Sao Paulo - Santos
Logistics Corridor Program

Final Report

duisport
excellence in logistics

Duisburg, 06/03/2012

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List of abbreviations

AG	Andrade Gutierrez
ALG	Advanced Logistics Group Consulting
ALL	América latina logistica
ANPR	Automatic number plate recognition
ARKOS	Automatisches Reihungskontrollsystem (Automatic composition checking system)
BNDES	O banco nacional do desenvolvimento (brasil development bank)
BRIC	Brazil, Russia, India, China
BTP	Brasil Terminal Portuário
CM	Container Management Magazine
CMA	Compagnie Maritime d'Affrètement
CGM	Compagnie Générale Maritime
CODESP	Companhia Docas do Estado de Sao Paulo (national port administration)
CPTM	Companhia Paulista de Trens Metropolitanos
CTC	Centralized traffic control
D3T	Duisburg Trimodal Terminal
DB	Deutsche Bahn (German railway)
DeCeTe	Duisburger Container Terminalgesellschaft
DIT	Duisburg Intermodal Terminal
DKT	Duisburg Kombiterminal
DUSS	Terminal of „Deutsche Umschlagsgesellschaft Schiene-Straße“
DVZ	Deutsche Verkehrs-Zeitung (German traffic newspaper)
ETCS	European train control system
FCD	Floating car data
GE	General Electric
GNP	Gross national product

GPS	Global positioning system
KEP	Kurier-, Express-, Paketdienstleister (courier, express and parcel services)
KV	Kombinierter Verkehr (combined transport)
NPLT	National Plan for transport and logistics
NYK	Nippon Yusen Kaisha
OCR	Optical character recognition
PA	Port authority
PNLP	National plan for port logistics
POS	Port operating system
PS	Port shuttle
RoRo	Roll on/Roll off
RRT	Rhein-Ruhr-Terminal
TEU	Twenty-food equivalent unit
TGG	Terminal de Granéis do Guaruja
TLP	Transport logistic platform
TMC	Traffic message channel
TOS	Terminal operating system
VICOS	Vehicle and infrastructure control and operating system
ZAL	Cargo transport centre/ platform for logistic

1. Scope of the project – future challenges for the Port of Santos

1.1 Mission Statement

The São Paulo-Santos Logistics Corridor Program is mainly targeted on a significant **Change of modal split towards rail transportation** within the Port of Santos to handle the rapidly increasing volumes combined with **high-class intermodal hinterland connections.**

It is therefore based upon an **Increase of capacity & efficiency of existing road & rail infrastructure** which shall be mandatory combined with the **Implementation of a road connection between left bank and right bank of the Port** and embedded in the **Implementation of an IT-platform for Traffic & Cargo Management (Transport Logistics Platform).**

Notwithstanding the obviously necessary **Retrial of potential further development of Rail and Road Accessibility to Santos / Serra do Mar** it will in light of the restricted capacities be unavoidable to develop a **System of intermodal Pre-Gates** mainly in Cubatão and Paranapiacaba region linked to the Container Terminals within the Port of Santos by the **Implementation of a novel container transport technology and logistic system.**

These Pre-Gates combined with the **Development of a Port Logistics Platform (Logistics Activity Zone)** within the Paranapiacaba region will compose the backbone of the **high-class intermodal hinterland connections** based on an **International standard modal split.**

1.1.1 Our vision for the Port of Santos

- The whole Port of Santos is integrated in an overall IT-platform (Transport Logistic Platform)
- Implementation of intermodal access to all terminals
- Implementation of a pre-gate system in the Port and the hinterland (e.g. Cubatão and Paranapiacaba) → unbundling traffic flows
- Development of a port logistic activity zone up Serra do Mar (Paranapiacaba)
- Connecting of all stakeholders via novel container transport technology based on a IT-Transport Logistic Platform

