



Port of Santos: prospection on the causes of access difficulties

Porto de Santos: prospecção sobre as causas das dificuldades de acesso

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Abstract: The port of Santos - the biggest in Latin America - is the main inbound and outbound gateway to the movement of merchandise in Brazil. Nowadays, due to the Brazilian economic growth, the port of Santos is expanding its capacity, with plans until 2024. In 2012 and 2013, the difficulties of access to the port of Santos were amply highlighted by the press. A holistic view of this scenario and the various causes of the difficulties of access to the port can contribute to a better understanding of the problem and its possible solutions. This paper investigates the causes of the problems related to the accesses to the port of Santos; the ongoing actions; and the foresight projects to adequate these accesses to the expansion of flow capacity. To this end, secondary data obtained from CODESP - the port management office, on-site observations, and interviews with business managers of some of the port main companies were used. The data collected allowed the identification of four groups of problems arising not only from structural causes, but also from the lack of efficiency in the port processes. The classification presented contributes to facilitate the understanding of the problem by the managers of these processes and represents the initial basis for building a theoretical model for the development of new research on the subject.

Keywords: Port of Santos; Port logistics; Logistical accesses.

Resumo: O Porto de Santos, maior porto da América Latina, é a porta de entrada e saída de grande parte das mercadorias que circulam pelo Brasil. Atualmente, com o crescimento econômico de que desfruta o País o porto passa por obras de expansão de sua capacidade, com planos até o ano de 2024. Nos anos de 2012 e 2013, as dificuldades de acesso ao Porto de Santos tiveram amplo destaque na imprensa. Uma visão holística desse cenário e das diversas causas das dificuldades de acesso ao porto pode contribuir para o melhor entendimento do problema e de suas possíveis soluções. Este trabalho tem como objetivo principal investigar quais as causas das dificuldades de acesso ao Porto de Santos e, como objetivo secundário, identificar quais as ações em andamento e quais os projetos previstos para adequar esses acessos à expansão da capacidade de movimentação do porto. Para tanto, foram analisados dados secundários obtidos no site da CODESP, órgão gestor do porto, e conduzidas observações in loco e entrevistas com executivos de alguns dos principais players atuantes no porto. Os dados obtidos permitiram identificar quatro grupos de problemas, decorrentes não somente de causas estruturais, mas também da falta de eficiência nos processos portuários. A classificação apresentada contribui para facilitar o entendimento do problema por parte dos gestores desses processos e, representa a base inicial para construção de um modelo teórico para o desenvolvimento de novas pesquisas sobre o tema.

Palavras-chave: Porto de Santos; Logística portuária; Acessos logísticos.

1 Introduction

The overall scenario of the port logistics in Brazil is worrisome. Despite its growth and high investments, several barriers still compromise the competitiveness of Brazilian ports, such as low modal integration, difficulties in moving equipment,

regulatory complexity, and limitations on land and maritime accesses (Brito & Botter, 2012).

The situation is not different at the main Brazilian port – the Port of Santos. According to the Dock Company of the São Paulo State – CODESP (2014a), the Port of

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Santos – the largest port of Latin America – allowed the income and outcome of approximately 114 million tons of loads, thus having an important role in the Brazilian economy, which is mainly sustained by the exportation of agricultural, mineral, and energy commodities. In 2012 and 2013, the Port of Santos was highlighted in the media due to its problems regarding access difficulties and huge lines of trucks waiting to unload agricultural products during the harvesting season. Several expansion projects to increase the port's logistics capacity are in progress, with public and private investments at around R\$ 7 billion for the expansion and modernization of the port to meet the loading demand until 2024, when it may reach the movement of up to 230 million tons (CODESP, 2014b). Therefore, the Port of Santos is at a decisive moment, in which despite the improvements that are happening, we can observe great difficulties regarding the flow of imported goods and also the disposal of the products that will be exported.

The literature on the port theme has discussed several aspects, such as the port-city relation with the works of Ornellas (2008), Liu et al. (2010) and Daamen & Vries (2013), or port competitiveness and efficiency aspects, such as the studies by Song & Yeo (2004), Silva & Rocha (2012), and Haralambides & Gujar (2012). The work of Brito & Botter (2012) specifically discusses the issue of land accesses to the Port of Santos; however, it evaluates a single project being implemented at the port by means of simulation techniques. This present empirical and exploratory study has as main objective to investigate the causes for access difficulties to the Port of Santos, and as a secondary objective, the identification of the actions in progress and projects planned to adapt these accesses to the expansion of the port's movement capacity. A holistic view of the present scenario was sought through secondary data available on CODESP's website, the port management office, in loco observations, and interviews with executives from different players acting at the port regarding the problems faced and their possible solutions.

The following section presents the configuration of the current scenario of the Port of Santos, followed by Section 3, which presents the projects for planned expansion and accessibility. Section 4 describes the data obtained in the field, concluding with the consolidation, discussion of results, and final conclusions in Sections 5 and 6.

2 Scenario configuration

The story of the Port of Santos, according to Vilas Boas (2005), started in 1502 when caravels and lateen-rigged ships arrived near the island of São Vicente and anchored at a primitive port called "Porto das Naus" (Port of Lateen-Rigged Ships). The landing of the navigators happened at this port,

and then they went to the town by canoes. Later, in 1532, Brás Cubas, one of the commanders of the expedition of Martim Afonso, saw better conditions of navigability and had the idea of transferring the port activities to the place where the Port of Santos is today.

In 1890, Santos was the most important port city in the country and had public illumination, trams, railways, and roads. Even with the apparent infrastructure, the port did not have any truly well-structured pier where great ships were able to berth safely and with minimum efficiency and agility during boarding. In this period, the port situation was worrisome. Finally, on July 28, 1888, a group of businessmen won the competition to build a new pier. The aim of this group was to open, four years later, a 260-meter rectilinear stretch of pier, creating the Port of Santos Improvements Company, which was responsible for the project. The official opening of the Port of Santos took place on February 2, 1892.

