Assessing the objectives of dry ports: main issues, challenges, and opportunities in Brazil

Abstract

Purpose: The purpose is to identify the main characteristics of Dry Ports (DP) in Brazil, discussing the role of this logistic player, challenges and opportunities. Furthermore, this study provides a structured framework to drive dry port decision-makers, identifying and assessing a network of means-end objectives, which could be replicable to other contexts.

Design/methodology/approach: This article approached initially a literature review and exploratory research to discuss the main characteristics of dry ports in Brazil. The second step was to conduct a qualitative analysis following the Value-Focused Thinking (VFT) approach in two case studies in Pernambuco state to assess the achievement of the main objectives.

Findings: This article identified that the main characteristics of dry ports in Brazil are offering additional services with a cheaper storage cost, handling mainly import cargo, and being connected to seaports through highways. Moreover, this study resulted in a framework to assess the objectives of dry ports which could be replicable in other contexts, improving the current operations of dry ports.

Practical implications: The framework to assess dry ports' objectives bridged the gap between the literature and the practice working as a tool to drive decision-makers to improve the current performance of dry ports in Brazil. Additionally, the main issues, challenges and opportunities discussed providing managers, policymakers, and dry ports operators with valuable insights into this theme.

Originality/value: This paper is the first study to present a framework to assess the objectives of dry ports as a valuable tool to drive decision-makers to improve dry ports operations. From this study, lessons could be learned and the process described could be replicable in other countries.

Keywords: Decision-making, Maritime logistics, Performance measurement, Supply chain competences.

Article classification: Research paper

1. Introduction

Developing a supply-chain infrastructure is one of the greatest challenges faced by governments, trying to achieve an efficient logistic network, and organizations, which worldwide strive to incorporate effective management into their existing competitive strategies (Arora *et al.*, 2016). As an option to improve the congestion in seaports, delays in the supply chain, reduction in transportation costs and environmental impact, Dry Ports (DP) have a key role to play in advancing port-hinterland connectivity, mitigating problems caused by constraints related to land and others that limit seaports' growth, coordinating the operation of the seaport supply chain and supporting regional economic development (Feng *et al.*, 2013); (Roso and Lumsden, 2010).

Dry port was originally defined as an inland terminal to and from which shipping lines can issue their bills of lading (UNCTAD, 1982), but the most widely used definition is that dry port is an inland intermodal terminal directly connected to seaport(s) with high capacity transport mean(s), where customers can leave/pick up their standardized units as if directly to a seaport (Roso *et al.*, 2009). However, as dry ports exist in very different forms and arrangements under different terms around the world, they differ in location, functionality, maturity level, ownership, and initiation processes (Khaslavskaya and Roso, 2020), making such definition a complex issue. Consequently, more studies about the characteristics of dry port operators around the world will enrich the discussion on this subject.

The quest for logistics management research is to evaluate current and former practices and provide guidance to practitioners and policy makers on what to do and how to act regarding present and future challenges (Nilsson, 2019). While studies about dry ports have become more significant in the last 10 year, the main research was applied in countries of Asia, Europe and North America, covering themes as dry port concept, network perspective, economic, performance and environmental impact (Witte *et al.*, 2019); (Khaslavskaya and Roso, 2020). However, this scenario of growth on dry port research is not the same in Latin-America, especially in Brazil, the largest country in South America with the seventh-largest

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national economy in the world. Only a few studies have described the context of dry ports in Brazil over the last years, despite the relevance of the country to the international trade market (Padilha and Ng, 2012); (Ng *et al*., 2013); (Rodrigues *et al*., 2020).

There are 56 dry ports in Brazil (Economy Ministry, 2020) which have played a major part in cargo operations. As the trade balance has presented records in the last years, and container handling has increased by almost 50% since 2010, positioning the country as the most important container-handling economy in South America and the 20th largest in the world (UNCTAD, 2019); (ANTAQ, 2018). In the same direction, Pernambuco state, located in Northeastern Brazil, outstands as the most relevant container hub in the region, with more than 1053 exporters and importers, handling more than 38% of the total volume in 2019 (ANTAQ, 2020); (MDIC, 2020).

Dry ports have been implemented as an alternative solution to logistics challenges, resulting in at least 37 benefits, as described by (Khaslavskaya and Roso, 2020). However, dry port implementation requires large investments and collaboration from many stakeholders as investors, customers, government agencies, rail and road carriers, seaport operators and so on, most of them with conflict of interests (Nguyen and Notteboom, 2016).

Despite the benefits which dry ports could bring to the supply-chain and the economic relevance of Brazil to the international trade market, there is a lack of information on this subject in the scientific literature as well in government regulatory reports in Brazil. To overcome these issues, this study discusses the main characteristics, challenges and opportunities of dry ports in Brazil, providing relevant information and insights into it to improve logistics network. Additionally, this article provides a structured framework to drive further dry port decision-making situations, identifying and assessing a network of means-end objectives through a Value-Focused Thinking (VFT) approach, applied in two case studies. In this way, this article will answer three main research questions (RQ), as follows:

RQ1. What are the main characteristics of dry ports in Brazil?

RQ2. What is the role of dry ports in Brazil and how it could be assessed?

RQ3. What are the main issues, challenges and opportunities related to dry ports in Brazil?