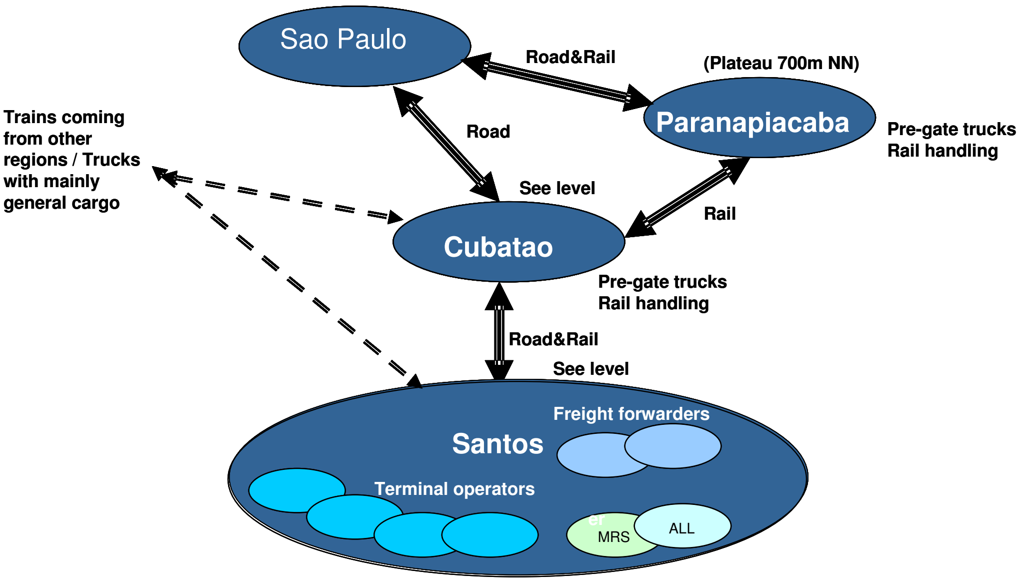


Figure 1: Transport connections Santos

1.2 Major trends & challenges at seaports are also challenges for Port of Santos

- Containerization and larger vessels
- Need for efficient stacking and terminal management systems
- Efficient hinterland transport and intermodal network
- Extended Gateway concepts to terminals, bundling of rail and barge container flows in the Port area and development of rail and barge shuttles
- Horizontal and vertical integration (need improved cooperation between stakeholders)
- Better data exchange between all stakeholders, optimized end-to-end supply chain security and environment
- Container and ship screening reduce CO2-emissions, optimize energy utilization and energy consumption.

1.3 Short extract: Terms of Reference

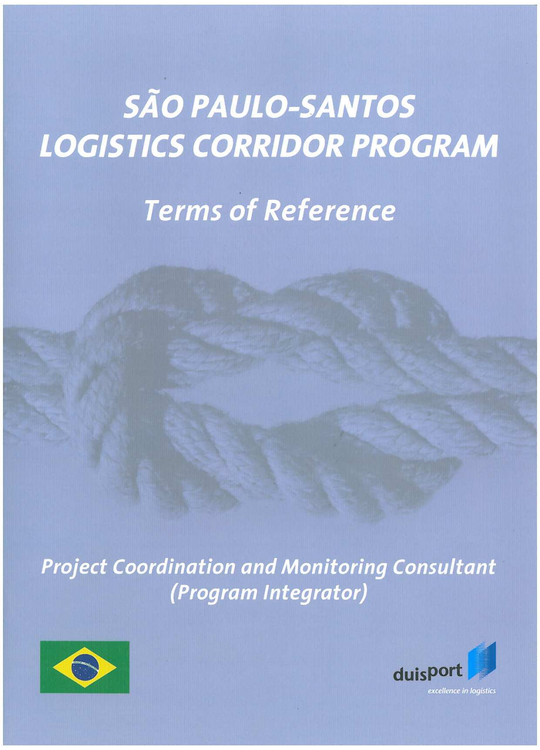


Figure 2: Terms of reference

duisport was entrusted to act as a program integrator:

- SEP / Government of Brazil is fully aware of these challenges and have therefore identified the São Paulo – Santos Logistics Corridor Program as the most adequate response to these challenges
- Various studies have been initiated (ALG & AG)
- Results and recommendation will be commented within this management summary
- <u>Not scope of the project</u>: Seaside operations of the Port & operations performance of terminals, railways or logistic operators.

→ **duisport will present recommendations indentified for the São Paulo-Santos Logistics Corridor Program within this report**

1.4 Problem statement

Summary of the challenges approaching the Port of Santos:

- Brazil's foreign trade grew from US $100 billion in 1996 to US $370 billion in 2008

- The São Paulo-Santos Corridor is nothing less than the main artery for Brazil's exports / imports

- Study of the Port of Santos carried out by Louis Berger Consultants and Internave Engenharia, funded by the IDB, has estimated that container movement in the Port may reach 9 mill. TEUs (ca. 100 mill. tons) in 2025, and liquid and solid bulk volumes 38 mill. tons and 69 mill. tons respectively by that year
  → In this scenario the number of trucks transiting the São Paulo – Santos Corridor will at least double

- Due to the pressure for road infrastructure and the main highway links to the City of Santos, the Federal Government, through its Secretariat for Ports (SEP) and the Port of Santos Authority (CODESP) have identified the São Paulo-Santos Logistics Corridor Program as the most adequate answer to this situation

- The program is built around the concept of a new transportation system between the Port of Santos and proposed logistics platforms behind the Serra do Mar range of hills and adjacent to the southern sections of both the new ring road and the planned railway ring around São Paulo

The role of **duisport**:

