ISSN: 2047 - 0398
SPECIAL ISSUE – VII|4|N|12| May | 2015

METHODOLOGY FOR ASSESSMENT OF INTERMODAL TERMINALS MANAGEMENT OF SOLID BRAZILIAN BULK

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ABSTRACT

The main objective of this work is to propose a model of assessment of attractiveness to intermodal terminals of grain. This objective was achieved through the literature review and the survey of relevant variables for determining the attractiveness. Later, with the tool of the AHP method, were set the weights of each variable. As a result, was presented a model of attractiveness of intermodal terminals through a Global Indicator of Attractiveness-IGA, whose variables are: operating capacity, storage capacity, infrastructure, access and integration, and services offered operating time. In order to evaluate the applicability of IGA in the case study, the value of IGA was calculated for 32 intermodal terminals. The terminals of the South and Southeast Regions showed the best results in relation to the IGA values of all 32 terminals studied. This shows the difference between the infrastructure corridors of runoff of agricultural products in Brazil.

Keywords: *Transport; Intermodal Terminals; Transportation of grains; Attractiveness Indicator.*

1. INTRODUCTION

The agribusiness includes the productive chain, from field to consumer, and it is one of the Brazilian economy engines, responding to about 23% of the national Gross National Production (PIB) and one third of the jobs (IBGE, 2012). According to data published by the Ministry of Agriculture, Livestock and Food Supply (MAPA, 2011) the farming production represented 36.9% of exports, in 2011, with $ 94.59 million of the $ 256.041 million exported by Brazil, finishing 2011 with a positive balance of $ 77.5 in trade balance.

However, despite the impressive figures, the Brazilian agribusiness stumbles in deficiencies found in the transport and communication infrastructure. The high logistics costs represent one of the main constraints to the growth of the regional and Brazilian economy. Here, costs are higher making production less profitable for the producer and causing loss of competitiveness.

The large expanse of the Brazilian territory and the internalization of production makes the distances to be traversed by the production for export until seaports are increasing, reaching more than 2,000 km. However, despite being the least suitable for distances of this magnitude, the road mode prevails as the main means of transport used for agribusiness logistics. This causes heavy losses and makes the transportation system one of the main bottlenecks for the development of the sector and as a result to the country's economy.

The transshipment terminals and intermodal terminals are located where the transport modes converge. These components of the logistical system sometimes portray themselves as attractive to a given logistical corridor, offering services or by storing the cargo. However, the opposite can also occur, the intermodal terminal becomes an obstacle on the route, shifting the burden to another corridor, and can even change the destination port. This choice between routes, the competition between the modes is highlighted and customer satisfaction with the logistics services provided at the points of transshipment may be decisive.

Thus, intermodal transshipment terminals need to be prepared to respond to the demand resulting from the scenario above, strengthening Brazilian competitiveness, ensuring growth and development for the country. The terminals must be suitable to meet the criteria of operational performance, deadlines, reliability, flexibility, cost and quality.

According to Calarge (2010) the terminals are somewhat effective, because they operate within the reality of the sector that has many bottlenecks within the modal, and according to customer segmentation that prioritizes volume and continuity of operation during the year. Customers often use inter-modality, but aren't satisfied with the services paid by operators. According to Colares-Santos (2012) the terminals feature as weaknesses the fulfillment of marketing dimensions "Product" and "Price"; and as a strong point to dimension "Square" (location), which denotes the need for investments in its infrastructure, as well as reworking the pricing strategies. According to these authors, the terminals need to operate with greater effectiveness, marketing aimed at customer satisfaction and their attractiveness.

In this work the concern is in reuniting some of these parameters in an indicator which expresses the level of attractiveness of the terminal. The logistical system client opts for a terminal not assessing only one aspect; their evaluation is always based on the set. Counting on the possibility that pointed to by Garver (2003, apud Colares-Santos, 2012) that customers tend to find it very important, prioritization of an aspect is not always easy. Therefore, this work is justified by the intention to unify the most relevant aspects for the attractiveness of a terminal, quantify them and group them in a global indicator.

Given the great potential of Brazilian agribusiness and the fact the Brazilian logistics infrastructure be one of the major bottlenecks for its expansion, analyzing the attractiveness of grain logistics terminals was the choice for this study guidance.

In this sense, the main purpose of this work is to propose a model for evaluating the attractiveness of intermodal terminals of grain.

2. THEORETICAL REFERENCE

Since transportation is part of logistics, the choice of the most suitable means of transport is part of the logistics management. In the transport system, mainly in the agribusiness sector, the three modes of transport to be considered are: rail, road and waterways.

One must also consider the combination of more than one mode of transport, in order to optimize costs and transport time. Hence, the inter-modality arises, regarded as a facilitator of import and export, since it takes advantage of what each transport modal has to better, to reduce costs and increase the level of service (BERTAGLIA, apud SANTOS 2005, 2012).

It is also important to have it clear the conceptual difference of inter-modality and multimodality. The two terms refer to transport action using two or more modes of transport, though each has its peculiarity.

Multimodal Transport of Cargos is one that, governed by a single contract, uses two or more modes of transport, from the origin to the destination, and runs under the sole responsibility of a Multimodal Transport Operator. However, some obstacles in Brazilian Law, mainly on tax issue, hinder the increase of this mode (ANTT, 2012).

But the intermodal transport also consists of the combination of more than one transport modal, but uses different contracts, unilaterally, with different companies responsible for cargo transport. In addition, document accompanying the cargo, the so-called bill of lading, is different for each modal transport used.

