), Rodrigue and Notteboom (2012), which provide different aspects of their concept. Freight villages also have been studied widely with many researchers providing proper a definition. According to Boile at al. (2008) freight village is *"A clearly demarcated and actively managed location, within which both multimodal freight transfer facilities and industrial activities are situated, along with commercial and/or worker support services"*. Leveque and Roso (2002) gave another interesting definition, according to which *"A dry port is an inland intermodal terminal directly connected to seaport with capacity transport mean where customers can leave/pick up their standardised units as if directly to a seaport"*. Nevertheless, freight village and dry port have an important difference despite the common characteristics. Dry ports are connected with at least one seaport while freight villages may operate without any kind of connection with maritime hubs. For this thesis, both definitions are used in order to include a larger range of facilities.

As mentioned above, not all inland facilities should be mentioned as "dry ports". According to Rozic et al. (2016) a hinterland freight facility is a dry port when: a) intermodality is feasible, b) there is connection with the port terminal by road and railway transport and/or inland waterways across a large capacity corridor, and c) there are groups of connected logistics activities that organize cargo transportation. Furthermore, Roso et al. (2009) investigated the elements of a dry port in comparison with other inland terminals. *"Inland terminal can be categorised as a dry port if there is a scheduled rail connection to a seaport and custom services, as well as other container operations"*. Boile and Theofanis (2017) also provided an extended typology

matrix of different kinds of inland facilities. Through a quantitative and a qualitative analysis, it is demonstrated that the implementation of such facilities could lead to a better environmental, social, economic and logistics impact. These positive impacts are analysed by many authors, including Li et al. (2009), Jeevan and Roso (2019), Zeng et al. (2013), Tadić (2020), Henttu and Hilmola (2011), Boile et al., (2008), and Boile et al. (2011).

As clarified above, not all inland terminals are the same as different criteria and factors affect their form and operations. Roso et al. (2009) categorized three types of dry ports based on their function and location with respect to distance from seaports: distant, midrange and close dry ports. Distant dry ports have the longest history and the main reason for their implementation is that the distance and the size of the flow "*make rail viable from a strict cost perspective".* Distant dry ports are conventional as they improve seaports' access to areas outside the traditional hinterland and offer them competitive advantage. Serving a new hinterland means serving new customers and the possibility of attracting new users is higher than in a mid-range or a close inland port. The presented cases of "duisport" and Khorgos belong to this category. According to the researchers, midrange dry ports are situated within a distance from the port generally covered by road transport. In case of mid-range dry ports, the distance from seaports is usually covered by road and *"they serve as consolidation points for different rail services"*. A close dry port takes the role of the seaport in terms of operations: *"offers larger possibilities for buffering containers and even loading them on the rail shuttle in sequence to synchronize with the loading of a ship in the port"*. A close dry port facilitates seaports in increasing their terminal capacity as cargo can easily be moved by rail, in a short time period, reducing the number of road links. In addition, they facilitate congestion mitigation while they contribute positively to environmental protection. Seaports are also able to handle bigger containerships due to the speedy transfer to the inland facility. Several criteria find implementation to all types, however, a freight village in a close distance from a city should be managed differently, which is clearly demonstrated in Boile et al. (2008) where possible locations of a freight village in NYMTC region are examined. Rodrigue and Notteboom (2012) present similar research, but their categorization is based on three major functions of inland ports. Firstly, satellite terminals are oriented to transship cargo from rail/barge to trucks and vice versa. This kind of transshipment in seaports area may be inefficient from a cost perspective, due to the lack of space, leading to additional charges. Load centers

constitute major intermodal facilities where functions such as warehousing, distribution as well as logistics functions take place. According to Hayuth (1988), load centers also allow shipping lines to increase the utilization of ships and reduce port time and charges giving that way a competitive advantage to their users. Finally, transloading centers link large systems of freight circulation either through the same mode or through multimodality. Wilmsmeier et al. (2011) observed two models of development based on where the integration comes from; the inside-out; and the outside-in. In the first category, the integration is driven from the inland terminal's side. Responsible for the development are public bodies, such as authorities, or private investors (e.g., logistics service providers). On the other hand, outside-in models' integration is driven from the seaport's side while responsible for the development phase are either public or private entities, such as port authorities or port operators and ocean carriers, respectively.

Rodrigue and Notteboom (2010) underline that in a European setting, a larger number of inland terminals is required. Considering their statement, this thesis is oriented around the optimum location of such a terminal prioritizing accessibility as well as the distance from markets. Locating a dry port is a strategic decision that cannot be made based only on cost-efficiency factors. Such types of decision problems are characterised as "multicriteria decision problems". A well-established inland facility enjoys significant advantages especially in terms of connectivity and collaboration with major seaports which try to reduce containers' concentration in their yards, which means a reduction of congestion in their gates. Better connectivity often means increasing revenues for a freight facility. For this purpose, Awad Núñez et al. (2016) analyzed different factor categories as well as their variables. Tadić et al. (2020) also provide a different scope of location selection criteria which includes several sub-criteria, including environmental, economic, infrastructure and socio-political ones. In addition, Boile et al. (2008) selected and weighted criteria and metrics from the pertinent scientific and trade literature as well as from inputs received from experts, emphasizing that regional objectives should be achieved by a freight village. Li et al. (2011), Tadić et al. (2019), Ozceylan et al. (2016) also examined factors and criteria that could affect the final location decision, trying to determine the optimum location of a dry port. Jeevan et al. (2017) propose that a strategic option is to place an inland terminal near economic zones, such as manufacturing areas.

Network location models have been widely used for determining the proper location for both public and private facilities according to Melcote and Daskin (2001). Location

optimization brings significant advantages. Tadić et al. (2020) mention that high operations efficiency and competitive advantage in global markets could be derived from proper location choice. A well-established dry port also promotes closer collaboration with different stakeholders according to Haralambides and Gujar (2012). Boile et al. (2011) analyzed the positive impacts deriving from well-located logistics facilities such as attraction of freight volumes and increased freight consolidation. Similar results are presented in Dorostkar et al. (2016) research, who stated that inland terminals help in empowering ports' role in transportation chains. Users of such type of facilities enjoy not only financial benefits but they save valuable time. Finally, Macharis et al. (2011) examined parameters that affect value of time. Location can be examined from different scopes and a sustainable choice at the stage of decision making is the key for long-term efficiency.

Othman et al. (2016) noted that logistics and multimodal transportation systems have become the pillar of the future maritime industry. Boile and Theofanis (2017) note that many studies worldwide indicate that freight consolidation and synergies achieved through collaboration, reduce logistics costs, which may be a strong incentive for companies to relocate in a freight village. According to Wang et al. (2016), the choice of a chain rather than a port becomes more critical for liner shipping companies, logistics service providers and shippers which leads to the multi/inter-modal transport of cargoes. The actors involved are shipping companies, logistics providers, terminal operators, port authorities, governments etc. Dry ports are an important node of modern supply chains as they handle a big share of cargo flows. Some of these supply chain actors are also involved in the development and management of dry ports. Different methods and policies are used for such development which define the kind of investment.

Dry ports development can be characterized by different kind of investments which often depend on the local, regional, and national government. For instance, according to Ng and Gujar (2009), dry ports in India (and to a large extent in Asia in general), are mainly developed by CONCOR (Container Corporation of India). Haralambides and Gujar (2011) noted that CONCOR proposed "*to let private investors handle, on contract or under franchise, all transport of containers and cargo by road between the*

satellite CFSs[2] and the rail-fed ICDs[3], and between ICDs/CFSs and shippers' premises". Bask, Roso et al. (2014) present cases of dry ports in Kouvola, Finland and Hallsberg, Sweden where the public sector played a major role in their development via cooperation with private investors. In the same spirit, Korovyakovsky and Panova (2011) and Rodrigue at al. (2010) examined several Russian and European cases respectively, most of them distinguished by Public Private Partnership (PPP) and landlord model. In PPPs, the public sector is usually involved during the development phase, while the private sector is responsible for inland terminal's operation and management. The landlord model includes ownership by the state and operation from other private investors or port authorities (Monios 2011). In the US, according to Rodrigue et al. (2010) and Wilmsmeier et al. (2011) the government has traditionally taken little action. Rail operators and real estate developers play a key role in dry port investments. In terms of PPP, Pavona and Hilmola (2015) mentioned that there are plenty of stakeholders who are interested in dry port projects, most of them usually being vertically integrated into the supply chain.

This thesis presents a comparative study of dry port developments at a European and global level. The research has been focused on case studies from Europe, Asia, and the US, with relevance to maritime logistics activities. An analysis of the existing typology and definitions as well as the main characteristics and services of an inland terminal/dry port takes place, while the development policy and the management structures are examined. The interest of transport providers, financial institutions, local and regional authorities in dry port development is underlined. Moreover, a framework of location determination of such inland facilities has been created and is presented below, focusing on the two major criteria categories which affect the most that kind of decisions-accessibility and distance from markets.

[2] Container Freight Stations-CFS
[3] Inland Container Depots-ICD

4. EVOLUTION OF TRADITIONAL LOGISTICS STRATEGIES

4.1 PORT-TO-PORT TO DOOR-TO-DOOR

Traditionally, trade has been oriented in the transferring of goods from one region to another. Ports had the role of hubs where cargo concentration and the switching from water to land modes was taking place. Receivers were only concerned in leaving/picking up their products at/from the seaports. On the other hand, carriers were taking the responsibility of their on-time, efficient, and safe movement. That kind of transportation system mainly consisted of road and maritime routes and seaports.

Nowadays, supply chains have become integrated and larger, more efficient, and focused on the final consumer. Port-to-port has been replaced by the door-to-door delivery strategy. Major container shipping companies have invested heavily in creating their own network in order to deliver the goods from the manufacturer to the final consumer. This network includes road and rail routes, maritime terminals, last mile delivery as well as reverse logistics services.

Simply speaking, that could be extremely risky in terms of delays and inefficiencies as several factors across the cargo's journey might affect the reliability of the network, with a reduction of profits and devaluation of company's fame. Considering the possibility of those costs, major carriers have also invested in inland hubs to ensure the continuity of the freight flows. Maersk and CMA CGM for example, are two giants of global container trade and key players in the world's biggest alliances. They have a well-established network, which has been expanded in major hinterlands. The cartographical coverage of the CMA CGM case is presented at a following section, while special reference is being made in the case of Maersk, whose hinterland connectivity involves 95 countries.

4.2 JUST-IN-CASE TO JUST-IN-TIME

Retailers during the last decade have been focused on "just in time" operations. Special attention is given to the cost of keeping inventory and the OPEX of warehousing.

Keeping inventory and securing that the organization will not lose sales means increased cost. Retailers should not only rent a facility to operate but also occupy a warehouse in order to keep their products safe and in a reasonable quantity. However, besides the cost, which has a strong impact to the price, there is a risk of obsolete products. If the seller struggles in marketing, notes low sales, and has already bought an increased number of products, then both inventory and lost sales costs will worsen the situation.

On the other hand, by implementing just-in-time, retailers are not obligated to keep inventory, a fact that helps them save money and reduce their OPEX. Logistics providers secure the safe, speedy, and reliable delivery of the goods. Retailers gain competitive advantage by offering the newest products.

5. FREIGHT VILLAGES AND DRY PORTS

5.1 RESEARCH INTEREST

Markets worldwide are oriented towards better connectivity in order to make the whole supply chain more efficient. Dry ports contribute to the improvement of seaport operational efficiency. Their main characteristics and typical functions are analysed below. Worth noting is that plethora of definitions of freight facilities are found in the literature. These are inland terminals; dry ports; inland ports; inland hubs; inland logistics centres; freight villages; inland clearance depots; inland container depots; inland freight centres; inland freight terminals. A description of some of these types of facilities and some of their distinct characteristics is given by Boile et al. (2008), as summarized in Table 5.1.

Research interest on inland ports was first noticed in 1984. Memphis dry port as a link for New Orleans is noted as the first official study which constituted the beginning of a new era in ports industry. Khaslavkaya and Roso (2020) presented a systematic literature review providing results of several scientific studies. Plethora of scientists examined the optimal location of inland ports while others categorized them based on their distance from the seaport they serve or the services they offer.

However, even after almost 40 years of continuous interest in the literature, there are differences among a range of definitions. This thesis uses both dry port and freight village definitions. As mentioned above, Boile et al (2008) defined a freight village as "*A clearly demarcated and actively managed location, within which both multimodal freight transfer facilities and industrial activities are situated, along with commercial and/or worker support services.".* Nevertheless, Boile and Theofanis (2017) mentioned that "*there are several types of freight villages all of them sharing some common elements bur at the same time having several distinct features"*. A Community Integrated Freight Village (CIFV) is *"a freight village containing community-oriented commercial activities"* in contrast with a Logistics Center Freight Village (LCFV) which does not. Additionally, a Freight Terminal *"is a location where loading, unloading, and intermodal transfer of shipments take place"*. Intermodal industrial parks differ from freight villages in that they have *"no commercial activities or workers support services incorporated into the facilities"*. Multimodal industrial parks *"have access to multiple modes to support industrial activities, but no connections between these modes through dedicated freight transfer facilities"*. On the other hand, industrial

parks differ from intermodal and multimodal industrial parks in that *"they lack the key features of dedicated freight transfer facilities and multimodal access"*. Summarizing their categorization, *"urban distribution centers offer means of reducing truck traffic in congested urban areas through cooperation and coordination among various stakeholders"*.

Type of Freight Village	Typical Features and Characteristics
Freight Village	A clearly demarcated and actively managed location, within which both multimodal freight transfer facilities and industrial activities are situated, along with commercial and/or worker support services.
Community Integrated Freight Village (CIFV)	A freight village containing community-oriented commercial activities.
Logistics Center Freight Village (LCFV)	A freight village not containing community-oriented commercial activities.
Freight Terminal	A freight terminal is a location where loading, unloading, and intermodal transfer of shipments take place.
Intermodal Industrial Parks	Intermodal industrial parks differ from freight villages in that they have no commercial activities or workers support services incorporated into the facilities.
Multimodal Industrial Parks	Multimodal industrial parks have access to multiple modes to support industrial activities, but no connections between these modes through dedicated freight transfer facilities.
Industrial Parks	Industrial parks differ from intermodal and multimodal industrial parks in that they lack the key features of dedicated freight transfer facilities and multimodal access.
Urban Distribution Centers	Urban distribution centers offer means of reducing truck traffic in congested urban areas through cooperation and coordination among various stakeholders.

Table 5.1: Freight villages categorization
Source: Boile et al. (2008)

Several definitions have also been given for dry ports. For this research, the definition given by Leveque and Roso (2002) is used, as noted earlier. According to them, "*a dry port is an inland intermodal terminal directly connected to a seaport with high-capacity transport means where customers can leave/pick up their standardized units as if directly to the seaport"*. In the definitions of both types of facilities the most important common characteristic is the intermodality, which is typically a requirement.

Despite the range of definitions, dry ports must be characterized by three very important elements, according to Rozic et al. (2016), as analysed in chapter 3, to confirm their role, as parts of the supply chain and ports' hinterland. While shippers are looking for certainty and professionalism and receivers for reliable and speedy delivery of their goods, extra pressure has been placed on the operator towards one specific direction; to design and organize activities that offer value.

The role of public and private sector in dry port development initiatives is examined, providing a view from a governance perspective. Thanks to the above-mentioned researchers, freight villages and dry ports development is separated in categories. Nevertheless, each region has its own development strategies and policies. For instance, in the US, the development by private sector, mainly by rail operators and real estate developers, is very widespread. On the other hand, in many Asian countries, because of the political environment, the public sector plays a principal role in such investments and in the management of the facilities. Special attention is given to the Public-Private Partnerships (PPP) where Special Purpose Vehicles (SPV) or Special Purpose Entities (SPE) are introduced. In PPPs, common share of responsibility, risk financing, losses and profits are observed as all members are concerned about reaching the set goals. The collaborating organizations, usually, create a new vehicle, which is responsible to build, operate and maintain the infrastructure. According to Haralambides and Gujar (2011), a SPV often signs the contract with the government. The reason of its creation is to control and spread the risk of the investment, as SPVs minimize the risk of each involved entity. The landlord model differs in key elements, such as control of risk and the level of interest by both public and private sector actors.