According to Silva & Cocco (1999), the Port of Santos was considered to be top-class in 1938. However, it faced the risk of becoming obsolete due to lack of management. High taxes and lack of investments were factors observed at that time, taking the Port of Santos to a fast decline circa 1970. In 1980, it won the 90-year concession term given to the Dock Company of Santos, and this was succeeded by the Dock Company of the São Paulo State (CODESP), which was later named as Port Authority by means of the Law of Ports of 1993. With the implementation of this law, CODESP rented port spaces to private companies, making the port gain efficiency and expressively increasing the cargo handling, from 28 million tons in 1990 to 42 million tons in 1999. The Port of Santos is responsible for the shipment of over a quarter of the Brazilian commercial balance. It has two margins, the right margin in the city of Santos with an area of 3,700,000 m², and the left margin in the municipal district of Guarujá with an area of 4,000,000 m², totaling a wharf extension of 13 kilometers. Located two kilometers from the Atlantic Ocean, at the center of the coast of the state of São Paulo, the Port of Santos extends along an estuary which includes the islands of São Vicente and Santo Amaro in its extremities (Berger & Berger, 2009).

According to CODESP (2014a), 114 million tons were moved at the Port of Santos in 2013, 50% of which referred to bulk solids, 36% to general cargo, and 14% to bulk liquids. The maximum forecast for the next 10 years is that the Port of Santos will have a movement demand of about 230 million tons, considering an optimistic scenario, thus more than doubling this quantity, as shown in Figure 1.

Among the national ports, the Port of Santos is the ranking leader of the commercial balance, responsible for 25.4% of Brazilian trade relations

in 2013. The unloading and arrival of cargoes at the Port of Santos are predominantly carried out on highways, as shown in Figure 2, with little growth of the railway system’s participation over the last years.

The area of influence of the Port of Santos, the primary hinterland, which is responsible for approximately 67% of the Brazilian GDP, is composed of 5 states: Mato Grosso, Mato Grosso do Sul, Minas Gerais, São Paulo, and Goiás. The states of Rio Grande do Sul, Paraná, Santa Catarina, Rio de Janeiro, Espírito Santo, and Bahia form the port’s secondary hinterland.

Projects with resources from the Growth Acceleration Program of the Brazilian federal government were carried out and improved the issue of traffic conditions. It is the case of the dredging for deepening and widening of the canal, which started in 2009. When totally concluded, it will bring multiple benefits to the Port

of Santos, such as allowing the access of larger vessels. The dredging project for deepening is already 95% concluded. The intervention will increase the canal’s depth from 12 to 15 meters, and its width from 150 to 220 meters, allowing two-way vessel traffic, as well as large vessels such as *Post Panamax* with capacity for 70,000 tons (CODESP, 2014d).

2.1 Accesses to the Port of Santos

According to CODESP (2014d), the Port of Santos is served by several access modals, such as road, rail, waterborne, and pipeline, besides the maritime access channel itself. The importance of the pipeline modal can be discarded, through which petrochemical products are transported. The existing accesses for each type of modal and their main characteristics are detailed as follow:

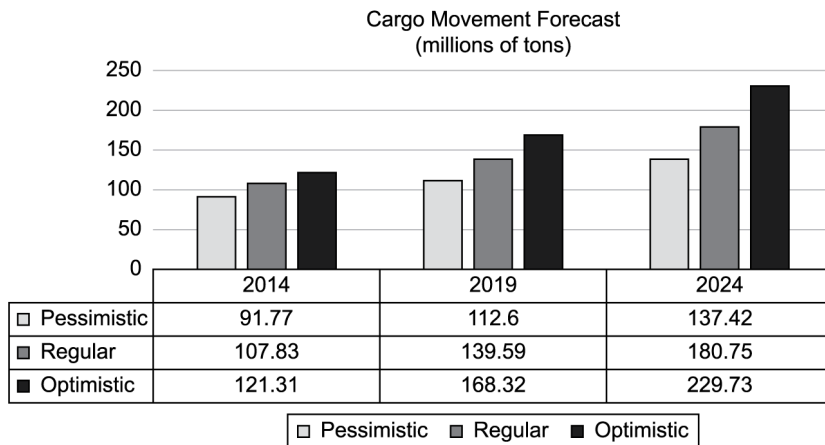


Figure 1. Demand projection for 2024. Source: Adapted from Barco (2014).

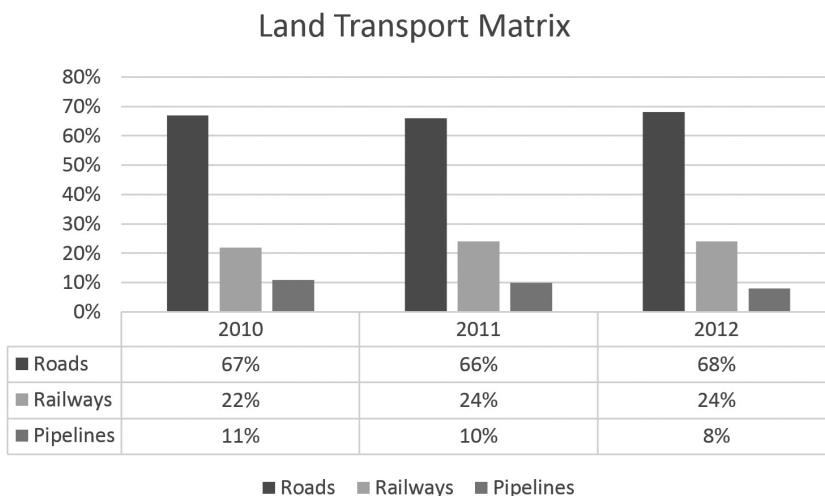


Figure 2. Land transport matrix at the Port of Santos. Source: Adapted from Barco (2014).

a) Road modal:

It is composed of the following highways:

- Padre Manoel da Nóbrega Highway (SP-055);
- Cônego Domênico Rangoni Highway (SP-055), also known as “Piaçaguera-Guarujá”;
- Anchieta Highway (SP-150);
- Imigrantes Highway (SP-160);
- Rio-Santos Highway (BR-101)/(SP-055).