By addressing the above questions, this study provides a useful insight into this theme to policymakers and dry port managers, in particular concerning the development of dry ports in Brazil and the issues that should be improved, as well for shippers and forwarders that use this logistic infrastructure as an alternative to become more competitive. The findings of our study contribute to the theme not only for providing a tool to assess the achievement of dry ports' objectives in Brazil, but also by describing the process which can be applied by other researchers in different contexts and countries. Furthermore, many positive and negative lessons could be learned from the experience of dry port development and operations in Brazil. As mentioned above, since only a few studies were developed in Latin-America about dry ports, this article fulfills a literature gap, reaching the call for more qualitative research on this subject (Khaslavskaya and Roso, 2020).

With this in mind, the article consists of seven sections and is structured as follows. The literature review was discussed in Section 2, followed by the Research Methodology in Section 3. Section 4 presented the findings of the study, describing the main characteristics of dry ports in Brazil, two case studies and a framework to assess the objectives of dry ports in Pernambuco state. Section 5 discussed the main issues, challenges and opportunities identified in this study, and finally, Section 6 brings the conclusion, limitations and directions to inspire the agenda for future studies.

2. Literature review

Dry ports can be considered as an essential part of an inland trade distribution system. In fact several terms are in use throughout different regions to describe facilities which have the functions of a 'dry port' (UNESCAP, 2015). As the name implies, dry ports provide all of the services of a seaport except for the loading of cargo to and from seagoing ships. It may be distinguished from an Inland Container Depot (ICD), in that it can accommodate all types of cargo, whereas an ICD specializes in the handling of containers and containerized cargo (UNESCAP, 2015). The concept of dry port refers to a logistics center established in inland area which has service function of customs declaration, inspection declaration and insurance on bills of lading (Ka, 2011). Services such as storage, consolidation, depot, maintenance of containers, track and trace, customs clearance, and others should be available at the dry port (Roso, 2007).

In this way, dry ports not only expand seaport hinterland areas and increase its cargo sources, but also simplify import and export procedures.

The development of dry ports are most advanced in Europe (Notteboom and Rodrigue, 2009). Currently, a wide array of rail operators makes up the supply of rail products out of European container seaports. From a network perspective, intermodal rail transport in Europe has undergone a transition from a meshed network to a hub-and-spoke network based on intermediate rail hubs and then finally the replacement of the network by a system of direct lines (Rodrigue and Notteboom, 2012). In the United States there are large inland terminals, commonly around metropolitan areas, commanding a regional manufacturing base and distribution system through the double stack train (Rodrigue and Notteboom, 2012); (Notteboom and Rodrigue, 2009). Compared to Europe, North American dry ports tend to be larger and cover a much more substantial market area. Another characteristic regarding the setting of a dry port, or at least the intermodal terminal component, is mostly in the hands of rail operators due to a different ownership and governance structure (Rodrigue and Notteboom, 2012).

On the other hand, China started to build dry ports later and many of them were developed to improve local economies in central and western China, consistent with the 'Go West' strategy produced in 2000 (Li *et al*., 2015); (Ka, 2011). In Russia, the construction of inland terminals was at a very early stage of development due to a lack of infrastructure development in seaport cities and existing regulations which impeded container seaport development and their inland connections (Korovyakovsky and Panova, 2011). Other studies detailed the development of dry ports in India (Haralambides and Gujar, 2011); (Haralambides and Gujar, 2012); Vietnam (Nguyen and Notteboom, 2016); (Nguyen and Notteboom, 2017) and Malaysia (Jeevan *et al*., 2015); (Jeevan *et al*., 2017a), discussing challenges, government policies, location-decision and investment strategies.

Initially called 'Depósitos Alfandegados Públicos' (Public Bonded Warehouses) and later 'Estação Aduaneira do Interior' (Inland Customs Station), dry ports were introduced in Brazil in 1976 at secondary zones, which are zones without foreign direct contact as seaports, airports or boundaries zones (Souza *et al*., 2017). However, the term 'Porto Seco' (Dry Port) was only adopted in 2002 (Padilha and Ng, 2012). In the same year, the use of dry ports for industrial operations was introduced by the Normative Instruction 241/02. In 2006, responding to the protracted legal disputes, the Provisional Measure 320 (MP320) was introduced, attempting to allow dry ports to operate by means of licenses issued by the Federal Revenue, expanding the scope of dry port to the Logistic and Industrial Customs Centre (CLIA) (Padilha and Ng, 2012). However, that provisional measure was considered unconstitutional and rejected by the Brazilian Senate (Ng *et al*., 2013). In 2013 another Provisional Measure (MP 612/13) brought this subject to the discussion again and several companies that were under the dry port regime requested to change to CLIA, but the MP 612/13 also expired without being converted into a law (Ng *et al*., 2013). Therefore, there is no standard normative for the creation of new CLIAs in Brazil and, in this article the terms CLIA and Dry Port are considered the same logistic operator.

Taking into account the different developments of dry ports around the world, classify dry ports becomes a difficult mission, considering the many services provided and the specificities of each country, which impact the logistics infrastructure. However, (Roso *et al*., 2009) proposed to classify dry ports through the distance from a seaport by *long distance* (>500 Km), *midrange* (between 100-500 Km) and *close distance* (<100 Km). The long distance is the most conventional of the three and the main reason for implementing it is simply that the distance and the size of the flow make rail viable from a strict cost perspective; a midrange dry port is then situated within a distance from the seaport generally covered by road transport and serves as a consolidation point for different rail services, implying the use of administration and technical equipment specific for sea transport; the close dry port consolidates road transport to and from shippers outside the city area offering a rail shuttle service to the seaport relieving the city streets and the port gates.