- Following studies have been initiated:
    - Logistics Platform Study
    - Serra do Mar Section Study
    - Studies by ALL, MRS

- To avoid the creation of a number of stand-alone-projects and develop a sustainable, subordinated and integrated inter-modal approach for the São Paulo-Santos Logistics Corridor Program, SEP / CODESP have agreed to entrust duisport with the position of Program Coordination and Monitoring Consultant (Program Integrator)

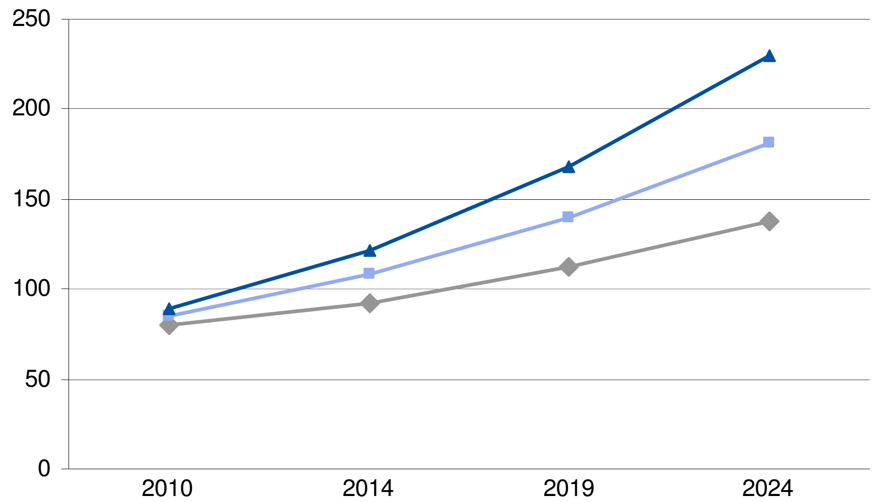
- **duisport** will bring in all its know-how as operator of the leading inter-modal & inland navigation hinterland hub in Europe without any restrictions

- **duisport** is specialized in developing inter-modal hubs systems, planning terminals and operating the complete supply chain.

1.5 Key assumptions

The final report is mainly based on following key assumption:

Forecasted tonnage growth until 2024[1]

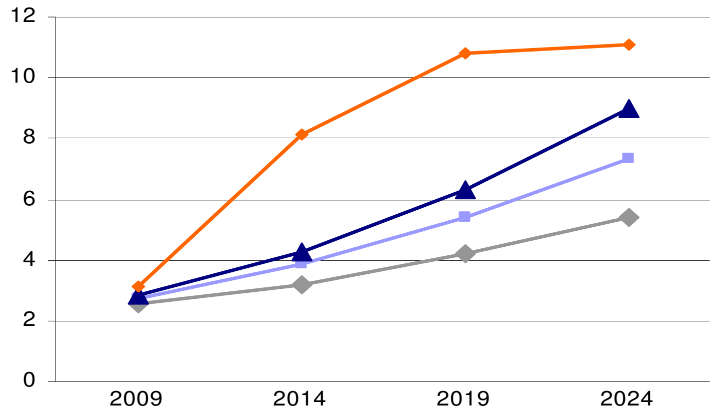


	2010	2014	2019	2024
pessimistic	80,34	91,77	112,60	137,42
base	84,76	107,83	139,59	180,75
optimistic	88,96	121,30	168,32	229,73

In an optimistic scenario the amount of total tonnage will grow from 88.96 million tons in 2010 to 229.73 million tons in 2024.

[1] Source: Louis Berger study

Forecasted container growth until 2024[2]



	2009	2014	2019	2024
pessimistic	2,57	3,19	4,22	5,39
base	2,74	3,86	5,38	7,32
optimistic	2,87	4,25	6,29	9,01
installed capacity	3,14	8,11	10,81	11,11

In an optimistic scenario the amount of container will grow from 2.87 million TEU in 2009 to 9.01 million TEU in 2024.

Forecast of exported goods[3]

EXPORTED GOODS

	2010	2009
Commodities	**51,7%**	**52,3%**
Sugar	20,3%	16,9%
Coffee	15,3%	16,1%
Meat	9,0%	11,8%
Metals	4,7%	5,1%
Various	2,4%	2,4%
Others	**48,3%**	**47,7%**
Chemicals /Plastics	9,7%	9,2%
Auto-parts	8,6%	8,2%
Paper	8,3%	7,4%
Food	6,4%	10,5%
Machinery	3,9%	2,0%
Building Materials	3,4%	1,5%
Textile	1,8%	1,3%
Eletronics	0,6%	1,3%
Various	5,4%	6,3%

→ Volume increase will be mainly driven by the containerization of agriculture bulk. Sugar was the No. 1 in export goods in containers in 2010 but not existed in 2007.

