

CONTAINERIZED CARGO SHIPMENT: A MULTIPLE CASE STUDY FOR DECISION-MAKING REGARDING PORTS IN SOUTHERN AND SOUTH-EASTERN BRAZILIAN REGIONS

Leo Tadeu Robles*

Business Management Post-graduation Program
Santos Catholic University - UNISANTOS
Santos, SP, BRAZIL
E-mail: leotadeurobles@uol.com.br

Marcos Mazza

Santos Metropolitan University - UNIMES
Santos, SP, BRAZIL
E-mail: marcosmazza@globo.com

ABSTRACT

The decision-making process regarding the choice of containerized cargo shipment port involves objective and subjective factors in terms of physical, structural, and operational port conditions, which are determinant for exportation logistics. Its complexity and relevance for shippers' performance recommend careful and rational approaches. In this sense, this study focused the decision process applied to the main ports in Southern and South-eastern Brazil, more specifically Vitória – ES, Rio de Janeiro – RJ, Itaguai – RJ, Santos – SP, Paranaguá – PR, São Francisco do Sul – SC, Itajaí – SC, and Rio Grande – RS and to containerized cargo exportation shipments, by using the Analytic Hierarchy Process (AHP), applied to the shippers' viewpoint. This exploratory study establishes a criteria and sub-criteria hierarchical structure based on academic literature adapted to Brazilian reality and then utilized for the empirical application. The primary data research was oriented to support the ports considered hierarchical classification and a survey was applied to foreign trade executives. The basic round indicated the Santos Port, hierarchically, as the first option for shipment, with the position maintained after the sensitivity analysis carried out on the results, indicating the application's consistency and robustness. Despite this, the study limitations recommend its extension to specific and particular situations.

Keywords: Brazilian Exportation; Containerized Cargo; Maritime Ports; AHP; Shippers' Decision Process.

1. Introduction

To analyze maritime ports as supply chain logistics connection elements, it is necessary to consider not only their activities' complexity, but also their organization form, as well, other issues affecting specific logistics characteristics. Ports offer different activities levels and promote domestic production outflow supporting the converting of the country's richness into foreign currency, and, thus, acting as internal and international logistics interfaces.

Ports importance is expressed for their role on global trade, as they are in charge of upwards of 80% of the volume marketed internationally, which is transported over the sea. (www.worldbank.org, accessed at April 23, 2006).

* Corresponding author

Bichou and Gray (2004) define ports as “multipart, complex organizations in which institutions and functions normally intersect themselves on several levels.” They are systems and, as such, offer a diversity of entries and exits that involve physical, geographical, operational, logistic, legal, etc., aspects (Valentine and Gray, 2001), and it is difficult to compare ports when they are analyzed based upon objective and subjective factors that involve their activities.

Ports can be considered “trade facilitators” (Song and Yeo, 2004) and each one presents its own characteristics and peculiarities. Each Port Administration must address them commercially, since the management of port activities requires a permanent analysis of their operational costs and, especially for their remarkable significance to products total cost and so far to products pricing. This issue justifies careful and rational approaches to the decision process regarding which port to choose to move goods by shippers. Ugboma *et al.* (2006) approached the importance of this process focusing the shipper’s point of view, analysing the selection of Nigerian ports and Guy and Urli (2006) focused the carrier decision considering New York and Montreal ports.

2. Purpose of the study

This study aims to research what and how objective or subjective factors are considered by shippers, in their decision-making process to shipment port choice for containerized cargo, considering the Southern and Southeaster Brazil main ports. The ports considered were: Vitória – ES, Rio de Janeiro – RJ, Itaguaí – RJ, Santos – SP, Paranaguá – PR, São Francisco do Sul – SC, Itajaí – SC, and Rio Grande – RS. These ports served the Brazilian most important economic and industrial region and are representative on Brazilian movements of cargo with higher value added relative, as shown on Table 1.

Table 1 – Containerized cargo participation in the general cargo moved in the port – 2007.