The BR-101 Highway, also called Coastal Highway, goes along all the Atlantic coast of Brazil, with an extension of 4,551.4 kilometers, from Rio Grande do Sul to Ceará. Its access to the port is at the Rio-Santos stretch, serving the north coast of the state of São Paulo. At the area from Ubatura to Peruíbe, BR-101 is known as SP-055, allowing the access to the Port of Santos and to the south coast of the state of São Paulo. The Anchieta-Imigrantes System links the capital of São Paulo and countryside of the state to the coast; the cargo transport through this system is done by the Anchieta Highway and the rising lane of the Imigrantes Highway. The Cônego Domênico Rangoni Highway connects the Port of Santos to the Rio-Santos Highway, which is part of the BR-101/SP-055 system. It is possible to see these access highways to the Port of Santos in Figure 3 (National Agency of Land Transport - ANTT, 2013).

b) Railway modal:

The railway network of access to the port, as seen in Figure 4, is basically managed by two concessionaires: Latin America Logistics (ALL) and

M.R.S. Logistics (MRS). Besides these, a network from the Metropolitan Trains Company of São Paulo (CPTM) is currently deactivated, which connects FERROBAN to PORTOFER (ALL, 2012).

ALL manages the PORTOFER and Bandeirantes Railways (FERROBAN) networks. The Perequê-Valongo and MRS networks are concessions of M.R.S. Logistics.

As the networks are divided between these two concessionaires, the concessionaire that manages each stretch must provide the right of passage to allow the use of this transportation modal.

c) Waterway modal:

The Tietê-Paraná and Paraguay’s waterways compose the waterway modal. As the waterways do not present direct connections with the Santos area, the Port of Santos depends on the intermodal transportation combining the railway and road modals. The Tietê-Paraná waterway allows the navigation from Conchas on Tietê River (state of São Paulo) and São Simão on Paranaíba River (state of Goiás) to Itaipu on Paraná River (state of Paraná). Paraguay’s waterway connects five countries through the Río de la Plata, Brazil, Bolivia, Paraguay, Uruguay, and Argentina. It starts in the city of Cáceres, in Mato Grosso, connecting the Port of Cáceres to the Port of Corumbá/Ladário. It goes through the capital of Paraguay – Asunción – reaching Nueva Palmira at the shore of the Uruguay River (Brasil, 2012).

d) Pipeline modal:

Petrobrás Transports (TRANSPETRO) is a wholly owned subsidiary of Petrobrás and operates in the transportation and storage of oil, its derivatives, and natural gas (PETROBRAS, 2012). Inside the Port of

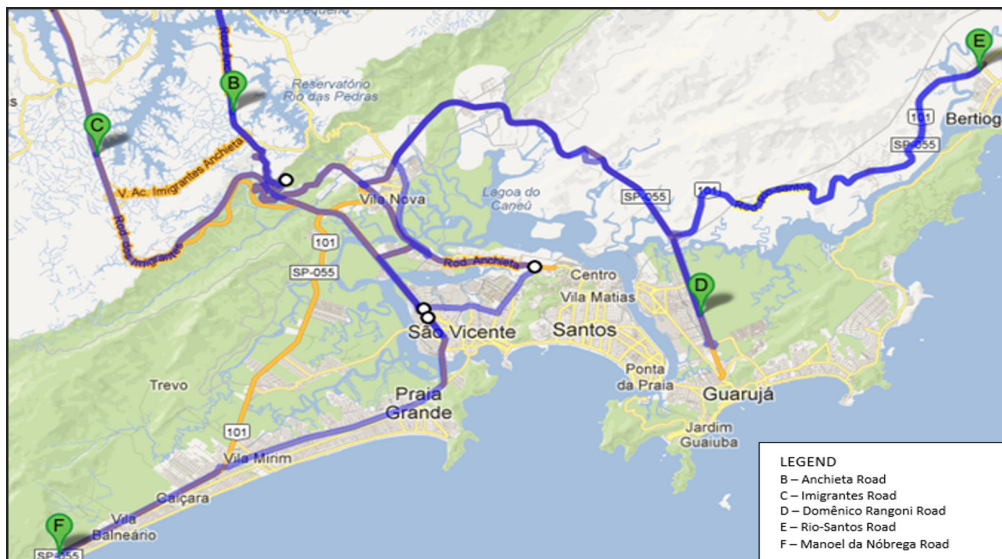


Figure 3. Access highways to the Port of Santos. Source: Google Maps (2012).



Figure 4. Railway network of the Port of Santos. Source: ALL (2012).

Santos, the cargoes are moved at the Alemoa terminal and on the Barnabé Island.

2.1.1 Local road accesses

According to CODESP (2014d), the Doutor Paulo Bonavides Viaduct, also known as Alemoa Viaduct, is the main local road access to the right margin terminals of the Port of Santos. This viaduct connects the end of the Anchieta Highway to Augusto Barata Avenue, better known as “Retão da Alemoa”, reaching the right margin of Perimetral Avenue, which extends eight kilometers to “Ponta da Praia”.

