PORT TERMINAL IN THE NORTHERN REGION OF BRAZIL: DECISION ABOUT PUBLIC PORT OR PRIVATE USE TERMINAL

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ABSTRACT

Brazil plays an important role in the world's trade of agricultural grains, notably soybeans. Recently, Brazilian production of soybeans has moved to the central-western and northern regions, thus creating a demand for new outflow routes for export. This paper discusses the decision factors for the implementation of specialized port terminals located in the northeast and north of the country, specifically in the area known as Arco Norte. As a methodology, the Analytic Hierarchy Process (AHP) decision tool is used. This involves applying a questionnaire to port experts and managers to identify and classify decision criteria for investments in the possible alternatives available in Brazil's regulatory legislation: leasing of structures in a public port terminal or implementing a private terminal. The results show Port Location (54%) as the most relevant criteria, followed by Economic and Financial (27.8%), Performance and Dimensioning (11.2%), and Contract and Legislation (6.9%) criteria. The study pointed to the investment priority the mode Private Use Terminals, which is confirmed by the country's recent investment in port terminals which has been effective.

Keywords: Soybean export logistics; multicriteria analysis; port planning; Brazilian ports

1. Introduction

In Brazil, agribusiness has been responsible for increasing the country's participation in global markets and this product group includes the country's most important export contributor, responsible for 44% of total Brazilian exports in 2017 (CEPEA, 2017). The main agricultural products exported are soybeans, corn, red and white meat, sugarcane, and coffee. The latter are the country's more traditional exports.

This paper focuses on soybean production and exportation, the recent production trend moving to Brazil's central-western and northern regions, and the consequent requirement for new alternatives to the traditional export routes of the national ports, Santos in São Paulo state and Paranaguá, Paraná state respectively in the south-eastern and southern regions (CONAB, 2017). However, the new port linkages have highlighted operational limitations for the export flow, mainly due to inadequate and inefficient land transport and local port infrastructure (CNT, 2015). Hibernon et al. (2016) pointed out that, despite the remarkable expansion of soybean production and exportation, the logistical cost is still a problem that must be solved in order to increase Brazilian competitiveness in the global market.

In Brazil, the port sector, as other infrastructure sectors, is regulated by the government and the services are provided by the private players. Brazil's Law N. 12815/2013, regulated by the Decree N. 9048/2017, constitutes the legal framework reinforcing and stimulating the private participation in ports operation (Brasil, 2013; 2017). As Galvão et al. (2017) observed, Brazilian legislation defines the concepts of Organized Port (port perimeter under Port Authority management); Port for Public Use (Public Port, PP); and Terminals for Private Use (TUPs), among which the main differences are the type of cargo handled, land ownership (privately owned or publicly rented), government authorization, and conditions of employing the dock workers.

In recent years, the tendering process for public ports on leased areas within the public organized ports has faced a lack of interest from private parties. For example, in 2013, a first round of bidding regarding the Arco Norte Logistic Corridor was unsuccessful, leading to its cancellation, as well as the subsequent tender processes related to public port areas leasing and operation port areas. This demonstrates private investors' lack of confidence in the present port regulations framework for investing in port facilities.

In this sense, this paper analyzes the attributes that support private decisions to become involved in Public Use Port Terminals (PP) or Private Use Terminals (TUP) by applying the Analytic Hierarchy Process (AHP) method. The AHP is used to identify and evaluate the main criteria adopted by decision makers to choose a port investment modality, regarding the alternatives of an area and infrastructure leasing in an organized public port, as opposed to implementation of a private use terminal. The study approached the information to support investment optimization in order to meet the current and future requirements of the Brazilian logistics system by identifying the relevant decision-making factors and their differences applied to public and private use terminals.

This paper presents a brief analysis of the soybean business in Brazil and its logistics requirements, describes the characteristics of the Arco Norte Logistics Corridor, presents a review of port competitiveness and performance indicators, describes the use of the AHP method and its application to decision making on investment in public or private ports in Brazil, and then analyzes the results and presents the paper's conclusions, limitations, and contributions.

2. Soybean business in Brazil

Soybean culture is important in Brazilian agribusiness and in the country's economy, especially with regard to exports. However, the country has a weakness related to logistical constraints in grain transport to export ports (Cutrim et al., 2015). In 2015, a study presented by a private entity, the CNT (National Transportation Confederation) focusing on the soybean and corn logistics chains emphasized the requirement of modernization, expansion, and interconnection of transport modes to enhance logistics efficiency and reliability for product flows from their true origin to destination. This will require greater integration, including improved warehousing facilities and a better-balanced modal transportation split in order to support the country's current grain production and its future expansion (CNT, 2015).

Historically, until the 1990s, national soybean production was carried out in Brazil's southern region. In more recent years, production has moved to the central-western region, mainly due to the existence of cheaper land, the adoption of new production technologies, and a migration of traditional and skilled producers from the south. The same process has occurred in the direction of the northern and north-eastern regions, with producers searching to fulfill increased demand, further stimulated by reasonable product prices (CONAB, 2017).

Soybean production in Brazil increased by 10.3% between 2000/01 and 2014/15 due to land expansion and productivity that has increased up to 3.0 ton/ha, the world's second largest for soybean cultivation. The European and Asian markets are the most significant destination of Brazilian soybeans, with China, due to its increasing demand, the main trading partner, consuming 62.9% of Brazil's soybean exports (CNT, 2015).