Ports	General cargo (ton) (A)	Containerized cargo			
		Quantity	TEUs	Weight (B)	(B)/(A) %
Vitória - ES	15,725,261	204,208	267,494	3,149,765	20
Rio de Janeiro - RJ	6,585,387	274,187	387,809	4,558,184	69
Itaguaí – RJ	3,625,581	162,794	229,742	2,897,853	80
Santos – SP	33,981,696	1,683,526	2,577,187	28,894,440	85
Paranaguá – PR	9,891,768	343,270	598,479	6,085,484	62
São Fco. do Sul – SC	2,407,223	137,589	226,806	2,017,118	84
Itajaí – SC	6,316,372	375,709	668,521	6,249,138	99
Rio Grande - RS	6,641,130	356,417	607,275	5,543,727	83

Source: Adapted from ANTAQ, 2008 – Performance Indicators

This study focused the decision-making process at shippers’ point-of-view when exporting high value goods that require special conditioning to be handled or, in a consolidated way; the products are handled in containers.

The ports importance is justified by their impact on exporters' competitiveness as a result of the logistics integration of the merchandise handling, transportation, and storage issues, as far as they determine the logistics total costs to be incurred. So, the port choice has to take in account the analyze of different factors, such as the port distance from its influence area, its access conditions, the port operators performance, the availability of movement equipment, the vessels frequency, in addition to other aspects related to general regulation and workforce used.

Thus, this study focused the determination of which port in the Brazilian Southern and South-eastern region (see Figure 1) provides the best geographical and operational conditions to its users, which factors are involved in the selection decision and the relative importance of each factor in order to determine the competitive advantages for the ports users-shippers.



Figure 1 – Brazilian Main Ports

Source: Antaq, 2008.

A few suppositions must be taken into account while analyzing the factors:

- Vessel stopover frequency;
- Container movement and port infrastructure;
- Logistics and economics conditions;
- Distance the cargo must cover;
- Port fees with the lowest relative value;
- Operational facilities.

In port analyses, more specifically those regarding port terminals that operate containers, it is a common practice to compare these terminals' performance evolution to the optimal or ideal results, and the performance is measured in tons or by the number of containers moved within a certain period. Furthermore, engineering approaches have supported the determination of optimal operations or the best performance that can be achieved by a port terminal under certain conditions. (Talley, 1988)

Following the same line of thought, Kulliname (2002) analyzes port terminal performance efficiency and proposes it can be calculated by the economic units' output and input ratio with the highest values ratio associated to the best performance or highest productivity.

This study, initially, considered the literature on the shipment port choice factors and, using a field research, to support the Analytic Hierarchy Process (AHP) method application, in order to determine a choice hierarchy for the ports located in Brazilian Southern and South-eastern regions, as described below.

3. Ports aspects

Economic globalization was possible and induced to the logistics chain restructuring and the enhancing information technology, with remarkable impacts on costs reductions that make it possible to make global production centres closer to each other, reducing space and time, and allowing a scenario of general and global trade. This environment embarks in order to support good and service currents, both the ports, restructured mainly to move containerized goods, and maritime shipping companies, resizing their vessels, have been presenting significant institutional and management changes.

But, the maritime transportation market's behaviour and characteristics of foreign trade should not be seen homogeneously all over the world. Many shippers have currently been facing their importer customer service requirements to deploying quality programs or just-in-time manufacturing systems, and as a part of their effort to compete under these new circumstances, they have started building supply relationships or establishing strategic alliances with transporters. (Brooks, 2002)

The growth in the flow of value added goods is more than a trend. Thus, research carried out by Baird (1999) among the 30 main ship-owners who operate liners, concluded container vessels with capacity between 10,000 and 15,000 TEUs are expected to start operating before 2010, and that these vessels will perform transshipment operations to offshore mega-hub ports, reducing conventional liner operations. De Monie (1997) *apud* Baird (2002) explains offshore is applied to an islet transshipment hub port, such as the Malta Freeport, in Malta, or to a remote peninsula such as Taranto, in Italy, and Salalah, in Oman, instead of ports located in urban areas, such as New York, in the United States, Hamburg in Germany, or Tokyo in Japan.