ISSN: 2047 - 0398
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Integration between modes through intermodal terminal is made both on inter-modality and multimodality.

2.1. Intermodal terminals

According to Rodrigues et al. (2009) terminal is any location from where the cargo and/or passengers originate, where they are intended or where cargos are handled during the transport process. The terminals are central and intermediate points in the movement of passengers and freight can be exchange points within the same modal system and ensuring the continuity of flows, in addition to being in very important points of transfer between modes.

Cargo terminals perform the following functions, according to Ballou (2006): reduce the productive market fluctuations or variation of supply and demand; reduce the cost of transport, shifting greater amounts in lots of loading; and achieve faster deliveries, by consolidating or dividing cargos.

According to Maas (2001) "intermodal terminal system" is inserted into a broader system (the transportation system, for example) and has a set of subsystems, in the example of a road terminal part the road mode "subsystem, the subsystem" rail mode and the "drive and storage subsystem" (or interface), among others, as illustrated in Figure 1.

3. SYSTEMS IN INTERMODAL TERMINALS

For the achievement of objectives is necessary a revision of the concepts of systems of indicators and also a survey of studies on performance evaluation, efficiency, marketing effectiveness, client satisfaction and attractiveness of the terminal, finally, studies that defined indicators for logistic terminals.

3.1. Concept and Function

According to Bowersox et al. (2007) a system of indicators should assist in performance measurement and control, and point out the best direction for improving the performance of the operation of a system. Knowing this, it is concluded that a system of indicators is a tool used to measure, control, the performance.

Lima (2005) defines a system of performance indicators as a set of integrated measures on several levels (organization, processes and people), defined from the strategy and objectives of the business unit, aiming to provide relevant information to persons responsible for decision making on the performance of products and processes, to assist in the decision-making process.

In these two concepts there is the focus on performance, whose definition is: degree to which a physical or economic system, reaches their goals. Such a concept is usually connected to physical systems efficiency and effectiveness of economic systems (MALIK and LAUGENI, apud 2005 COSTA, 2002).

In addition to this definition, several studies in the area of transport indicate four performance dimensions: efficiency, which is the degree to which a system uses inputs in the processing of its products or services; effectiveness, that is the degree to which a system achieves its goals and objectives; productivity is the relationship between outputs (products or services) and input (inputs) in a productive system; and quality which is defined as fitness for use, i.e., the level of satisfaction of a particular product in meeting the goals of users during their use (JURAN, 1993 apud SANTOS, 2007).

Thus, as Razzolini (2000, apud SIGOLI 2001) although they are not an end in themselves, performance measures are critical to allow one to determine a strategic competitive positioning. At this point, before the comparison between companies, because a competitive positioning depends on not only a company, but the market consisting of several companies in the same business.

Therefore, the existence of a company is conditional to an advantage it has over its competitors. If an organization operates at a disadvantage in any particular market sector, probably will operate with higher costs and will be a matter of time until it is crushed by their rivals (HANDERSON, 1998 apud SHIRO, 2011).

There is then a direct relationship involving a company's performance and its competitiveness on the market. The quality, cited as one of the dimensions of performance involves directly the client, being one of the determining factors, along with the price at the time the customer choose the company.

The definition of that system of performance indicators is not a simple process, has to follow a methodology for implementation which depends on the company and the branch of activity. That is because despite the importance of the measures within an organization, it must be sure that measures alone cannot provide sufficient information for decision-making (LIMA, 2005).

A model proposed by Sproesser (1999, apud COLARES-SANTOS, 2012; SOGABE, 2010 and CALARGE, 2010) proposes performance analysis of multidimensional way. Figure 2 shows the performance measurement methodology encompassing the three suggested dimensions: efficiency, equity and effectiveness; and their sub-dimensions.

According to Calarge (2010) in this model the efficiency dimension is a quantitative approach of the company's performance. It is represented by results of inputs and outputs of profitability and productivity. But the equality dimension seeks to demonstrate if all clients are being met, if the demand is met by the products of the company and is therefore a significant means to public or mixed economy companies, whose principle is serving everyone.

The efficiency dimension, treated in this model, is associated with intangible aspects related to customer perception, i.e. tries to reproduce the view of the customer, their satisfaction and expectations. In this dimension, the distribution variables, stimulation and adaptation are linked to issues related to the product, price, place/distribution and promotion (COLARES-SANTOS, 2012), as follows:

a) distribution: is related to aspects of accessibility to services, points of sales, logistics, among other factors;
b) stimulation: is linked to factors of product promotion, price, among other forms of marketing; and
c) adaptation: binds to the development of new products, new technologies and infrastructure from the point of view of customers and operators of intermodal terminals.

In this work the approach regarding the performance has emphasis on aspects of effectiveness, because the attractiveness of the terminal is linked directly to the customer perception with respect to this product and its expectations. However other aspects do not cease to be observed.

4. METHODOLOGY

This study employed the exploratory/inductive research with a quantitative approach, whose strategy is a multi-case study. In order to provide an overview of the infrastructure and operational capacity supported by the analysis of 32 intermodal terminals, being that the research base. The work was divided into steps, represented in Figure 2:

5. MODELING FOR THE ASSESSMENT OF ATTRACTIVENESS

In order to create an assessment indicator, firstly variables and data to be measured must be established.

5.1. Selection of variables

In order to check the variables, first 15 attributes were defined and ranked by Colares-Santos (2012) as the market attributes of customer satisfaction. As this universe of attributes is the result of a survey conducted with 54 32 clients intermodal terminals (sample of case study of this work), it is considered that, in relation to customers, the variables chosen have already been validated. From this universe and based on other studies presented, experts in transportation and logistics were interviewed. The number of respondents was determined by convenience and their availability, as this was not the only parameter for selection and the opinion was nearly unanimous, was deemed sufficient. Another criterion used in the definition of the variables was the accessibility to information for later validation of the proposed method through the case study.