According to Monios (2011), *"inland terminal development begins as a market-driven process from the outside-in, but once regional authorities realize the potential benefits for their regions of such developments, they begin to pursue development from the inside-out, seeking actively to capture maritime flows".*

5.2 FUNCTIONS AND SERVICES OFFERED

The services offered by an inland terminal depend on its size but there are some core ones that take place in every freight village and dry port. The majority of them provide storage and depot space for containers and goods as well as warehousing services. In addition, in order to save valuable time for shippers, most dry ports are responsible for

customs clearance services, packing/unpacking operations and distribution. Bigger inland terminals often try to gain competitive advantage in global supply chains, by following Porter's differentiation strategy. So, they offer a variety of services, the so called "added-value services" including labelling, power supply, maintenance of containers, track and trace, empty container depot, insurance of stored goods, advising services, cargo storage of reefer containers.

Each type offers different services due to numerous components. For instance, a dry port in close proximity to a seaport usually has similar functions, in contrast with a facility located deeply in the hinterland, which may constitute a pick-up location for retailers or a freight consolidation center. However, there are core activities which take place in every facility. Warehousing and container handling operations are crucial for the existence of the facility. In addition, the ability to shift modes (from rail to truck and vice versa) strengthens a terminal's competitiveness. Unpacking or packing activities are usually offered by inland ports in the final market's region, where the goods will be available.

Special attention is given to the aforementioned value-added services whose importance has increased during the digitalization era. Tracking has been added as a function to the top priorities list of the shippers. Knowing where the cargo is, ensures safety and limited delays while it effectively allocates risks and responsibilities. Furthermore, by offering maintenance of containers, a facility gains the preference of shippers that seek elimination of risks during the transportation process. Customs clearance, which mainly concerns those who are involved in import-export processes, is available in multiple freight villages and dry ports worldwide. In combination with Free Trade Zones (FTZ), customs clearance saves time and cost while it facilitates and accelerates the distribution of cargo. With the significant development of the environmentally friendly electric vehicles and vessels, the need for power supply was generated. Summarizing, entering in today's competitive markets, inland ports have to satisfy stakeholders' needs and offer a variety of services they are willing to pay for, such as advising and insurance of stowed goods, to ensure their profitability. Table 5.2 presents categories of typical and value adding services.

Typical services	Value adding services
Container handling	Track and trace
Packing/Unpacking	Customs clearance
Warehousing	Free-Trade-Zone
Stowage	Labelling
Distribution	Power supply
Mode shift	Maintenance of containers
Empty container management	Insurance of stowed goods
	Advising services
	Reefer services

Table 5.2: Typical and value adding services

In mid-2021 the average price of cold storage has notably increased, due to the lack of available space and the high operational costs. Inland ports constitute a proper area to accommodate that kind of services as developers look to build or buy space in the sector. Providing reefer storage, the facility gains profits while the potential buyer saves time, capital, and exploitation costs.

Another major concern of the liner shipping companies worldwide is the empty container shortage-generated from the freight imbalance between Europe/North America and China-and repositioning them to major hubs where they can be filled again with cargo. Global manufacturing hubs are mainly in Asia providing to the rest of the planet final and semi-finished goods. As a result, over 50% of the containers return empty to where production takes place which costs both time and productivity, as the container is not operational during the backward journey. Freight villages and dry ports may constitute a solution for regulating the incoming and outgoing number of containers. Containers whose content belongs to one single receiver may leave the terminal as scheduled. However, in different cases, opening the container, transferring the goods to trucks or trains (if feasible), and sending the empty container back to the production zone by making a good use of similar inland facilities worldwide may be cheaper, faster, and more efficient than returning them with a high-OPEX 23,000 TEUs box-ship. The opportunity cost of storage in a European port is higher than sending them back by rail through the utilization of the freight villages.

There has been observed significant evolution in terminals, and generally in trade hubs, processes. Ports nowadays seek relief from cargo concentration in their yards while

shippers and receivers are becoming more and more demanding in time and cost punctuality. From a port-to-port strategy, the container shipping industry is now specialing its services to a door-to-door distribution model which requires many more assets, reliability, and flexibility in cargo movement. Ports and dry ports in collaboration facilitate the supply chains operation by supporting the services offered.

5.3 ROLE AND IMPORTANCE

Several inland facilities have been developed worldwide, as also demonstrated in this thesis. Nevertheless, supply chains have been stretched and serious delays occur in major seaports, especially in Asia, the west coast of the US, and western Europe. The principal cause for this situation is the freight flows which continue to increase, mainly because of the increasing consumer needs. The situation following the onset of the COVID 19 pandemic contributes to this situation.

In a market in which it is impossible to find an empty container and in which there is a very high demand for global freight, shipowners need to move goods faster and increase the ship utilization. Increasing vessel sizes, cargo volumes and shipment sizes test seaport capacities as they are required to handle more TEUs in a shorter period of time. Seaports' infrastructure and productivity increase does not always cope with the increase in size and technology of the ships and, as a result, container yards are congested with a large number of containers while terminal gates are congested by dray truck traffic jams.

Focusing on the logistics perspective of this situation, the role of freight villages and dry ports becomes increasingly important.

5.4 FREIGHT VILLAGES OR/AND DRY PORTS IN A NETWORK CONTEXT

The previous section examined the different types of freight villages and dry ports, presenting their characteristics, functionalities and services offered, also pointing out common elements and features. Such kind of facilities, in collaboration with seaports, may create an integrated network which can manage the increased freight flows in a more efficient manner.

According to Korovyakovsky and Panova (2011), there are three response scenarios to deal with the increasing number of containers in seaports; physical expansion, which is not always feasible due to a series of reasons; changing of container yard management, which is usually effective in a short-term; and creating terminals in the hinterland. Dry ports are being developed in several parts of the world. Developing large-scale inland facilities contributes to the expansion of ports' hinterland.

The presented cases from the US, Europe and Asia in Chapter 6 of this document illustrate their importance for modern transportation and logistics networks as well as for the functionality of the supply chains. Special attention should be given to the existence of freight villages and dry ports in landlocked countries, which make good use of the economic corridors generated by global initiatives. This thesis examines the optimal location of such facilities by creating a framework of criteria and metrics weighting the accessibility and distance from markets as the most crucial elements which match up with the presented cases of "duisport" and Khorgos Gateway Dry Port. To highlight the importance of freight villages in a transportation network, a graph is presented in figure 5.1, based on the work by Higgins and Ferguson (2011).

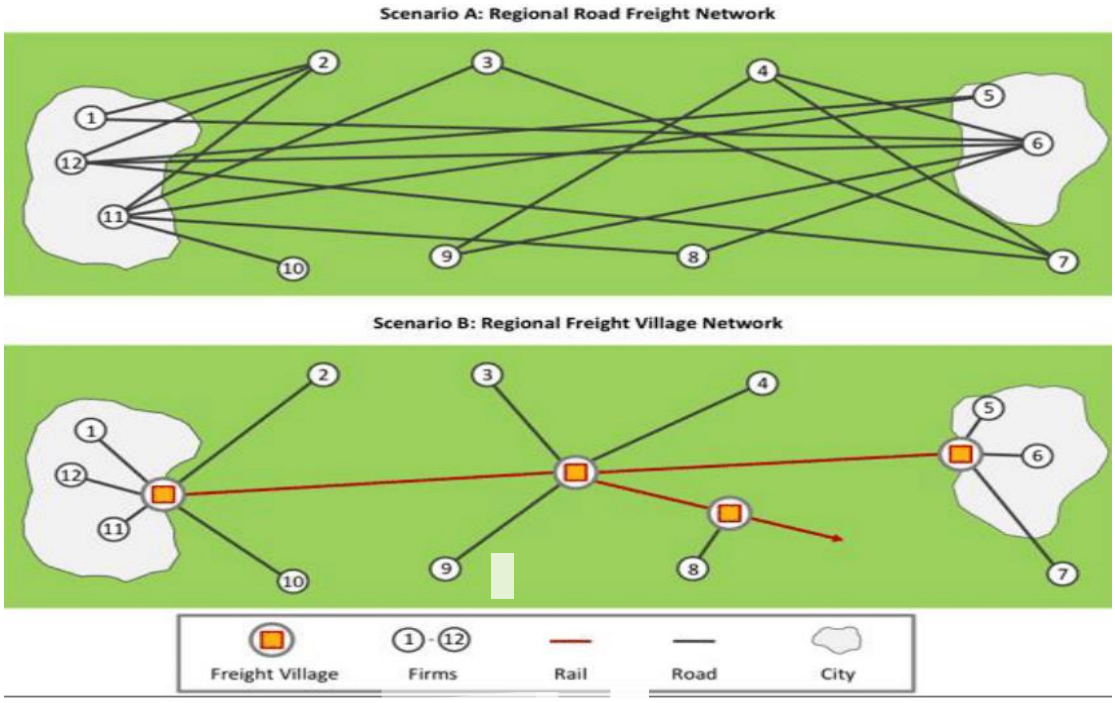


Figure 5.1: Scenarios of implementing (and not) freight villages in a network
Source: Higgins and Ferguson (2011)

Figure 5.1 depicts two scenarios in the same transportation network. Scenario A does not include freight villages or rail connections. The twelve existing firms between the two cities are obligated to transfer their goods by truck, a fact that creates a series of problems. Firstly, congestion and bottlenecks will be created both in urban areas and on the highways, while the increasing carbon emission will affect the residents and their well-being. From a logistics perspective, such a stretched network creates issues of safety, reliability, and inefficiencies to shippers and receivers. By introducing more

environmentally friendly and higher capacity transport modes in the long-haul segments of the network, the whole supply chain becomes more efficient.

In Scenario B critically located freight villages and rail connections are implemented. The number of firms, the cities, and the distance between them are the same as in Scenario A. By locating four inland facilities between the markets-cities, however, the number of truck miles is eliminated. There is a major rail route which connects city A and B, as well as a "feeder" rail route which facilitates firm No8. As depicted, firms use truck haulages only to and from the freight villages for concentrating the goods in one departure/arrival place. Firms No. 3,4,8,9 enjoy reduction to their operational costs due to the direct connection with the railway. Interaction between firms No. 5, 11, 12 with the utilization of railway in Scenario B, increases the potential to save time and cost for all actors.

According to Sussman (2000), people and, subsequently, firms like flexibility. The freight village network, as shown in Scenario B, presents an integrated transportation system where stakeholders can place their firm in a different location and enjoy environmental, logistics, social and economic benefits.

Boile and Sdoukopoulos (2020) reviewed, assessed, and grouped identified publications into four thematic clusters, which respectively deal with; hinterland concept evolution; development of intermodal transport networks; hinterland contestability; and coordination and cooperation among and between stakeholders of the maritime and hinterland transport chain. Special attention is given to the second one which refers to the development of intermodal transport networks; *"the establishment, development and operation of inland intermodal terminals; and the assessment of the performance of the transport and logistics system considering a variety of possible improvement measures"*.

Based on the statement above, the benefits of such kind of networks are given, providing a further point of view as well as reason for establishing freight villages and dry ports in existing transportation networks.

A well-stablished network, by making good use of almost all transport modes, freight villages and dry ports as well as other kinds of terminals, either maritime or hinterland, enjoys the reduction of truck miles which are responsible for the big carbon footprint during the previous years. The reduction of delays improves the provided level of services (LOS), leading to the increase of demand, i.e., the attraction of users and, subsequently, freight flows and profit. The existence of inland facilities in a

transportation network encourages the relief of the corridors and facilitates the movement of cargoes, as many options and modes are available to the users saving valuable time and cost. They also constitute a place not only for freight consolidation but for shifting cargo between modes when necessary. From an economic perspective, the network is becoming competitive against similar ones or against traditional maritime routes, especially nowadays with the fully stretched and congested seaports. Its importance for a region is worth noting as it is accompanied by the upgrade of the infrastructure and the new job opportunities it creates.

Table 5.3 summarizes the benefits of a network that includes freight village facilities and points out to the common elements with traditional networks. Both create new jobs and contribute to regional/local development with the latter in a smaller scale.

Benefits	**Networks including Freight Villages**	**Traditional networks**
Reduction of truck miles	√	
Reduction of carbon footprint	√	
Reduction of delays-better LOS	√	
Increase of profits	√	
Regional development and new job opportunities	√	√
Attraction of users	√	

Table 5.3: Benefits of networks including freight villages

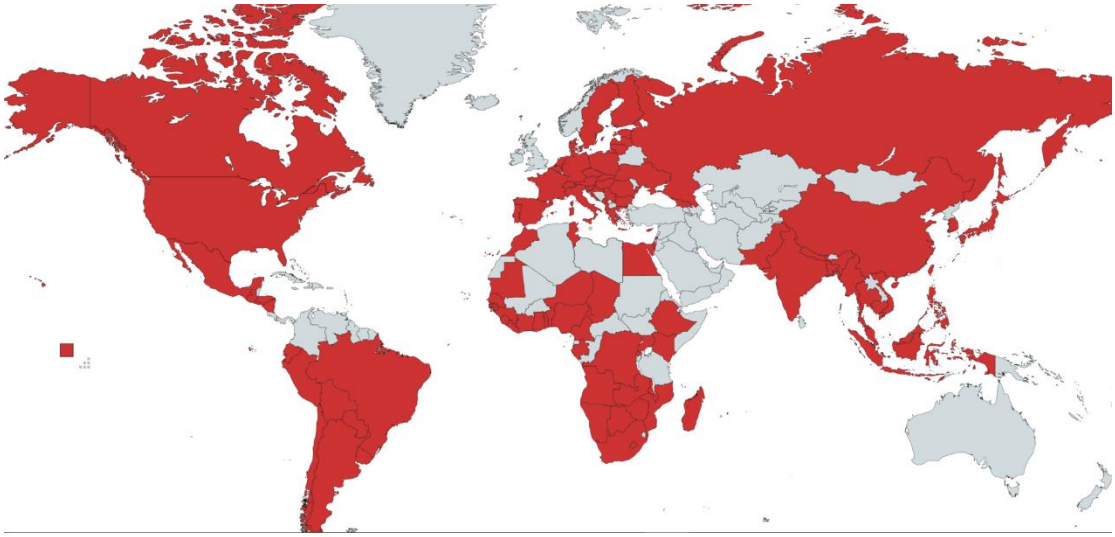
5.5 LINER SHIPPING COMPANIES' INTEREST FOR INLAND FACILITIES

Freight villages and dry ports may address the concerns of various supply chain stakeholders, including ocean carriers, and more specifically container shipping companies. As clearly stated above, liner shipping competitiveness and efficiency is related to four important components; reliability; speed; responsiveness; and value. To ensure the safe, on-time, and low-cost delivery of the goods is not an easy task. Sussman

(2000) described transportation systems as CLIOS; complex, large, integrated, open systems. Major ocean carriers, especially during the last ten years, have invested in maritime terminals as well as in the expansion of their hinterland network for both elimination of delays and support of their door-to-door strategy. In this thesis, the biggest container shipping company, Maersk, and one of the giants of global trade, CMA CGM, are examined, demonstrating their strategy for expanding their services in major ports' hinterlands. Despite the fact that more than 90% of finished and semi-finished goods worldwide are transferred by ships through the oceans, liner companies, which are for-profit businesses, have increased their interest for establishing a hinterland network able to relieve major seaports, efficiently deliver goods and reposition empty containers back to the manufacturing hubs. However, ocean carriers rarely own facilities as they cooperate with local logistics providers, or they follow the landlord model-payments for the utilization of the terminal for cost-optimization factors.