Despite the above classification, the size and logistics infrastructure will vary in different countries, making vast the difference of distances involved. Some of the major inland manufacturing and commercial centers of China and India are 1,400 – 1,800 km from the seaports, while the international trade of Central Asia must travel between 1,000 and 8,000 km to find an outlet to the sea. By contrast, in other countries, such as the Republic of Korea and those of Southeast Asia, distances between trade origins or destinations and seaports are comparatively short, in some cases being in the range of 100-300 km (UNESCAP, 2015).

Also in relation to the location function, (Beresford *et al*., 2012) China's dry ports are classified into three groups, namely *seaport-based*, *city based* and *border dry ports*. Seaport-based refer to facilities which are sited at the coast with a major function of pre-customs clearance and find to capture more cargo flowing along the inland supply chain and to relieve capacity constraints at the seaport. The city-based is typically positioned within a larger logistics cluster which serves production and consumption besides offering a wider range of value-added logistics services than the seaport-based. On the other hand, a border dry port refers to one located in the border area, with the major function of being a transshipment center or custom clearance service. In another view, (Notteboom and Rodrigue, 2009) proposed seven dimensions characterizing inland nodes as transport modes served, ranging from *unimodal*, when it is connected only by road; *bimodal*, when there are another options as railways or barge; and *trimodal*, when the dry port is connected with the seaport by three transportation modes.

Developing a dry port requires a high investment level and there could be many options for obtaining funds. Some countries adopted the concession policy, as applied in China (Beresford *et al*., 2012). Implementation of the extended gate concept is seen as a good solution for ports in East Africa, but it would require a joint effort by multiple stakeholders, both private and governmental (Khaslavskaya and Roso, 2020). Another option is the public and private cooperation through Public–Private-Partnership (PPP) agreements, as discussed by (Haralambides and Gujar, 2011) in India, (Panova and Hilmola, 2015) in Russia and (Nguyen and Notteboom, 2017) in Vietnam. In Brazil, dry ports operate under the concession regime, after a bidding process managed by the Federal Revenue (Ng *et al*., 2013); until now, there is no record of PPPs applied to dry port development in Brazil.

Several authors use mathematical models of optimization, simulations, qualitative and quantitative analyses, multicriteria methods, among other strategies to obtain the dry port implementation benefits. Among the most relevant problems approached in the literature are the dry port location-allocation (Wang *et al.*, 2017); (Komchornrit, 2017); (Wei and Sheng, 2017); (Nguyen and Notteboom, 2016); (Chang *et al*., 2015); the network between dry port, hinterland and seaport (Chen *et al*,. 2018); (Tsao and Linh, 2018); (Kramberger *et al.,* 2018); (Wei *et al.,* 2017); dry port performance and optimization (Jeevan *et al.*, 2017a); (Haralambides and Gujar, 2012); (Ng and Tongzon, 2010); evaluation of the transportation system (Qiu and Lam, 2018); (Lättilä *et al*., 2013); analysis of the viability of the dry port (Dadvar *et al.,* 2011) and its environmental impact (Roso, 2007); (Muravev and Rakhmangulov, 2016).

Synthesizing the literature review about dry ports, two recent systematic reviews covered the most relevant research on this subject (Khaslavskaya and Roso, 2020); (Witte *et al.,* 2019). The fact that the publications grew over a decade show interest in the phenomenon of dry ports, which is represented in different forms around the world, fulfilling different purposes for various stakeholders (Khaslavskaya and Roso, 2020). Findings also showed that in addition to the fact that dry ports differ regarding location, functions, services, ownership, and maturity level, much attention is paid to dry ports as undervalued components of the maritime 'transport/logistics/supply chain' systems, while their roles as components of the 'regional' systems are largely overlooked and have been attracting more attention only in the most recent years (Witte *et al.,* 2019).

Considering the examples of dry port in several countries, including Brazil, some lessons can be learned, avoiding risks from the project to the operational phase. As mentioned by Rodrigue *et al*. (2010) and Khaslavskaya and Roso (2020), each dry port has specific characteristic influenced by the country policy rules, multimodal infrastructure and operational issues, fulfilling a specific role in the supply-chain. However, this issue remains unclear to policy makers, investors and dry port operators in Brazil. This study overcame this gap by assessing dry ports' objectives in Brazil and responding to the question '*What is the role of dry ports in Brazil and how it could be assessed?*'

3. Research Methodology

To answer the research questions, this article followed the strategy presented in Figure 1. In 'Stage 1' a literature review was conducted based on the model described by the NHS Centre for Reviews and Dissemination (2001), adapted by Tranfield *et al*. (2003). The data collection and analysis period was from December 10, 2018 to April 8, 2019, limited to published research from the period 2000-2018. The databases used in this review were Scopus and Web of Science, in surveys published in English or Spanish. For a wide coverage, key terms referring to the dry ports used were those described by Nguyen and Notteboom (2016), Roso (2007) and Roso *et al*. (2009): Dry Port, Inland Clearance Depot (ICD),

Intermodal Freight Centre, Intermodal Freight Terminal, Freight Nodal Terminal, Inland Port and Container Freight Station (CFS). The search for keywords was limited to the title of the paper, using only articles and reviews of the databases defined. After filtering all articles resulting from the search and removing duplicates, 76 articles were selected as literature support for this research, working as a typology to the next steps.