In 2017, Brazil produced almost 115 million tons of soybeans, with the central-western region, comprising the states of Mato Grosso, Mato Grosso do Sul, and Goiás, accounting for 50.9 million tons (44.3%) and Paraná, Rio Grande do Sul, and Santa Catarina states (southern region) accounting for 40.9 million tons (35.6%) (IBGE, 2017). Almost half of the country's soybean production is destined for export, highlighting Brazil's position as an important international economic player. Brazil, Argentina, and the U.S.A. are the main world soybean exporters with a total of 18.5 million tons in 2017/18 (USDA, 2018). Figure 1 shows the main Brazilian ports and a representation of the Arco Norte ("North Bow") ports corridor, a hypothetical line linking the northern and north-eastern Brazilian ports, possible alternatives for soybean exports.

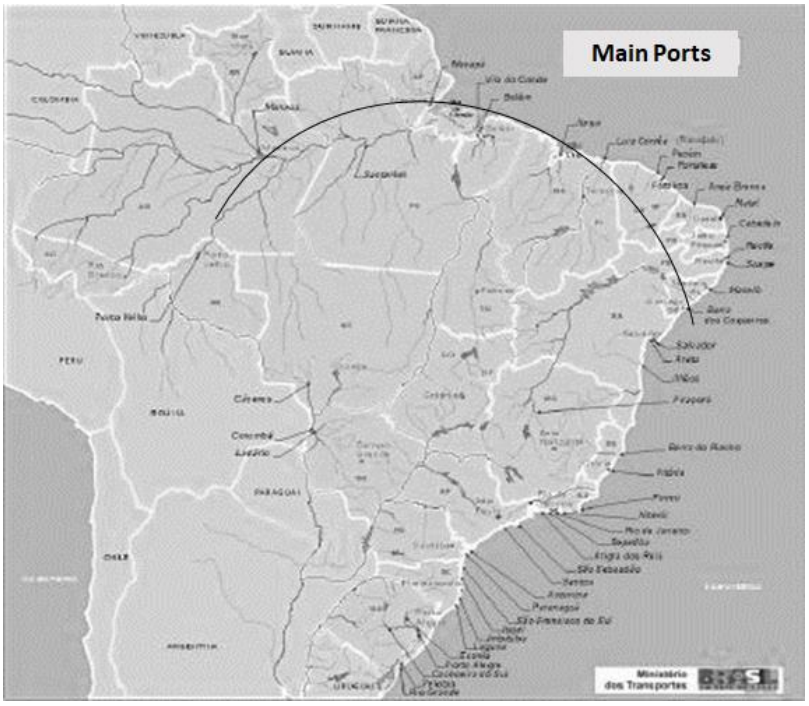

Figure 1 Brazilian main ports
Source: Adapted from MTPA, 2018

When discussing the potential difficulties for soybean exportation from the ports of the northern region, Hibernon Filho et al. (2016) confirmed the current lack of port capacity to meet the regional export demand, which represents a significant concern considering the forecasted production and export growth. They also pointed out that Brazil's apparent institutional and political impasse could cause institutional instability, reducing investment in public or private ports which requires major investments with long-term returns. Thus, institutional and legal security is essential.

The Brazilian Ministry of Agriculture (MAPA) forecasts that the area planted with soybeans will reach 43.2 million ha in 2026, an increase of 10.0 million ha over the next ten years. The production projections for 2025/2026 indicate a production of 129.2 million tons, a 35.1% increase over 2015/16. Domestic consumption is predicted to increase by 22.6%, reaching 53.4 million tons. Thus, approximately 75.8 million tons will be available for exportation, and with stocks carried over this figure is predicted to reach a possible 96.8 million tons of soybeans exported in 2025/26 (see Table 1).

Table 1
Brazil: Soybean production, consumption and export projections (thousand tons)
Source: MAPA, 2017

Year	Production		Consumption		Exports	
	Projection	Upper L.	Projection	Upper L.	Projection	Upper L.
2015/16	95,631	-	43,600	-	55,350	-
2016/17	100,783	110,264	43,001	47,135	57,602	63,550
2017/18	103,228	114,837	44,970	50,815	59,891	68,227
2018/19	106,866	121,169	46,032	52,099	62,161	72,432
2019/20	109,877	126,301	47,094	53,376	64,431	76,291
2020/21	113,162	131,578	48,156	54,645	66,701	79,961
2021/22	116,339	136,517	49,218	55,908	68,972	83,497
2022/23	119,562	141,385	50,280	57,165	71,242	86,931
2023/24	122,975	146,110	51,342	58,417	73,512	90,285
2024/25	125,975	150,755	52,404	59,663	75,512	93,573
2025/26	129,181	155,316	53,466	60,905	78,053	96,805

The soybean export logistics chain is comprised of the collection from rural production sites, an intermediate warehousing phase, and transportation to export ports. This transportation is mainly by highways, and to a lesser extent by railways, and much less by waterways with, of course, dependence on the possibility of multimodal moving. Presently, the production has to travel long distances with significant transit time from the pick-up of goods by the carriers (mainly trucks) to their arrival at the destination.

Brazil's transportation matrix is mainly based on road transport, which demonstrates a remarkable imbalance. For example, at Port of Santos (south-eastern region), the main Brazilian port, no more than 27% of its movements use the railway mode, with the exception of the agribusiness sector (sugarcane, soybeans, and corn) with 53% (Porto de Santos, 2018). In general terms, the railways in Brazil almost exclusively transport commodities destined for export (mainly iron ore and agricultural products).