5.5.1 MAERSK

According to the official website of Maersk, anyone interested in inland services can find information in 95 local offices, in different countries. That means Maersk is collaborating with logistics companies or manages its own networks in an effort to be competitive in an industry, where market share is top priority for companies involved, as well as to maintain and expand, if feasible, its clientele. Maersk's local offices for inland services are presented below in Map 5.1:



Map 5.1: Maersk's local offices for inland services

The countries are grouped by region and mentioned below, for further understanding of Maersk's involvement in global trade:

North and South America

Canada, United States, Latin America, Bolivia, Chile, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Peru, Nicaragua

Asia Pacific

Cambodia, China, Indonesia, Japan, Malaysia, Myanmar, Philippines, Singapore, South Korea, Taiwan, China, Thailand, Vietnam

West and Central Asia

Bangladesh, India, Nepal, Pakistan

Europe

Albania, Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Egypt, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Israel, Italy, Latvia, Lithuania, Montenegro, Morocco, Netherlands, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tunisia, Turkey, Ukraine

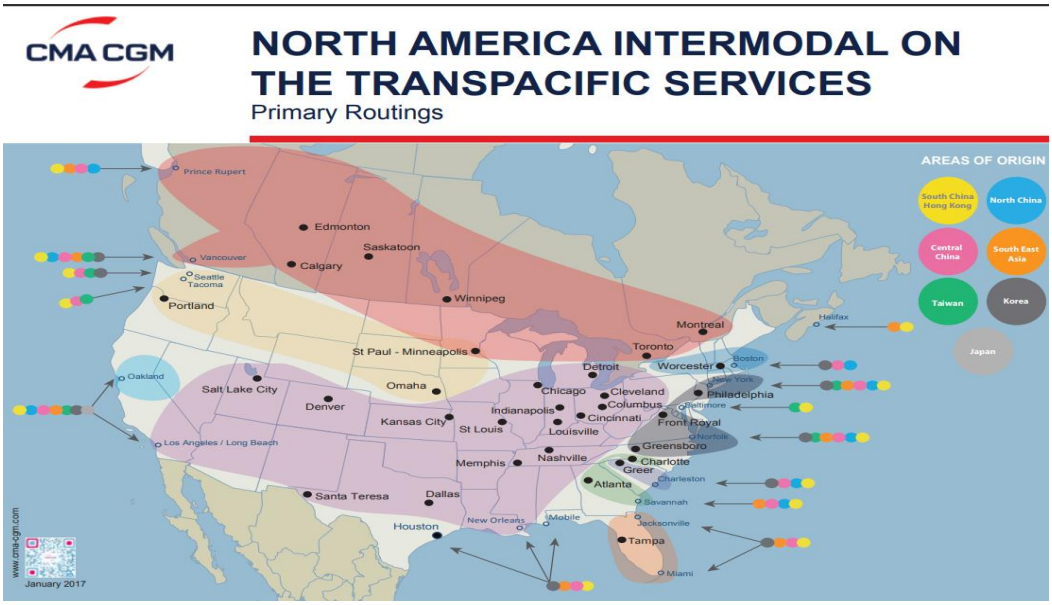
Africa

Angola, Benin, Botswana, Cameroon, Cabo Verde, Chad, DRC, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea Bissau, Ivory Coast, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, South Africa, Togo, Uganda, Zambia, Zimbabwe

5.5.2 CMA CGM

The CMA CGM's site offers more descriptive information by providing maps with the routes and the names of inland facilities. It is worth noting that routes differ from one region to another because of the nature of the operations that take place. For instance, in Asia, where manufacturers mainly operate, inland terminals are not far from the seaports or the production zones. Routes are not expanded deeper in the hinterland, but they are concentrated near by maritime terminals. In Europe and North America, which are the major consuming markets of the global economy, operations are oriented in delivery of the goods. From north to south and east to west, inland terminals and networks cover most of the regions. Comprehensive maps are presented below.

North America



Map 5.2: CMA CGM inland network in North America
Source: CMA CGM

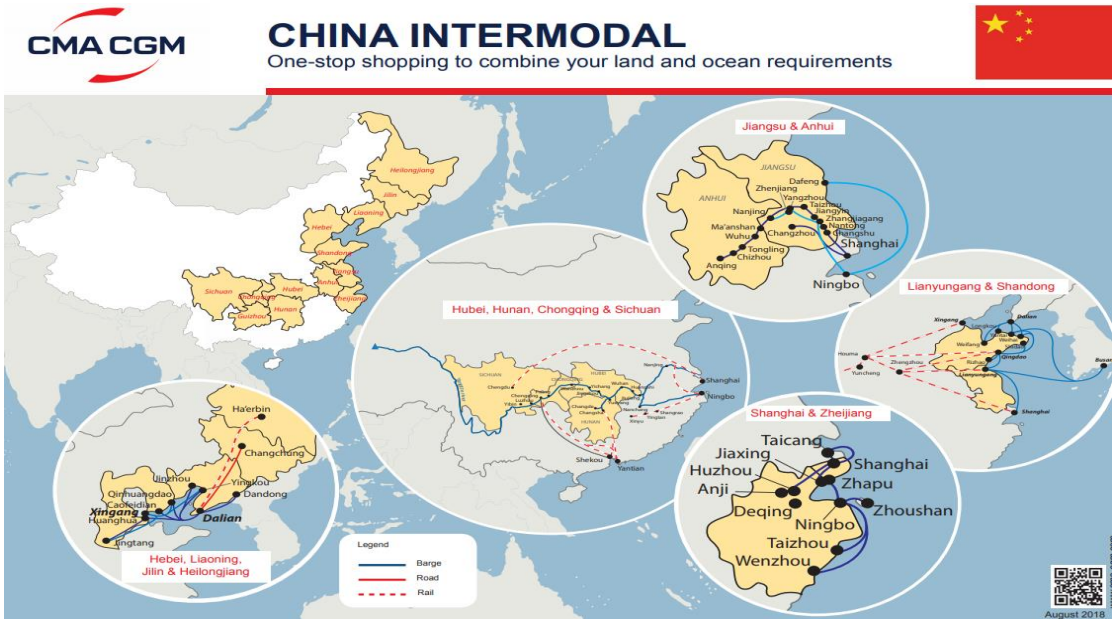
In North America, flows come from both the east and the west seaboard, creating the need of intermodal transport connections between the two sides. Intermodal transport requires multiple options in terms of modes as well as inland hubs where the cargo consolidation takes place. Dry ports clearly gain the preference of shippers, as a facility which combines the two requirements mentioned above.

Europe

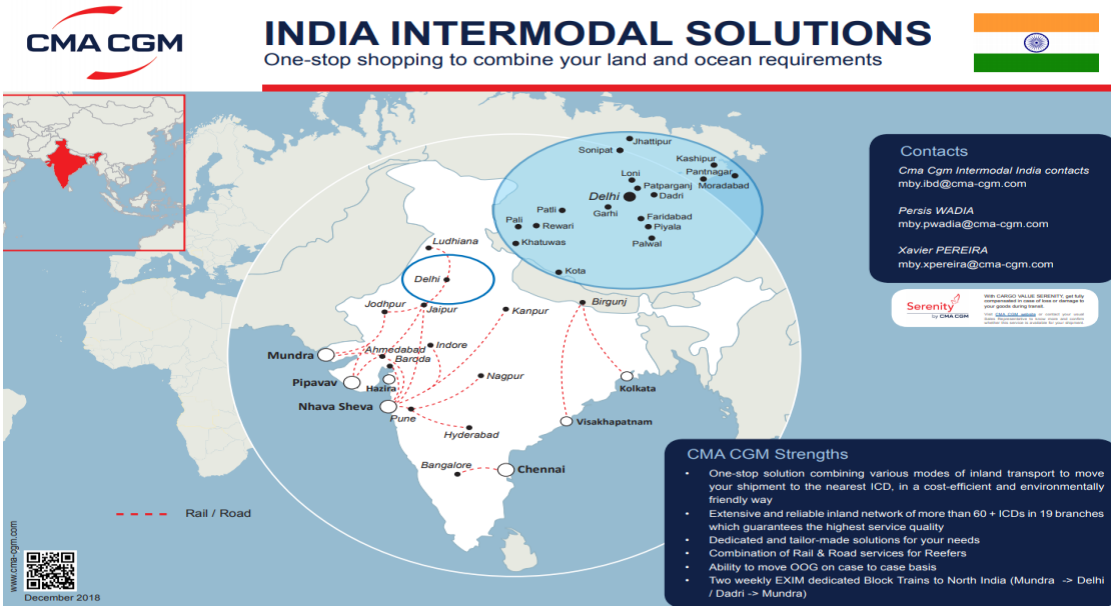
Map 5.3: CMA CGM inland network in Europe
Source: CMA CGM

The importance of inland freight facilities is much clearer in Europe where cargo is mainly concentrated in northwest and delivery starts from there. Rail and barges are responsible for the movement of containers, using inland terminals across the journey. The examined case of Duisburg is depicted on the map strengthening the quality of the providing framework for dry ports location selection. In Spain, special attention should be given in Madrid which constitutes a hub in the heart of the country's hinterland. A dry port in the Madrid region is examined and analysed in the next chapter of this thesis. In north-eastern Europe, several countries are non-traditional trade players, however, they take advantage through the establishment of dry ports as labour force costs are less than in stronger European economies, i.e., Germany.

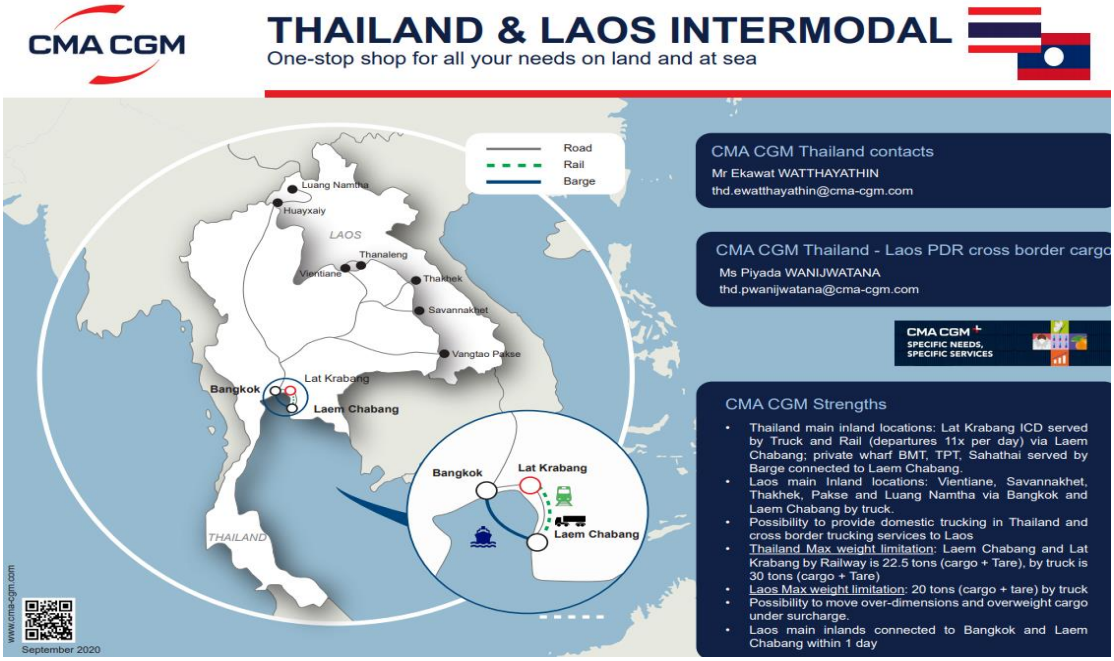
China, India, Thailand



Map 5.4: CMA CGM inland network in China
Source: CMA CGM



Map 5.5: CMA CGM inland network in India
Source: CMA CGM

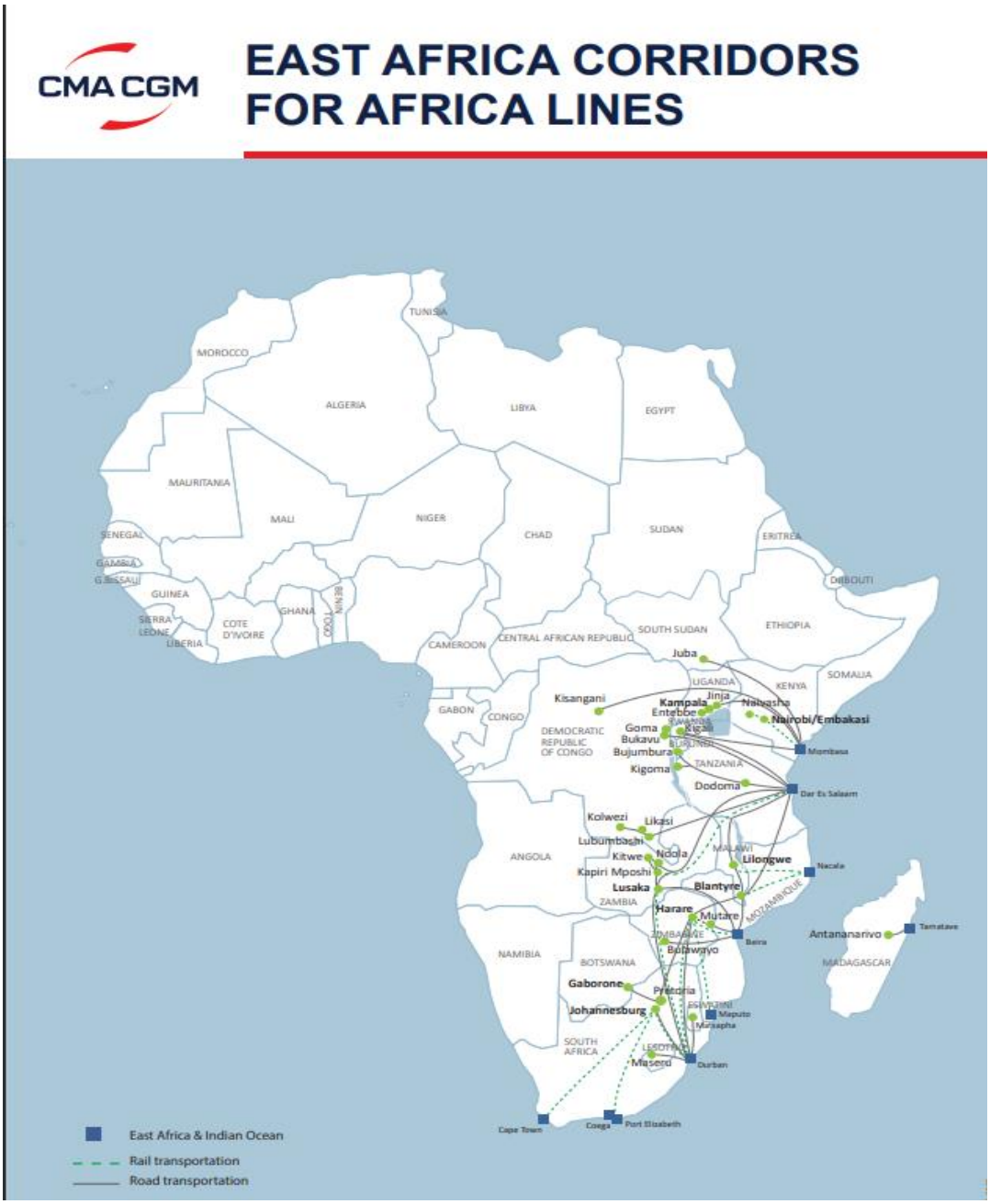


Map 5.6: CMA CGM inland network in Thailand and Laos
Source: CMA CGM

Production of final and semi-finished goods takes place in Asia. Subsequently, inland terminals are located in proximity to the seaports facilitating ocean carriers' and port authorities' job. Lat Krabang, in Thailand, one of the examined cases in Chapter 6, which has the role of Inland Container Depot (ICD), is involved in CMA CGM's inland network. The same kind of dry ports allocation is also observed in India. In China, there is significant presence of barges in cooperation with the port of Shanghai. Inland terminals across the river route have been developed contributing to the transportation

of fully packed containers to the seaport as well as to the reposition of empty ones to manufacturers' facilities.

Africa and Middle East



Map 5.7: CMA CGM inland network in Africa
Source: CMA CGM

Map 5.8: CMA CGM inland network in Afghanistan.
Source: CMA CGM

Over the last few years, developing countries gather the eyes of different stakeholders across the supply chain. Khorgos Gateway Dry Port in Kazakhstan, which was analysed above, is a good case but not the only one.

In East Africa, CMA CGM operates in an expanded and well-developed network. A similar situation is observed in Afghanistan but in a more preliminary stage. There are two major reasons of utilizing these countries. Firstly, the cheap labour force and, secondly, the fact that these regions were suffering a lack of investments for a significant time period due to political instability, which continues being a problem in most of them. However, there is a win-win situation for both governments and carriers. Countries gain taxes and upgrades in public infrastructures and companies gain profits, save costs and time, and expand their network and market share.

6. DEVELOPMENT OF FREIGHT VILLAGES AND DRY PORTS

6.1 CASES FROM EUROPE, THE US AND ASIA

The implementation of inland facilities, including dry ports and freight villages, is broad around the world. For this reason, a pool of different cases has been created demonstrating their international character and importance. Among them, there have been selected facilities from the US, Asia, and Europe with different characteristics, such as size, capacity, and type of development. Several of them follow the Public-Private Partnership model while others belong to totally public or private investments. Special attention is given to their economic transactions. Especially in the US and Europe, inland facilities constitute the place where tenants operate their business due to cost savings, through streamlined cargo operations and the possible existence of Free Trade Zones which allow the tax-free movement of goods in a specific country.