Thus, it was possible to identify 6 relevant variables to compose the attractiveness of an intermodal terminal of grain.

Thus, the overall indicator of attractiveness is mathematical model which has variables: the operational capacity, storage capacity, infrastructure, access and integration, and services offered operating time. It is important to note that the proposed attractiveness indicator does not include the financial aspects of the sector. Set forth below is the description of each selected variable:

a) Variable 1: Operational Capacity (CO) – It is the result of various components; reception capacity, operational capacity of each equipment and also involves the efficiency of workers. The installed capacity of reception or landing is determined according to the balance operational capability, the tumblers and the weigh hoppers and also depends on how many equipment are used, present in the terminal. In this study, the operational capacity will be treated according to equation (1), because the capacity of reception is directly linked to the installed equipment, which will be assessed in another variable.

$$CO = \text{Operational capacity of shipment (ton/hour)} \quad (1)$$

b) Variable 2: Capacity Storage (CA) – The Brazilian agribusiness sector is very deficient in structures only dedicated to storage, therefore structures of terminals which work also as warehouses has become common, which is seen positive by the producers, because it eases the problem of lack of warehouse. For this variable, there is an equation (2).

$$CA = \text{Static capacity installed of storage (ton)} \quad (2)$$

c) Variable 3: Infrastructure (IE) – The number of terminal equipment directly affects their operational capacity, however the correct sizing of the infrastructure according to the demand of operation is also essential. To the client, the impression caused by a large number of equipment available is positive, generating a good expectation compared to service that will be offered. In this study, the variable will be as equation (3).

$$IE = \text{Nº metallic boxes of shipment} + \text{Nº of segregation cells} + \text{Nº de tumblers} + \text{Nº de weigh hoppers} + \text{Nº de scales} \quad (3)$$

d) Variable 4: Access and Integration (AI) – For a terminal to exercise its function and be called intermodal, there must be at least two modal integration. Therefore, intermodality aspect is a fundamental part to assess the attractiveness of a terminal. This variable will be defined by the characteristic of the intermodal operation, that is, identifying if the terminal has rail, road waterways, waterway or road-rail-waterway intermodality.

e) Variable 5: Operation time (TO) – The time is counted from the entrance to the exit of the vehicle, including time of analysis and release of cargo, unloading of the cargo and vehicle output, normally done in the procedure of cargo reception. But the waiting time for the release of the documentation is characteristic of the dispatch procedure. Despite of happen in different stages, the variable time of operation, is defined by the sum between them, according to the equation (4), as below.

$$TO = \text{Average time of reception} + \text{Average time to wait for the documentation release} \quad (4)$$

f) Variable 6: Services offered (SO) – When it comes to attractiveness of a terminal, the provision of these services is also an important variable to be evaluated. By offering other services, the terminal can offer advantages in relation to the price of such services, because of large volume of grain moved. The most frequent are: pre-cleaning, transshipment, storage, customs services, purge, cleaning, drying and segregation. In the study of Colares-Santos (2012), the factor "variety of products/services" is one of which features highest dissatisfaction among customers. Here the equation in use (5).

$$SO = \text{Number of services offered in the terminal} \quad (5)$$

5.2. Variables´ Validation and Hierarchy

Once defined the indicators, it is necessary to know their weight in the assessment of attractiveness of the terminal. Through interviews with 10 actors involved in the logistics industry, among them two terminal managers, three subject matter experts, four researchers from academia and a users´ representative, the definition and validation of the weights of each variable were done with the aid of the AHP Analytic Hierarchy Process method. As the interviews were made with only ten respondents, appropriate statistical treatment to analyze the discrepancy of opinions could not be done, however the method includes the calculation of the rate of inconsistency which ensures the consistency of reviews in the absence of major distortions in the final equation.

5.2.1. Modeling application

After the selection of the AHP method for assigning weights to the indicators that make up the Global Indicator of Attractiveness of Intermodal Terminals of Grain, the software Expert Choice was chosen as computing tool to help carry out the steps involving data processing method. The Expert Choice is a computational tool that uses the AHP method in its operating system which is easy to be understood by the user and presents the results amicably and quickly. In addition, the fact of being a software fairly used by academia contributed for being selected.

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In applying this method, the following steps were taken:

1) Questionnaire development, comprising the following steps: hierarchical structuring and joint comparison of indicators based on the numerical scale of comparison proposed by Saaty (1991);
2) Questionnaire application by means of interviews taken personally and individually with tem professional: a users´ representative, two terminal managers, three subject matter experts and four researchers from academia;
3) Processing of data obtained in the questionnaires by Expert Choice software, analysis of the consistency of each rate array generated by each questionnaire applied, and the consistency of the result array rate and;
4) Analysis and presentation of the results generated

While interviewing the experts, the objective of the study was presented and the chosen rate were validated by all respondents.

5.2.2. Presentation of the Results
Following in the footsteps of the method, the used software presented the following results (Figure 4).