The logistics infrastructure for agricultural commodities' outflow must also consider the availability of warehouses for storing and treating the harvest, as well as port structures for transshipment of cargo and loading on ships. The warehousing structure is considered a problematic and critical issue for Brazilian agribusiness exports, suffering from inadequate provision and underinvestment to meet the sector's requirements (Caixeta Filho, 2006).

Nevertheless, the transportation link determines the profitability of Brazilian agribusiness. The country's transport system imposes a barrier to the exploitation of the farms' advantages (before the gate) in grain production and, in fact, it is a major issue for competitiveness in the international markets.

As previously indicated, the projected grain production growth for Brazil will exceed the national infrastructure capacity resulting in consequences such as transport delays, breaches of contracts, and significant losses in the international markets. According to CNT (2015), the only alternative for improving Brazil's logistics infrastructure involves

increasing the level and integration of public and private investment in infrastructure. Some of these required investments have already been implemented in the Arco Norte Export Logistics Corridor, covering the northern and northeasters regions, as discussed in the following section.

3. Arco Norte Export Logistics Corridor

The search for new logistics alternatives became a priority with the geographic shift of agribusiness and the movement towards the central-western and northern regions (CNT, 2015). An advantage of the displacement of the agricultural frontier to the north is its greater proximity to the northern hemisphere, with gains possibilities in transport time and even freight volumes due to capacity expansion of the Panama Canal (Hibernon Filho et al., 2016).

The Arco Norte Logistics Export Corridor, also known as the Arco Norte System, comprises multimodal corridors, port support, and operational platforms located at Porto Velho, Rondônia state and Miritituba, Pará state, both in the country's northern region. These logistics platforms are used to transport regional grain production to the Arco Norte ports of Itacoatiara, Amazonas state; Santarém, Barcarena; Vila do Conde, Pará state; Itaqui, in the city of São Luís, Maranhão state; and Santana, Amapá state (Movimento Pró-Logística do Mato Grosso, 2017). Figure 2 shows the main Arco Norte System corridors; related to Madeira, Tapajós, and Tocatins river basins.

The transport infrastructure comprising these logistics corridors is still considered inadequate to link the production zones to the Arco Norte System ports. Regarding roadways, the system suffers from a lack of maintenance and even of asphalt paving in many places. On the waterways, more signaling devices are required for navigation safety, and the rail network is dispersed and not significant. Because of these conditions, long-distance cargo transportation occurs by trucks moving directly from production farms or via transshipment terminals (Movimento Pró-Logística do Mato Grosso, 2017).

However, despite all its deficiencies, the Arco Norte System has increased its participation in the national soybean and corn exports from 17.2% in 2014, to 21% in 2015, and 19% in 2016 (Movimento Pró-Logística do Mato Grosso, 2017). In the Amazon river basin, the main transportation mode is the waterway, supported by trucks production moving between transshipment points.

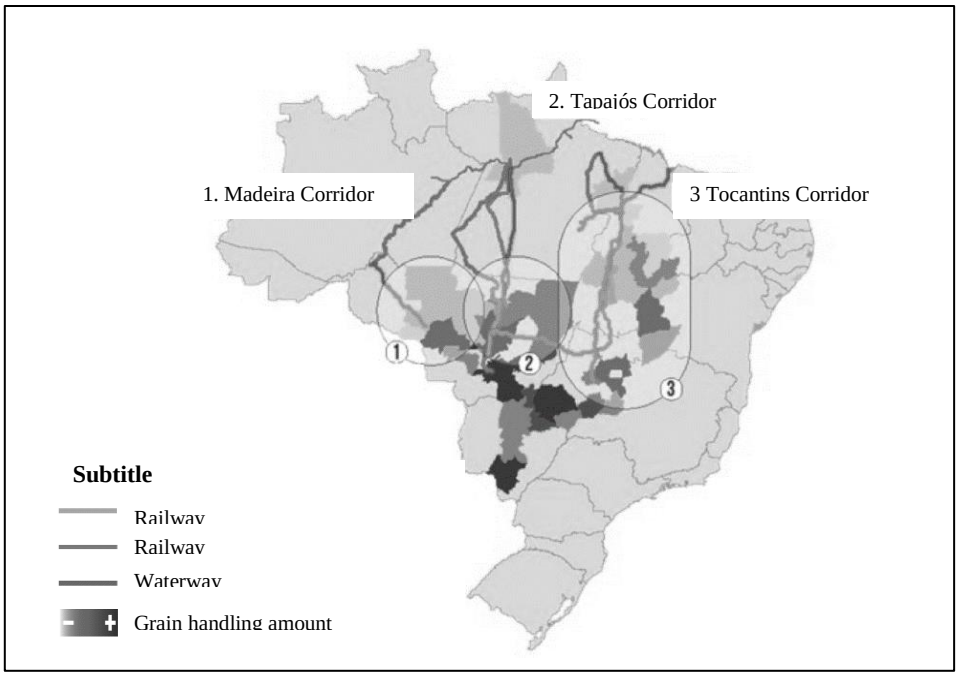

Figure 2 Arco Norte export logistics corridor
Source: Adapted from Movimento Pró-Logística do Mato Grosso (2017)

4. Brazilian port institutional framework (public and private) and port competitiveness issues

An efficient logistics system is a basic requirement to face the commercial and competitive pressures of the global agribusiness market, and requires steady modernization and expansion of transport and port capacities. Brazil, a coastal country, has been historically developed by its port infrastructure and, in recent years, port institutional regulation has been marked by significant institutional and legal changes (Galvão et al., 2017).