Two major criteria have been considered for the selection of those cases. Firstly, the research is oriented in providing a description of a variety of good cases with different profiles, including different size, geographical characteristics, type of development, capacity, as well as modes of transport operating in the facility. Secondly, pertinent cases have been selected based on the publicly available information, to a level of detail that enables a thorough description of the facility. Those whose development and operation is in one sector's hands are presented following by the facilities implementing the PPPs. Their performance in terms of profits and operation undoubtfully underlines the successful location selection decision, the main topic of this thesis. Both the political scene and the culture of a country affect the final form of the terminal in terms of governance. As clearly demonstrated below, the presence of the private sector in that kind of investments is very widespread in North America while, on the other hand, the public sector is more heavily involved in Asian countries.

6.1.1 LAT KRABANG ICD, THAILAND, ASIA (1995)

In Asia, the development strategy differs from the European and the US one. Inland terminal and other investments, in general, are seriously based on the public sector's influence. Another key feature is that the capacity of such inland facilities is usually much bigger than in Europe. It is widely known that containers start their journey to European markets mainly from Asia, where the manufacturing part of goods takes place. So, supply chains, in order to achieve scale efficiencies, need to be flexible, and that is achieved through the implementation of dry ports with no capacity issues. Lat Krabang, occupies 80 hectares of land, able to provide cargo consolidation, distribution,

warehousing, customs clearance, empty container storage services and Chassis storage facilities with a capacity of 1.7 million TEUs per year. This Inland Container Depot (ICD) is publicly owned and operated by the State Railway of Thailand (SRT), which is the only shareholder, and whose development is a result of STR and Module Operators joint venture. The ICD offers a two-modal connectivity (rail to road and vice versa), with some important cargo carriers renting its space such as Evergreen, Hanjin and NYK, although there is expressed interest by CMA CGM and ONE.

6.1.2 HUTCHISON PORTS VENLO, THE NETHERLANDS, EUROPE (1982)

In contrast with the case of Lat Krabang ICD, Hutchison Ports Venlo belongs to a private investor. The facility is offering great accessibility. It can be reached by the core rail and road network and can also provide barge services via inland waterways. The terminal is operated by Hutchison Ports. In an area of 9 hectares, the terminal has storage space for 5,400 TEUs from rail and 1,900 TEUs from barge. Unfortunately, no further information about total handling capacity is available. Additional services are offered; Road, shuttle, barge operations; customs clearance; consolidation/ deconsolidation; and empty container storage. Many tenants operate under its roof including ECT, Keyrail, D.B. Schenker, DELTA (APM), Home (HPH). Among its stakeholders and shareholders, European Container Terminal, APL Logistics and Betutweroute (Keyrail) have significant presence. Venlo dry port is characterised by significant strengths, keeping an important competitive advantage because of its location in a close distance to the German border. It serves different markets in different hinterlands. Venlo's dry port is depicted in Map 6.1. Its great connectivity allows the cooperation with main European ports such as Rotterdam and Antwerp. According to Prologis, the global leader in industrial real estate, in February 2016, Venlo was the number one logistics location.

Map 6.1: Hutchison Ports Venlo

Source: Google Earth

6.1.3 BNSF LOGISTICS PARK CHICAGO, USA, NORTH AMERICA (2002)

In case of inland terminals developed in the US, the private sector has been the major investor. The BNSF Logistics Park Chicago constitutes one of the biggest in the country with a capacity around 3 million TEUs per year in an area of 2630 hectares. For its development, Burlington Nothern, Inc. and Santa Fe Pacific Corporation worked together, however, its operation is assigned to BNSF Rail Operator. This inland facility belongs to totally private investments and represents the most typical American model. The logistics park, apart from other services such as parking, restaurants etc., provide FTZ (Free Trade Zone), trans-modal load centre and import logistics rail-truck-rail. Its notable connectivity with rail/road allows important franchises to operate into its space as tenants. Walmart, DSC Logistics, Maersk Logistics, American Honda Motor Company; American Isuzu Motors; American Suzuki Motor; Ford Motor Company/UPS Logistics; Hyundai Motor America; KIA Motors America; Mitsubishi Motor Sales; Nissan North America, and Subaru of America, Major 'big-box' retailers, 3PLs, Georgia-Pacific, Pacific Asian supply chains are brands which increase the prestige of the terminal. Among its shareholders, Prologis, CenterPoint, and BNSF have significant impact despite the fact that some of them did not contribute to its development. Map 6.2 shows an aerial photo of part of the land occupied by the facility, focusing on the rail and road connections.

Map 6.2: BNSF Logistics Park Chicago

Source: Google Earth

6.1.4 CENTERPOINT INTERMODAL CENTER ELWOOD-JOILET, USA, NORTH AMERICA (2010)

With its rather large area of 2590 hectares, CenterPoint Intermodal Center Elwood-Joilet can handle 3 million TEUs per year offering warehousing, distribution, and container depot services as well as rail-served facilities and land sales or leasing. CenterPoint is responsible for both operation and development. However, during the first stage of its construction CenterPoint had a different name, Capital and Regional Properties Corporation. It also follows the typical American model as a fully private business. The terminal is well-connected with a reliable rail/road network, attracting important tenants such as Acres Truck Parking, Adrian Carriers, BNSF Railway, Central States Trucking Co., Clearwater Paper, cmi, ConGlobal industries, ContainerPort Group, C R England, CTDI, CYPRESS Medical Products, DeLco, DSC Logistics and supply chain management, GAVILON, Georgia-Pacific, GERTSEN INTERSTATE SYSTEMS Inc, THE HOME Depot, International Transload Logistics, J.B. Hunt, LAFARGE, MARS, MSC, Midwest warehouse & distribution system, NEOVIA, NFI, Odyssey, Partners Warehouse, PRAIRIE Material, PRIMESOURCE, RMC, RoadOne Intermodal Logistics, SaddleCreek Logistics Services, SAMSUNG, SATURN, Stepan, UNION PACIFIC, VULCAN Material co., WALMART, XPOLogistics, ZE, unis. CenterPoint is the only one shareholder, making good use of facility's management. In terms of stakeholders, Union Pacific Joilet Intermodal

Terminal, BNSF Chicago, Norfolk Southern Railway, CSX, NAIHiffman have serious interest in its sustainability and efficiency.

6.1.5 INTERPORTO BOLOGNA, ITALY, EUROPE (1971)

Interporto Bologna is the first presented case from the European continent with public-private partnership being the philosophy of its development. Different organizations, in terms of ownership and services offered, cooperated and most of them hold their part in the Interporto Bologna SpA. The terminal occupies 410 hectares of land, able to handle 300,000 TEUs per year, which makes it a strong competitor in global markets. It provides a range of services, including handling, storage management, container repair, transhipment, shuttle services, customs clearance, fumigation, management of dangerous goods, agency services, handling, and surveillance of ADR containers. Interporto Bologna can be approached by rail or road which facilitate many important brands to place their operation in the terminal's area, like Ferrari, Maserati, Lamborghini, Ducati, Barilla, Parmareggio, Ima and GD. As mentioned above, Interporto Bologna belongs to many shareholders' portfolio. More specifically; Comune di Bologna 35.10%, Provincia di Bologna 17.56%, Camera di Commercio di Bologna 5.90%, Trenitalia S.p.A 1.49%, Praoil Oleodotti Italiani SPA 2.26%, Fi.Bo.SSPA 2.48%, A.B.S.E.A. 1.49%, L'Operosa S.c.a.r.l. 1.10%, Cassa di Risparmio in Bologna SPA 4.10%, EM.RO Popolare SPA 2.68%, Dexia Crediop SPA 1.13%,,, Banca Nazionale del, Lavoro Partecipazioni SPA 2.08%, Sanpaolo IMI SPA 2.31%, Banca Monte dei Paschi di Siena SPA 1.68%, Unicredito Italiano SPA 8.12%, Banca Popolare di Verona E Novara s.c.a.r.l 1.43%, Le Assicurazioni D'Italia SPA 1.69%, Gruppo Societa' Artigiano s.r.l 1.43%, Associazione Industriali di Bologna 5.04%, Interporto Bologna SpA 0.94%. Furthermore, 3PLs companies, logistics operators, Multimodal Transport Operators, freight forwarders, shipping agents, road transport companies and couriers, ecommerce operators and rail intermodal transport operators are involved. The company structure of the Special Purpose Vehicle (SPV) is depicted in the following chart (Figure 6.1).

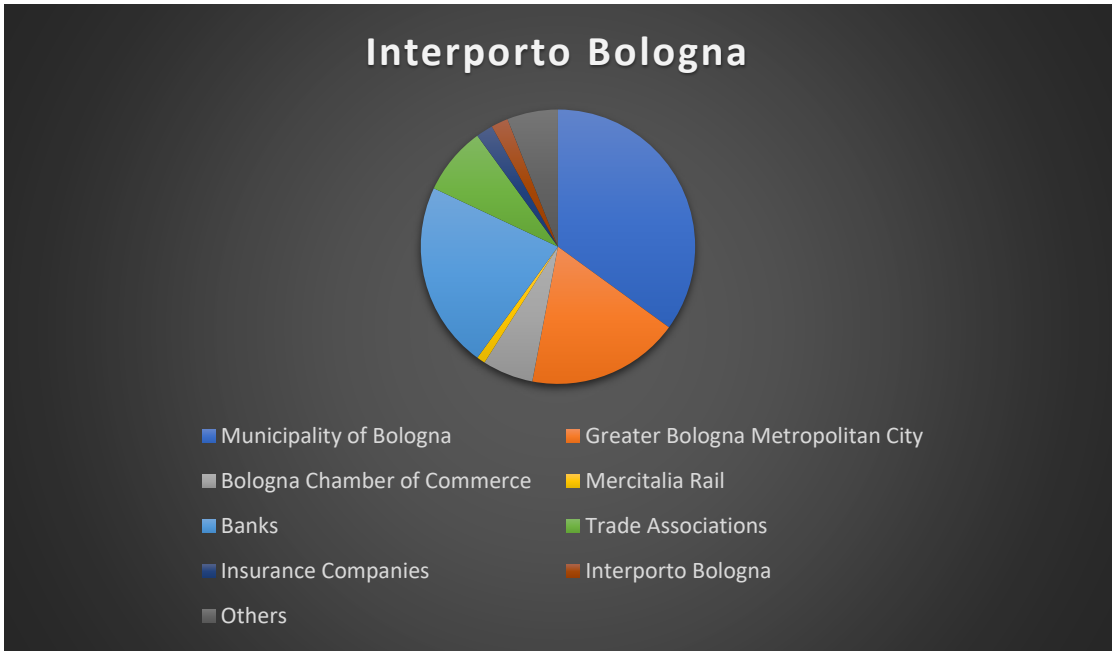
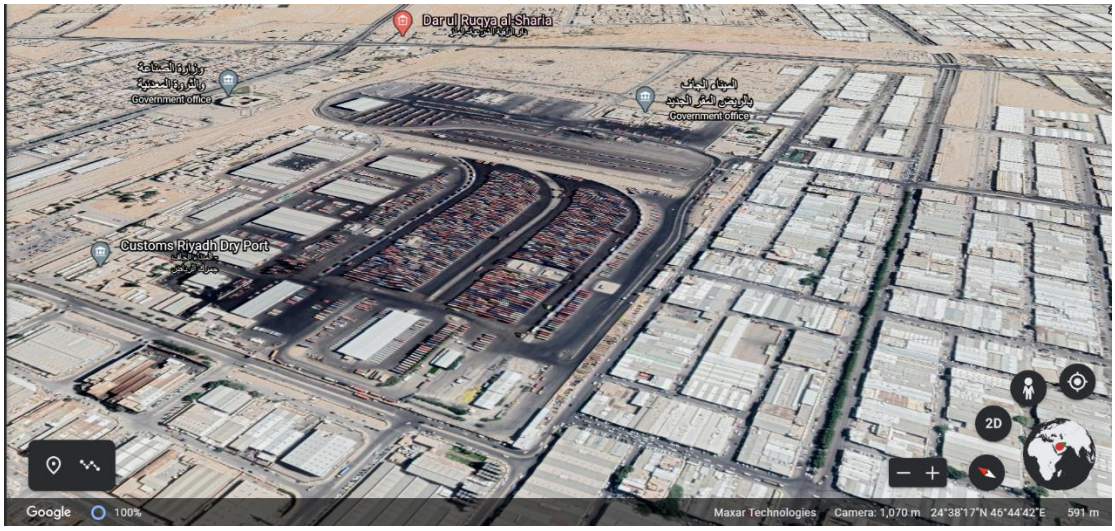


Figure 6.1: Interporto Bologna Company Structure

Source: Interporto Bologna

6.1.6 RIYADH DRY PORT, SAUDI ARABIA, ASIA (1982)

In contrast with Lat Krabang ICD, the public-private partnership stands out, in a facility in Asia, where this method is not widespread. Riyadh Dry Port is placed in a 92 hectares piece of land, with the ability to handle annually 1 million TEUs. Saudi Port Authority was the key-player for the development part while the operation is managed by BAAS International Group and Saudi Railways Organization. To satisfy users' expectations, the terminal offers services such as transhipment, refrigerated storage, customs clearance, maintenance of containers, road haulage and forwarding while many tenants like CMA CGM and BIG operate in it. As mentioned, dry ports are only a part of the supply chain, and the cooperation of different parts is more than required. So, Sea Port of Eastern Province and Damman Sea Port are among the stakeholders despite the fact that they may not have direct financial interests. In Map 6.3, an aerial photo of the terminal is shown, indicating its size in relation to the surrounding area.



Map 6.3: Riyadh Dry Port

Source: Google Earth

6.1.7 DRY PORT MADRID IN COSLADA, SPAIN, EUROPE (2001)

Different public owned organizations cooperated in its development. Specifically, Spanish Ministry of Development, Municipalities of Madrid and Coslada, Spanish Port Authority and Spanish National Rail Operator joined their forces and created the SPV named "Puerto Seco de Madrid". However, the recent trend of vertical integration by pioneering container shipping companies, led COSCO to take advantage of the situation and sign a contract to operate the terminal. So, Conte Rail, a subsidiary of COSCO, is responsible for the services offered by the dry port. In a space of 14 hectares, by having the ability and equipment to handle 64,165 TEUs per year (2018) and the rail/road accessibility available, the Dry Port Madrid in Coslada constitutes a node for the ports of Barcelona, Valencia, Bilbao, and Algeciras which are some of the main shareholders holding a 10.2 % each. Madrid Regional Government also holds the biggest part of 25% as well as Entidad Publica Empesarial de Suelo and Coslada Local Counsil with 13.08% and 10.92% respectively. The dry port provides all the core services such as customs clearance, rail services, road transport services, empty container depot, container cleaning and repair and warehousing. Except for users, investors and residents, the most important stakeholders of the project are COSCO Shipping Co. and Continental Rail. The tenants operating right into the area of the dry port include: ACL, MRW, PEPSICO, TDN, EL CORTE INGLES CEDIAL, IVECO, DECOEXSA, DOCKS LOGISTICS, SADECO, TRANSPORTES CEREZUELA, CTT EXPRESS, BIMBO, AGILITY, DHL FREIGHT, DIPLOMATIC SUPPLY, TOLDOS MONITA, ENVIALIA,

SUPERMERCADOS COVIRAN, SENDING, EVOLA GROUP, CECAUTO, GEWISS IBERICA, ADI GLOBAL DISTRIBUTION, VOITH, RHENUS, CARRIES TRANSICOLD, ALVACO, CORREOS EXPRESS, FERROLI, NTL TRANS, TRANSNATUR.

6.1.8 RICKENBACKER INTERMODAL TEMRINAL (COLUMBUS, OH), USA, NORTH AMERICA (2008)

Rickenbacker Intermodal Terminal has been planned and developed by Columbia Regional Airport Authority, Duke Realty Corporation and Capitol Square Ltd. while the operation part is assigned to Rickenbacker International Airport and Norfolk Southern Corporation. Based in the state of Ohio, the terminal handles 260,000 TEUs per year, in a land of 70.8 hectares (in its initial phase), especially due to its excellent connectivity with road, rail and air corridors. It also provides users with all type of services such as storage, warehousing, Free Trade Zone, distribution and manufacturing, interchange of shipping containers between trains and trucks as well as the presence of double-stack rail cars directly from the Port of Norfolk, Virginia. It is argued that not only the terminal offers a great variety of functions in terms of number, but it serves the users with the proper way which attracts a plethora of corporations willing to utilize its infrastructure (tenants). Goodyear, Amazon, Anheuser-Busch Owens & Minor, Crate and Barrel Lasership, RGLP, American Showa, BASF, Hyperlogistics, FedEx, UPS, Kalitta Air, Atlas/Polar Air Cargo and Evergreen International Airlines, Exel/DHL Global Logistics, Expeditors International, Freight Expediters, Hellman Worldwide, Kintetsu, HA Logistics, Polar Air Cargo, Kalitta Air and Nippon Express, Commodity Logistics and ODW Logistics operate in Rickenbacker Intermodal Terminal. Unfortunately, information on shareholders and company structure is not available, however, among the stakeholders, Norfolk Southern and Heartland have a primary role.