Globalization implies on more developed countries emphasis to overcome cargo movement barriers, including transshipments in the different stages of products handling, which is an important aspect for maritime transportation, the mode that predominates in international trade, responsible for nearly two-thirds of world trade in metric tons. (Kumar and Hoffmann, 2002)

International trade represents new challenges to logistics. The biggest of them has been focusing logistics costs unrelated to transportation. “The logistics costs taken into account consist largely of the cost of transportation, while, in fact, these costs often contribute to less than 50%, and, at times, less than 30% of the total door-to-door logistics costs.” (Frankel, 2002)

Ports, as one of the fundamental parts of the logistics export chain processes considered from the interior of the country to their location and to final destinations, had transformed their function of mere cargo dispatch and receipt providers and points of modal transportation changed to a new role of logistics platforms, i.e., a strategic centres that meet the growing shippers requirements with a competent and agile maritime service.

Wignaraja (2002) claims developing countries face a new industrial manufacturing context established progressively and irreversibly by globalization, one that eliminates trade barriers, increases the use of technology, cuts transportation and communication costs, and renders corporations highly mobile. This globalization offers developing countries the possibility to achieve industrial growth faster, and unprecedented economic prosperity resulting from their access to new markets, technologies, skills, and to new capital.

With this in mind, analyzing port competitiveness, Brazilian ports need, strategically, to substitute comparative advantages for competitive ones, in the trend of increased operation and terminal specialization, although there still is general cargo movement in the wharfs. Fourgeaud (2000) mentions a few port performance indicators: technical evaluation of the port’s performance – average number of stopovers and average good flow/volume in a standard period of time; number of stopovers per berth per year, cargo volume or weight moved per hour, per stopover or per day, per tripletⁱ or crane; requisites: a) shipper or ship owner’s – main average of the vessel’s lead time, by the cargo lead time and by the data regarding quantity, if possible and; b) the Port Authority’s - berth occupation fee and general traffic.

Fourgeaud (2000) said, however, that all of these parameters do not result on “instantaneous” performance, i.e., that registered during an hour, a shift or a stopover and which describes a terminal’s technical capacity. A merchandise flow registered in an extended period of time also depends on parameters related to competitiveness, market participation, seasonal effects, mooring capacity, etc. The author reinforce that the best performance is seen in private terminals, and not in public wharfs, which have cargo handling and equipment maintenance carried out by the Port Authorities. This better performance takes place in container movement done by high-performance terminals dedicated to one or a few ship-owners, particularly those operating large vessels, with time in the port optimized by the portainers and by handling shipments that represent most of the vessel’s cargo, in addition to the scale economies possible for this type of movement.

Unsatisfactory port performance may result from different causes, such as: (1) the port’s physical characteristics, such as access from the sea (dredging and other factors that render access difficult); land access, such as poor road conditions and restricted access to highway or railway transportation networks; and the port’s capacity, such as berth and storage area deficiencies, insufficient space for vessel operation; (2) vessel-related organizational parameters, such as old ships with narrow hatchwaysⁱⁱ, wide twin deckⁱⁱⁱ cranes for heavy volumes, remaining idle for a long time during the vessel's stopover at the port.

Goebel (2002, pp 326) offers wider vision for maritime transportation which points to new port service characteristics, ship-owner technical, market and management changes, and on port structure as well, determined by the increased use of containers as cargo units:

“...A few aspects, such as the following, can be highlighted: the evolution in transshipment operations; increased computerization resulting from the growth in scale; transportation service

offer to a larger number of places of origin and of destination; ship-owner mergers; and the offer of service packages, in addition to maritime transportation, adding value.”

The changes made to the transportation logistics in the past few decades, brought on by containers, present to specialized terminal operations a set of conditions described by Fourgeaud (2000), including all of these terminals’ operational performance, offered an idea about the complexity involved in movement activities, both of full and of empty containers.