Idalino Pinez Street, better known as Adubo Street (“Fertilizer Street”), is the only gateway for trucks that come from all around the country to load or unload at the several terminals of the left margin of the Port of Santos. This street received this name for being the main access route to the old Fertilizers Terminal (Tefer) of Guarujá for years, which the private company Fertimpont manages today. Adubo Street, with 1.15 kilometers of extension and 10.5 meters of width, has three lanes: two for those going towards the Port of Santos and one for who is leaving it. Adubo Street is accessed via the Cônego Domênico Rangoni Highway, and it is located between Álvaro Carmelo Street and José Lourenço Guerra Street, in the municipal district of Guarujá. This street crosses the railway and Santos Dumont Avenue, a lane with heavy local traffic, and gives access to the left margin of Perimetral Avenue, which extends for four kilometers to the district of Vicente de Carvalho.

2.2 Traffic congestions on road accesses

According to Resende & Sousa (2009), the term “congestion” does not have a universally accepted definition; however, a road can be considered congested if the average speed is below its projected capacity. This definition is still imprecise because the perception and expectation regarding congestions are different for each person. Congestions result in a set of negative externalities, such as an increase of journey time, emission of pollutants, number of accidents, noise pollution, etc.

The road accesses to the Port of Santos go through constant congestions due to lines of trucks that try to reach the port terminals for unloading, transforming the road accesses to the maritime terminals into a giant outdoor parking lot. As shown in Figure 5, the movement of trucks on both margins of the Port of Santos totaled 18,528 vehicles on a single day in 2011.

According to National Transports Confederation - CNT (2012), the reasons for these congestions start with the lack of storage capacity at the production sites. The exporters of agricultural commodities cannot align the road journeys of their cargoes with the anchoring of vessels on which the cargoes will be loaded. Terminals that schedule the arrivals of trucks are also rare, which makes some vehicles remain stopped for days, occupying road space. Deficient planning of port zoning also aggravates congestions, placing the bulk carrier terminals opposite the entrance for trucks, such as the case of soy.

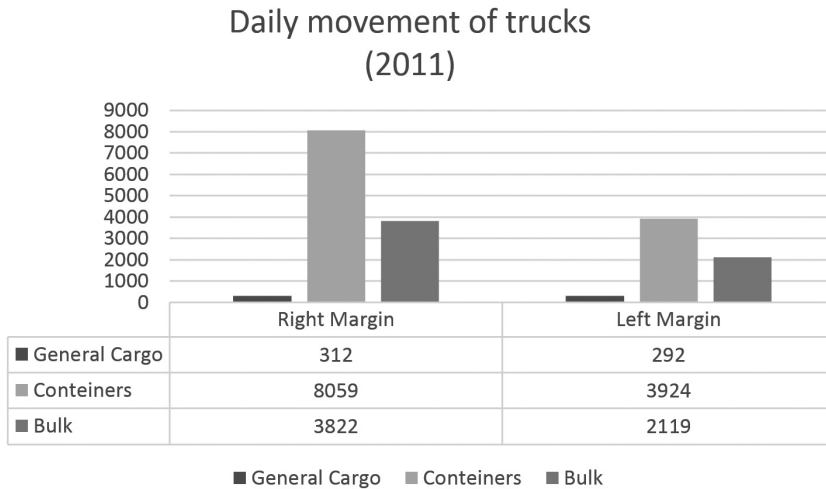


Figure 5. Daily movement of trucks in 2011. Source: Adapted from Barco (2012).

Loading and unloading delays complicate port bottlenecks and help to make lines of trucks at the entrance of terminals that extend along the roads. The regular operation time for a truck at the port should be three hours, but it can reach 36 hours or even more. As roads and rails are not physically segregated, road congestions also affect the railway. Trucks usually take all the free space, including rails, hindering or even blocking the passage of trains at specific stretches of the port.

According to the ECOVIAS (2012) concessionaire, the Anchieta-Imigrantes System is also a victim of congestion. The system’s roads are constantly congested with vehicles going towards the port, fighting for space with other passenger cars, which are the largest users of the system.

3 Expansion projects and accessibility studies for the Port of Santos

With several growth alternatives, one of the Port of Santos’ main challenges is to plan its expansion based on proposals and studies that point to a horizon of possibilities, demanding a careful analysis of the most adequate actions that guarantee the expansion of the main port system of the country with quality and efficiency.

The first version of the Developing and Zone Plan of the Port of Santos (PDZPS) was developed in 1897, when the technical difficulties for the pier construction with stone walls were overcome, which had started circa 1890. In 1892, the Dock Company of Santos (CDS) was set up, authorized to expand its installations to Outeirinhos when the first expansion plans started. Since then, the Developing and Zone Plan of the Port of Santos has been complemented with several projects under CODESP’s responsibility (CODESP, 2014d).

In 2010, CODESP and the Special Secretary of Ports (SEP) of the Brazilian federal government presented the Expansion Plan and Accessibility Study of the Port of Santos, which aimed at directing the growth of the largest port of Latin America in relation with its demands until 2024 (CODESP, 2014b). The Expansion Plan characterizes the port scenario from 2009 to 2024, considering the possible executable projects until then and the already consolidated ones, aligned with studies on hinterland demand covering origin and destination markets, main commercial partners, and global and Brazilian average GDP, among other variables. The study located and defined areas to install new terminals for containers, bulk solids and liquids, and passengers, as foreseen in PDZPS, which indicates the port zone and shows the division of operational areas of the terminal of Santos. The areas of Conceiçãozinha and Barnabé-Bagres will move the solid bulk cargoes; the mineral bulk solids will be moved in Vicente de Carvalho. The liquid bulk cargo terminals require speed, once the current capacity installed is smaller than the demand for this type of movement. The spaces planned for moving bulk liquids will be located on the islands of Barnabé and Alemoa.

According to CODESP (2014b), all these projects focus on meeting an optimistic projection that the Port of Santos will move three times more quantity of cargo until 2024. It will surpass the current 83.2 million tons to 230 million tons, considering that the general cargo will be 53% of this volume, bulk solids 30%, and bulk liquids 17%. The quantity of containers moved will also triplicate – from 3.1 million to 9 million TEUs (twenty-foot equivalent unit).