[2] Source: Louis Berger
[3] Source: Santos Brasil

2. Basic studies

2.1 Study Louis Berger Group[4]

Initially, in the Louis Berger Group study the development and build up of the port of Santos was analyzed. To do this the following aspects were considered:

- Infrastructure of the port,
- Companies located in the port,
- Infrastructure of the region,
- Analysis of sea traffic,
- Commercial aspects,
- Legal and institutional aspects,
- Environmental aspects.

An additional component of the study is a description of the current situation of the port, presented through advantages and disadvantages.

The general advantages of the port were seen to be:

- Santos has a large number of shipping lines.
- Santos has a large port area.
- Geographical proximity to an economic region and the associated necessity of logistics activities.
- In comparison with other ports, the port of Santos has good access and a good range of services on the modes of transport rail and road.
- The port has a sufficient loading depth.

[4] The Louis Berger Group, Internave Engenharia São Paulo, *Plan of development and expansion of Port of Santos – Consolidated preliminary report*, São Paulo, 2009

The following were seen to be more disadvantageous:

- Logistical bottlenecks on the roads and rails.
- Congestion of the roads in the city of Sao Paulo.
- Division and structure of the terminals.

In addition, a strategic analysis and forecast of demand as well as the capacities of the port facilities and access points to the port were presented. In the next step the study analyzed and selected various development possibilities. The development alternatives were subsequently submitted to a feasibility study that included a technical, financial and environmental analysis.

Accordingly the following development projects were proposed:

- Building up the Alemoa facilities (liquid bulk cargo, crude oil).
- Building up the Barnabé facilities (liquid bulk cargo, e.g. chemicals).
- Developing a new terminal in Itapema (solid minerals).
- Developing a new terminal for plant bulk cargo for export (options: Conceiçãozinha and Santa Rita).

In the further course of the study the following optimization potential was identified:

- Reducing downtime.
- Raising productivity.
- Raising handling capacities.
- Building a new terminal.
- Internal optimizations.
- Optimizing access points.
-

Furthermore, recommendations are presented about how the competitiveness of the port and the terminal can be improved. Finally, using a monitoring system the operational and financial performance level and the demand for port services have been methodically reviewed.

2.2 Accessibility study University of Sao Paulo[5]

This study from the University of Sao Paulo describes the effects of increasing traffic volumes on the road mode of transport. It is expected that transport volumes will increase from 80 million t today to 195 million t in 2024. By 2019 it will be possible to master these transport volumes by optimizing the highway. However, from 2024 problems between downtown and the plateau are expected.

From 2014 it is also expected that the Anchieta and Immigrantes roads will meet their capacity limits. The following alternatives for this are to be reviewed:

- Construction of a new road.
- Approval of truck traffic in both directions including on working days. This alternative is to be reviewed by detailed studies by Artesp and Ecovias. In addition, the lifting of the prohibition of truck traffic towards the valley on the Imigrantes highway is necessary.
- Increasing carriage performance by rail. This would mean that the modal split of rail would have to be increased from 12% today to 61% in order to master the quantity of goods. The tonnage carried would grow from 15 million t today to 63 million t in 2019 and 120 million t in 2024. It would not be possible to implement this alternative for 2024 in particular. Therefore, additional optimization of the road mode of transport should be carried out.

5 Prof. Dr. Nicolau Gualda et al. (University of Sao Paulo).: *Accessibility study of Port of Santos (Estudo do Sistema de Acesso ao Porto de Santos),* Sao Paulo, 2009

2.3 Port development plan CODESP[6]

In the study to develop the port of Santos a development and zoning plan has been presented. This will ensure that the port will meet future requirements taking into account the surroundings and the environment. Action options and the bases for decisions are presented for this purpose. The development and zoning plan is a component of dynamic planning that can be adjusted to changing conditions and new scenarios.

The following action options and bases for decision should be taken into account in the planning:

- Studies should be produced and solutions found for the following problems:
  - Shipping and port.
  - Repair shipyard for ships.
  - Shipyard for building up the navy.

- Producing studies to assess cabotage:
  Identifying the potential and barriers to introducing and building up cabotage and showing the possibilities to draw on new investments and new companies

- Preparing studies on the capacity of waterway port access points: developing mathematical models to assess interactions of the factors such as an increase in vessel size or restriction by crossing points. Producing forecasts relating to the increase in feeder shipping, high seas shipping and cabotage.

- Preparing a port road plan: investigating the whole road network of the ports and the influences of the modes of transport rail and road.