- Relationship between shipped and unloaded containers – empty containers aren’t always included in port statistics, but they involve important movements and costs;
- Unproductive movements, i.e., handling containers that don’t have to be unloaded, but have to be moved – empty containers, lighter containers, and those that contain hazardous materials are stowed on top or on the deck;
- Portainers automation level; one of the movement cycle limit phases is the time spent positioning the spreader precisely over the container (shipment), or the container on a trailer, a MAFI trailer (specialized device used to move containers within the port’s limits) or a chassis manoeuvring on the vessel’s side (unloading);
- The more modern cranes are automated and equipped with an anti-swing device, but the issue of their of delivering or removing containers capacity without delaying the operations of unloading the containers from the vessel to the land persists;
- The average container weight and the proportion of containers that require special attention; flat racks, reefers, bulks, etc; and the container size composite: 20’; 40’ and 45’’, that require spreader manoeuvres or replacements;
- Trade restraints; many navigation lines mooring at a port may have similar trade restraints, leading to stopovers being distributed unequally.

Brazilian ports costs aspects

Exported products competitiveness may be lost or their margins eroded due to high logistics costs, considering the time factor in carrying internal transportation out due to the distances that are covered and delays in the different movement, storage, and shipment logistic stages.

Song and Yeo (2004) emphasize that modernization and the amount of equipment used will may allow efficiency, port facility enhancements, terminal exploration concession by major ship-owners, the identification and development of feeder routes, maintaining competitive fees compared to other ports, improved efficiency, among others, are tied to a port’s competitiveness.

In Brazil, and in countries that have extensive territories, the great amount of ports along their coasts, the determining factors of the exporters’ choice of a port for shipping their goods must involve the analysis of all of a port operation’s aspects, i.e., from how the legislation is applied to execute the cargo licensing processes and the other exports procedures; how the port terminals offer their services; whether the facilities to accommodate and move containers are appropriate; whether the equipment (portico cranes, forklifts, transtainers, vehicles, etc.) is sufficient and operate satisfactorily; whether the port, for its central administration or the concessionaires who are in charge of port activities, offers services on attractive costs, which, as is known, can represent important differences in the total base costs for pricing and, doubtless, determinant for the product’s margins, i.e., identifying that the operation as a whole is profitable.

4. The decision factors considered

The following set of components had been identified as decision factors for containerized cargo shippers for their choice of shipment ports: Port location; volume of cargo involved, prices and costs involved; and port infrastructure and management, as set forth below.

Port location – Deciding on the choice of this or the other port, aiming at minimizing logistics costs by optimizing transportation, handling, and international shipment activities, supposes the potential of competition among the ports to be considered. That way, comparative port advantages are grouped in two distinct groups: (1) maritime and land facilities, such as access channel and berth depth; operational costs and appropriate land access; and (2) port administration turned to the port customer; commercial performance; marketing conditions; environmental preservation activities; private partnerships; and interfaces among authorities and the society (Geipot, 2001, pp 55).

In Brazil, most of cargo is moved by trucks. Service level, costs, a huge offer and infrastructure conditions justify this fact, mainly when high value goods are considered. So, highway transportation represents the main link between regions that produce goods with value added and the ports, especially for trucks flexibility, this mode adjusts best to the land transportation alternatives for exports. The unsatisfactory railway transportation infrastructure conditions in Brazil, the structure and location of the existing railways, the impossibility to double stack containers movements made it a poor alternative for container transportation. Short sea maritime container transportation, although increasing in the last years, must still enhance its service level offer.

Volume of cargo – The shipper-ship-owner relationship present a direct impact for the amount of cargo to be shipped. Ship-owners, maritime transportation service providers will, obviously, pay attention on the demand and the regularity of the cargo offered by shippers. Cargo regularity is a factor that provides ship use balance. Also considering the volume the shipper offers, shipment regularity and the bookings, freight negotiation can establish loading priorities. To ship-owners, scale frequency regularity in certain ports complements this relationship. Ship-owners also consider cargo readiness.

The importance of the volume of cargo to ship may be considered as a decision factor regarding the shipment port for a unique user (shipper) and service providers or ship-owner relationship, since the shipper considers the economic importance of his cargo relative to the total transportation services as a condition to establish where and when his goods will be shipped or unloaded. To shippers, “larger cargo volumes reduce transportation costs thanks to the scale economies.” Some ship-owners promote their vessels’ stopovers both for shipment and for unloading. (Kumar and Hoffmann, 2002)

Price and service level – Which port activities or services can be provided and represent a good service level? In Brazil, the legal aspects involved in cargo licensing for shipment using the Integrated Foreign Trade System (SISCOMEX) and the full execution of customs dispatches must be associated to this consideration. For cargo delivery at the terminals, it is important to consider the time of delivery of containerized or yet to be containerized goods, i.e., the lead time for truck unloading and processing through the terminal’s gate, to identify the cargo or the container taking the operating system in use into account.