Figure 1 – Research strategy

Aiming at identifying the main characteristics of dry ports in Brazil, exploratory research on secondary data such institutional websites of dry ports operators and on reports from the Federal Revenue and the Ministry of Economy, Industry and Foreign Trade was carried out from June to July, 2019. The objective of this step was to bridge the literature of dry ports classification and the current context in Brazil. In this way, this article classified dry ports in Brazil to fulfill the RQ1 based on the definitions of (i) Roso *et al*. (2009); (ii) Beresford *et al*. (2012); and (iii) Notteboom and Rodrigue (2009) as: *(i) close, midrange and long distance dry port; (ii) seaport-based, city based and border dry ports; (iii) unimodal, bimodal, multimodal.*

The 'Stage 2' sought to identify the role of dry ports in Brazil and proposed a framework to assess the achievement of their main objectives. Investments in dry ports are expensive and depend on network connections, multiple regulations and stakeholders interests (Dadvar *et al*., 2011); (Khaslavskaya and Roso, 2020). Thus, covering the main characteristics of dry ports in Brazil and proposing new tools to improve the current environment are important issues to be taken into consideration before new developments and policy changes. As the research was exploratory in nature, a qualitative method was deemed appropriate (Eisenhardt, 1989). According to Voss *et al*. (2002), case research is a powerful research methodology that can be used to exploratory investigations where the variables are still unknown and the phenomenon not at all understood.

In this way, this article focused on a deep analysis of dry ports in Pernambuco, a northeastern state located strategically in the middle of the northeast region as shown in Figure 2, with 9.5 million inhabitants (IBGE, 2020). The biggest seaport in northeast is Suape, located near Recife, the capital of Pernambuco. As a container hub, Suape outstands as a cargo handling unit, moving approximately 40,000 TEUs per month in 2019, while the two dry ports on that region presented difficulties, handling a low cargo volume in the same year (1,100 TEUs per month) (ANTAQ, 2020). To obtain higher external validity, both dry ports in Pernambuco were analyzed following the case study methodology described by Voss *et al*. (2002) and the VFT approach, which will be detailed in the next section.

Figure 2 – Dry Ports in Pernambuco state

3.1. Value-Focused Thinking (VFT) approach

Value-Focused Thinking provides a systematic approach to structure complex decisions for subsequent analysis (Keeney, 1996) and has been largely applied in several issues as energy transition scenario evaluation (Höfer and Madlener, 2020), security technology (Tshering and Gao, 2020), strategic research funding decision (Parreiras *et al*., 2019), urban water supply system (Monte and Morais, 2019), waste management (Alencar *et al.,* 2011) and sustainability perspectives in e-commerce channels (Shukla *et al*., 2018). This method focuses on the decision maker's values, which provide the foundation for interest in any decision situation and are made explicit by the identification of objectives (Keeney, 1992).

Value-focused thinking includes numerous procedures to guide decisions. First, several techniques help compile an initial list of objectives. The process of identifying objectives requires significant creativity and hard thinking about a decision situation (Keeney, 1992). Second, these objectives are categorized as means-end objectives and logically structured. Fundamental objectives concern the ends that decision makers value in a specific decision context while means objectives are methods to achieve ends (Keeney, 1996). Third, several procedures assist in using the objectives to create alternatives and Fourth, the objectives are examined to identify worthwhile decision opportunities (Keeney, 1996). This article will explore up to the second step, identifying the role of dry ports in Brazil and assessing fundamental and means-end objectives.

To summarize the main steps to build the model of values and the framework to measure the achievement of objectives, this article followed four steps described by (Keeney, 2001) as detailed in 'Stage 2' of Figure 1. The steps are described below: (i) developing a list of value through a wish list, indicating what

decision-makers care about in the particular context of dry port operations; (ii) converting the list of values into objectives following three features which define an objective: decision context, an object and direction of preference; and (iii) structuring the objectives tracing means–ends relationships. To define the objective as means or fundamental objectives, specialists were asked "Why is this objective important in the decision context?" If the objective is an essential reason for interest in the situation, it is a fundamental objective; however, if the objective is important because of its implications to achieve some other objective, it is a means objective.

The last step (iv) was specify measures to indicate the degree to which the objectives are achieved. Essentially there are three types of attributes to measure the achievement of the fundamental objectives: natural attributes, constructed attributes, and proxy attributes (Keeney, 1992). The author explains that natural attributes are those that have a common interpretation to everyone. However, if a natural attribute does not exist or if it seems to have inappropriate built-in value judgments, there are construct attributes, to measure the associated objective directly, or proxy attribute to measure the associated objective indirectly. Although an attribute may seem obvious for a given objective, a good deal of thought should be given to appraising the value judgments built into that attribute. However, sometimes it is difficult to figure out an appropriate attribute for an objective, but it cannot be neglected (Keeney, 2001). In this research the measurement framework was built based on the experts' suggestions.