The Brazilian government and its agencies have focused on stimulating private sector investment to develop the logistics and port sector. In this sense, Brazilian port reform was successful in adopting a landlord model of port governance with Port Authorities responsible for port management and the private sector for investment and operations. However, the full implementation of this model requires further development of port business management.

Law 12815/2013, named the Port Law, confirmed the option to concede and lease land and public infrastructure in the so-called organized port (a polygon established by the law regarding public ports - PP) to the private sector for cargo movement and storage operations. Decree N. 9048/2017 aimed to attract more private investment to ports and regulated the terms of concession and lease agreements of terminals for public use, the extension of the term of the contracts, the possibility of expansion of the leased area, and of the period of leasing renewal.

The Decree also defined new criteria for the authorization and operation of out-of-port terminals, with an extension of the deadline for operations to begin. It also provided ANTAQ, the national regulatory agency, greater autonomy in the authorization process for private installations, and introduced the first phase of new documentation requirements in applications for authorization.

Previously, the concession and lease agreements term were 25 years, and only able to be renewed once for the same period. Through the Decree, this term became 35 years, with a limit of 70 years in total.[1] The concessionaire or lessee was previously required to formally express its interest in extending the agreement to the granting authority at least 24 months before the end of the term; now, it must express its interest at least 60 months in advance.

Previously, those interested in obtaining a port facility authorization had to make a request to ANTAQ in two steps, at any time, by presenting the required documents. Following ANTAQ's approval, the interested parties would present more specific documents within ninety days. Next, ANTAQ would send the documentation to the granting authority within a period of 15 days, for analysis and to conclude the process. Finally, the binding contracts would be signed. Now, once the request is authorized, ANTAQ sends the documents to the granting authority directly for contract finalization in a faster and much less bureaucratic process.

Previously, any expansion of the port facility into areas located outside the organized port, not exceeding 25% of the original area, would be approved by the granting authority through a new concession contract. Now, the new contract does not require a new public announcement and depends only on approval by the granting authority. In addition, private terminals located within the organized port can now expand their facilities.

In the sense of port investment as a tool for local, regional, and national development, this study builds on port competitiveness studies such as those conducted by Tongzon (1995), Malchow and Kanafani (2001), Nir et al. (2003), Khan (2004), and Bichou and Gray (2004).

Worthy of note is a 2017 issue of the scholarly journal *Research in Transportation Business and Management (RTBM)*, which published 21 port studies addressing port governance, organization and performance. Brooks et al. (2017), the journal guest editors, identified some of the drivers of ports' role in national development. These included private sector participation (devolution) as part of government aims to assure port conditions while making the ports more profitable and efficient, as well as "greener" and more sustainable. Rodrigue and Notteboom (2017) pointed out that international export and import of grain are important in international trade and have an effective role in the global economy.

[1] This issue is currently under legal judgement and the matter of these discussions on government entities is far beyond this paper's focus.

This study is concerned with private port operations and uses the multi-criteria analysis method to support decision making to evaluate and choose between public or private use port terminals to Brazilian ports in the Arco Norte System. The main objective is to identify the most important criteria for the investment decision between PP or TUP.

5. AHP method as a decision support tool for investment decision between public and private ports

The AHP multi-criteria analysis method is based on an active weighting process in which the various relevant attributes are represented by their relative importance. This method is characterized by the division of the problem into descending hierarchical levels, starting with the global objective, criteria, sub-criteria, and alternatives at successive levels (Saaty, 1996). The AHP method results are derived from pair comparison measurements using values from 1 to 9 based on the rating scale for comparative trials (Saaty, 2008).

Pinheiro et al. (2003) observed that one of the main advantages of the application of the AHP method is to avoid subjective or biased weighting factors in multicriteria analysis to support a decision-making process and emphasized one particular issue. As is well-known, the participants in a process could influence the output decision by interfering in the weighting of the relevant criteria. This does not imply that it is necessary to eliminate the personal factor or human intervention in political, social or other terms, rather it is necessary to establish an agreed upon basis for discussions.

According to Silva et al. (2007), the AHP supports the decision-making process and can lead decision makers to evaluate and select from among alternative courses of action for certain problems. To achieve this, the AHP method divides the decision problem into hierarchical levels in order to facilitate understanding and evaluation through the construction of the stages of the multi-criteria model and proposes weighting factors for each criterion.

5.1 Multi-criteria hierarchical analysis applied to the port sector

Applications of the AHP method as a tool to support the decision-making process for port choice have been presented by Song and Yeo (2004), addressing Chinese ports; Lirn et al. (2004), looking at transshipment ports; and Mazza and Robles (2004), who looked at Brazilian container ports. More recently, Du (2014; 2015) used AHP for evaluating the performance of European container ports.

Nazemzadeh and Vanelslander (2015) applied the AHP method to identify factors affecting port selection for northern European ports. The results identified the following port selection criteria, in decreasing order of importance: port costs, geographical location, quality of hinterland connections, productivity, and capacity.