[6] Companhia Docas do Estado de São Paulo (CODESP): *Port development plan (Plano de Desenvolvimento e Zoneamento do Porto de Santos)*, Santos, 2010

- Reviewing the efficiency of the organization of CODESP.
- Reviewing the organization of the terminal: location, access points, types of freight, equipment and the needs of the port's users etc.
- Reviewing the organization of port services, railroad, pilots etc.
- Reviewing energy consumption of the facilities installed.
- Planning future renovation needs: the planning should encompass new terminals, new projects and the facilities administered by CODESP.

2.4 National plan for logistics and transport (NPLT)[7]

The “National plan for logistics and transport” includes the following targets:

- Restarting planning for the transport sector on the basis of a geographical information system with information about supply and demand.
- Taking account of logistics costs caused by goods movements.
- Optimizing the modal split (i.e. increasing the proportion of transport by rail).
- Describing action instructions and implementing projects to develop the rail-water system to relive the road mode of transport
- Building up the rail infrastructure.
- Developing a strategic plan for water transport (implementing expansion work, building water terminals etc.).

By implementing the targets described above, in 15-20 years it will be possible to increase the proportion of goods transported by rail from 15% currently to 35%, and waterborne goods transport from 13% to 29%, thus reducing the proportion of goods transport by road from 58% to 30%.

In addition, the NPLT sets the following targets:

- Taking environmental protection into account.
- Implementing projects related to socio-economic issues:

    a. By increasing efficiency in consolidated areas, land can be utilized for agricultural use.
    b. Reducing regionally related structural weaknesses.
    c. Better integration of and connections for the region.

[7] Ministry for transport et al.: *National plan for logistics and transport (Plano Nacional de Logistica e Transportes)*, Brasilia ,2009

2.5 National plan for port logistics (PNLP)[8]

The "National plan for port logistics" is not yet finished at the time of writing and has only been available as a draft version up to now. The completed report will then present a master plan for the following 12 public ports:

- Santarém
- Vila do Conde
- Mucuripe und Pecém
- Suape
- Salvador e Aratu
- Vitória
- Rio de Janeiro
- Itaguaí
- Santos
- Paranaguá
- Itajaí
- Rio Grande.

To prepare the master plan some initial problems were listed:

- Goods volumes have increased strongly over the past few years. As a result there can be restrictions of port capacities.
- The ports need a new institutional structure with regards to legislation.
- The management model of the ports requires optimization.

[8] SEP (Port Office), UFSC (University of Santa Catarina): *National plan for port logistics – preliminary draft (Plano Nacional de Logistica Portuária)*, Florianópolis, 2010

The PNLP will restart planning and systematically analyzing the processes of the Brazilian ports in an integrated manner. The targets of the master plan are described below:

- Increasing the capacity of the port system in Brazil.
- Defining an institutional organization.
- Optimizing the management (or efficiency) of the national ports.

As a result, the plan will show a diagnosis of the port logistics of the Brazilian port sector. With the help of forecasts and trends various scenarios will be prepared and evaluated. In addition, the master plan will present medium to long term action instructions and bases for decisions with reference to infrastructure, suprastructure, logistics and the hinterland, business and finance as well as management and the environment.

2.6 Study "Logistics platforms" by ALG[9]

In the pre-study on the feasibility of the goods transport center in the port of Santos new value creation for logistical processes will be made possible and the competitiveness of the companies in the port will be increased. The development focal points of the study are:

- Strategic assessment of the national and international framework concept for logistical developments.
- Market research of the profitable business branches in the goods transport center as well as an analysis of the demand.
- Developing a management concept that foresees strong involvement of the public and private sector.
- Preparing a business and financial concept that takes account of the profit, the costs, the profitability and the risks of the scenarios detailed as well as their effects on the feasibility of the project.
- Drafting a business plan that describes the strategies and the targets of the project in detail.
-

The results of the study are presented below:

- Context analysis

  Due to the increasing growth of the port the infrastructure will be further developed and through continual improvements the elements that will serve to make trade activities easier will be supported. Both measures can be realized through logistically optimizing the foreign trade activities processed by sea.

9 Advanced Logistics Group (ALG): *Estudo de viabilidade de uma Zona de Atividades Logísticas no entorno do Porto de Santos - Relatório de Avanço (Feasibility study for the establishment of a logistics centre in the environment of Port of Santos)*, Sao Paulo, Barcelona, 2011

- Supply analysis

  Brazil has a development plan for the infrastructure of transport, logistics and foreign trade that will contribute to tapping the hinterland. In addition, the supply of logistics services has to meet flexibility and quality requirements and times and costs adjusted for a global market. In this context, logistics processing times, caused by customs procedures in particular, will be reduced.
- Needs analysis

  In the needs analysis the requirements of the port's logistics infrastructure were identified. For this which types of goods are mainly carried in the logistics chain were analyzed in particular.
- Strategic analysis of the goods transport center