Two expansion projects for the port are already concluded, the Brazilian Company of Port Terminals (EMBRAPORT) and the Port Terminal of Brazil (BTP). The EMBRAPORT terminal is a venture of Odebrecht TransPort Company to construct and

operate a private port terminal of mixed use at the port's left margin. The total investment in this new terminal is of approximately R\$ 2.3 billion, and with the conclusion of the first phase, it is capable of moving 1.2 million TEUs per year. The BPT terminal received a total investment of R\$ 1.2 billion and is capable of moving 1.2 million TEUs per year, and 1.4 million tons of bulk liquids. In addition to these, investments to optimize and expand other terminals are also foreseen, such as Tecon Santos-Brasil, Libra, and Right Margin Containers Terminal (TECONDI) estimated to move around 1.9 million, 1.35 million, and 900 thousand TEUs per year, respectively.

In the accessibility studies, part of the Expansion Plan and Accessibility Study of the Port of Santos (CODESP, 2014d), the necessary conditions were evaluated for the access roads to the Port of Santos to be properly dimensioned to the growth forecasted to move cargoes, focused on the primary hinterland. Projects with resources from the Growth Acceleration Program of the Brazilian federal government are in progress and intend to improve the issue of traffic conditions. This is the case of Perimetral Avenue and the dredging for deepening and widening of the canal which started in 2009 and 2012, respectively. When totally concluded, they will bring multiple benefits to the Port of Santos, as allowing the access of larger vessels, in the case of dredging. The project of dredging for deepening of the pier is already 95% concluded; the intervention will deepen the canal from 12 to 15 meters and widen it from 150 to 220 meters, allowing the two-way traffic of ships, in addition to larger vessels, such as the *Post-Panamax*, with capacity of 70 thousand tons (CODESP, 2014c).

On the other hand, the project to construct and remodel the Perimetral Avenue is limited by the urban growth. The expansion of the left and right margins of these avenues will meet the already consolidated land uses, as well as the current urban interferences. The project foresees two 10-meter-wide lanes for the right margin. For the left margin of the Port of Santos, in the municipal district of Guarujá, the project will focus on solving the problem of access to the port, eliminating the conflict with the urban environment and connecting Perimetral Avenue to the Cônego Domênico Rangoni Highway without interfering with the urban area. The accessibility studies also include a project that foresees improvements in the flow of vehicles at the crossing between Adubo Street – main access road to the port's left margin – and Santos Dumont Avenue. The stoplights that currently operate with four stages will be reduced to three, and the direction of the traffic lanes of Adubo Street will be inverted, which might collaborate to decrease the slowness of the traffic at the crossing.

Besides these projects, an underwater tunnel will also be constructed, which will connect the left and

right margins of the port through an underground tunnel, removing the conflict among the urban area, highway, railway, and important terminal accesses at the Valongo stretch. In December 2013, the auction notice to build the tunnel was published, which shall be concluded in 2018.

In the context of accessibility projects, we must also consider the Ferroanel project, at the point of signing the contract between the state and federal governments, and whose implementation shall substantially reduce the port's dependence on road accesses in the long term. The north stretch of the Ferroanel will be a priority because it has the largest transportation potential. When concluded, it is predicted to be responsible for 90% of the demand, according to data from The National Association of Railway Carriers – ANTF (2014). The projections state that this stretch will move around 40 million tons of cargo until 2040, 24 million of which will be headed for the Port of Santos.

4 Data obtained in the field

Analyzing the expansion projects for the Port of Santos and their relation with the logistical accesses, we have selected representatives from the companies acting at the port by convenience. Different points of view of the current port scenario and the difficulties faced were collected, as well as the expectations after the expansion. The data were obtained through interviews with executives from some of the players at the port, in addition to direct observation and documents acquired at onsite visits. We used a questionnaire with open questions for the structured interviews with the executives as an instrument to collect data, applied from August to October 2012. A representative was interviewed from each of the following acting players at the port: port authority (CODESP), road haulier, road concessionaire, railway concessionaire, logistics site, and maritime terminal.

Chart 1 identifies the representatives interviewed from each player:

a) CODESP

The Dock Company of the State of São Paulo (CODESP) is a mixed-activity holding company linked to the Special Secretary of Ports of the Brazilian

Chart 1. Representatives from the interviewed players.

<i>Player</i>	<i>Position or Function</i>
CODESP	Advisor to the Presidency
Road haulier	Operations Coordinator
Road concessionaire	Operations Manager
Railway concessionaire	Communication Counselor
Logistics site	Operations Manager
Maritime terminal	General Manager

Source: Authors.

federal government. It plays the strategic role of port administrator and port authority, looking after the development and inspection of rental contracts. It also intends to prepare the Port of Santos for a substantial boost in the flow of cargoes, implementing administrative measures, aiming at providing the port with adequate planning to allow its expansion. CODESP is responsible for managing 42 of the 56 terminals of the Port of Santos, while private companies manage the rest of them.

During a visit to CODESP in September 2012, accompanied by the advisor to the Presidency, we could obtain a broad view regarding the logistical accesses of the Port of Santos, the world's largest exporter of sugar and orange juice. According to the interviewee, the excess in the flow of trucks at the commercial period intensifies as trains that pass through the same line from the passengers of the city of São Paulo are released for circulation only at the night time, thus decreasing the quantity of cargoes that can be drained by the railway modal. As manager and port authority, CODESP highlights some reasons that restrict the working hours of the port, making it impossible to have a better efficiency at the waiting time of the cargoes at the terminals. One of the main reasons is the decrease of inspection operations (Aduana, Agriculture, and ANVISA), which operate with a reduced workforce outside business hours. According to CODESP, one action that would help to drain the cargoes is the release of containers under a customs transit system, which would allow to transfer cargo to a customs precinct closer to the importing company. The static capacity of the terminals is impaired partially due to the importers' slowness to unload the cargoes, which is a result of lack of storage in their installations or financial cash flow. Added to this is the large number of cargoes lost for several months or even years due to the lack of inspectors to conduct a sanitation and the necessary bureaucratic process to bring the auction to fruition, which also hampers the cargo outflow.