Considering the shipment movement and based on the containers received and positioned at the specialized terminal shipment locations, the operation may take place with the vessel’s unbalance and will obey the previously-established loading plan. Meanwhile, in public wharfs, container shipment operations are conditioned to the lead time on the side of the ship as per its loading schedule. Any and all movement generates a shipper cost, whether during receipt, unloading, cargo unitization, shipment, storage, or simple container movement.

Infrastructure and management – The number of specialized port terminals in container movement is considered in the physical infrastructure analysis. The existence of more than one terminal establishes natural competition that may increase service providing quality and, by competition, result in a possible prices charged reduction. Another aspect to take into account involves physical and technical operation

aspects based on the equipment available at each terminal. It must be noted that most specialized terminals operate with idle capacity.

The relationship among port operators with port management, with service providers, and with the Port Authorities, has a direct impact on performance. The Port Authority is responsible for fees charged at the terminals approval, influencing port prices attractiveness, an important decision factor for shippers. The joint analysis of these factors, using the Analytic Hierarchy Process method, is presented following.

5. The Analytic Hierarchy Process – AHP application

The AHP is a decision-making multiple criteria process which established a hierarchical structure for decision criteria that applied to the basic data gathered regarding the factors and the listed ports analyzed.

The AHP method can be defined as a “multi criteria decision-making approach” and was developed by Saaty (1977), who approached the decision-making problem structuring it as a hierarchy or set of integrated levels. Structuring the AHP method’s problem involves no less than three levels: the objective of the decision, the criteria to be considered, and the alternatives available. The method uses quantitative and qualitative criteria for this purpose. (Saaty, 1990)

The AHP method allows for proportioning the condition of testing and measuring criteria and sub-criteria not in an isolated manner, rather in relation to all others. This study selected in the logistics-port universe decision factors, analyzing their consistency and validity and comparing the sub-criteria two by two. The dynamic sensitivity that appears, resulting from the comparison of all criteria among each other, puts the shippers “in tune” regarding the service levels provided and their costs and, thus, the cost/benefit analyse is based on the values that are actually paid.

In this regard, this study’s methodology was composed of two non-excluding approaches:

- Research in secondary sources to obtain the defining factors theoretical base, regarding the main aspects, applied to containerized cargo export context in Brazil;
- Research of primary data used in the AHP method referred to structured interviews applied to professionals of the value added good exports sector, classified as shippers.

A structured questionnaire was elaborated to undertake the research project based on four factors or criteria used to analyze the ports under consideration. Each criterion was divided into sub-criteria for a more detailed analysis in order to offer the respondents a wider view and, at the same time, more detailed of the shipment process and of the conditions that should guide their decision insofar as the best shipment port for containerized cargo is concerned. In that sense, the factors division involved:

- **Port location** criteria included:
 - a) Distance from the hinterland;
 - b) Port access infrastructure;
 - c) Domestic transportation cost.
- **Infrastructure and management** criteria included:
 - a) Number of terminals;
 - b) Equipment and movement;
 - c) Storage facilities; and
 - d) Efficiency and management.
- **Cargo volume involved** criteria included:
 - a) Freight negotiation;
 - b) Shipment priority; and

- c) Stopover frequency.
- **Price and service level** criteria included:
 - a) Customs dispatch cost;
 - b) Movement and storage cost;
 - c) Unloading lead time; and
 - d) Service level.

The primary data field research involved two basic and concomitant stages, as follows. The first stage included the primary survey comprised by structured interviews performed using a questionnaire developed and structured to apply the Analytic Hierarchy Analysis and submitted to the shipper’s in an intentional sample (freight forwarders, NVOCCs and exporters) as their assigns or representatives, in the html format to allow the receiver to respond online.