6.1.9 SAVANNAH-APPALACHIAN REGIONAL PORT, USA, NORTH AMERICA (2018)

Following the Rickenbacker development philosophy, Appalachian Regional Port have been developed by the partnership of private and public sector. The terminal has been run by Georgia Ports Authority, while its development/construction is a result of the State of Georgia, Murray County, Georgia Ports Authority and CSX

Transportation joint-venture. The inland port handles approximately 50,000 TEUs per year in an area of 17 hectares and its major function is transloading import logistics. It can be characterized as a satellite terminal. According to Rodrigue and Notteboom (2012), a satellite terminal is close to a port facility but at the periphery of its metropolitan area. A satellite terminal operates as load centre for local or regional markets. As most of its kind in the US, rail/road network constitutes a milestone and permits to different tenants like CSX Transportation, TCW Inc., Averitt Express having their own space in the terminal's area. Furthermore, shareholders and stakeholders are in the same group following the same direction to achieve revenues either financial or socioeconomic. Savannah Port Authority, Savannah Economic Development Authority, Duke Realty, CSX Railway and NS Railway have mutual interests with the operators. The difference of this inland facility, in comparison with the other ones in the US, is that its size, and possibly its governance, do not allow for a large number of tenants.

6.1.10 EAST WEST TERMINAL, HUNGARY, EUROPE (2022)

East West Terminal is placed in a strategic position, as Hungary is bordered by several countries in Central Europe and the facility will serve as a gateway of the New Silk Road. This terminal is in an early phase of development. East West Terminal occupies a 125 hectares piece of land and is able to handle 1 million TEUs per year, as well as, to offer a variety of different functions to its users. Container transfer from rail to truck, 5G Access, semi-trailer transhipment, loading/unloading containers, empty container storage, 24/7 customs clearance, moving and storing of dangerous goods, distribution, software access, truck parking are planned to be available. In this case, the development is a result of public-private partnership while responsible for the operation is a SPV named "East West Intermodal Logistics Service Private Company". Because of its well-placed area, it provides notable accessibility via rail and road. Important companies, like CAMCO Technologies, have already expressed interest and signed contracts to operate their business in the terminal's infrastructure, despite the fact that it will open its gates in early 2022. Until the time this thesis is written, there are two main shareholders; 50% belongs to Greennovatik Energetikai Fejleszto Limited Liability Company; and 50% to Trusty Business Management Private Limited Company. However, the Hungarian government has contributed with

capital to this investment and has its own interests. Some of them could be the new job opportunities that will be offered to the unemployed population, or the taxes.

7. LOCATION SELECTION OF FREIGHT VILLAGES/DRY PORTS

7.1 MULTIMODALITY SWOT ANALYSIS

Multimodality may be defined as the existence of different modes of transport in the same place (e.g., a freight village or a dry port, a seaport, or any kind of terminal) serving the same purpose, under one or more transportation contracts. Multimodality generates accessibility which is the major factor considered in the location selection of a freight village and a dry port. The aim of this subchapter is to present a SWOT Analysis for the presence of multimodality in inland facilities. For instance, a container is transferred from the manufacturing area to an inland port by truck and then into a barge in order to arrive at the deep-sea port. Three modes of transport are usually met in freight villages and dry ports; truck; rail; and inland waterways. Multimodality offers a range of strengths and opportunities to the facility as well as weaknesses and threats. Table 7.1 portrays the components of the SWOT Analysis.

Strengths	**Weaknesses**	**Opportunities**	**Threats**
Easy mode shift	High terminal's OPEX	Future spatial expansion	Possibility of limited space due to increased flows
Reduced cardon footprint	Difficulties in modes coexistence	Market integration	Congestion
Strong competitor (all modes in one place)	Scheduling	Attract investors, users, tenants	Task confusion (different modes=different functions)
	Lack of expert staff	Collaborations with mega seaports	Externalities (social cost)
		New jobs	Pollution due to unequal use of modes (e.g., lots of trucks)

Regional development

Table 7.1: Multimodality SWOT Analysis

Strengths

The presence of two or more modes in a freight village or dry port facilitates the easier shift from one mode to another saving time and money from carries and receivers. Multimodality also contributes to a reduced carbon footprint for the terminal as well as for the region, by eliminating truck miles. In terms of economic benefits, the terminal becomes a strong competitor in global markets as it gains advantage through the facilitation of the supply chain actors.

Weaknesses

Multimodality does not only generate strengths. Such a facility is characterized by high operational expenses (henceforth OPEX). Maintenance of the terminal's infrastructure takes a big share of the OPEX. Furthermore, it is worth mentioning that a sustainable terminal requires well trained staff with high level of expertise, which sometimes is infeasible to find and hire. People who work in a multimodal terminal are experienced in multitasking jobs. Special attention is given in scheduling of modes arrivals and departures which is the biggest challenge of the multimodal project and also one of the most difficult tasks. Scheduling in large-scale freight facilities requires punctuality and skilled human resources. Finally, the coexistence of different modes may be conflicting because of the different interests.

Opportunities

A multi-connected inland facility operates as a buffer for actors across the supply chain contributing to the reduction of their costs. More and more shippers are becoming familiar with the offering opportunities expanding the terminal's clientele. Subsequently, the increasing flows of inbound cargo may lead to physical expansion and to a bigger market share which is not possible without the existence of multiple modes of transport. A multimodal freight village or dry port attracts tenants who are seeking profit maximization, flexibility, speedy processes, and financial risks elimination. The potential of an inland terminal may be one of the features which determines their decision, to invest or not. Additionally, municipalities are seeking for revenues, through taxes, and for economic development of the entire territory, while

residents are looking for new job opportunities and reduction of externalities (e.g., traffic jam and bottlenecks). Finally, users' and tenants' needs are similar, with speedy delivery and low costs being those which concern them the most. Several mega seaports around the world are collaborating with dry ports. The better connection the latter offers, the more possible is to make such kinds of economic agreements.

Threats

Opportunities are accompanied with threats which should be considered in order to ensure the continuity of a terminal's profitable operation. Firstly, different modes discharge hundreds, even thousands of containers, on a daily basis, generating the possibility of an available capacity shortage. In addition, multimodality without scheduling leads to congestion in yards and gates having a negative impact on operational issues and on the terminal's economic situation. Congestion also creates externalities, the so called "social cost", which usually degrades the residents' well-being and the surrounding environment. Special attention should be given in labor force tasks division to avoid confusion and conflicts. Summarizing, multimodality must promote the environmental friendliest modes and mitigate increased truck utilization. The sustainability of such a project is based on respect to environmental issues.

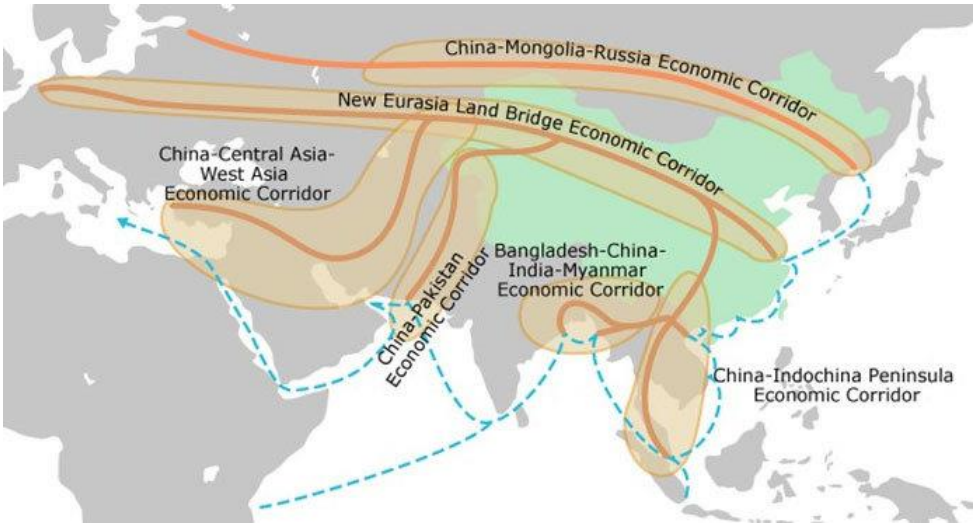
Strengths and weaknesses usually derive from the organization's internal environment while opportunities and threats from the external. Successful corporations try to ensure the limitation of weaknesses applying the strategy of "internal integration". On the other hand, the "external adaptation" keeps the organization in vigilance for possible threats or opportunities.

7.2 THE BELT AND ROAD INITIATIVE

Today, transportation networks are more integrated than ever before. Trucks, ships, trains, barges, aircrafts are parts of the same network involving different actors and serving consumers around the world. To achieve that, several hubs have been created to facilitate modal shift. Furthermore, several initiatives have been developed worldwide requiring more sustainable and efficient transportation networks equally involving different actors and modes. The "Belt and Road Initiative" (henceforth BRI) involves 71 countries from Europe, Asia, and Africa and may constitute the greatest one. This global infrastructure development strategy adopted by the Chinese government in 2013 with almost $160 billion of infrastructure projects being in planning or construction phase, demonstrates the importance of different modes

efficiency across the whole supply chain. Nonetheless, efficient modes need efficient networks.

The BRI provides six economic corridors from China, covering significant geographical area including northwest Europe, Russia as well as the Indochina peninsula. This project aims to improve connectivity and cooperation among different countries. Asia, and more specifically China, will have the opportunity to move their goods easier, safer and with lower cost. The project also contributes to the economic development of many counties which face different kind of difficulties (e.g., in the Middle East). These counties will be the buffer in goods transportation. Its great coverage is clearly depicted in Map 7.1.



Map 7.1: BRI's six economic corridors

Source: www.intsguide.com

According to Statista[4], the biggest amount of money, in 2020, invested in the BRI is in East Asia following by West Asia, where Khorgos Gateway is placed. The importance of the network around the Khorgos Gateway Dry Port is analysed below. Figure 7.1 portrays China's Belt and Road investment map.

[4] www.statista.com

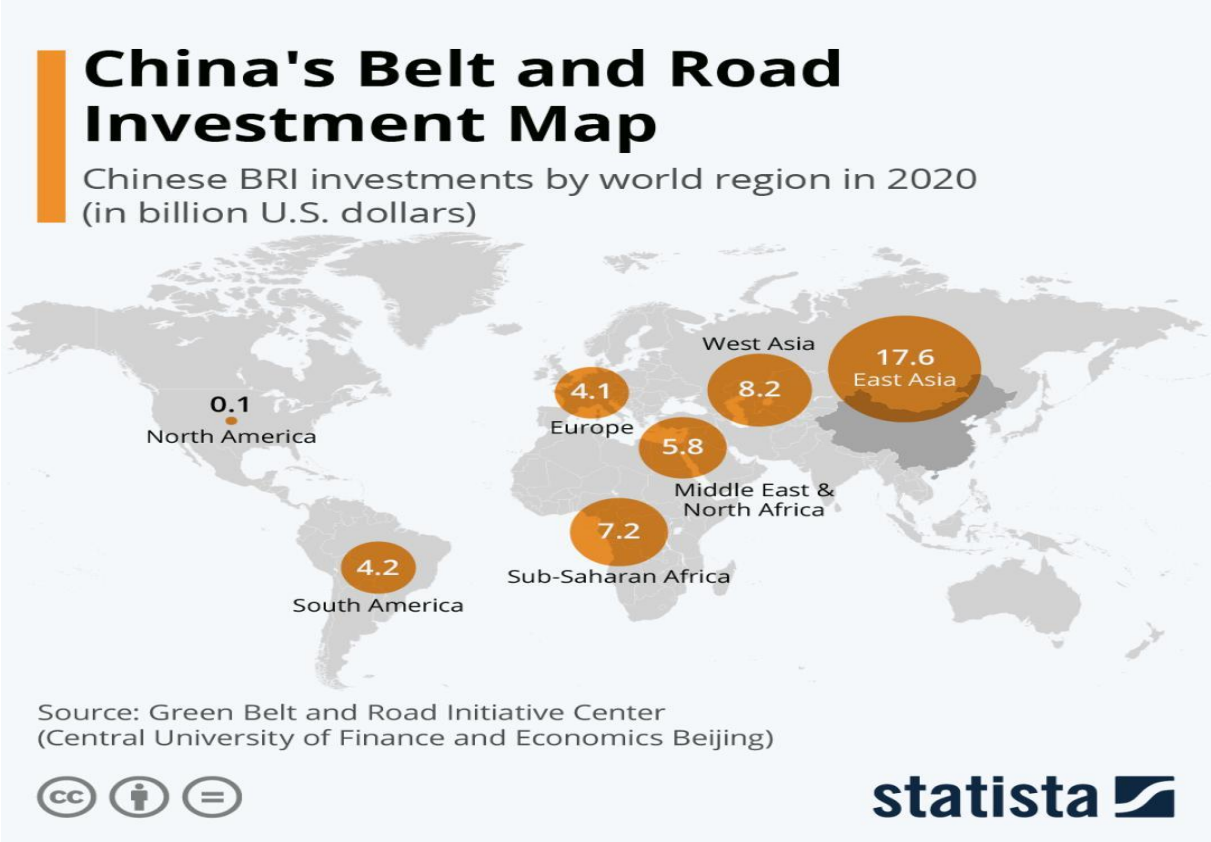


Figure 7.1: BRI's investment map

Source: Statista

7.3 THE TRANS-SIBERIAN RAILWAY INITIATIVE

This thesis focuses on two corridors; China-Mongolia-Russia Economic Corridor; and New Eurasia Land Bridge Economic Corridor, while special attention is given to the Trans-Siberian railway network, the longest rail line in the world.

Among the purposes of the Trans-Siberian Railroad is to expand trade in East Asia. As Map 7.2 shows, the rail services start from Moscow and end to Vladivostov. However, the Russian capital because of its position, communicates with several European capitals and cities facilitating the movement of goods and creating more integrated transportation systems.

Map 7.2: Trans-Siberian connections

Source: www.intermodal-logistics.com

Both initiatives have strong impact in present and future global trade. Obviously, maritime transportation offers low cost per unit, but now, more than ever before, capacity in seaports reaches its limits. On the other hand, hinterland transportation networks such as BRI networks and the Trans-Siberian Railroad offer flexibility by creating a sustainable environment where different kinds of transportation modes coexist and collaborate. A system that includes both maritime and hinterland networks, promotes cost efficiency by reducing transportation time and industry's carbon footprint.

7.4 LOCATION DETERMINATION CRITERIA

Shippers, carriers, and receivers evaluate transportation level of services from three different perspectives; transportation time; reliability of services; and cost, which are often regulated by the Porter's five forces (competition in the industry, potential of new entrants into the industry, power of suppliers, power of customers, threat of substitute products). Freight villages and dry ports, in order to be efficient, must be properly located, a strategic decision made during the planning phase. This thesis follows a different approach of dry ports' location selection. Several criteria from the pertinent literature, and more specifically from the scientific works of Awad-Nunez et al (2016), Tadic et al (2020), Boile et al (2008), Li et al (2011) and Ozceylan et al (2016), were selected and synthesized creating a framework that emphasizes in specific categories. A pyramid is presented in Figure 7.2 focusing on two major criteria categories as the

foundations of the whole project, framed by the support ones. The metrics of each category are presented in Figure 7.3, contributing to the framework's design. The cases of "duisport" in Germany and Khorgos Gateway Dry Port in Kazakhstan demonstrate that the presented decision-making theory leads to users' attraction and, subsequently, to higher profit levels. However, not only the location affects the terminal's efficiency but also the management, market's situation, operational decisions etc. For the purpose of this thesis, only the location selection effects have been considered.