To ensure the reliability of the case study, an interview protocol with open-ended questions was developed. To achieve qualitative data, the authors were the facilitators of the VFT approach, interviewing six top managers of both dry ports operating in Pernambuco through a semi-structured questionnaire with 69 open-ended questions. Two experts work as operational managers of dry ports, acting as decision-makers in daily and strategic issues. Other three experts work as commercial and customer satisfaction managers, dealing with customers' demands on a daily basis. Finally, one of the experts works as a custom manager, being a specialist in Brazilian customs' process. All experts are graduated and four of them post-graduated. Two of them have more than 20 years of experience in dry ports, supply-chain management and international trade; the other four managers have between 10 and 20 years of professional experience, validating the quality of the decision-makers as key references in both dry ports analyzed.

The interviews and discussions were carried out individually and in group with the experts between August and October, 2019; the meetings happened at the dry ports facilities separately, focusing on the experts' daily experiences and perceptions about the role and objectives of the dry port. Following the companies' compliance, both dry ports analyzed were referenced as Dry Port A (DP A) and Dry Port B (DP B). The results of 'Stage 2' were the means-end objective network and the framework to measure the achievement of the objectives of the dry ports.

Dry port A is located between Suape container seaport (22 km) and Recife downtown (29 km), the capital of the state. Under a concession regime, DP A is classified as a close dry port, connected with container terminal only by road; handling 650 TEUs per month, DP A utilizes 18% of its occupancy average, moving mainly import cargo (98%), including products like tire, rubber, beverage and healthcare equipment. Dry port B is also located between Suape container seaport (13 km) and Recife downtown (49 km), connected by road. Classified as a close dry port under a concession regime, DP B has 39,000 square meters total facility area and a warehouse with 8,000 square meters. With capacity for 1,515 TEUs, dry port B handles 460 TEUs per month on average, operating mainly import cargo (95%).

The last stage 'Stage 3' of the article was a discussion of the main issues, challenges and opportunities of dry ports, bridging the gap between the literature and the practice to aid decision-makers to improve the current environment of this logistic player in Brazil. As a result, the RQ3 was answered and the authors presented the insights and recommendations for future agendas on the subject of dry ports.

4. Findings of the study

4.1. Characteristics of dry ports in Brazil

Brazil is essentially an exporter of commodities as soya, crude oil and iron ore, and an importer of manufacture products such as medicines, fuel, drilling rigs, vehicle parts, and electronic circuits, which represent the highest value in the trade balance (MDIC, 2019). While 50% of the value exported was commodities and 36% was manufacture products in 2018, almost 86% of the value imported in the same year was manufacture products (MDIC, 2019), which influences directly the way that dry ports operate in Brazil, characterized by handling import cargo. In the same direction of the international trade growth,

seaports in Brazil handled more than 10 million TEUs in 2018, representing an increase of 7.22% over 2017 (ANTAQ, 2018) and positioning the country as the largest container-handling economy in South America (UNCTAD, 2019).

Responsible for 65% of the transport share in Brazil, the road sector is the most used for freight transport and connection between seaports and hinterland, which results in high logistical costs, congestion of roads and cities, as well as increased air pollution (Khaslavskaya and Roso, 2020). Despite this, the Brazilian road network has shown a small evolution in recent years, stagnating around 1.7 million kilometers since 2001 (CNT, 2017). A survey conducted by the National Confederation of Transport showed that 28.2% of the highways in Brazil presented a poor or bad state, 33.6% regular and only 38.2% good or great, which shows the necessity of improvements in that sector (CNT, 2017).

On the other hand, container transportation using waterways is not explored to its full in Brazil, with less than 2% of the total number of containers handled in 2018 (ANTAQ, 2020). With 15% participation in the transport matrix and focused on transport commodities as iron ore and grains (80% of total volume), Brazil has a low density of rail network compared to continental countries such as Canada, India, USA, China and even other developing countries in Latin America, such as Mexico and Argentina (ANTF, 2019).

Dry ports in Brazil work under concession regime or, when applicable, permission. In addition, tax inspection activities on foreign trade operations are supervised and carried out by the fiscal-auditors of the Federal Revenue, that are installed inside the dry port facility, controlling the import and export dispatches and allowing all steps of customs clearance to be done in the same place. According to (Ng *et al*., 2013), dry ports in Brazil are generally understood as bonded warehouses of public use where cargoes under customs control can be moved, stored and cleared, besides some additional services. In addition to the possibility of removing goods from seaports earlier, when the cost of storing in dry ports is lower, imported goods can be stored for up to 120 days, which in seaport would be 90 days. Another advantage is that companies operating through dry ports can close the export of their products with exchange clearance before the shipment of goods, being stored at the disposal of the importer. Furthermore, dry ports specialize in providing solutions tailored to customer needs and are located close to major industrial and commercial centers in Brazil.

There are currently 56 dry ports operating in Brazil classified as shown in Figure 3, mainly located in the southeast (29) and south (17) of the country. Among them, 28 are classified as *close* dry ports, 19 *midranges*, and 9 *long distance*; those dry ports are located on average 30 km, 248 km and 831 km, respectively, far from seaports by road. In addition to the distance classification, 20 dry ports are classified as *seaport based*, with emphasis on 5 in the state of Santa Catarina, which assist operations at the seaports of Itapoá and Itajaí, as well as 5 dry ports in Santos, where largest seaport in Brazil is located; another 31 dry ports are classified as *city based*, with emphasis on the 20 located in the state of São Paulo, which is the largest commercial and population center in the country. This fact reinforces that dry ports in developing countries are situated in the proximity, or even inside industrial zones to serve the many small local shippers, or in the middle of the chain for transloading between two transport networks (Nguyen and Notteboom, 2016). The remaining 5 dry ports are classified as *border based*, with emphasis on Uruguaiana and Foz do Iguaçu, which are two of the largest dry ports in Brazil, bordering Paraguay and Argentina.