In a Brazilian port case, Mazza and Robles (2004) used financial and operational criteria to characterize container port choice. Their criteria were port tariffs, service level, operational capacity, and financial stability. The authors identified that port location is the primary factor in costs incurred by shippers, due to the relationship between the distance covered and the weight (tonnage) of the cargo transported.

Gartner et al. (2012) presented a proposal for multi-criteria modeling through the application of AHP to port problems of regulation, planning, and management in privatized port areas, dealing with the hierarchy of areas destined for leasing investments. In addition, they observed that the method was appropriate to the port sector due to its multidisciplinary nature, which involves socioeconomic, environmental, and political value judgments.

The choice of location for a port terminal expansion involves several specific attributes that, from experts' perspectives, could be analyzed by applying the AHP method. These criteria could cover aspects related to road access, availability of area for expansion, socio-environmental impacts, and local infrastructure conditions (Loureiro et al., 2015). Magalhães and Botter (2015) determined the AHP method to be an adequate decision support tool regarding regulatory issues in privatized port areas. The application of the AHP method to the decision-making processes in the public sector is common, as presented by Pinheiro et al. (2003), although it has not been frequently used in Brazilian port leasing project analysis. This paper aims to help rectify this oversight.

5.2 Modeling the Analytical Hierarchy Process

This study used the AHP method as a decision support tool to evaluate and select the most viable type of port facility investment for soybean export operations in the northern region of Brazil. The AHP can be justified by its potential to deal with various decision makers' different perceptions of the relevant criteria.

The objective was to identify the main criteria relevant to support decision makers in the choice of investment, considering the alternatives of Public Port leasing or Private Use Terminal implementation, as allowed and established by current Brazilian regulatory instruments. The AHP structure was elaborated based on four criteria and their subsequent sub-criteria (Figure 3), some established by a literature review as previously mentioned in Section 5.1 and others observed in Brazilian port regulation, such as contract conditions, port legislation, and performance and dimensioning required by public and private ports. Each criteria was evaluated in terms of its respective sub-criteria, and compared with each other on a scale of relative intensity of importance ranging from 1 to 9 (Saaty, 2008).

The criteria "Port Location" relates to the availability of transportation infrastructure and superstructure, regional port availability, consideration of land and waterway access, availability of areas for future expansion, and the existence of port structures. The "Economic and Financial" criteria consider the determining factors for the technical, economic and financial, and environmental feasibility analysis of the terminal.

"Performance and Dimensioning" involves the terminal's operational efficiency which is directly related to its installed operational capacity. It considers the loading capabilities, land reception, warehousing, and annual handling capacity. The criteria "Contracts and Legislation" evaluates the requirements and constraints of the public bidding requirements regarding the lease of a terminal in a public port, as well as the legislation that regulates the authorization of terminals for private use, and national development plans.

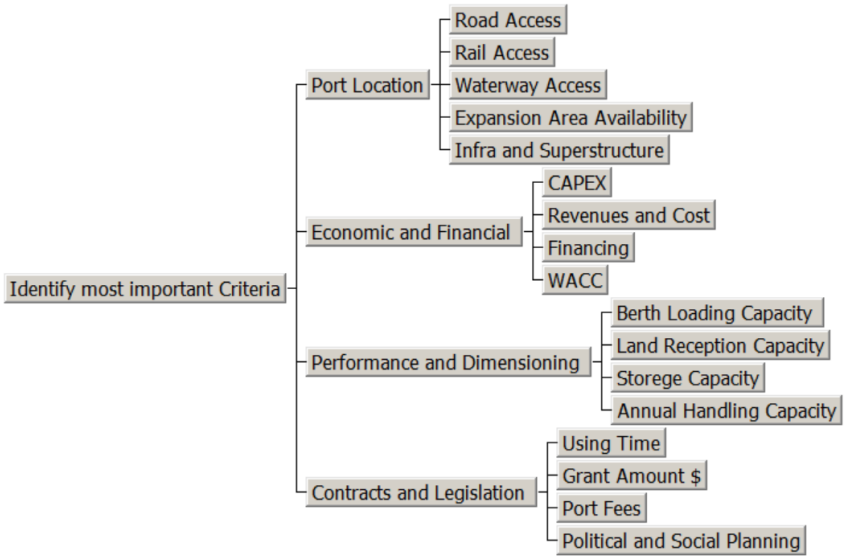

Figure 3 Analytical Hierarchy structure
Source: Excerpted from Expert Choice software

Following the construction of the hierarchy, the definition of priorities and comparative judgments was carried out by the sample of decision makers and port sector experts. This group was purposefully selected and contacted by e-mail, telephone, and a social network (LinkedIn) to verify their willingness and availability to participate in the survey. The final decision-making group included 35 members, comprised of 19 specialists, including engineering consultants and port operators; five academic researchers and 11 professionals linked to the surveillance and regulation of waterway transport services and ports. Each decision maker selected compared the criteria in a given hierarchical level as described in an online questionnaire implemented using the application Google Forms as observed in the appendix.

Once the values of the decision-makers' priority judgments were obtained, they were evaluated using a demonstration version of the software package Expert Choice. Both demonstration and complete versions are available on the manufacturer's website (http://expertchoice.com/). The Expert Choice structured decision tool allows users to analyze complex problems in a clear and understandable way, to accurately measure the importance of competing objectives and criteria, to synthesize information, knowledge and judgments to conduct sensitivity analyses, to communicate clearly and to share results, to iterate with participants in the decision process when needed, and to allocate resources as required.