The inconsistency, reason of consistency (RC), obtained was 0.07, below the maximum that is 0.10 for more than 4 criteria according to the AHP method, so the result is consistent and can be used without adjustment. After the results, there is the equation (6) representing the global indicator of attractiveness.

$$IGA = 0.155 * CO + 0.100 * CA + 0.300 * IE + 0.173 * AI + 0.185 * TO + 0.088 * SO \quad (6)$$

Where: IGA= Global Indicator of Attractiveness
CO= Operational Capacity
CA= Storage Capacity
IE= Infrastructure
AI= Access and Integration
TO= Operation Time
SO= Offered Services

From this equation it is possible to observe how the criteria or variables contribute to the attractiveness. The constants of each variable represent the sensitivity of the indicator to each attribute. The graph in Figure 5 shows visually how each attribute represents, in this case, for example, the infrastructure, the most representative, its weight, indicates its importance reflected in 30% on attractiveness of the terminal.

6. APPLICATION IN A CASE STUDY

The goal of the case study is to assess the applicability of the model using the global indicator of attractiveness-IGA. For doing this, the IGA will be calculated for 32 intermodal terminals throughout the Brazilian territory.

Primary data collection was conducted along the 32 managers of intermodal terminals, located along the five national logistics corridors. Some port terminals were included in the sample of the survey, so the term waterways may refer to both accesses by interior waterways as by sea.

In Table 1 each terminal location searched are arranged. In order to preserve the identity of the companies, numbering of 1 to 32 was used, followed by the acronym in the region where it is located the terminal.

For this case study were needed the following data:

- Features if intermodal operations;
- Services offered in the terminal;
- Amount of grains moved over the last 12 months;
- Average time of attendance of a truck-(analysis and release of cargo, unloading of the cargo and vehicle output);
- Average time to wait for the documentation release
- Installed capacity of reception – landing (nominal);
- Static capacity (installed) of storage;
- Number of segregation cell (silos, warehouses etc.);
- Number of scales;
- Number of tumblers;

ISSN: 2047 - 0398
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- Number of weigh hoppers and;
- Number of metallic boxes of shipment.

The criterion adopted for classifying the terminal was the flow of goods in direction to the final consumer. For example, if the flow of transshipment terminal is greater from road to rail modal, this terminal was considered a roadrail one; if the flow is the inverse, this was considered railroad (SANTOS, 2012).

In Table 2 is presented the amount of terminals per intermodal combination type in the current sample.

7. INDICATOR OF GLOBAL ATTRACTIVENESS OF EACH TERMINAL

Using the data, the global indicator of attractiveness can be calculated for each terminal, through the equation (6) already commented previously.

For each variable of the equation presenting a value of the same order of magnitude, it was observed the need to transform the raw data of the variables in rates, grades. The use of three integer values for the grades was defined in order to accommodate all 6 variables. As in the variable "number of ways met" there are only 3 entry options, keeping the default was the choice. Thus, by the mathematical method of tercil, which divides the data sorted into three subsets of dimension data essentially equal, Table 3 which lists the ranges of values of each variable with a note which can be 1, 2 or 3 was elaborated.

Table 4 lists the terminals, the values of variables and the note received by each variable.

From table 4, the IGA equation of each terminal can be extracted. The equation 7, exemplifies the equation of terminal 14S, selected randomly, from which that IGA of the terminal 14S is 2.269.

$$IGA_{14S} = 0{,}155 * 3 + 0{,}100 * 1 + 0{,}300 * 3 + 0{,}173 * 2 + 0{,}185 * 2 + 0{,}088 * 1 \qquad (7)$$

Applying the same process for all 32 terminals, the connection of terminals and their indicators of attractiveness, in descending order, as evidenced in table 5, is reached.

The global indicator of attractiveness presented values between 2.815 and 1.174, the average of the values was 2,000 and the median was 2,011, showing that the dispersion of the values was low. To complete the analysis, a comparison was made with the results of Santos (2012) who studied the operational efficiency of intermodal terminals Brazilian grain logistics chain using the same sample of 32 terminals. Table 6 presents efficiency values determined by Santos (2012) and the calculated values of attractiveness, IGA, for the sample.

It is observed that only eight terminals are efficient (2S, 13S, 21SE, 23SE, 26SE, 2CO, 4CO and 8CO), according to Santos (2012). Table 7 brings the values of IGA and the classification as the IGA ranking of these eight terminals.

The eight efficient terminals according to Santos (2012) occupy several positions in the ranking. Also, it is interesting to note the presence of the terminal 2CO between the efficient terminals, since this is what has the smallest in IGA, between terminals searched.

With the data efficiency from Santos (2012) and the IGA values of all terminals (Table 6), a correlation of 0.02 was calculated, so able to conclude that there is no relationship between the efficiency determined by Santos (2012) and the indicator of attractiveness proposed for this work, the IGA.

8. CONCLUSION

This research complies with its main objective to propose a measure of attractiveness of intermodal terminals by means of an indicator. It is important to note that the proposed indicator is an indicator of performance, is an indicator of attractiveness, that is, a parameter that guides the choice/decision for the user or terminal client. For developing this indicator, therefore, the variables seen as important in the bibliographical references were applied as priorities and weighs established aiming the terminal attractiveness.

All the specific objectives of the work were also achieved. The characterization of the intermodal terminal of grain took place with the definition of the concept and functions and with the detailing of its main features and physical structure.

In the case study, the description of the 32 grain terminals in the country in relation to the volume handled annually and after the description for each variable used in the indicator was important to characterize the group of terminals and to analyze the results obtained with the IGA calculation of each terminal.

In general, the terminals of the South and Southeast regions showed the best results in relation to the IGA values of all 32 terminals studied. This shows the difference between the infrastructure corridors of runoff of agricultural products in Brazil. The increased use of these regions to access to seaports during the last decades, resulted in larger investments in logistics infrastructures, therefore in more attractive intermodal terminals.