Figure 3 – Classification of dry ports in Brazil

The discussion above shows that, although Brazil is a country with continental dimensions, most dry ports are located near seaports and the main consumer markets, connecting to the hinterland through a weak transportation system. Indeed, currently there are 10 *bimodal* dry ports, 9 connected by railway and 1 by barge; however, the railway focus is the commodity cargo transportation. The other 46 dry ports are *unimodal*, connected with the main Brazilian highways. These results show the challenge that this country has to face to improve the connections among dry ports, seaports, railways, and hinterland. However, the current scenario is not encouraging, as the dry ports of Uruguaiana and Santana do Livramento, which were managed by Rumo Logística, the company that owns the largest rail network in Brazil, ceased to operate by rail in 2017 (Exame, 2017). Besides the poor transportation infrastructure, dry ports in Brazil face two other significant challenges which include competition from seaports and the lack of a clear institutional framework in regulating dry ports (Padilha and Ng, 2012). These questions will be addressed in the following topics. The full data of Brazilian dry port classification are presented in Appendix 1.

4.2. Assessing the objectives of dry ports

The dry ports in Pernambuco present similar characteristics. Both are classified as *close* dry ports, *seaport based* and *unimodal*. These logistics structures work as a support to the seaport, reducing the congestion and occupancy in the yard and transferring some customs process to the hinterland area. As in the northeastern region there are no railways to hub the cargo in the hinterland and transport to the seaport in high capacity, the main advantages to operate through dry ports are the reduction of storage cost, additional services offer and customs special process. The main objectives of dry ports in Pernambuco and the framework to assess them are detailed below.

4.2.1. Case study in Dry Port A

Through the VFT strategy, it was possible to answer the RQ2 designing the means-end network, as shown in Figure 4. As Brazilian dry ports have a different logistic function, compared with developed countries, identifying dry port strategic positioning is fundamental to understand their social and economic role in the supply chain. In this way, the strategic objective of DP A is to offer customized logistic solution to customers. As in Brazil there is not a railway infrastructure that could support the container transportation through hinterland, reducing the logistic cost and the congestion in seaport gate and highways, DP A fulfills the role of support the customers' demand of customs warehousing, bonded warehousing, container handling, packaging, labeling, sealing, palletizing of goods and other activities. To achieve this strategic goal, the managers listed three fundamental objectives, namely: to meet customer needs, to increase profitability and to expand market share; and 17 means-end objectives, which represent the main values of this logistic player.

Figure 4 – Means-end network of Dry Port A

With the Brazilian economy downturn in recent years, along with the current world recession, accompanied by the rising dollar rate, the volume of the import cargo handled by DP A decreased, while the competition with the seaport, which reduced storage rates to keep the container in their yard and maintain the storage profit, increased. In this context, DP A looks for competitive differential meeting specifics demands as: cargo handling and storage, weighing, cleaning and disinfecting, sampling collection, sealing, stuffing and unstuffing container cargo, repacking, palletizing, lashing cargo, customs process and so on. Furthermore, DP A works in a flexible and personalized way, which does not happen between seaport and customers due to the high volume of container processes. To meet the demand, DP A keeps a close relationship with customers to understand their needs and offer personalized logistics services, what is also a challenge to be flexible on demand, meeting customers' deadlines.

One of the most important values in DP A regards customers' satisfaction. To achieve it, a good relationship with stakeholders is required as well as the prevention of conflicts during the operational process, which is possible through the information reliability. Besides that, to continue working inside the competitive business environment, DP A must be profitable; in this way, the managers believe that performing an efficient operation, decreasing the execution time, and working to reduce the bureaucracy in proceedings related with customs institutions as Federal Revenue are the main means. On the other hand, exploiting different operation services could also bring more profits to DP A, as happened in the beginning of the operations, when DP A specialized in handling oversized containers and special cargo. However, in any situation, it is necessary to have a qualified team, avoiding operational mistakes and achieving the deadline agreements.

As an additional logistic player, DP A must offer a competitive price and promote a reduction in total logistic cost to customers. Considering that it is not possible to obtain cost reduction through railway transport, DP A works to overcome this challenge offering a better storage price to bring volume cargo. To the managers, understanding customers' needs, keeping a close relationship and offering a competitive logistic price are the challenges to achieve the strategic objective, justifying the positioning of dry ports as a logistic player in the supply chain.

4.2.2. Case study in Dry Port B

The strategic objective of DP B is adding value in logistic operations of import, export and additional services. The managers believe that it is the main function of a dry port as a supply chain player, supporting the import and export processes with services which are not the core business of seaports. To assess this strategy, the managers listed: meeting costumers' needs, increasing profitability and fulfilling the role as a supply chain player as three fundamental objectives that express the main values of DP B and 18 means-end objectives, as presented in Figure 5.