  The logistics platform (ZAL) will be used a changing point between maritime and terrestrial transport modes. The Baixada Santista location will maximize the chances to optimize the processes of mode change and will contribute to improving the port-city route. In addition, the platform can act as a hub for companies located in the Planalto. This makes the provision of additional services for freight producers possible. A further part of the strategic analysis will show the necessity of rail transport to manage goods flows between Baixada Santista and the Planalto long term.
- Location analysis of the goods transport center

  Six various locations were analyzed in the study. The ZAL should be located in the inland waterway area of Santos. Of the six locations, according to ALG Location 5 has the most advantages. These advantages are primarily seen to be its good location and the good transport connections. In addition, the location is suitable under long term viewpoints because there is enough land available. The public sector should develop the necessary instruments to promote the location in accordance with the program model. The ZAL is seen as an essential chance to ensure transport flows around the port in the short to medium term. The size of the land should be selected so that future expansion of the ZAL is possible.

- Functional presentation of the goods transport center

  To be able to offer logistics services, areas for processing goods in the container yard and in the warehouses are to be foreseen. The short term need of a truck and service center was also identified in the study. To steer transport flows it recommended setting up a new outer port in the ZAL. It is possible to offer alternatives to road transport (by rail or waterway) to connect the ZAL with the various port terminals, if demand requires this.

The results published in the final report are presented in the chapter “Development of a Port Logistics Platform (Logistics Activity Zone)”.

2.7 Study "Serra do Mar crossing" by AG[10]

On the basis of the expected rise of port handling from 83 million t currently to 240 million t in the next 15 years and particularly with reference to the burden on the road mode of transports, alternatives are presented in the study "Serra do Mar crossing". The following alternatives for transport – of containers in particular – from and to the port of Santos will be reviewed:

- Transport by water between the port of Santos and Serra do Mar.
- Building logistics platforms at the foot of the peak of the coastal mountains (Serra do Mar).
- Transporting via guidance systems or monorails in tunnel sections in the coastal mountains.
- Division between rail and road according to needs in the coastal mountains.

Furthermore, the following pre-studies and calculations are recommended:

- Needs study and advance calculation of medium transport volumes and freight handling in the port of Santos (summary of the freight carried, carriage volumes, analysis of the most important sources of demand and provisions, analysis of the effects on the surrounding area).
- Analysis of environmental protection provisions and environmental guidelines (budget planning in the event of any compensation necessary, environmental compatibility studies, assessing solutions with the fewest effects on the rain forest etc.).

[10] Andrade Gutierrez (AG), Preliminary Report "Serra do Mar crossing", not finished yet.

- Identifying the capacities necessary (transport capacities, calculating the storage areas in the logistics platforms, calculating the number of tunnels, identifying the facilities required for water transport, study of the facilities required for transport from the foot to the peak of the coastal mountains).

- Budgeting the investment and preparing a schedule.

- Identifying operating costs (labor, consumables etc.) and revenues (carriage and storage of goods, commercial relocations).

- Technical implementation and concepts (topographical measurement, geotechnical investigations, solutions and facilities necessary for water transport and the logistics platforms, route management planning, planning rolling stock).

- Services (describing the services to be provided, defining operational requirements).

- Financial planning (preparing a business plan, risk analysis, calculating taxes and deductions for port operations, establishing a business and finance model etc.).

- Legal aspects (including justifying and selecting the financing model, legal structuring of the project).

3. Current Situation

3.1 Market participants and their strategies

“The rails don’t go far enough into the ports. The roads are congested“[11]

Preamble

According to various current investigations Brazil is investing too little in its transport infrastructure, so that a deterioration of the infrastructure cannot be prevented. In order to prevent further worsening, at least 3% of the GNP should be invested in the infrastructure. This has been calculated by Claudio Frischtak, President of the consultancy InterB in Rio de Janeiro. However, according to Frischtak, on average this has actually been only 2.32% over the past 10 years. In comparison: in China 13.4% was spent in 2010 alone, in India almost 6% and in Chile almost 6.2%. In Brazil 212,000 km of fixed, asphalted roads are available, in contrast in India there are 1,500,000 km of roads, although much smaller in terms of area. While in Germany, which is 24 times as small, there is a 38,000 km rail network available, in Brazil there are only 28,000 km.[12]

[11] Dalmo Marchetti, logistics expert of BNDES

[12] DVZ International 27.08.2011

3.1.1 MRS

MRS operates the mountain route on the left bank. The electrified mountain route consists of one track with a length of around 8 km with a maximum 10% gradient.