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Appendix

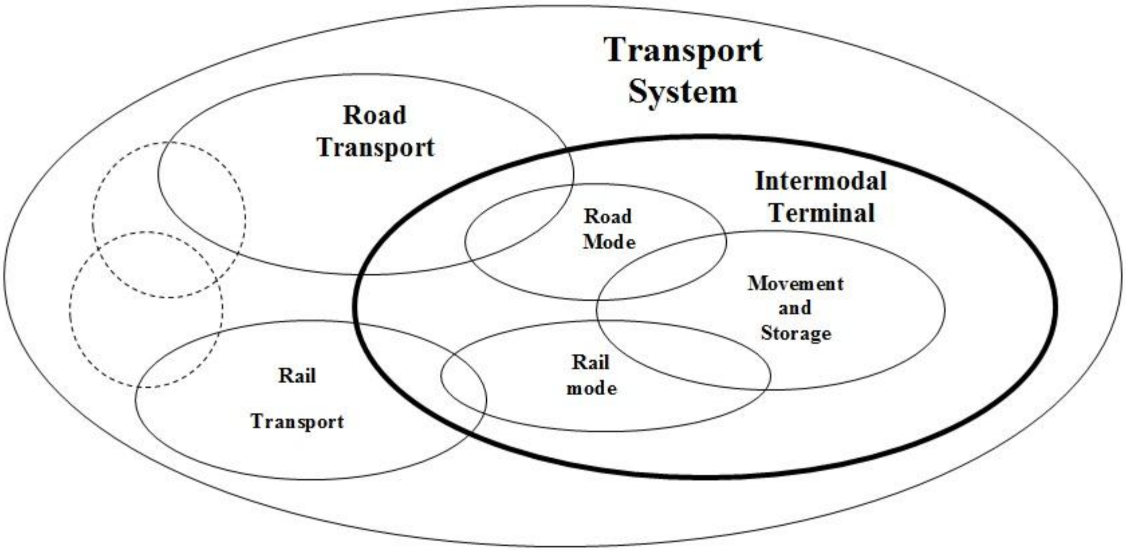

Figure 1 – Vision of the Transport System and its subsystems with emphasis on roadrail intermodal terminal

Source: MAAS (2001).

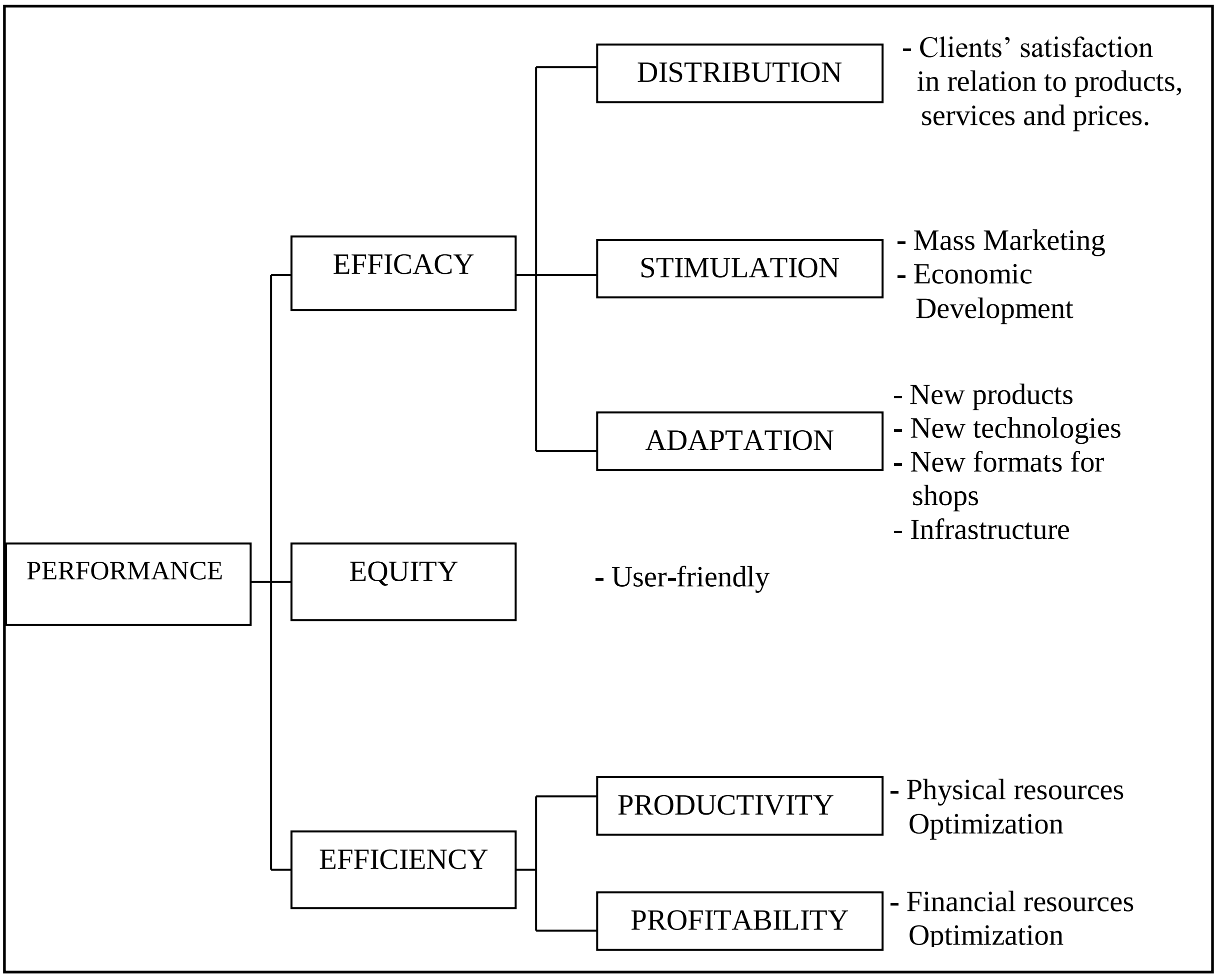

Figure 2 – Model of Performance Analysis
Source: Adapted from Colares-Santos (2012) and Sogabe (2012).