In the second stage, the survey questionnaire was sent electrically to respondents, i.e. executives working at exporting companies listed in the national exporter reference file (<www.brazil4export.org.br> and accessed at Nov. 11, 2005); and, also, the questionnaire was made available for voluntary responses at the São Paulo Trade Association portal. However, the response level was affected by firm technical restrictions for receiving surveys via e-mail (filters, etc.)

Unfortunately, there exists in Brazilian corporations a resistance culture that leads their executives not to participate in these kinds of surveys. This fact can be explained by a mere lack of interest in participating or a profound and unjustified sense of confidentiality of the information provided.

In this sense, the sampling study was not probabilistic and, regarding the method used, it was not possible to identify the respondents. Thus, the approach adopted does not allow us to generalize the results and can be configured as a multicases study, but it can be considered to comply with the proposed application of the AHP methodology in the containerized cargo shippers’ decision regarding the shipment port. Table 2 shows questionnaire distribution.

Table 2 – Survey distribution

Companies classification per revenue/year	Messages sent with questionnaire	Messages returned (*)	Responses received
10 to 50 million US\$/year	333	146	12
Above 50 million US\$/year	136	64	10
Total	469	210	22

(*) Messages returned due the address or other technical reason

Other limitations were imposed to the study, for example, the availability of data regarding the sub-criteria, specifically highway transportation and customs dispatch costs and distance from the hinterland. Containerized cargoes highway transportation costs and the distance from hinterland involve different places of origin and the port itself, where they also can be consolidated. The customs dispatch costs are normally connected to other administrative services in the exports operation and, thus, subject to individual negotiations for each exporter. These factors, themselves, should require a research effort beyond the researchers’ resources and the time available, and could be considered for an exclusive study.

6. Results obtained applying AHP methodology

The information obtained in the structured interviews, in the responses to the online questionnaires and in the secondary sources were processed, firstly, by a basic round of one AHP methodology demo software, that, although a demo, fully accomplished to the study requirements, the information gathered and available for processing. A technical limitation the demo software imposed only allowed 20 of the 22 questionnaires to be processed.

Table 3 presents the primary survey’s processing result identifying the decision-making tree and criteria participation distribution in the shipment port choice objective criteria and of the sub-criteria in each of its criteria. Notice the “Price and service level” criteria, with 44.4% participation, revealing the importance port price and the level of services rendered by the port have for shippers when deciding the shipment port.

Table 3. Criteria and sub-criteria weights in the choice of shipment ports

Criteria	Weight	Sub-Criteria	Weight	Total
Port location	0.158	Access infrastructure	0.158	
		Highway transportation cost	0	
		Distance from the hinterland	0	0.158
Infrastructure & management	0.198	Movement equipment	0.049	
		Storage facilities	0.050	
		Efficiency and management	0.023	
		Number of terminals	0.076	0.198
Cargo volume involved	0.200	Shipment priority	0.083	
		Stopover frequency	0.063	
		Freight negotiation	0.054	0.200
Price and service level	0.444	Unload lead time	0.148	
		Service level	0.163	
		Movement and storage cost	0.133	
		Customs dispatch cost	0	0.444
		TOTAL	1.000	

The indicator values secondary data research applied to each criterion for the ports considered were incorporated in the criteria and sub-criteria considered utilizing their weights resulted from the AHP software processing, resulting in a hierarchical classification of the ports, the study’s objective. (Table 4) Table 4 shows the results that indicate the Port of Santos in the first place in the shippers’ choice for containerized cargo shipment. Note the result is not deterministic, but it is indicative of the AHP methodology application's consistency and viability. The choice of port must certainly be made based on actual situations and the AHP method itself recommends interactive rounds among the decision-makers to familiarize them with the method and with the discussion’s theme.