b) Highway concessionaire

It is the concessionaire responsible for managing the 176.8 kilometers of road extension that compose the Anchieta-Imigrantes System, which is the main connection between the metropolitan area of São Paulo and the Port of Santos. With an average flow of 2,000 vehicles per hour, which can reach up to 12,000 vehicles per hour on peak days, the Anchieta-Imigrantes System is composed of the following highways: SP-150 (Anchieta Highway), with 55.9 kilometers; SP-160 (Imigrantes Highway), with 58.54 kilometers; SP-040/150 (Planalto Interconnection), with 8 kilometers, connecting the Anchieta and Imigrantes Highways at the top of the Mountain range; SP-059/150 (Santos area Interconnection), with 1.8 kilometers of

extension; SP-248/55 (Cônego Domênico Rangoni Highway, better known as "Piaçaguera-Guarujá"), with 30.6 kilometers; and SP-055 (Padre Manoel da Nóbrega Highway), with 21.6 kilometers of extension.

The concessionaire responsible for the Anchieta-Imigrantes System, visited in September 2012, manages ten lanes that connect these two regions, four of them on Anchieta and six on the Imigrantes Highway. According to the concessionaire's operations manager, this system is the only in Brazil that operates with the possibility of reversal of lanes, easily adapting to flow variations. An average of 90,000 cargo vehicles and passenger cars use these highways every day; however, many of them use untolled urban areas. Approximately 12,000 of these are commercial and cargo vehicles, considering only the trucks taxed at toll stations. The representative interviewed from the concessionaire stated that the maximum flow that the system can absorb is 12,000 vehicles per hour; however, the bottlenecks generated at the entrances of the destination cities have made the maximum flow to be 10,000 vehicles per hour so far. The total gross weight allowed in the system is 45 tons per axle, and the concessionaire is responsible for operating the scales to verify the load. The Anchieta-Imigrantes System's administrator obtained a 20-year concession in 1998; however, this period was extended for five more years due to the inclusion of a new project to build a clover at Kilometer 55 of the Anchieta Highway, amplifying the accesses to the Cônego Domênico Rangoni Highway, and thus to the port's left margin.

According to the concessionaire, the Anchieta-Imigrantes system is able to absorb the flow increase due to the expansion of the Port of Santos; however, it was highlighted that despite the structures of the Imigrantes Highway withstanding the traffic of heavy vehicles, there is a prohibition that meets Ordinance 11/2002 from São Paulo State Transport Regulatory Agency – ARTESP (2002), Decree Number 46708, and prevents the transit of heavy vehicles on the descending lane of the Imigrantes Highway SP-160. The law considers the age and average level of damage of the heavy vehicle fleet (trucks, trailers, and semi-trailers), dual use vehicles and passenger cars (minibuses, vans, and buses), taking into consideration the study developed by the National Association of Motor Vehicle Manufacturers - ANFAVEA and its affiliated companies under the effect known as "fade" – overheating of brakes that occurs in vehicles equipped with drum brakes. The study concluded that the circulation of these vehicles on the descending lane of Imigrantes would be temerarious in virtue of a significant risk of efficiency loss of the brakes due to an inclination of approximately 6% of the ramp and the low sinuosity of the lane. This prohibition is valid as there are no evaluations from practices in the

coastal mountains, characterizing a relevant limitation to the flow of heavy vehicles in the system and at the access to the port. The decree is also applied to the ascending lane in case it is being used as descending.

c) Railway concessionaire

With over 21,300 kilometers of railway network and a direct connection with the Port of Santos, the concessionaire links the Santos region to the cities of Santa Fé do Sul, Panorama, and Colômbia through a segment of approximately 3,000 kilometers of railway lines, draining the production from the states of Mato Grosso, Mato Grosso do Sul, and São Paulo by means of the São Paulo railway network, granted until 2028. The company, which was visited in November 2012, executes the largest part of the railway transportation of cargoes at the Port of Santos through the network known as PORTOFER.

The executive interviewed highlights that there is a huge restriction to the railway modal at the port due to different network concessions and the need for requesting the right of way at sections from other concessionaires. Besides, the network accesses to the port only allow one train to pass at a time, totaling a maximum of 18 trains per day that enter or leave the port, or approximately 1,120 wagons per day in 2011 taking into consideration the trains from all concessionaires. Most of these compositions transport bulk cargo, unloaded from the trains at one of the five hoppers available at the Port of Santos. In some cases, this process is slow with approximately 3 wagons per hour, resulting in a bottleneck in operation. The rest of the compositions is loaded from containers and is usually managed by logistics operators due to customs procedures.

In order to increase the flow of cargoes entering and leaving the port through railways, the concessionaire works with intersection sites at some strategic segments of its network, minimizing the difficulty of the single rail and enabling the passage of a train while another one awaits at this yard according to the prioritization of the railway concessionaires. Aiming at increasing the participation of the railway modal to drain cargoes at the port, the concessionaire in partnership with CODESP is developing a project to duplicate the rails at the Campinas-Santos segment with resources from the Growth Acceleration Plan from the Brazilian federal government. The first stretch between Perequê and Cubatão has already been concluded, which allowed to increase from 30 to 60 the number of wagons in daily circulation at the port's right margin. The project, which has been executed by stretches, foresees the duplication of 383 kilometers of railways from Campinas to Santos, and will enable the removal of approximately 1,500 trucks from the highways.