 ISSN: 2047 - 0398
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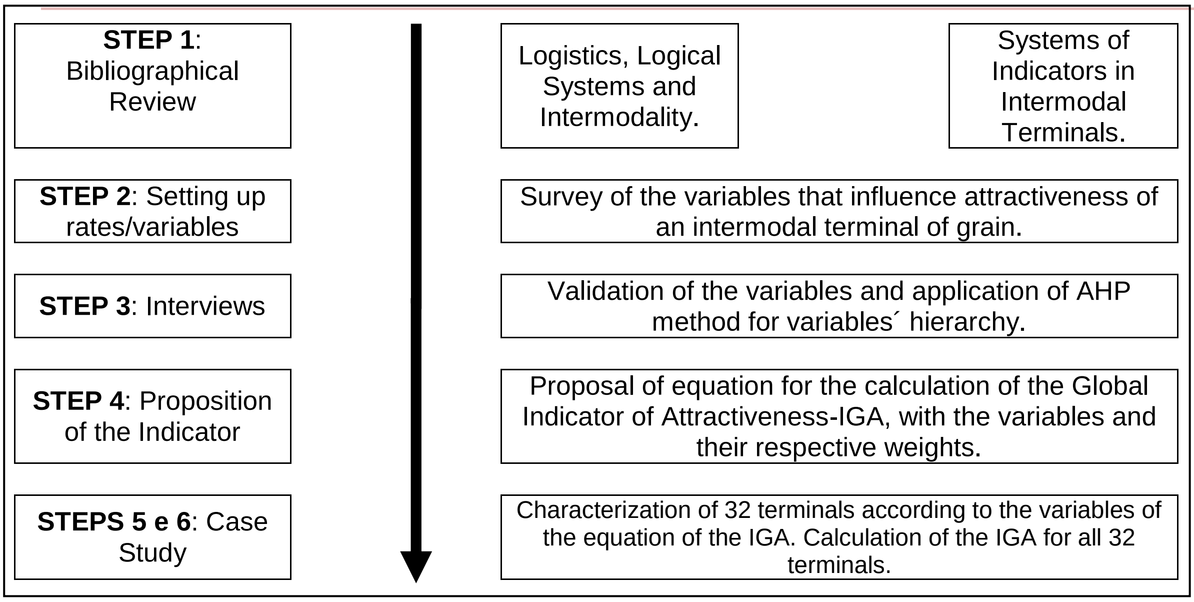

Figure 3 – Scope of the methodology adopted in the work

Source: Elaborated by the authors, 2014.

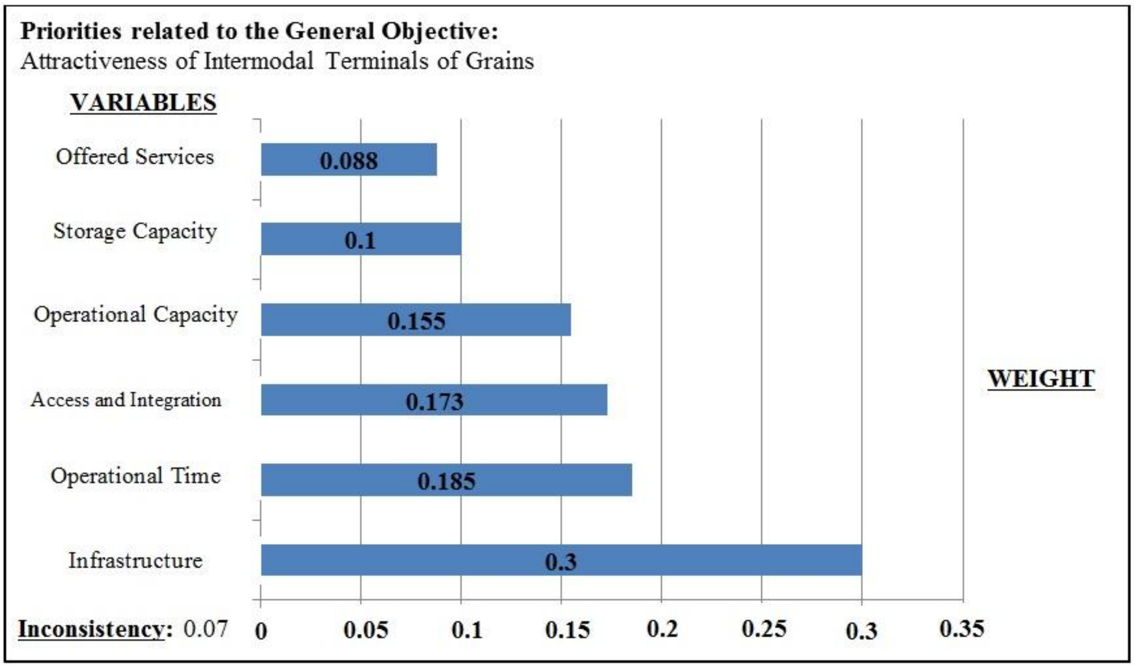

Figure 4 – Criteria/Attributes which compound the Global Indicator of Attractiveness and its weights

Source: Elaborated by the authors, 2014.