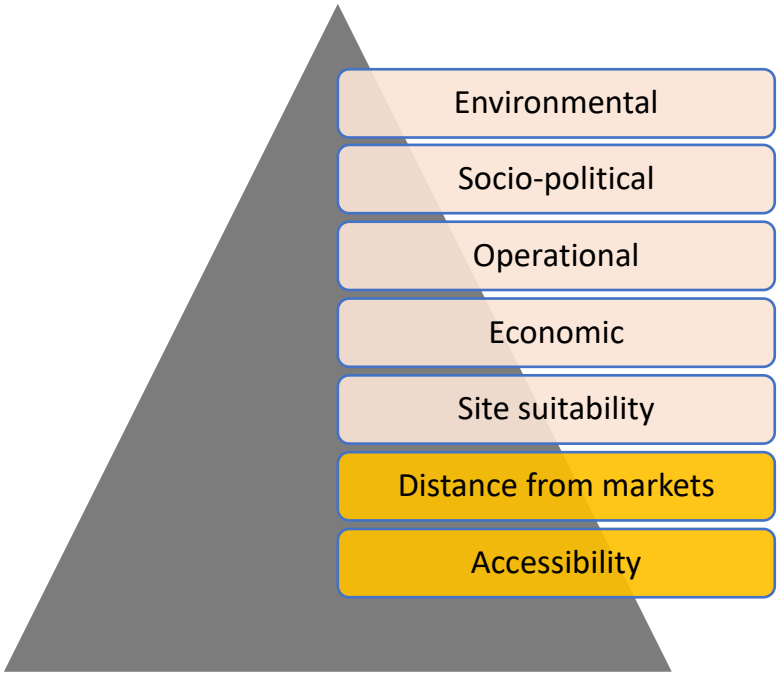


Figure 7.2: Criteria categorization

Initially, the opportunity cost of developing a dry port and not another facility should be examined. For the purpose of this thesis, we assume that the development decision is made. Furthermore, the term "markets" refers to two different categories. The first includes deep-sea ports and industrial/manufacturing zones with typical retail markets being in the second. This special categorization is due to the nature of clients of an inland facility, as it serves both parts of trade. An example is presented to further clarify. Auto parts manufacturers from Japan use a dry port to transport efficiently their products to different car dealerships in Europe. In this case the dry port serves two different clients/markets; the manufacturers in Japan; and the receivers in Europe who serve the final consumers.

However, the example's facility could be placed in several locations. On the one hand, freight villages and dry ports may be a great fit for locations with increased flows of cargo which remain relatively stable for a significant time period (e.g., near industrial zones or seaports) relieving the regional networks and terminals from traffic pressures. On the other hand, a possible location may be in a close proximity from the retail market where the final products' journey ends, improving time-consuming operations such as last mile delivery or unpacking of containers. The analysis below, presents the criteria that must be considered in freight villages' and dry ports' optimal location selection with the assumption that they are not existing facilities but new ones. Both primary and support criteria have been taken into account as inseparable.

Accessibility

Accessibility constitutes the milestone of this research and the base of the pyramid in the above Figure. According to Vickerman (1992), *"there is today the need to calculate accessibility, not just as accessibility along the network, but also involving accessibility to the network".* The first component the decision makers should examine is the underlying infrastructures of the region, which save cost and valuable time, as well as the transportation networks and their status. The existence of economic corridors in the region makes the difference as their presence often transforms a traditional network to an integrated transportation system, mainly because of the huge cargo flows which require almost excellent management and connectivity. The closer a freight village or a dry port is placed to these corridors, the more possible is to be a key player in markets where corridors end up or pass through. Subsequently, multimodality as well as the ease of shifting modes may be the elements which provide competitive advantage to the terminal. An approachable terminal by all four types of modes, rail, road, water, and air, is often impossible but the coexistence of the first three in several instances of tri-modal terminals, such as "duisport", is common.

Distance from markets

The second primary criterion examined is the distance from markets, the deep-sea ports and the manufacturing areas being the most important ones. Modern logistics centers do not only offer warehousing or tranship cargo services but they include customs clearance, and a number of other so called "value-adding services". Economic corridors have strong impact in the second criterion, too. Despite the distance between the facility and the markets, that kind of corridors make the connection easier and more direct.

After considering the primary criteria, the decision makers conclude in a few possible options. Nevertheless, the final decision is made after analysing the support criteria, too. The framework is offering flexibility-as it can easily be adjusted to almost any geographical region-and time saving. Considering accessibility and distance from markets first, several options may be rejected, leading simultaneously to faster and well-documented results. Figure 7.3 gives a comprehensive picture of all criteria as well as their metrics.

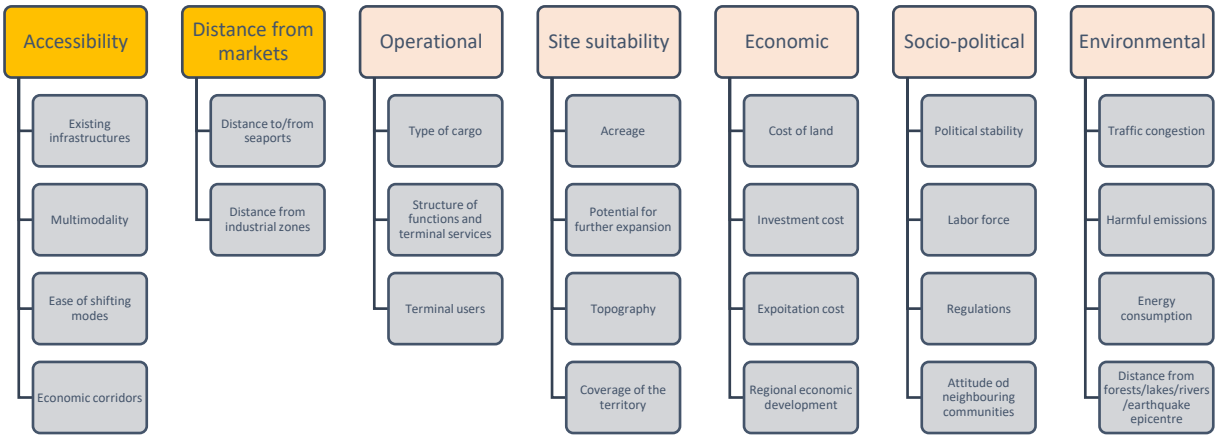


Figure 7.3: Criteria and metrics

Operational criteria

The next set of criteria refers to the operations of the facility which strongly affect the site suitability. The type of cargo basically determines the terminal's users as well as the structure of its functions and services. A freight village or a dry port responsible for handling maritime containers has significant differences from a dry bulk inland port.

Site suitability

The size of the terminal and the potential of further expansion are crucial components which if wrongly assessed may create future inefficiencies in several occasions. The terminal will not serve a stable demand created by the "seasonality" of the markets. If the developers decide to build a facility for serving maximum demand, the operating expenses may overcome the profits for most of the periods. In addition, the option of developing a facility able to handle average demand will create congestion, leading to unreliable services and costs across the whole supply chain. The optimum size, in most

cases, is between these two points (Sussman, 2000). Finally, the topography and the coverage of the territory should be evaluated properly from the experts.

Economic and socio-political

The economic and the socio-political criteria constitute two categories which are perceived as the most weighted in several studies. In terms of economic criteria, special attention is given in regional development. A facility, in order to be effective, should fit in the regional environment by creating new job opportunities for the residents and/or contributing to infrastructure upgrade. Different kinds of cost such as land, exploitation, and investment in equipment/technology are included. Political stability and regulations are interdependent components which concern the developers who seek for certainty and willingness to focus only on business issues. Part of the labour force employed in the freight village or dry port should be hired from the surrounding community promoting the utilization of the local/regional assets.

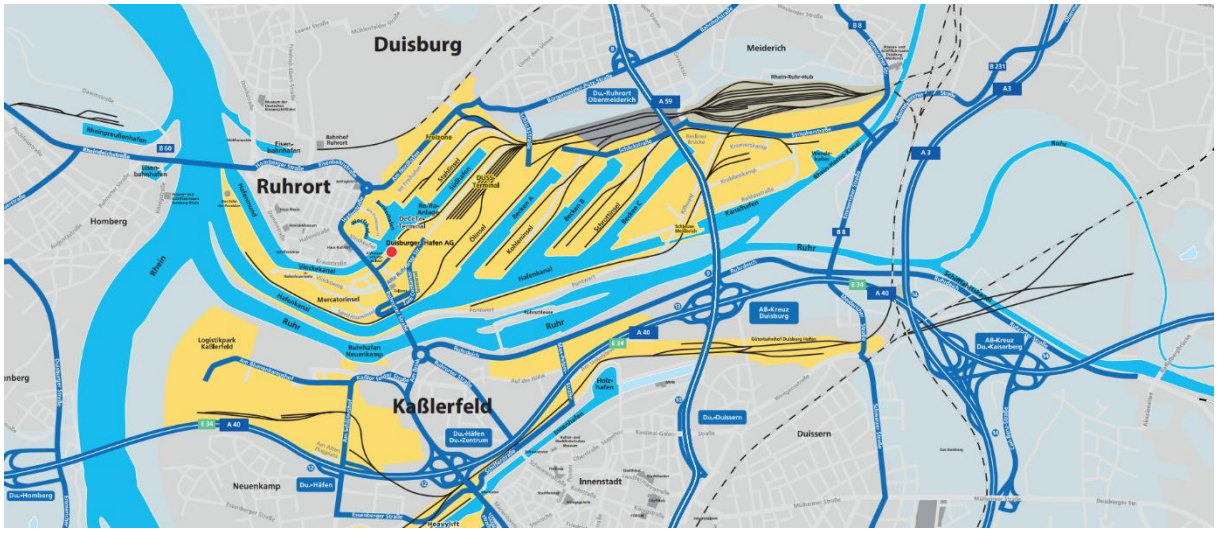
Environmental

In the last examining criteria category, environmental factors are presented, which belong to the top of the pyramid. In the past recent years, policy makers and developers have expressed sensitivity to environmental protection. A dry port is responsible for managing the traffic in their gates and the surrounding area as well as controlling the emissions from the vessels involved in cargo transportation. Keeping distance from lakes, forests and earthquake epicentre is not always feasible but is strongly recommended.

7.5 THE CASE OF "duisport"

Duisburg inland port is located in western Germany near by the Netherland and Belgium borders and is the world's largest inland container port. Duisburg Hafen AG and its subsidiaries own and operate the terminal as a totally private sector's investment. The port occupies 1,550 hectares with 21 port basins, 200 km of track, 8 container terminals with 21 gantry cranes, 5 import coal terminals, 19 facilities for handling liquid goods and approximately 0.6 million m^3 tank room for liquid goods among them. In 2020, "duisport" handled 4.2 million TEUs and increased its stowing capacity to 15,000 containers. The inland port of Duisburg constitutes a trimodal logistics hub making good use of road, rail, and inland waterways. More specifically, several trucks, 25,000 trains to 100 European as well as to many global destinations and 20,000 barges per year, mainly from Rhine and Ruhr, reinforce terminal's accessibility. The terminal

enjoys great connectivity in proximity to a node of TEN-T network while uses connections to major motorways (A2, A3, A40, A57, A59), as depicted in Map 7.3.



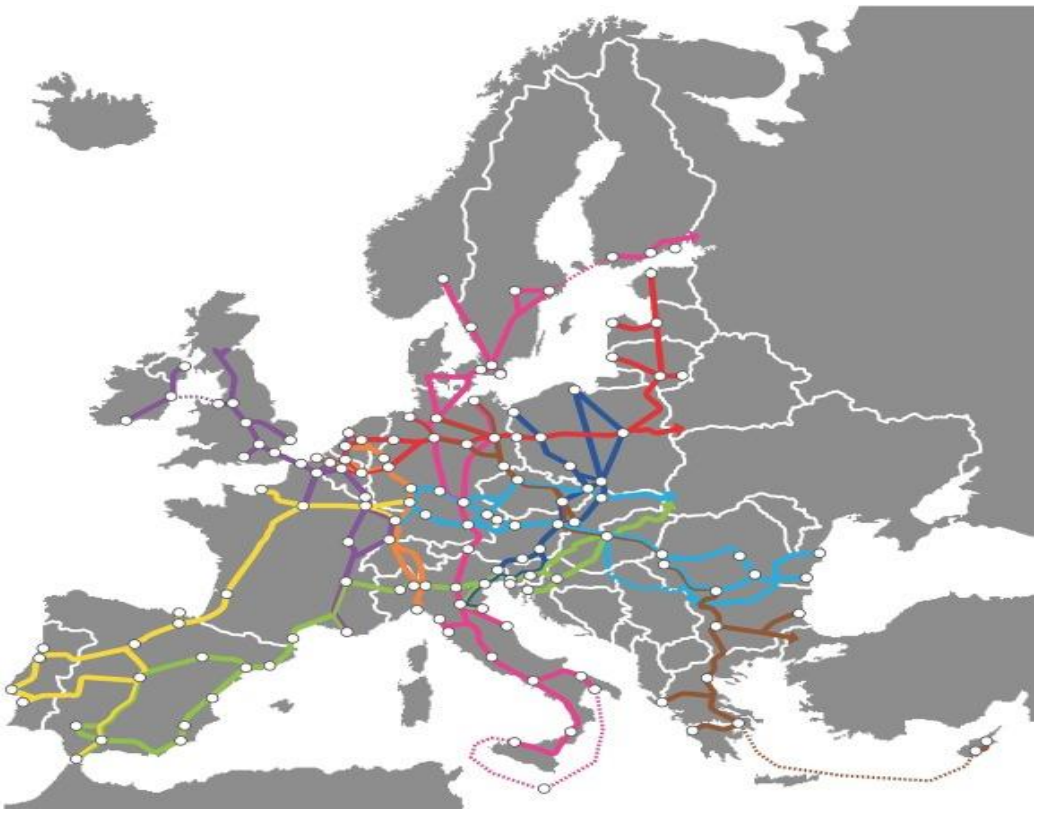
Map 7.3: "duisport" multimodal connections

Source: www.duisport.de

Since 1998, 1 billion euros have been invested in the terminal. The offering services demonstrate why "duisport" is the world's largest container inland port; procurement/distributions logistics, pre-packaging, customs clearance, sea freight, intermediate storage, container stuffing/stripping, export packaging, pre/post carriage to seaports, 6,500 m² covered transhipment building with direct rail connection, 2,000 m² storage building for material that can be handled by forklifts, 10,000 m² external warehouse (for container storage, among other things). "duisport" is also an attractive area for tenants to operate mainly because of its strategic position. Audi, DB Schenker, DHL, Hewlett Packard, Johnson & Johnson, Kühne + Nagel, Mitsubishi, Fressnapf, Chal-Tec and Siemens are famous brands in global markets positively influencing the terminal's status.

The terminal consists of skilled labour force, a key feature of its successful operation, as well as high-technology equipment, a combination which offers advantages against competitors. At least 1,600 employees within "duisport" group and 51,580 direct and indirect port-dependent employees work in around 300 transport and logistics companies in the whole Port of Duisburg. In terms of specialized equipment, the terminal owns 16 forklifts, 3 to 37 t, 1 container forklift, 1 x 40 t crane, 2 x 32 t crane, cross braces, and hooks.

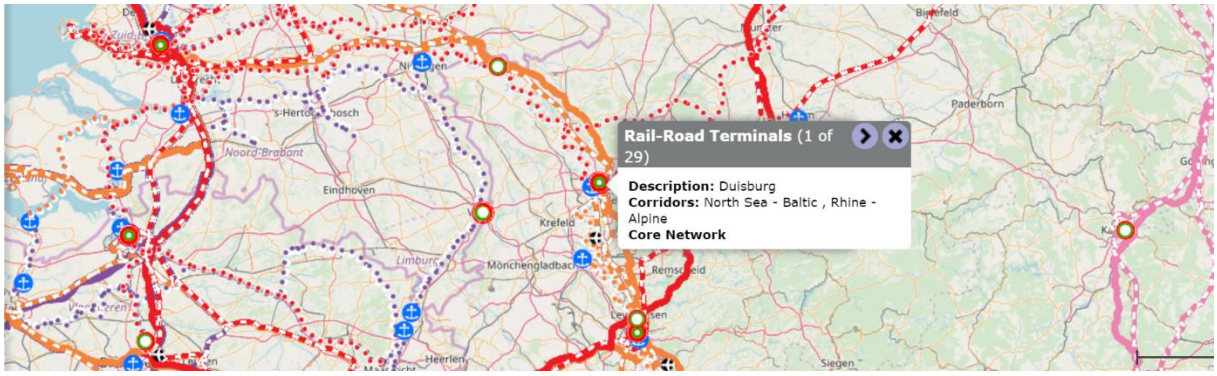
Duisburg inland port may perfectly apply the container multimodal transport concept. Great accessibility does not only contribute to economic effects but also to environmental issues. *"Shifting freight transport away from trucks as much as possible to trains and ships not only relieves heavily used traffic routes but also reduces the impact on the environment to a considerable degree. Intermodal transport concepts connect Duisburg to almost every European country and all of the continent's important industrial centers."*. "duisport" is concerned with reducing truck miles as much as possible. There is rail connection between Duiburg and main hubs in China as part of the New Silk Road. The journey lasts 12-16 days and offers speedy delivery of goods as well as flexibility in mode shift. In European region issues are managed in a more convenient way. TEN-T network, as presented in Map 7.4, constitutes a core transportation system with *"the ultimate objective to remove gaps, reduce bottlenecks and technical barriers, as well as to strengthen social, economic, and territorial cohesion in EU"*. The European market is affected by the TEN-T network which reduces transport time from a maritime to an inland port and makes a good use of almost all modes of transport.