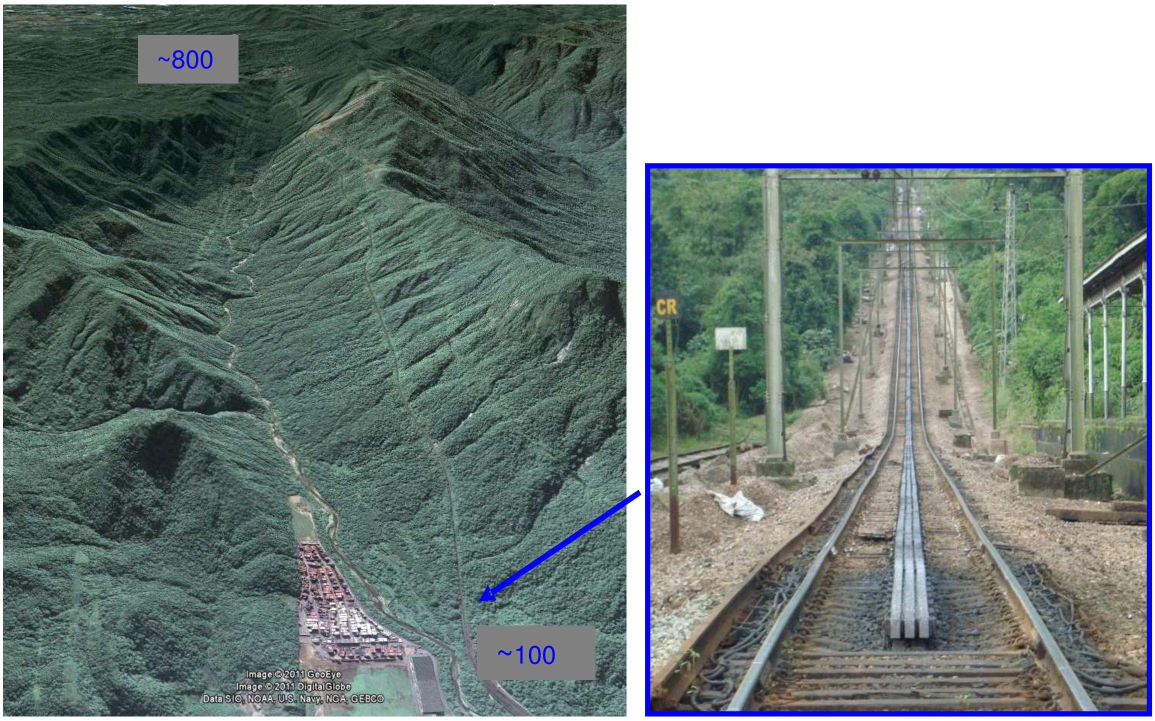


Figure 3: MRS via cog wheel

Due to the age of the existing locomotives (approx. 40 years old) currently a maximum of 14 circuits are possible on the mountain route. One circuit consists of 3 wagon groups of around 500 t.

The time interval here between the individual wagon groups is 6 minutes and one circuit cycle takes a total of 75 minutes. It is assumed that per day and direction approx. 10,500 t can be transported via cog wheel. This corresponds to a carriage performance of approx. 7,350,000 t a year.

The build up of capacity planned by the management will take place in three phases:

According to internal statements in **Phase 1** up to 50 new locomotives will be bought. Up to now 7 locomotives have been ordered from Stadler Rail with an option to order additional locomotives (cf. Projects planned by MRS Logistica S.A.). The locomotives have an output of 5,000 kW and a tractive effort of 350 kN. Thus the locomotives are up to 50% more efficient than the engines used up to now. In **Phase 2** the existing shunting tracks will be built up and new bypasses / meeting tracks will be built. If the government approves the further development plans to build a parallel track in **Phase 3** under environmental specifications, a significant increase in carriage performance will be possible after completion of the parallel track.

In addition, an increase of carriage performance can be reached by optimizing the train control. There is a further possibility in building up the track infrastructure to allow the use of double stack container trains in future as well. This is also to be taken into account in realizing a variant of the connection of the parts of the port (tunnel or bridge).

MRS is the owner of the track infrastructure in the port. Merely the last 2 km are owned by the Port Authority. The provision of transport services is done by a sub-contract to PORTOFER with ALL. However, PORTOFER also leases the other infrastructure from MRS together with ALL.

However, it must be determined that with the current quantities from the SANTOS BRASIL terminal and the future quantities from the EMPRAPORT terminal, the maximum possible transport capacity will already have been reached on the mountain route after final development. This assumes that customers can be convinced that the railroad is a real alternative to the truck.

Currently, according to MRS cooperation with SANTOS BRASIL is difficult because the terminal demands usage fees for its railroad terminal and at the same time an increase in rail traffic in the terminal is not desired. This is also therefore the case because inbound and outbound shunting in the railroad terminal blocks the in/out gates of the terminal as such, interrupting the traffic flow in the terminal. Currently 4 trains per day travel to SANTOS BRASIL.