The software was used to calculate the local average priorities and the overall priorities, ensuring the matrices normalization and the logical consistency of the judgments. However, it was difficult to obtain complete responses from all 35. Despite follow-up requests, only 12 fully and effectively answered the questionnaire. It is necessary that participants be fully engaged and committed because missing data and inconsistent judgments can interfere with the analysis. The commitment of the specialists interviewed for this research was assured by the researchers through further personal contacts with the

respondents. Subsequently, the data from the final 12 participants' judgments were combined, the data normalized and its consistency verified.

The pairwise comparison generates square matrices, where the number in line *i* and column *j* gives the importance of criteria C*i* in relation to C*j*. The number of judgments required to construct a generic judgment matrix A is *n* (*n*-1) / 2, where *n* is the number of elements belonging to this matrix. The elements of *A* are defined by the conditions:

$$\boldsymbol{A} = \begin{vmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/a_{21} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ 1/a_{n1} & 1/a_{n2} & & 1 \end{vmatrix}$$

Conditions:

- $a_{ij} > 0 \rightarrow \ Positive$
- $a_{ij} = 1 \ \therefore \ a_{ji} = 1$
- $a_{ij} > \frac{1}{a_{ji}} \rightarrow \ Reciprocal$
- $a_{ij} = a_{ji} \ . \ a_{ji} \ \rightarrow Consistent$

The normalized matrix was calculated by the sum of the elements of each column and dividing each element by the respective column summation. The calculation of priorities is represented by the arithmetic mean of the standard matrix lines which represents the priority of each element.

The pairwise comparison of the alternatives related to a criteria of a hierarchical level immediately superior will have a vector of weights *W = (w1, w2,.., wn).* The priorities can be calculated through the product of all intermediate priorities from the lowest hierarchical level to the highest.

The logical consistency is calculated through the Consistency Index *(CI)* of subjective character, composed for each alternative based on preferences derived from the comparison matrix. The *CI* evaluates the degree of inconsistency of the matrix of parity judgments, through the equation *CI = (λmax - n) / (n - 1)* where *n* is the order of the matrix and *λmax* is the highest eigenvalue of parity judgments matrix.

The Consistency Ratio *(CR)* allows the inconsistency to be evaluated according to the order of the judgment matrix, through the equation *CR = CI / RI*, where RI is the Random Index. The *RI* is the consistency index obtained for a reciprocal random matrix, with nonnegative elements, for varied matrix sizes n. A *CR* less than 0.10 is acceptable. For values of *CR*> 0.10 a revision in the comparison matrix is suggested.

Table 2 summarizes the results obtained for the priorities for each criteria analyzed, aiming to identify the most relevant criteria for decisions applied to public and private ports investment alternatives.

Table 2
Brazil: Soybean production, consumption and export projections (thousand tons)
Source: Excerpted from Expert Choice software

Level 1 - Objective	Level 2 - Criteria	Level 3 – Sub-criteria
Identify most important criteria for choosing investment between public use terminal or private use terminal	Port Location (54,1%)	Road Access (37,3%) Rail Access (30,1%) Waterway Access (18,3%) Expansion Area Availability (9,1%) Infra and Superstructure Availability (5,3%)
	Economic and Financial (27,8%)	CAPEX (52,3%) Revenues and Costs (28,5%) Financing (10,7%) WACC (8,5%)
	Performance and Dimensioning (11,2%)	Berth Loading Capacity (54,7%) Land Reception Capacity (25,5%) Storage Capacity (11,4%) Annual Handling Capacity (8,5%)
	Contracts and Legislation (6,9%)	Using Time (57,5%) Grant Amount $ (23,9%) Port Fees (11,9%) Political and Social Planning (6,7%)

In the Port Location criteria (Figure 4), the importance of the sub-criteria Road Access and Rail Access were highlighted, with 37.3% (0.373) and 30.1% (0.301), respectively. The other sub-criteria add up to an importance of 32.7% (0.337), with the Infra and Super Structure Availability subcategory, at 5.3% (0.053), as the least important.

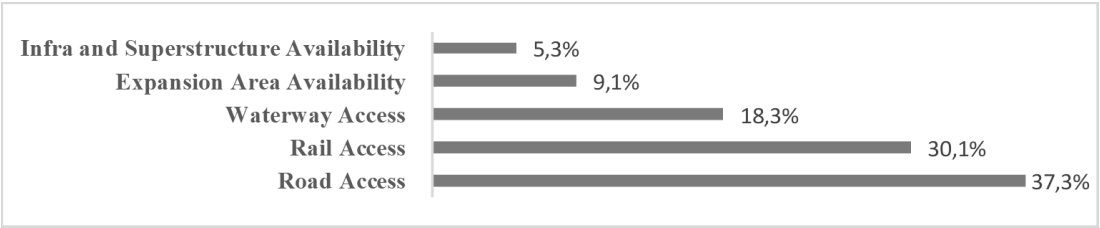

Figure 4 Criteria "Port Location" priorities from Expert Choice

The results of the analysis of the Economic and Financial criteria (Figure 5) show the predominance of the CAPEX (Capital Expenditure) sub-criteria at 52.3% (0.523), followed by Revenues and Costs 28.5% (0.285), Financing 10.7% (0.107), and WACC (Weighted Average Cost of Capital) 8.5% (0.085). CAPEX, capital needed to invest for terminal construction and implementation, is an essential variable in the terminal feasibility analysis to be performed in the project phase. Other sub-criteria, although important as indicators to verify the terminal viability, were evaluated with low importance in relation to the previous sub-criteria.