Map 7.4: TEN-T network

Source: ec.europa.eu

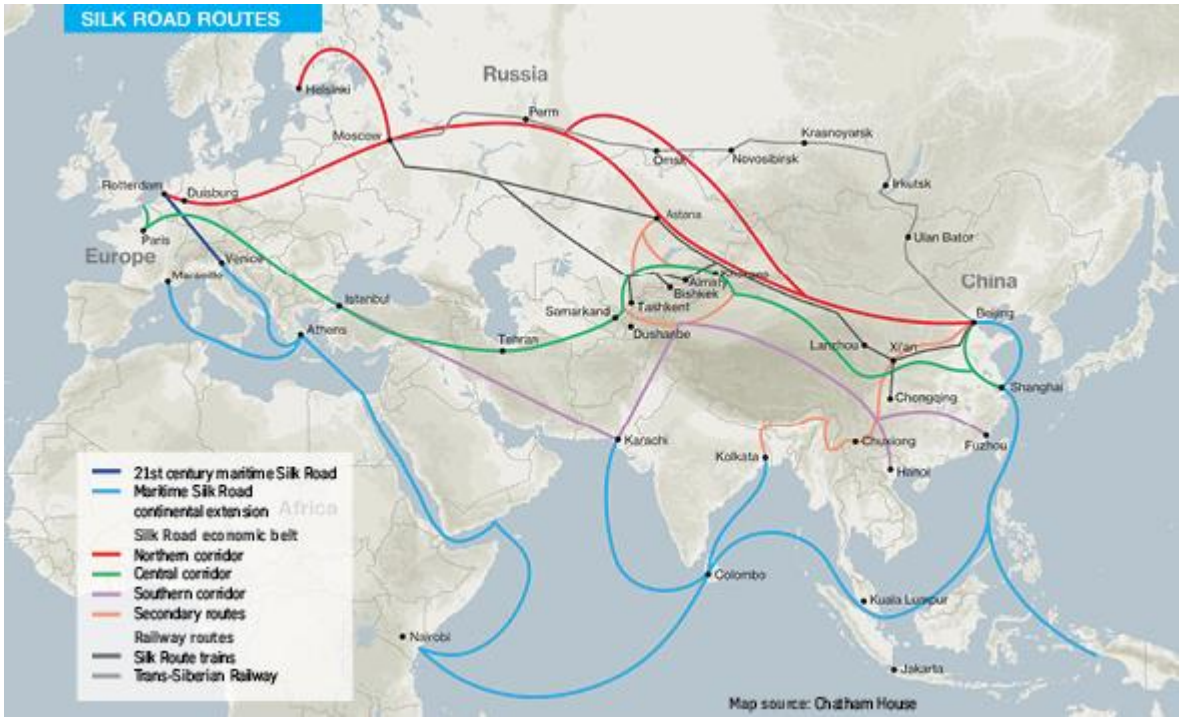
Accessibility is the strongest feature of “duisport”. Apart from the trimodal connectivity, it is located among significant economic corridors, such as TEN-T network. Map 7.5 illustrates that the freight village is directly connected with North Sea-Baltic and Rhine-Alpine corridors while North Sea-Mediterranean and Scandinavian-Mediterranean corridors are in a close proximity. As analysed above, that kinds of corridors help transfer goods in a quicker, safer, and more efficient way. They also constitute a “path” leading to several markets, promoting competition, and returning profits to those who effectively use them.



Map 7.5: “duisport” location on TEN-T

Source: ec.europa.eu

Additionally, “duisport” is also part of global initiatives such as BRI-The new Silk Road. More specifically, “duisport” is on New Eurasia Land Bridge economic corridor (Map 7.6) facilitating the movement of goods from manufacturing hubs (Asia) to the retail markets (Europe). In addition, “Great Stone” industrial and logistics park near Minsk (Belarus), which covers an area of more than 90 square kilometres has been developed with Duisburg inland port being involved.



Map 7.6: "duisport" on BRI

Source: www.automotivelogistics.media

TEN-T networks as well as BRI constitute great examples of what distance from markets means. Distance from markets also means how easily the final product can be available to consumers. Dry ports like "duisport" gain substantial benefits from their position, such as increasing the number of users or joining forces with important actors of the global trade. Maersk, one of the largest container shipping companies, announced in late 2020 that they plan investments in Duisburg-the development of a distribution center. The company emphasizes on the excellent infrastructure and connection of "duiport" to international trading routes underlining the *"long-term and sustainable competitive advantages"* deriving from its location. An additional worth noting agreement is the one between Singapore PSA International and "duisport" whose interest is focused on investing in multimodal terminals serving the Asia-Europe container rail freight trade. A well-located large-scale inland facility may constitute a buffer for different actors of the supply chain; ocean carriers; logistics companies; or Port Authorities.

Duisport sales

Table 7.2 is given below, summarizing data from the official "duisport" website, and demonstrating that inland terminals gain the prominence in users' preferences. The strategic location of "duisport", its great connectivity, and its proximity to global

economic corridors increase the revenues of the facility in a tremendous rate. Between the years 2013 and 2018, revenues increased by more than 100 million EUR. With the increasing number of TEUs worldwide, shippers are seeking for using relieving mechanisms, such as inland ports, which reinforce the reliability and the sustainability of the system.

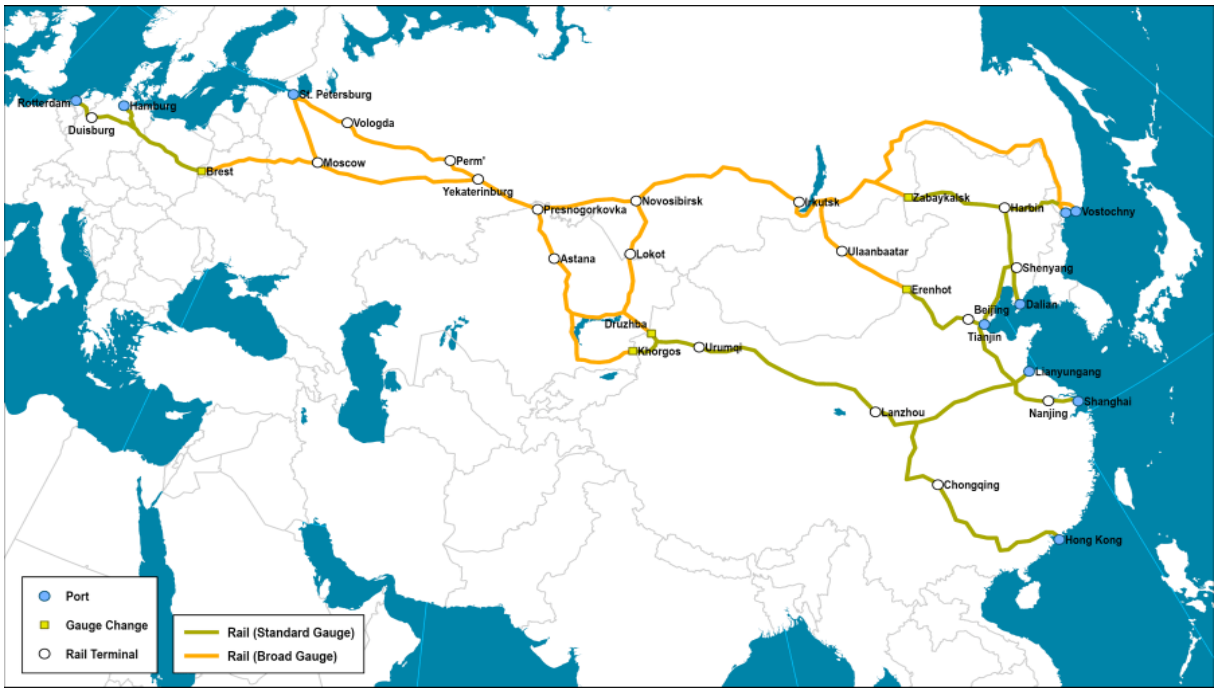
Year	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Duisport Group sales revenue	175.4	197.6	217.3	230.0	249.7	**278.5**

(in EUR milllion)						

Table 7.2: Duisport Group sales revenue between 2013-2018
Source: www.duisport.de

7.6 THE CASE OF KHORGOS GATEWAY DRY PORT

Similar to the case of "duisport" is that of the Khorgos Gateway Dry Port, which belongs in the New Eurasia Land Bridge economic corridor of the BRI initiative. More specifically, Khorgos occupies one of the furthest points on Earth away from any ocean and connects Kazakhstan-the largest landlocked country-with China by rail, expanding the range of possible dry ports' locations even in a long distance from a seaport. The terminal handles cargoes which start their journey from China to European cities such as Duiburg, Lodz, Hamburg etc. The facility is offering a range of services with storage, production, textile manufacturing, chemical and metal treatment, logistics and warehousing being among them. COSCO Shipping Company is responsible for the management of the terminal, but the whole project is a tripartite agreement consisting of COSCO, the Lianyungang Port Holdings Group Co., Ltd. and Temir Zholy (KZT), the Kazakhstan's national railway operator. Map 7.7 depicts the New Eurasia Land Bridge economic corridor with "duiport" and Khorgos Dry Port being parts of it.



Map 7.7: New Eurasia Land Bridge economic corridor

Source: Transport Geography

Khorgos does not only connect Kazakhstan with China, but also China with Moscow and western Europe as Map 7.8 shows. However, Kazakhstan as a former member of the Soviet bloc, uses wider rail gauge which means whenever a train from China to Europe, and vice versa, arrives, the cargo needs to be transferred to different wagons, which takes approximately 47 minutes. It is estimated that 65 trains cross through Khorgos Gateway every month which equals with 6,200 TEUs, while volume is expected to increase in the next few years.

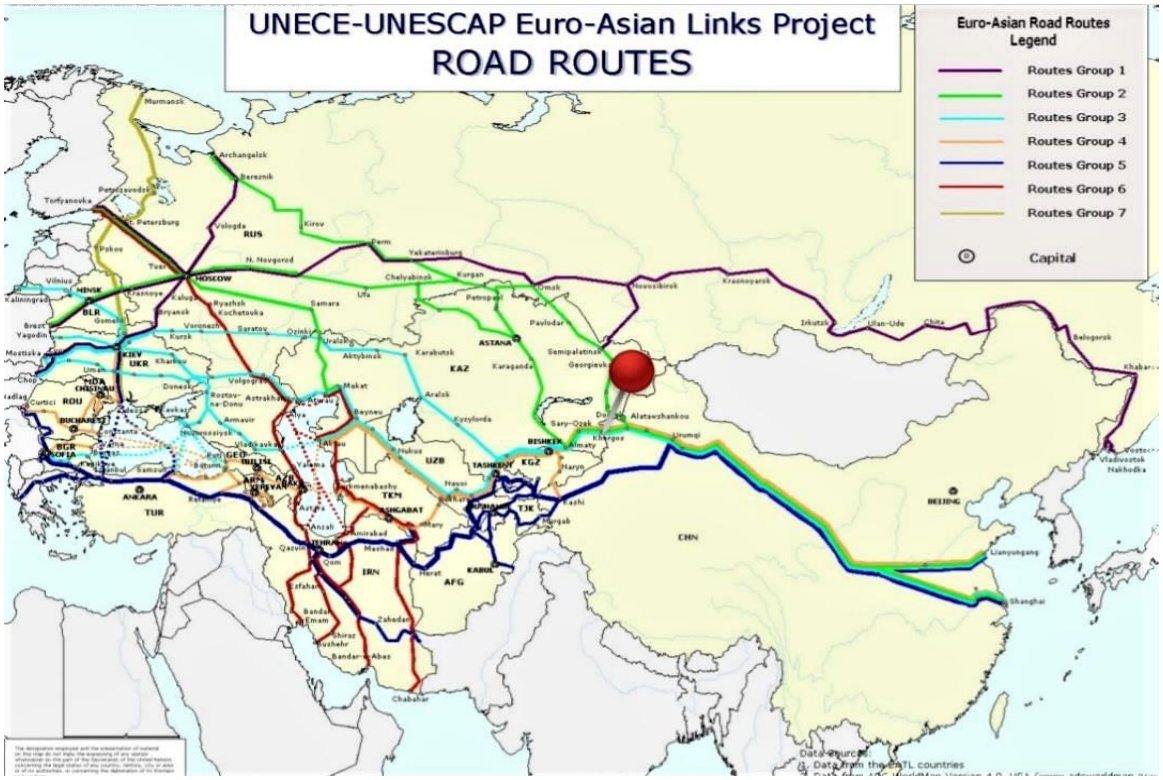
Map 7.8: Khorgos' location in Asia-Europe route

Source: Research Gate

Hinterland transportation has not been that widespread until recently, as manufacturers preferred sea transportation with reduced cost per unit even if the journey lasted longer. For instance, a train carrying 88 TEUs needs 20 days to get to London from Yiwu while a ship needs 40 days. High-capacity transport modes, like ships, are generally cheaper and more environmentally friendly, but not very flexible or fast. The presence of dry ports facilitates their cooperation. Inland facilities such as Khorgos Gateway demonstrate that today's globalised market can be managed efficiently by reducing delays and showing the way to countries which are not traditional trade players.

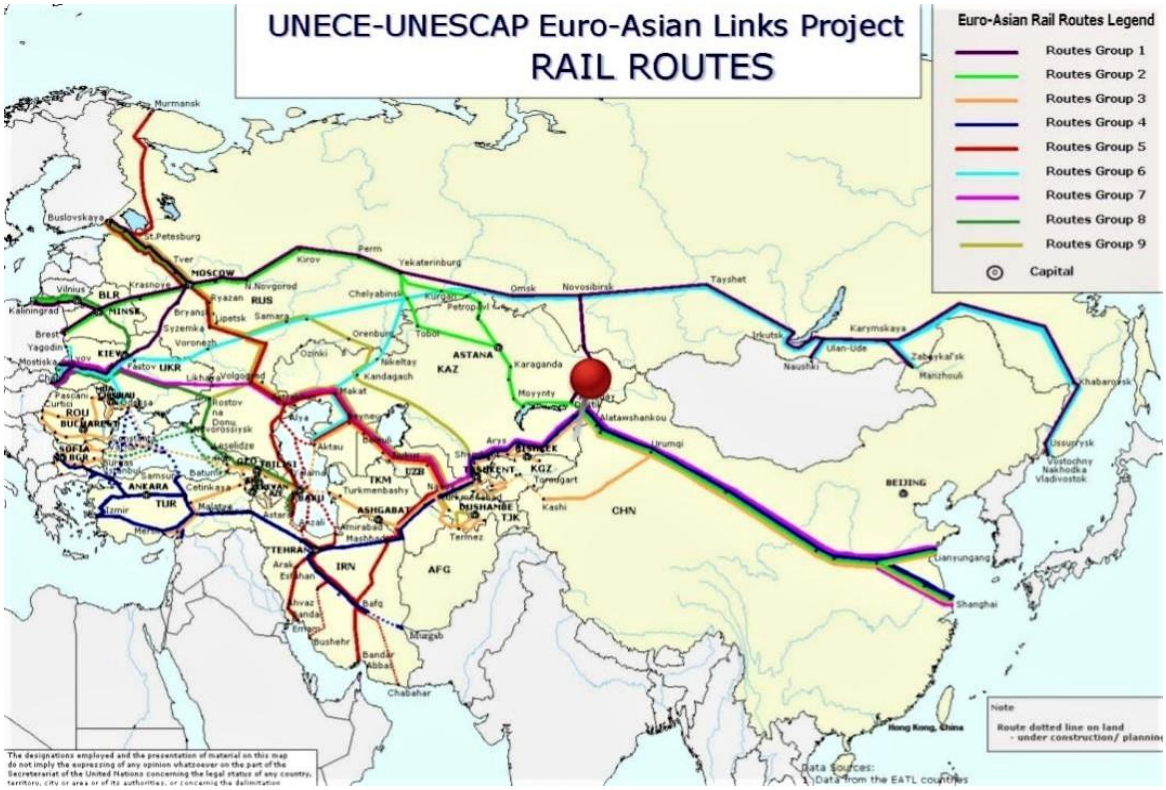
Khorgos' strategic location is also demonstrated by the Euro-Asian Transport Links (EATL) project starting with the phase I (2002-07), which includes the maps, as a joint undertaking between the United Nations Economic Commission for Europe (UNECE) and the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP). The EATL project identified main Euro-Asian road as well as rail routes for priority development and cooperation. On Maps 7.9 and 7.10, the road and rail

routes, respectively, are depicted. The pin on the map illustrates the Khorgos Gateway Dry Port.