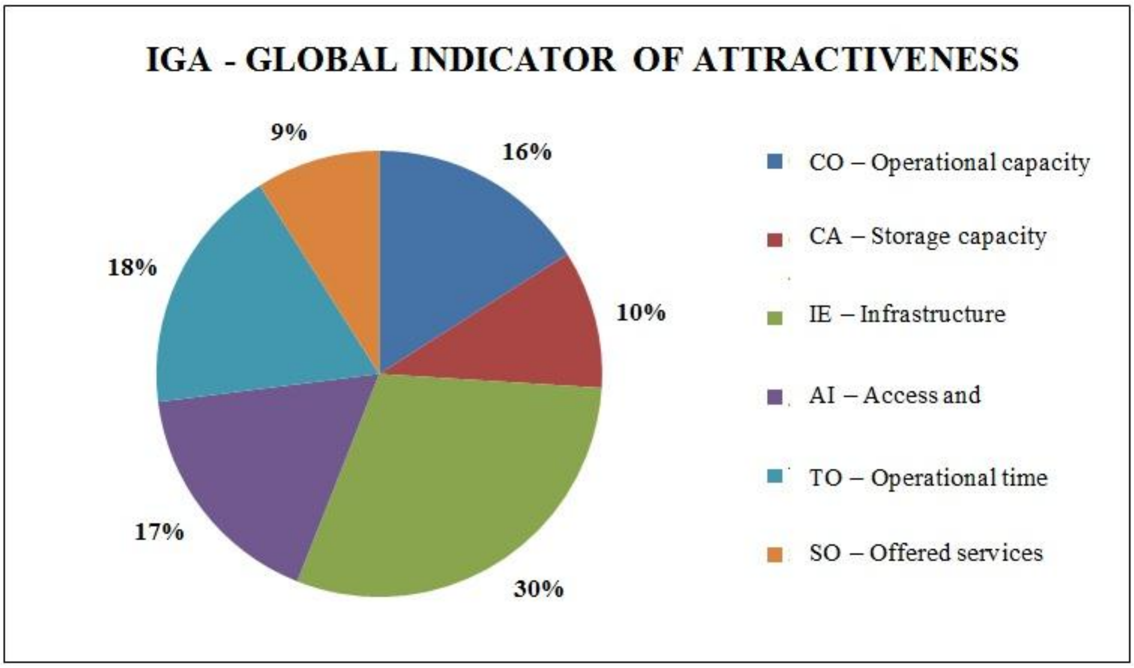

Figure 5 – Graph of the representative of each variable about the IGA

Source: Elaborated by the authors, 2014.

Table 1 – Localization of the terminals surveyed

Terminal	City	State	Terminal	City	State	Terminal	City	State	Terminal	City	State
1 CO	Cáceres	MT	9 S	Rio Grande	RS	17 NE	Porto Franco	MA	25 SE	Araguari	MG
2 CO	Cáceres	MT	10 S	Estrela	RS	18 NE	Porto Franco	MA	26 SE	Vitória	ES
3 CO	Alto Taquari	MT	11 S	Guarapuava	PR	19 NE	São Luís	MA	27 SE	Pederneiras	SP
4 CO	Alto Araguaia	MT	12 S	São Francisco do Sul	SC	20 NE	Salvador	BA	28 SE	Sumaré	SP
5 CO	Campo Grande	MS	13 S	Paranaguá	PR	21 SE	Uberlândia	MG	29 SE	Uberlândia	MG
6 CO	São Simão	GO	14 S	Paranaguá	PR	22 SE	Uberaba	MG	30 N	Porto Velho	RO
7 CO	São Simão	GO	15 S	Passo Fundo	RS	23 SE	Uberlândia	MG	31 N	Porto Nacional	TO
8 CO	Maracajú	MS	16 NE	Porto Franco	MA	24 SE	Uberaba	MG	32 N	Porto Nacional	TO

Source: Elaborated by the authors, 2014.

Table 2 – Amount of terminals per type of modal combination

Intermodal Combination	Number of Terminals
Roadrail	16
Roadwaters	6
Roadrailwaters	4
Railroad	2
Road-road	2
Railwaters	1

Source: Elaborated by the authors, 2014.

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Table 3 – Grades assigned to each interval of the variables of the attractiveness indicator

Variable	Unit of Measure	GRADES		
		1	2	3
Operational Capacity	tonnes/ hour	below 280	between 280 and 720	above 720
Storage Capacity	tonnes	below 25.000	between 25.000 and 105.000	above 105.000
Infrastructure	nº of equipment	below 11	between 11 and 19	above 19
Access and Integration	nº of transportation modes attended	meet 1 mode	meet 2 modes	above 3 modos
Operational Time	minutes	above 250	between 250 and 40	below 40
Offered Services	nº of offered services	below 5	between 5 and 6	above 6

Source: Elaborated by the authors, 2014.