Another project that the interviewee mentioned was the restructuring of the PORTOFER network at the right margin stretch. The rail currently goes through some maritime terminals, hampering the operation for trains and trucks that will unload or load their cargoes. The trucks waiting for release from the terminal often remain on the rails, blocking the passage of the trains and slowing down the efficiency of both modals. According to the interviewee, it is expected that the use of the railway modal match the road modal until 2024 with the implementation of the scheduled projects.

d) Road haulier

It is the largest provider of integrated and customized logistics services of the country, with over 90 branches, a fleet of approximately 12,000 trucks and a workforce of 20,000 employees. The company has branches strategically located to support ports, which allows it to experience everyday problems related to road accesses. The branch, visited in October 2012, is strategically located in Cubatão, facilitating the access of its vehicles to the areas of the Port of Santos.

The haulier uses previous schedule to load or unload containers whenever it is possible, thus avoiding vehicles to remain at the port's proximities without need. Scheduling is not available for bulk cargo, resulting in lines of trucks, especially during the harvesting season. The haulier's operations coordinator mentioned that one of the factors which cause a huge impact on the flow of vehicles in the logistics system as a whole is the traffic of empty containers. The containers must be returned to the area intended for storing empty containers at the places recommended by the owners at port areas after delivering the cargoes to their final destinations. In order to improve this return operation, the haulier is developing a strategy with the owners to decrease the number of journeys with empty containers, reloading the trucks whenever possible with cargoes from companies that are located near the area where the material coming from the port was unloaded. The haulier's representative reports that the access to the port's left margin by Idalino Pinez Street, also known as Adubo Street, is a critical point for their operation, and they consider this the main bottleneck in the road access system to the Port of Santos.

e) Maritime terminal

The maritime terminal visited is responsible for loading and unloading operations of containers and general cargo, providing operational facilities for customs transit, in addition to other port activities. It has a total area of 155,000 m²-105,000 m² consist of a customs terminal with a 1,085-meter pier extension for anchoring with three docking berths. It moved

approximately 800,000 TEUs in 2011, representing 27% of market share.

Following the expansion projects that the Port of Santos has been going through, the terminal visited in October 2012 will receive an investment of approximately R\$ 550 million with the intention of remaining competitive and supplying the growth for the demand forecast. It foresees an expansion of 115,000 m² of customs area, increasing its static capacity from 13,600 to 22,500 TEUs. According to the terminal's general manager, the capacity of road accesses that will drain the received and dispatched cargoes causes great concern with the growth of the movement capacity of the Port of Santos. This situation is intensified during the grain harvesting season, especially soy, which is prioritized at the port due to governmental exportation regulations, increasing the cargo movement at this period. The soy grains are completely transported in bulk by means of road and railway modals. Besides the harvest peak, the movement of general cargo tends to increase during the last trimester of the year due to the holiday season. As an alternative, the company aims at developing multimodality each time more, using for instance the railway modal. Currently, the company moves approximately 150 containers per journey every week at this modal, with a established itinerary. Its restrictions are low train speed when compared with the road modal, and the division of railway lines among different concessionaires, resulting in the need for authorizations for passage.

The long period to release the cargoes through the Brazilian customs – around 48 hours – is one of the factors highlighted that interfere in the movement capacity of containers, and consequently in the flow of heavy vehicles inside and outside the terminals. In order to minimize customs impacts, the terminal created dry ports, which allow the cargoes to undergo their clearance out of the organized port. The interviewee mentioned a possible solution for the congestion of trucks waiting for the entrance at the port which would be the need for using tags linked to the port scheduling system, allowing vehicles heading for the port only to be released at toll stations at the Anchieta-Imigrantes System when authorized.

f) Logistics site

The logistics site makes services available to support all the logistics chain. It encompasses integrated logistics, storage, foreign trade, transports, and information focused on the efficacy of operational processes and in solid partnerships with clients and collaborators. With approximately 440,000 m² of total area, 140,000 are destined for the yard to park trucks heading for the Port of Santos, whether it be for the loading or unloading of cargoes, thus decreasing the quantity of trucks at the areas around the port while

they wait for the release to unload or for the vessel to berth. According to information obtained during the interview in September 2012, the logistics site offers 650 official parking places for trucks to wait for the scheduled time to access the port, this way doubling the number of places in order to meet the demand, using areas that would be intended for other services. This area destined for the parking of trucks helps to decrease the number of vehicles awaiting at the port's entrance to load or unload. The site has a contract with some companies, including Copersucar, Bulk Terminal of Guarujá - TGG, and Cosan. In these cases, the logistics yard itself is responsible for contacting the port for scheduling. For sporadic trucks, i.e. those that do not belong to one of the client companies, the only service provided at the site is parking. Through partnerships with some owners, the logistics site makes an area available for storing empty containers, ensuring that some road hauliers do not need to remove or return these containers to port areas, also with a yard destined for repairing these empty containers. This way, even if a breakdown is present, they do not need to return to the port area in order to be able to circulate again.

The representative also informed that the site offers customs clearance services, such as Special Place for Exportation Customs Clearance - REDEX, which is a place where cargoes destined for exportation go through customs clearance and are regulated by the Brazilian Federal Revenue Office. A new area is also under construction which will be destined for a logistics and customs center, infrastructure to facilitate and rationalize the movement of importation and exportation flows. These two services directly assist in increasing the static capacity of maritime terminals because they are able to redirect the volume that would be awaiting at the terminal to undergo customs clearance, as well as decentralizing the arrival and departure of cargoes nearby the port.

According to the interviewee, the area destined for full containers operates as a warehouse. The trucks bring their cargoes, and the containers are loaded or already come to the site loaded, then await for the availability of vessels for boarding. This process facilitates the loading of vessels because the site is strategically located for this transportation to happen fast when solicited.

5 Consolidation and discussion of results

The analysis of data obtained in the field allowed us to identify several causes for the access difficulties to the Port of Santos, which were classified into four distinct groups in order to facilitate understanding and systematize possible improvement actions. Among them, we can mention: flow difficulty at port areas,

restrictions to the railway modal, misuse of the capacity of the maritime terminals, and congestions at the accesses.