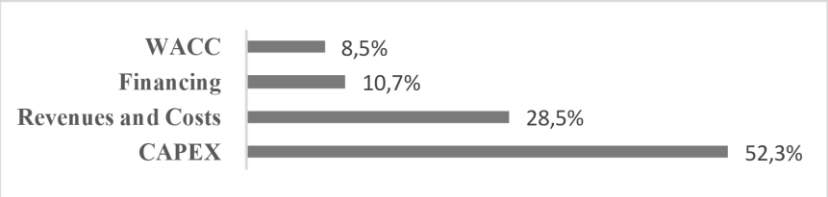

Figure 5 Criteria "Economic and Financial" priorities from Expert Choice

The terminal efficiency analyzed by the Performance and Scalability criteria (Figure 6) had its importance in the loading capacity demonstrated by a 54.7% (0.547) index, higher than the other sub-criteria. The sub-criteria Annual Movement Capacity at 8.5% (0.085) was the least important, although intrinsically related to cargo loading capacity for exporting vessels, it also depends on the efficiency of other land-based and warehousing processes.

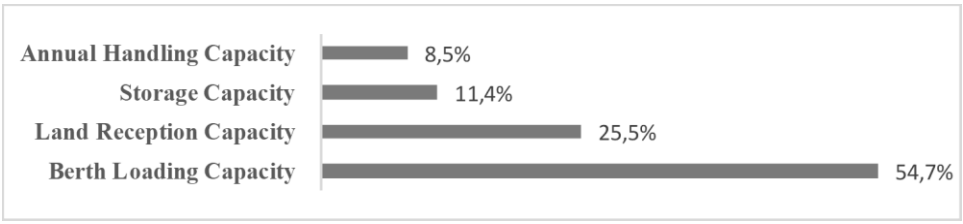

Figure 6 Criteria "Performance and Dimensioning" priorities from Expert Choice

The analysis of the criteria Contract and Legislation (Figure 7), which covers aspects of terminal leasing at the public port and authorization of the private port, demonstrates the Use Period sub-criteria, at 57.5% (0.575), as the most relevant. Note that, following recent changes in the law regulating the operation of public and private terminals, the leasing term of a public terminal, previously 25 years, has been extended to 35 years. For terminals for private use, the operating authorization term remains 25 years.

The sub-criteria Concession Value 23.9% (0.239), Port Fees 11.9% (0.119), and Political and Social Planning 6.7% (0.067) express lower relevance than the Term of Use of the terminal. However, these sub-criteria are also significant for terminal economic feasibility and may have different interpretations for each terminal model.

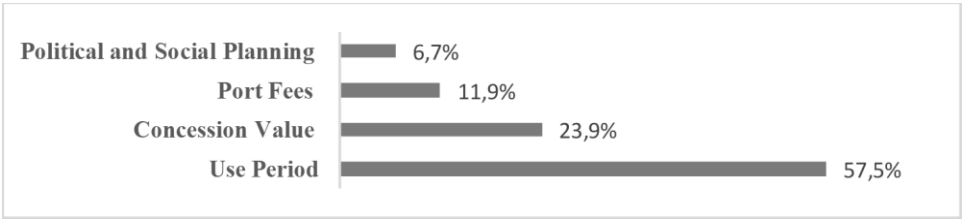

Figure 7 Criteria "Contract and Legislation" priorities from Expert Choice

The interaction between all criteria judgments determines the final priority of each in relation to the objective. The final priority will be determined by the sum of the products multiplied by the criteria weighting combined with the sub-criteria priority weightings.

Global priorities can be determined as the product of all intermediate priorities from the lowest hierarchical level to the highest. Figure 8 shows that the criteria of greatest importance to the overall objective was Port Location 54.1% (0.541), followed by the Economic and Financial Criteria at 27.8% (0.278); Performance and Dimensioning 11.2% (0.112); and Contract and Legislation 6.9% (0.069).

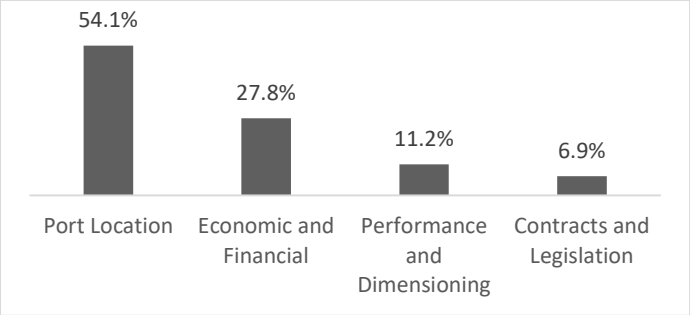

Figure 8 Global Priorities from Expert Choice

The sub-criteria priorities most relevant to the overall objective are Road Access with 23.4% (0.234), Rail Access with 18.9% (0.189), CAPEX with 12.1% (0.121), and Waterway Access with 11.5% (0.115). When combined, these contribute 65% of the total importance for the decision-making process as analyzed.