Map 7.9: UNECE road routes (EATL project)

Source: UNECE



Map 7.10: UNECE rail routes (EATL project)

Source: UNECE

7.7 “duisport” AND KHORGOS GATEWAY DRY PORT IMPORTANCE

This thesis aims to address the role of inland facilities in global transport networks, including freight villages and dry ports and presenting their types, characteristics, operations, and development models. Such facilities are not important only for the containers’ concentration, storage, and distribution. By examining different perspectives, their overall importance for the transportation networks and the society is worth noting.

In order to provide an adequate and explanatory example, the assumption that the two facilities do not exist is considered. The analysis above underlines the strategic location for both freight villages as well as their commercial interactions in an international level. Several countries and global initiatives have also been involved either in networks development or as investors in the facility itself. The effects of the hypothetical lack of these specific facilities-“duisport” and Khorgos Gateway Dry Port-are examined from a network and a social perspective.

“duisport” is located in western Germany in a close distance to the Netherlands and Belgium borders. The terminal is responsible for offering a wide range of services including the handling of 4.2 million of containers, according to the company’s publicly available official data of 2020. Moreover, the inland port of Duisburg creates over than 50,000 direct or indirect jobs mainly for the local community. On the other hand, Khorgos Gateway Dry Port, which is located in Kazakhstan, offers similar functions with “duisport” being a hub for containers, especially those coming from China to the European markets. As deriving from the analysis above, both facilities constitute important hubs of the BRI initiative.

In duisport’s case, the lack of such kind of terminal leads to a huge volume of the containers in the road network trying to reach their destination, creating congestion, harmful emissions, and inefficiencies across the supply chain. In Khorgos’ case effects would be different. Kazakhstan is a landlocked country which without such facilities could not be a player in global trade and infrastructure would possibly not be upgraded. Shippers would also choose another easier route, probably an ocean line. As a result, key infrastructures such as major highways seaports would be more stretched, leading to increasing carbon footprint and delays.

Besides, dry ports are important for the local economies and residents’ wealth. Lost job opportunities would affect the community, mainly from an economic perspective.

Germany, and generally north European countries, are characterized by their healthy economies which means that residents can easily find jobs, but in Kazakhstan's case, things come up differently. Residents are more depended on foreign investments.

Summarizing, the importance of inland freight facilities is obviously bigger than the previous years (less freight flows). Transportation is a main engine of every economy. Inland facilities are much needed for establishing a reliable network in collaboration with the already established maritime one, in order to achieve the set goals referring to increased efficiency, reduction of carbon emissions and delays.

7.8 BENEFITS OF A WELL-ESTABLISHED FACILITY

This thesis aimed to provide a clear picture of large-scale freight facilities operating in the hinterland, with emphasis being placed on their optimum location and the development models which are often implemented. The various types of such facilities have been categorized depending on the offered services, the distance from the seaports, and the type of investors.

The implementation of dry ports in combination with a strategically selected location leads to several benefits affecting the stakeholders and shareholders, the residents, the global supply chains as well as the terminal itself. For this purpose, based on the literature examined for this thesis, these positive impacts have been separated in three major categories; logistics benefits; environmental benefits; and socio-economic benefits.

7.8.1 LOGISTICS BENEFITS

From a logistics perspective, the dry ports implementation, and more specifically their establishment in an optimum location, is related with plenty of benefits. The reduction of congestion and traffic in key nodes of global trade such as seaports, and their terminals, as well as road networks facilitate the speedy and safe movement of containers. A wisely chosen location empowers maritime ports situation in supply chains via the increase of their connectivity, trade volume, and capacity. The faster the containers leave the port to reach the inland terminal, the more available space is created, increasing the total throughput, and making feasible the handling of bigger containerships, if the port's physical characteristics allow it. From the analysis above and the presented framework, multimodality is a key feature of large-scale inland freight facilities. As a result, they offer smooth and low-cost modal shift, and subsequently a package of combined solutions for goods transportation. Furthermore, dry ports and freight villages offer shippers the opportunity to expand the range of their

logistics services as derived from the analysis. Such kind of facilities are not only oriented in picking containers up, but in facilitating the whole process (e.g., Free Trade Zones etc.). The customs clearance services are those which save time from shippers, carriers and receivers. Another potential benefit, which was not found in the examined literature, is the reduction of empty containers repositioning cost. According to Schlingmeier (2016), the total annual cost of empty journeys is about US$300 to 500 million for a mid-sized global shipping line, and US$15 to 20 billion for the whole shipping industry. It requires further investigation, but if a part of the world's empty containers could be repositioned by using inland terminals, then the liner shipping industry could benefit by further expanding their portfolio to dry ports.

7.8.2 ENVIRONMENTAL BENEFITS

Bjerkan and Seter (2019) provided an overview and categorization of the main areas where further energy efficiency improvements can be realized in ports, building upon the existing relevant literature. In the fourth category, they refer to land activities prioritizing the mode split leading to greener transportation and reduced energy and fuel consumption, a process that dry ports and freight villages obviously facilitate.

Similar results have been found in the existing literature which concludes that inland facilities, like those presented in this thesis, reduce the CO2 emissions leading to a better local and regional environmental impact. By implementing dry ports, transportation industry gets closer to the goals the Paris Agreement (2015) has set. The reduction of greenhouse gases and the mitigation of climate crisis are in top priority for every country. The presence of a dry port may also reduce problems related to issues of environment in coastal cities. The further adoption of new technologies in inland freight facilities would motivate all actors across the supply chain to proceed in renewable energy sources for the operation of these terminals.

7.8.3 SOCIO-ECONOMIC BENEFITS

The implementation of inland freight facilities, including dry ports, in a location with great connectivity, increases the share of rail operators as well as other investors. Trains use electric power for their operation, a fact that reduces the transportation costs. Moreover, the cooperation of those facilities with seaports increases the competition between the later leading to improved services in terms of quality and subsequently to the attraction of freight volumes. Facilities located in the hinterland, with the scope to serve the seaports and the global supply chains, according to Boile and Theofanis

(2017), allow *"the closer collaboration between different stakeholders and the developing of synergies among them"*.

A well-established dry port will attract users, tenants, and profits from the very first months of its operation. For this reason, new job opportunities will be created, either directly or indirectly. The multimodality as well as the need for large-scale freight flows movement will motivate the development of the regions of the country and the integration of coastal areas with cities. Regional development is inseparable with that kind of facilities. This thesis underlines that, with the upgrade of the infrastructure as well as the jobs created, the quality of life in the region is improved, and even small cities can implement that kind of projects. There is also economic growth in regions that traditionally were not involved in trade due to the distance from the ocean. That seems to have been changed. Landlocked countries, such as Kazakhstan, can earn profits from the establishment of inland facilities, contributing to global trade's relief and offering a new route from production to consumption and vice versa.

Summarizing, the port industry is getting more and more integrated with the involvement of both "outside-in" and "inside-out" investors, who try to mitigate the risk for their companies. Since the early 10s, port industry is facing a revolution in freight volumes as well as in partnerships (liners, dry ports etc.). The establishment of dry ports is the present and the future as well. The sustainable port of the future may be the port with a number of cooperating dry ports, assisting the freight volumes in a smoother manner and being greener and less congested.

8. CONCLUSIONS

The purpose of this Master's thesis was to analyse the dry ports concept and examine the location selection problem which is one the most difficult and multi-criteria-considering tasks during the planning phase. In the beginning, a Systematic Literature Review was presented. Different cases from around the world were examined from the investment-model perspective. The analysis of the selected cases from three regions was based on recently updated data which sought to provide a better understanding of the freight facilities' development initiatives as well as to present the private sector's involvement in their development. Summarizing, a framework consisting of criteria from the existing literature has been developed, which gives insight in the location selection problem in large scale freight facilities with "duisport" and Khorgos Gateway Dry Port supporting the framework and validating its principles.

During their early implementation, large scale freight facilities were developed mainly as either public or private initiatives. On the one hand, private sector is looking for new business opportunities with the scope to maximize profit by contributing to smoother and more effective supply chain activities while, historically, has been a better "entrepreneur"/operator than public authorities. On the other hand, public sector seeks to better accommodate increasing freight flows and deal with the increasing truck traffic, especially in urban areas; promote a more rational use of available land; and increase social benefit. In early schemes, the presence of both private and public sector had been obvious, with public being responsible especially for the initiation and the development phase while private gaining higher shares once the facilities were established, which is clearly depicted in the analysis of the selected cases.

PPP schemes seek to exploit the expertise of each involved party, to share authority and responsibility and optimally meet well defined objectives in large scale freight facility development initiatives. They have been applied for many decades as the previous review indicates. "Interporto Bologna" was established in 1971 and a SPV was created to manage the terminal; Riyadh Dry Port was established in 1982 with important connections with Sea Port of Eastern Province and Damman Sea Port. Subsequently, Dry Port Madrid in Coslada in 2001, Rickenbacker Intermodal Terminal in 2008 as well as Savannah-Appalachian Regional Port in 2018 are more recent projects where PPPs implementation facilitate the cooperation with major seaports. In Madrid, the

development started as a public initiative due to the plethora of different public bodies involved including Spanish Port Authority as well as in case of Savannah where Georgia Port Authority also operates the terminal. In both cases, the Port Authorities are involved from the early stages of their development. It is worth mentioning that Dry Port Madrid in Coslada is a node for the ports of Barcelona, Valencia, Bilbao, and Algeciras verifying the results derived from the analysis. All parties involved in a PPP are concerned with mitigating the risk and planning facilities for long-term efficiency. The last case presented, the East West Terminal in Hungary, is due to open its gates in 2022. Both public and private bodies are responsible for its development. Different tenants have already expressed their interest to operate in the terminal while the facility will serve as a gateway for the New Silk Road with significant economic advantages.

PPPs in large scale freight facility funding and development have been the preferred mechanism in many cases for over 30 years. Actors involved in the process may have different interests and objectives. However, large-scale freight facility development better facilitates supply chain operations by promoting the strengths of both parts, public and private. The principal outcome of such a model is the offering of flexibility. The presented cases from the three regions show that there is strong potential for PPPs in funding inland freight facilities, including dry ports, with the involvement and collaboration of Port Authorities, 3PL companies and relevant transportation providers. The coexistence of both public and private sector creates a steadier environment by absorbing to a greater extent the possible fluctuations.

Among this thesis' purposes was to provide a comparative analysis of selected dry port cases with a global geographical coverage with special attention given in their development strategy.

Different development policies in the three regions were noted. In Europe, public-private partnerships are more widespread with significant involvement of Port Authorities. By implementing PPPs, both parts control the risk of the investment, and, at the same time, they focus on the services they are responsible for. For instance, a Port Authority and a rail operator collaborated to develop a dry port. After the construction completion, Port Authority is responsible for management while the rail operator has the control of the terminal's operation. On the other hand, inland ports in the US show the important role of the private sector, represented mainly by rail operators or real estate developers. Another important key feature is the size, with

freight villages in the US typically occupying many more hectares of land than in Europe. The number of tenants, as it derives from the analysis, shows how competitive they are in global markets. In Europe and the US, the public sector participation in large scale freight facility development is stronger during the initiation and development phase, and rather limited in general. In several Asian cases, the public sector involvement tends to be stronger, with several facilities with notable size and capacity fully developed and operated by the public sector, because of the government policies in these countries. When competition is encouraged, plenty of private investors, such as container shipping companies, follow a vertical integration. To achieve that, in most cases, the flexibility of the public sector facilitates the whole procedure, creating a win-win situation. Hence, the global competitive environment triggers opportunities for both sectors.

Nevertheless, the public and the private sector have different objectives to achieve. The public sector requires regional development through new job opportunities and financial benefits to the state and region. The private sector's principal objectives are mainly oriented in revenues, functionality of the terminal and satisfied users as well as increased market share. Public-private partnership empowers the coexistence and balance of these interests.

Considering the trends around freight volumes, modern supply chains and global trade in combination with the increased flows of cargo make dry ports implementation mandatory in many cases, as they improve port hinterland connectivity and further support interaction among carriers, manufacturers, shippers, and receivers. By reviewing the development policies, the thesis demonstrates that freight facilities, including dry ports, can be implemented through PPPs as a funding mechanism, even in today's competitive environment where private sector's share increases rapidly, a fact that removes barriers and facilitates stakeholders and investors. Transport providers, financial institutions, local and regional authorities should be perceived as equal players in a competition game. By investing in dry ports, involved stakeholders could gain significant advantages and strengthen their position and that is what an innovative development policy like PPP promotes. This part constitutes a preliminary investigation of good practices in freight facility development, which may provide a good reference for further and targeted research and provide some insights in new facility development.

Nevertheless, the major aim of this thesis was the examination of the location selection of an inland freight facility, including dry ports and freight villages. From a logistics perspective, an optimal-or at least good-choice facilitates the faster and the more efficient transportation of goods while offers the chance for more services available to users, such as transhipment of their cargoes or reverse logistics due to excellent connectivity. However, the facility is also economically affected. Making collaborations with major seaports, railway and inland waterway transport operators increases its competitiveness and provides access to several markets which could not be reached without the proper location of the terminal. Following the same approach, transportation cost may be optimized, a fact that attracts new users and increases the revenues. Finally, the environmental perspective of the whole project has been taken into account, highlighting the significant reduction of traffic congestion in streets and ports gates due to the proximity to economic corridors and, generally, integrated transportation networks.

Location selection is a strategic decision made during the planning phase. The economic life of the facility and the revenues, which are obviously connected with the users, depend on it. Several studies refer to location optimization considering several criteria from major perspectives; economic; environmental; social; logistics; and political. This thesis focuses on networks perspective underlining the importance of accessibility, in terms of multimodal connectivity and proximity to corridors, and the distance from markets-proximity to corridors and infrastructure is also involved. Support criteria have been included providing a framework for developers and decision makers.

Integrated networks and the presence of initiatives connect trade hubs, reduce distances, and integrate supply chains. The BRI initiative creates challenges and offer chances. The BRI initiative includes almost exclusively hinterland transportation from Asia. On the other hand, seaports, traditionally, expect profit from ocean transportation. The implementation of freight villages and dry ports involves equally all actors and making the New Silk Road more sustainable and seaports more profitable. “duisport” and Khorgos Gateway Dry Port constitute great instances of the location’s importance for a freight facility.

“Duisport” and Khorgos Gateway have also great impact on seaports operation, either cooperating or not. Without such international dry ports and freight villages, more

congestion in yards and gateways would be noticed, especially in Asia, North America, and Western Europe. That would lead to delays and inefficiencies across the supply chain which is already stretched to the maximum. Well-located dry ports contribute to a better management of the trade flows worldwide, pushing them into hinterland networks and making a good use of routes that were not in shippers' preferences during the past years.

The location optimization is not a simple process as different factors affect the outcome. Inland freight facilities as well as their location may also play a different role, optimizing the supply chain functionality. During the pandemic of COVID-19, e-commerce rates increased rapidly as consumers were not able to shop from their local stores due to health and safety protocols and restrictions. In addition, in mid-2021 there have been noticed huge delays in Asian terminals, especially in Yantian International Container Terminal (YICT), which stopped its operations due to restrictions. Inventory rates dropped to historical low levels, which normally will take almost a year to be rebounded. How could possibly freight villages help retailers reaching again the pre-COVID inventory rates? This may be the scope of a study on inland terminals utilization, which could be examined in future research.

In conclusion, this Master's thesis was oriented in providing a basis for future studies in location selection problems as well as in dry ports and freight villages examination as possible freight hubs in an existing network. Quantitative tools may be used in future research, based on the presented framework, to provide further insight on eliminating the possibility of a not reliable, sustainable, profitable choice. On the other hand, the implementation of Public-Private Partnerships in inland facilities, as examined in the selected cases, could be further examined as an investment model for regional ports in Mediterranean countries. In Greece, several ports, such as Thessaloniki, Volos, Igoumenitsa, have gathered eyes of many investors.

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