Figure 5 – Means-end network of Dry Port B

Customs bureaucracy process is a problem faced in developing economies as Brazil and it impacts directly dry ports to meet customers' needs. The managers identified that maintaining close customer communication and alignment of process between stakeholders enable DP B to manage process information efficiently. Other means-end objectives are providing a broad infrastructure to offer additional services and the quality of warehousing operations, which reduce the total logistic cost to clients. As mentioned before, the customers of dry ports in Brazil look for suppliers that offer additional services and take care of import and export process in a personalized way in the secondary zone, avoiding the congestion in seaports and reducing storage cost.

To increase profitability in the competitive environment between seaport and other players, DP B works to offer information reliability to customers and perform an efficient operation reducing the execution time. With the complexity of import and export process in Brazil, dry ports need to manage information and deadlines between customers and customs stakeholders, as the Federal Revenue, to offer specific services that the seaports are not able to provide. The managers stated that if dry ports are not able to fulfill this gap, customers will not identify benefits in operating through this player and the profitability of the dry port could reduce. In this way, the managers work to show to the customers the usefulness of dry port operations as a logistic option.

As dry ports are an additional player in the supply chain, according to the managers, many shippers avoid to use it because it will add a new step to manage in their process. Despite this weakness, DP B works to create a partner relationship with stakeholders and customers to identify new operation opportunities besides keeping a close relationship with the seaport, considering that if the seaport offers a good service, clients could intensify investments in the region, increasing the profitability of dry ports.

As in the northeast of Brazil the population is concentrated near the coast and the main customers are located in the seaport influence zone, DP B takes on an important role reducing the logistic cost, achieved by the low storage cost and additional services, which stimulate the import and export process. However, as dry ports in Brazil operate in a concession or permit regime, some rules and procedures must be met. In this way, the managers pointed the customs procedures, ISO, OEA (Authorized Economic Operator) and stakeholders' requirements as means-end to achieve their fundamental objectives. It is also a challenge to DP B fulfill those requirements considering that customs rules are changing constantly, and the customers have demanded more agility in the import and export process. However, the managers affirm that customs processes are becoming less bureaucratic, adding new technology to offer information reliability.

4.3. Framework to assess the achievement of the objectives of dry ports

Extending the discussion about the role of dry ports in Brazil, the fundamental and means-end objectives resulted from the VFT were aggregated to propose a framework to assess the achievement of objectives, validated by the experts interviewed as shown in Figure 6. As a first step to future debates, the framework can enhance the process and benefits of VFT, providing useful insights as clarifying objective meaning in addition to measuring the achievement of fundamental and means-end objectives, working as a guide to decision-makers.

Figure 6 – Framework to assess the achievement of dry ports' objectives

Most of the attributes in Figure 6 are natural, becoming easier to calculate. However, this facility may not result in less discussion about the objectives. Furthermore, there are constructed attributes that should be in a rating scale, which can be numeric or verbal. Among the numerical scales there are ratio, interval and ordinal scales, while Likert is a widely verbal scale used (Almeida, 2013). As there are many ways to build a constructed attribute, this article is limited to specifying them as a 'Satisfaction scale', which is open to adjust to each case to identify the objective achievement level.

The framework aggregated four fundamental objectives as *increase profitability* and *expand market share*, both well-known objectives which dry ports work to reach, as mentioned by (Nguyen and Notteboom, 2016); (Ka, 2011); (Kramberger *et al.,* 2018); as well as *meet customers' needs* and *fulfill the role as supply chain player* as specific fundamental objectives of dry ports in Pernambuco, which should be explored to achieve the best benefits of these logistic players in that region, since the reduction of transportation cost using railways is not possible. The experts also defined 23 objectives as means-end to

reach the fundamental objectives; it means that the framework reflected the policy context, network infrastructure, competitive environment, operational issues and other characteristics of dry ports in that region.

As mentioned above, DP A and DP B are currently handling a low volume of container cargo compared to the Suape seaport (1,100 TEUs compared to 40,000 TEUs per month in 2019). In this way, a development of new dry port facilities is not an option in the state of Pernambuco. Customs policy changes to improve the bureaucratic process are important and essential to promote dry port operations, however, it takes time and depends on the Federal Revenue and Brazilian Senate. Improving the network infrastructure, building railways to reduce the transportation cost and connecting dry ports to seaports and hinterland are also a long term and expensive project that involves multiple stakeholders. As an option to overcome the current problems and improve the operation in Pernambuco, the proposed framework works as a feasible tool to drive dry ports operators' decisions to the main role of the dry port.

The framework proposed is a powerful tool to drive decision-makers, going deeply in the specific characteristics of the dry ports and the role of those players inside a specific environment. However, the usefulness of the attributes will depend on the maturity of the company. As a proposal, the managers and governments should not limit the discussion about the role of dry ports in Brazil at the listed attributes, being necessary to define to each case the control limits and the level of quality of each attribute, to convert data into useful information. Furthermore, the implications of the results are not limited to the case studies presented; all steps followed above could lead other studies within different contexts and countries, since our study presented the VFT approach as an applicable option to assess the objectives of dry ports. Hence, this article fulfills the literature gap presented by Khaslavskaya and Roso (2020) and Witte *et al*. (2019) regarding tools to drive dry port decisions.

5. Main issues, challenges and opportunities

Dry ports perform functions that depend on geographic, political and economic factors and even the current logistics infrastructure, which makes defining global standards and concepts a difficult activity (Khaslavskaya and Roso, 2020). As the research on this topic is concentrated in countries of Europe and Asia, which have a high container handling volume and a consolidated railway infrastructure, the adequacy of models and definitions to the reality of developing economies is more subject to errors, as in the research that disregards Latin American structures as dry ports (Roso and Lumsden, 2010). This article fulfills this gap in the literature.