More than one of the players interviewed highlighted many of these causes, which reinforces the credibility of the table obtained. Chart 2 consolidates these data:

Besides structural projects that demand larger scale investments, such as the ones foreseen in the Expansion and Accessibility Plan of the Port of Santos, we could identify a series of administrative actions that could improve the efficiency of several port processes. In addition to these, we also found smaller scale projects that could improve access logistics that are either already in progress or could be started relatively fast to minimize the limitations that the access system imposes for the port’s expansion. On the one hand, administrative and/or regulatory actions, such as previous scheduling for loading and unloading and the implementation of dry ports, could minimize the flow difficulties at port areas and the misuse of the capacity of maritime terminals. Production engineering tools, such as modeling and simulation, in addition to operations management and organizational engineering concepts, could be useful in the project and implementation of these actions.

On the other hand, restrictions for the railway modal and congestions at accesses are difficulties whose causes are structural, and therefore demand investments in larger scale projects, as the restructuring of the railway network and the construction or remodeling

of Perimetral avenues. We could identify the existence of several projects coordinated by CODESP regarding the Expansion and Accessibility Plan of the Port of Santos aiming at improving its accesses based on the estimates of flow increase until 2024. Important projects are in the process of being procured, such as the construction and remodeling of stretches of the Perimetral Avenue at the port’s right margin. At the left margin, the first stage of implementation of the Perimetral Avenue was concluded, including the completion of a set of viaducts that eliminated the last road bottleneck in the region, ending the road-railway conflict. A project to create new accesses to the terminals at the left margin is also in progress, as an option for the only access we have today, which is Adubo Street.

We could also verify the concern from the players involved in this research to plan and execute their own alternatives to adapt themselves to the current conditions and minimize the growth impacts of the port activity. The classification of the several causes identified for the access difficulties to the Port of Santos, proposed in Chart 2, contributes to better understand the problem on the part of the managers from these players, and also to systematize possible improvement actions in order to make them more effective. We also believe that the classification proposed represents the initial basis to build a theoretical model that facilitates the development of a new research on this theme.

Chart 2. Consolidation of the research results.

Consolidation of the research results		
Causes	Group	Actions
<ul style="list-style-type: none"> ✓ Traffic of empty containers; ✓ Lack of availability to schedule bulk cargo. 	Difficulty of flow at port areas	<ul style="list-style-type: none"> ✓ Previous schedule for loading and unloading; ✓ Implementation of sites to store empty containers; ✓ Reloading of containers close to the destination areas; ✓ Use of regulatory sites.
<ul style="list-style-type: none"> ✓ Railway lines divided by different concessionaires; ✓ Slowness from hoppers to unload wagons; ✓ Interference from the PORTOFER railway network with road accesses. 	Restrictions to the railway modal	<ul style="list-style-type: none"> ✓ Duplication of the rails at the Campinas–Santos access network; ✓ Restructuring of the PORTOFER network at the right margin; ✓ Implementation of sites to cross compositions.
<ul style="list-style-type: none"> ✓ Slowness to release cargoes at customs; ✓ Slowness by hauliers to unload cargoes; ✓ Lost containers; ✓ Restrict working hours of the inspection agencies. 	Misuse of the capacity of the maritime terminals	<ul style="list-style-type: none"> ✓ Release of containers in customs transit system (Dry Port); ✓ Rationalization of the importation/exportation flow; ✓ Customs clearance at the sites.
<ul style="list-style-type: none"> ✓ Bottlenecks at the local accesses to the port, “Adubo Street”; ✓ Traffic restrictions for heavy vehicles at the descending lane of the Imigrantes Highway; ✓ Interferences with urban traffic; ✓ Lack of physical segregation between roads and railways. 	Congestions at the accesses	<ul style="list-style-type: none"> ✓ Construction of the clover at Km 55 of the Anchieta Highway. ✓ Revamping of “Adubo Street”; ✓ Construction or remodeling of the Perimetral Avenues at the right and left margins.

Source: Authors.

6 Conclusions

The Port of Santos – the largest port of Latin America and responsible for the majority of the Brazilian international trade – has been suffering with the expansion of the flow of goods largely due to lack of infrastructure of logistics access network.

This study aimed at investigating which are the causes for access difficulties to the Port of Santos, and it also intended to identify the ongoing actions and scheduled projects to adequate these accesses to the expansion of the movement of the port, which were fully accomplished.

We executed this study by means of exploratory research, involving interviews with executives and in loco visits to different acting players at the port, as well as analyzing secondary data obtained from CODESP's website, port authority and managing body of the Port of Santos.

The data obtained allowed the identification of several causes for the access difficulties to the port, which were classified into four distinct groups: difficulties of flow at port areas, restrictions to the railway modal, misuse of the capacity of maritime terminals, and congestions at the accesses. The authors also verified that access difficulties to the Port of Santos are not only caused by structural issues, but also by a lack of efficiency from several port processes that could be minimized through administrative actions and/or the implementation of new regulations. We could identify possible necessary actions to mitigate these problems, some of which have already been implemented, while others are in the process of being procured or at project stage. The holistic view of the current scenario of access difficulties to the Port of Santos obtained with this work indicates that these actions may be enough to reestablish the balance between the port system's capacities and the access modals in the long term. The classification presented for the several causes of access difficulties to the port contributes to better understand the problem on the part of the managers involved with port operations, and it can also serve as a basis to develop new researches of this subject.

With the existence of several public and private organizations involved with different improvement projects already in progress, the role of the coordination of CODESP as port authority and managing body of the Port of Santos is fundamental.

The authors highlight that they did not intend to conduct a deeper technical analysis of the current improvement projects regarding their suitability and compatibility with the expansion perspectives of the port activity, which could be the object of future researches.

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