Table 4 – Data and grades of each variable of the indicator per terminal

	Operational Capacity of expedition		Static Capacity of Storage		INFRASTRUCTURE		Access and Integration		Operational Time		Offered Serviços	
Terminals	Tonnes/ hour	Grade	Tonnes	Grade	Amount of equipment	Grade	Type of integration	Grade	Total in minutes	Grade	Quantity	Grade
1 CO	500	2	10000	1	6	1	Roadrail	2	400	1	2	1
2 CO	250	1	2700	1	5	1	Roadwaters	2	360	1	2	1
3 CO	700	2	24000	1	11	2	Roadwaters	2	545	1	4	1
4 CO	1140	3	37000	2	16	2	Roadwaters	2	230	2	2	1
5 CO	150	1	47900	2	35	3	Roadwaters	2	320	1	6	2
6 CO	450	2	97700	2	20	3	Roadwaters	2	260	1	8	3
7 CO	450	2	14000	1	8	1	Roadwaters	2	540	1	7	3
8 CO	80	1	16000	1	16	2	Roadrail	2	35	3	6	2
9 S	3750	3	502000	3	39	3	Roadrailwaters	3	240	2	5	2
10 S	900	3	38000	2	51	3	Roadrailwaters	3	35	3	6	2
11 S	400	2	60000	2	39	3	Roadrail	2	40	2	8	3
12 S	3000	3	115000	3	13	2	Roadrailwaters	3	20	3	2	1
13 S	135	1	50000	2	21	3	Railroad	2	45	2	2	1
14 S	2500	3	148	1	78	3	Roadrail	2	144	2	3	1
15 S	500	2	250000	3	66	3	Roadrail	2	75	2	8	3
16 NE	700	2	9300	1	7	1	Roadrail	2	445	1	2	1
17 NE	750	3	6000	1	7	1	Roadrail	2	30	3	6	2
18 NE	300	2	60000	2	8	1	Roadrail	2	480	1	7	3
19 NE	3500	3	187000	3	15	2	Roadrailwaters	3	370	1	5	2
20 NE	2000	3	240000	3	16	2	Roadwaters	2	195	2	3	1
21 SE	200	1	244000	3	60	3	Roadrail	2	30	3	6	2
22 SE	90	1	130000	3	11	2	Roadrail	2	1455	1	6	2
23 SE	240	1	96000	2	17	2	Roadrail	2	140	2	8	3
24 SE	90	1	23500	1	19	2	Roadrail	2	40	2	10	3
25 SE	380	2	100000	2	18	2	Roadrail	2	35	3	2	1
26 SE	600	2	420000	3	25	3	Railwaters	2	0	3	4	1
27 SE	500	2	60000	2	11	2	Watersrail	2	8	3	4	1
28 SE	350	2	405000	3	41	3	Railroad	2	30	3	5	2
29 SE	200	1	150000	3	18	2	Roadrail	2	80	2	6	2
30 N	1000	3	40000	2	13	2	Roadwaters	2	390	1	4	1
31 N	240	1	8	1	6	1	road-road	1	37	3	3	1
32 N	180	1	30	1	5	1	road-road	1	75	2	4	1

Source: Elaborated by the authors, 2014.

Table 5 – Global Indicator of Attractiveness of each terminal researched

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Classification	Terminals	IGA	Classification	Terminals	IGA	Classification	Terminals	IGA	Classification	Terminals	IGA
1	10 S	2,815	9	14 S	2,269	17	5 CO	1,962	25	3 CO	1,629
2	9 S	2,73	10	19 NE	2,245	18	29 SE	1,947	26	18 NE	1,605
3	28 SE	2,587	11	6 CO	2,205	19	17 NE	1,942	27	7 CO	1,505
4	12 S	2,527	12	20 NE	2,169	20	23 SE	1,935	28	31 N	1,371
5	26 SE	2,499	13	25 SE	2,099	21	8 CO	1,932	29	1 CO	1,329
6	15 S	2,49	14	27 SE	2,099	22	30 N	1,884	30	16 NE	1,329
7	21 SE	2,432	15	4 CO	2,069	23	24 SE	1,835	31	32 N	1,186
8	11 S	2,39	16	13 S	2,059	24	22 SE	1,762	32	2 CO	1,174

Source: Elaborated by the authors, 2014.

Table 6 – Efficiency values (SANTOS, 2012) and IGA

Terminal	Efficiency (SANTOS, 2012)	IGA	Terminal	Efficiency (SANTOS, 2012)	IGA	Terminal	Efficiency (SANTOS, 2012)	IGA	Terminal	Efficiency (SANTOS, 2012)	IGA
21 SE	100,00%	2,432	1 CO	83,50%	1,329	25 SE	34,30%	2,099	10 S	10,70%	2,815
23 SE	100,00%	1,935	9 S	72,40%	2,73	24 SE	33,00%	1,835	15 S	10,20%	2,49
26 SE	100,00%	2,499	3 CO	59,70%	1,629	32 N	27,40%	1,186	5 CO	9,40%	1,962
2 CO	100,00%	1,174	30 N	51,60%	1,884	14 S	25,80%	2,269	7 CO	7,30%	1,505
4 CO	100,00%	2,069	29 SE	44,30%	1,947	6 CO	21,80%	2,205	17 NE	6,50%	1,942
8 CO	100,00%	1,932	19 NE	40,40%	2,245	20 NE	20,60%	2,169	11 S	4,30%	2,39
12 S	100,00%	2,527	22 SE	39,60%	1,762	27 SE	12,30%	2,099	28 SE	3,20%	2,587
13 S	100,00%	2,059	18 NE	38,60%	1,605	16 NE	11,10%	1,329	31 N	2,60%	1,371

Source: Elaborated by the authors, 2014.

Table 7 – IGA and the classification in IGA range of the efficient terminals by Santos (2012)

Efficient Terminal	IGA	Classification
12 S	2,527	4
26 SE	2,499	5
21 SE	2,432	7
4 CO	2,069	15
13 S	2,059	16
23 SE	1,935	20
8 CO	1,932	21
2 CO	1,174	32

Source: Elaborated by the authors, 2014.