Table 4 – Port hierarchical classification

Classification	Port	Values
1 st	Santos – SP	0.75991
2 nd	Rio de Janeiro – RJ	0.583892

3 rd	Rio Grande – RS	0.53539
4 th	Itaguaí – RJ	0.51528
5 th	São Francisco do Sul – SC	0.49863
6 th	Paranaguá – PR	0.48861
7 th	Vitória – ES	0.384441
8 th	Itajaí - SC	0.37128

The Table 5 compares the Port ranking from hierarchical classification obtained by the AHP process and their ranking regarding TEUs 2007 movements. There are two coincidences, specifically Santos and Rio Grande ports and the bigger ranking discrepancy is related to Itajaí Port. This port locate in the South state of Santa Catarina is specialized in reefer container due to red and white meat exportations, what could explain the result. As far as this fact is concerned, the AHP process shoed itself as capable to classify the Brazilian ports considered, and a sensitivity analysis was carried out to test the results robustness.

Table 5 – Port hierarchical classification comparison

Ranking AHP	Port	Movement TEUs 2007	Ranking Movement 2007
1 st	Santos – SP	2,577,187	1 st
2 nd	Rio de Janeiro – RJ	387,809	5 th
3 rd	Rio Grande – RS	607,275	3 rd
4 th	Itaguaí – RJ	229,742	7 th
5 th	São Francisco do Sul – SC	226,806	8 th
6 th	Paranaguá – PR	598,479	4 th
7 th	Vitória – ES	267,742	6 th
8 th	Itajaí - SC	668,521	2 nd

Sensitivity Analysis

It was considered for the most important sub-criterion detected weight, “Movement and Storage Cost” (with 44.4% participation – Table 3), a higher cost to the Santos Port than to the other ones in this sub-criterion.

Santos choice can also be justified by the fact that Port on the criterion that embarks this sub-criterion, the port appears next-to-last place. Thus, in the simulation carried out, Santos Port movement and storage costs were considered above 20% Paranaguá port (which placed last in the sub-criterion). The results obtained confirm Santos port as the first hierarchical position for choice, and the first four positions remained unchanged, allowing one to conclude for the acceptability and consistency of the basic AHP round results.

7. Conclusions and Recommendations

It is concluded that the studies and analyses that were carried out allow one to state that the decision-making process regarding containerized cargo shipment port can be supported by the application of the AHP methodology that allowed the main port aspects consideration regarding the export process of value-added cargo conditioned in containers. The method contributes to a wide-ranging view of the objective and subjective aspects and allows the adjustment via weighting estimation (as in this study) or by interaction with the decision-makers, referred to shipment ports.

However, there were difficulties in having access to Brazilian exporting companies what restrict the sample used, particularly due to the restrictions to answer electronic surveys by the their professionals who are in charge of exportation, including affecting the quantity voluntary responses. Another fact to take into account, and which is not exclusive to this work, involved the restrictions the companies impose on information they classify as strategic, even though confidentiality was assured and the impossibility of individual responses being identified had been stated.

The factors identified and that were excluded in this study can be considered as subject of individual shipper negotiations. However, the range of factors that were considered includes, dynamically, the shipper analyses bases and attends to the requirements imposed by the AHP methodology and the researchers considered the project's objective achieved.

The first hierarchic position established for the Santos port in the basic round of the AHP model pointed this place as far as the operating conditions are taken into account for the “Port location” criterion, in the “Access infrastructure” sub-criterion; and “Infrastructure and management”, in the “Movement equipment,” “Storage facilities,” and “Number of terminals” sub-criteria. The Rio Grande port takes the highlight in the “Efficiency and management” sub-criterion, the Rio de Janeiro port in the “Service level” sub-criterion; the São Francisco do Sul port in “Unloading lead time;” and the Sepetiba port in “Movement and storage cost.”

It is important to note that the sensitivity analysis when carried out, assuming the Santos port with the highest cost among those analyzed; it maintained its hierarchical first-place position.

The limitations that were run-on to recommend this type of study and the managerial view are extended to international logistic activities in order to enhance knowledge regarding a sector that is undergoing profound institutional and managerial changes and is remarkable in its importance for national economies, as far as for ports to gain region development.

As a result, the study aimed at contributing to advancing academic research in the maritime transportation sector in Brazil and to a better understanding of the role this mode has in exports logistics for high value added products, assisting the national effort for a more significant role among the countries for foreign trade, a dynamic element of the developing countries economies.

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