The combined synthesis of priorities with respect to identifying the most important criteria for choosing investments between public use terminals and private use terminals is shown in the Figure 9. It is noted that the sub-criteria road access with 20.2%, rail access with 16.3% and CAPEX with 14.6% are the most important in relation to the overall objective. The transport of commodities by roads and highways is predominant in Brazil, thus it is expected to have a strong influence in the decisions of investment in terminal ports.

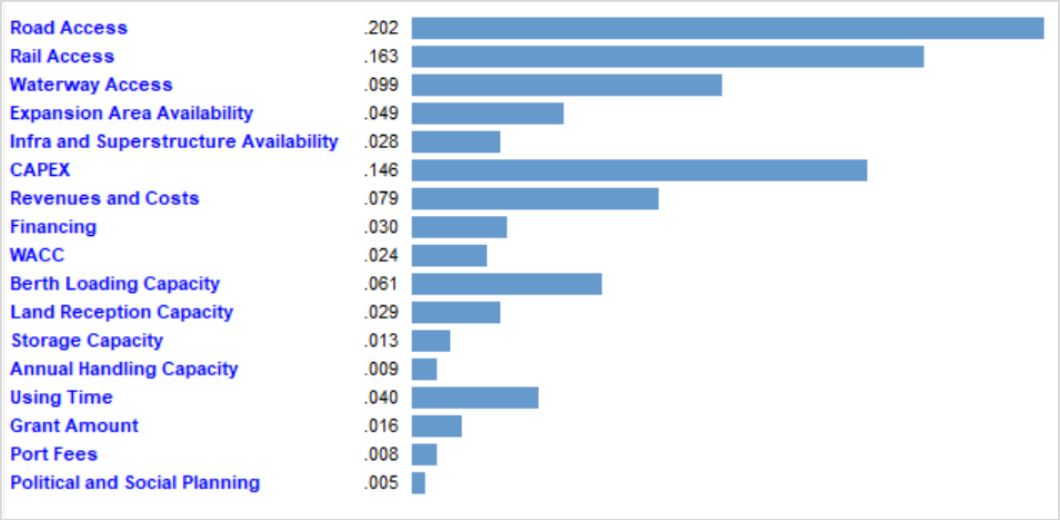

Figure 9 Combined synthesis of priorities from Expert Choice

Finally, the decision makers were individually asked their preference for the type of port facility model they thought was most appropriate for investing in to facilitate grain exports in the north and northeast routes of Brazil (the Arco Norte System). This question was not associated with the AHP method, whose objective was to identify the most relevant criteria in the choice of investment in port terminals; however, it was done to verify these experts' preferences to reflect the current trend for private ports in the region. All of the respondents opted for private use port terminals. This unanimous decision in favor of TUPs may be associated with Brazilian institutional and legal uncertainties due to the political situation presently faced by the country.

In port concessions, the bidders are usually provided with a basic terminal infrastructure, ensuring that after the bidding process they can begin operations in a short period of time. However, the terminals bids related to the Arco Norte System are greenfield projects, that is, they do not have any existing port infrastructure. Therefore, the winning bidder would be responsible for all terminal structures, including the environmental liabilities, and should also guarantee to the granting authority the return of all facilities at the end of the concession. On the other hand, once a TUP is authorized, the entire port undertaking will be under the control of the investors.

Another issue identified in interviews with the respondents was the lack of complete information in public notices which is necessary for the full understanding of the object being tendered, as a factor for the decisions in favor of private terminals. This information gap often prevents a precise definition of the project's unique characteristics which are important for planning and determination of implementation costs and revenues, and thus for the terminal feasibility analysis.

At the time of writing, none of the published tenders relating to area and port infrastructure leasing in Arco Norte that have focused on the movement of grains have received interest from investors, demonstrating their feelings of insecurity regarding TUPs. However, subsequent to Law 12815/2013, only TUPs have been authorized by ANTAQ.

6. Conclusions

The literature review and data gathered demonstrate the importance of agribusiness in general and the soybean export trade in particular to the Brazilian economy. Nevertheless, a remarkable need for investment in logistics and port sector development to allow greater competitiveness for Brazilian products on the international market remains. Despite deficiencies in the transport infrastructure linking production zones and exporting ports, the Arco Norte system has increased its share of domestic exports. The question of the best way to maintain private investment continuity in the port sector remains, especially regarding the alternatives of investment in terminals in PP or TUPs.

The application of AHP to assess the decision factors identified the criteria of Port Localization, at 54%, as most important. The important sub-criteria of Port Location were identified as the availability of road and rail access. The low density and extent of the railway network and the poor utilization of the waterways in the export routes result in the predominant use of the road modality. In addition, assessment of the Economic and

Financial Criteria established the priority of the sub-criteria CAPEX and Revenues and Costs.

The use of the AHP multi-criteria analysis methodology was a study objective and it can be considered accomplished. In addition, the main criteria for choosing an investment model were identified and the researchers concluded that the AHP method offered decision makers and interested parties a tool for analysis and choice between the alternatives of a public or private terminal. Moreover, interviews with the respondents found that 100 % of them would prefer to invest in private use terminals. This result is in accordance with the current situation in Brazil.

Thus, the AHP method is recommended for future studies analyzing multiple alternatives of public and private terminals. The tool can be further extended to terminals specializing in the movement of the different types of cargo. In addition, it is suggested that the technique be applied with a larger number of professionals, including interested investors.

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