Brazil is a country with an old seaport structure. Despite of the seaport law nº 12.815 of 2013, which allows the private operation of seaports through a concession bid (Ng *et al.,* 2013), the development of new facilities is still in the early stage, presenting difficulties as overcapacity and congestion which could be improved by dry port facilities. As shown in the results, 84% of dry ports are concentrated close or midrange distance from seaport and 91% of them are city or seaport based. This result shows that dry ports in Brazil are concentrated on the sea coast, which is also the most populated region, performing road transport to connect the logistics players, despite the fact that Brazil is a country with continental dimensions.

Although few dry ports in Brazil operate through a railway connection, as requested by the main definitions in the literature (Roso and Lumsden, 2010); (Khaslavskaya and Roso, 2020). Through the case studies and the VFT approach, it was possible to identify that the dry ports in Pernambuco are specialized in offering additional and personalized logistic solutions with a reduced storage cost, relieving bureaucratic processes and the occupancy in seaports, and meeting the benefits described by Qiu and Lam (2018) and Nguyen and Notteboom (2016). However, in Brazil this scenario changes when the container handling decreases, making dry ports and seaports start to compete for storage cargo. This happens when the seaport occupancy is low, which makes them reduce rates to retain more containers and increase their profits (Jeevan *et al*., 2017b); (Ng and Gujar, 2009).

Summarizing the main issues, the authors conclude that dry ports in Brazil support exporters and importers offering storage capacity and additional services in a customs area, located mainly near the coast, connecting the hinterland to the seaport through highways. The authors also reinforce the main challenges faced in Brazil are the bureaucratic customs process, the lack of legislation, the competitive environment between seaport and dry ports besides the poor intermodal infrastructure, concluding that the current environment of dry ports should be improved to achieve the best benefits of this logistic structure, reaching the 37 benefits listed by (Khaslavskaya and Roso, 2020).

Despite the benefits, investments on dry ports depend very much on existing logistic network connection infrastructure, political, social and financial regulations besides multiple stakeholder interests (Dadvar *et al*., 2011); (Khaslavskaya and Roso, 2020). In this way, it is not possible to change the characteristics of dry ports in Brazil to meet the best benefits in a short time. To bridge the literature and practice, the framework proposed through the VFT in DP A and DP B will drive these dry port decisions as a management tool. Moreover, dry port operators should focus on the main role that this logistic player holds in the current supply chain, reaching more container cargo and adding value to the customers. In this way, a better use of the current dry ports in Brazil is fundamental to justify new developments and policy changes.

6. Conclusion, limitation and future work

Development of dry ports emerged mainly in European and Asian countries as an option to optimize the network with hinterland, reducing the total logistic cost and the environmental impact. However, studies considering developing economies as Brazil are still scarce. The literature about dry ports has focused on new developments and dry port location-allocation problem, with little attention being drawn to the usefulness of managerial tools to improve dry port performance. To overcome these gaps, a literature review followed by exploratory research was conducted to expose the current scenario of dry ports in Brazil. After that, two case studies were developed through a VFT approach to identify the means-end network, building a framework to assess the achievement of the objectives of dry ports.

The results showed that dry ports in Brazil fulfill a different role, when compared with developed countries, offering cheapest custom storage services, performing additional and personalized logistic solutions, reducing bureaucratic processes and the occupancy in seaports. Moreover, this article identified the challenges faced by dry ports in Brazil as the poor network infrastructure, bureaucratic customs process, lack of legislation and a competitive environment, bringing relevant information to the society and policy makers. Furthermore, the framework to assess the objectives of dry ports works as an option to improve the current operation context, without the need for high investments, policy changes or multiple stakeholders' action.

6.1. Managerial and research implications

This article brings theoretical and practical implications for researchers, investors, dry ports operators and the society. The first theoretical achievement was the classification of dry ports in Brazil and the promotion of a discussion about their main issues, challenges and opportunities. As the research about dry ports in Brazil still remains in an early stage and there is lack of information from government institutions, the current context of dry ports in Brazil was completely unknown. This article fulfilled this gap working as a first step for future developments.

The managerial contribution of this research, bridging theory and practice, was the proposition of a framework to assess the achievement of the objectives of dry ports in Pernambuco, the container hub state in the northeast of Brazil, which have been presenting low cargo volume and should be improved. Our findings showed that the VFT approach could guide dry port operators towards decision-making on the main role of the dry port in the region. Besides the lessons which could be learned from the development of dry ports in Brazil, the framework proposed can be applied in different contexts and countries, in order to achieve the best benefits from dry port operations.

6.2. Limitation and future work

The main obstacle to this research was the lack of information about dry ports as well as the scarce or outdated data provided by regulatory government agencies in Brazil. About the limitations, the framework to assess the objectives of dry ports cannot be generalized as representing all dry ports in Brazil. However, the authors presented the VFT approach as an alternative to a systematic discussion that can be replicated in other practical cases, countries and contexts, enriching the discussion on the theme of dry ports. In this way, the authors encourage future works to measure the real advantage for customers to use dry ports as an option in developing economies and the identification of the main criteria which represent the success of dry ports through different stakeholders' perspective.

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APPENDIX 1

Appendix 1 – Classification of dry ports in Brazil