3.1.2 ALL

ALL sees the main problem in the lack of capacity of the existing track infrastructure in the port area .Even the access track in the pre-shunting yard on the right side is, at around 1500 meters, not sufficiently long to accept the incoming trains. As early as this point the trains have to be divided by laborious shunting. (cf. Figure 4)

Figure 4: Pre-shunting yard right bank

All other tracks, especially in the individual terminals, are not sufficiently long, so that economically sensible shunting operations are barely possible. In addition, the condition of the track is deficient so that the maximum permitted speed of shunting operations is limited to around 5 km/h.

Currently around 1000 wagons/day are shunted or delivered on the right bank. The maximum possible capacity according to ALL – under the given conditions of the infrastructure – is 1,200 wagons/day. Thus the capacity at the moment in the TECONDI terminal is 15 wagons, in the LIBRA terminal 40 wagons (using 2 tracks) and in the SANTOS BRASIL terminal 88 wagons (using 4 tracks).

According to ALL there is an additional problem in the necessity to shunt the trains in and out permanently to deliver individual wagons to the customer because there is no inflow control by the customers.

The mountain route has already been built up with 2 tracks in part and is electrified. However, according to ALL the gradient of the Serra da Cremalheira already has a great influence in the circuit speeds of the trains going uphill. With the development it will be possible to carry up to 16 wagons per train group. The maximum capacity will then be 350 wagons in one circuit. The build up of the infrastructure is largely being financed by the customer UORO VERDE, the largest sugar producer in Brazil.

The current maximum capacity for container traffic on the mountain route is 1000 TEU/day in one circuit. However, in purely mathematical terms 1100-1200 TEU/day are possible.

Together with BRADO LOGISTICA, the terminal already existing in Cubatao will be built up to be able to load the running containers from truck to the railroad and in the other direction (cf. Projects planned by ALL Logistica). After the completion of the terminal a maximum capacity of the mountain route of approx. 1,000,000 TEU/a is planned. In order to be able use the terminal optimally a separate shunting yard has been planned between the mountain route and Cubatao. The trucks will then shuttle the containers to and from the container terminals in the port.

An additional container hub is planned with the partner in ARARAQUARA. To increase transport performance there will be double stack transportation on most routes, if possible.

According to ALL there is also the possibility to clear the bottleneck between Santos and Campinos. Although this one track route has two gauges (1000 und 1600 mm) it should be expanded to two tracks promptly.

In contrast, the route between Mato Grosso and Santos, whose current capacity is around 500 wagons/day, is highly profitable in bulk traffic (+ 20% compared to container traffic), because there are too few roads and too few alternative transport capacities to be able to transport the quantities produced at peak times as well.

3.1.3 Port Authority CODESP

The Louis Berger study provides for a turnover of approx. 230 million tonnes per year by 2024 for an assumed optimistic scenario. The expansion plans include widening the channel in the port to 220 m and deepening it to 15 m by 2012. The passenger terminal will also be extended.

Both banks of the port basin are currently served by ferry connections so that only low transport capacities can be achieved. In addition, the crossing ferries disrupt the routes of the arriving and departing seagoing vessels. A connecting bridge or, alternatively, a tunnel solution has previously been planned. The tunnel solution is preferred by CODESP. The bridge solution is favoured by the customers. The bridge will be operated by CODESP. Both solutions are currently in planning and necessary traffic studies have not yet been compiled. No specific expectations regarding a possible project start date are yet available.

There are, as yet, no sufficient plans for the necessary revision of the infrastructure in the port area. With regard to the additional terminal extension plans, the need for further concessions for container terminals is no longer recognised. Instead, the construction of multi-user terminals, e.g. for vehicle shipment, etc., is planned.

Due to the ongoing complaints from local residents, the relocation of the bulk terminal from the right bank to the left bank during 2025 is being considered.

3.1.4 PORTOFER

PORTOFER is the concession-holder for the 90 km of internal rail track and has four internal rail sidings at the port of Santos. Until 2000, when PORTOFER was founded, the Brazilian railroads had only a small participation in the freight volumes handled in the Port of Santos, something in the order or 3% to 4%. PORTOFER was than created as a terminal railroad operating the trains that came from Ferroban, Ferronorte and Novoeste RRs. This reduced significantly the stopover times for trains passing through the Port. The major commodity exporters, such as Cargill, ADM, Bunge and Copersucar, increased the used of rail transport. In 2007, rail freight is expected to accelerate due to the opening TGG, a high capacity grain terminal built by Bunge, Amaggi and ALL RR.

3.1.5 ECOVIA /ECOPATIO

ECOVIA is the owner and operator of the motorways.

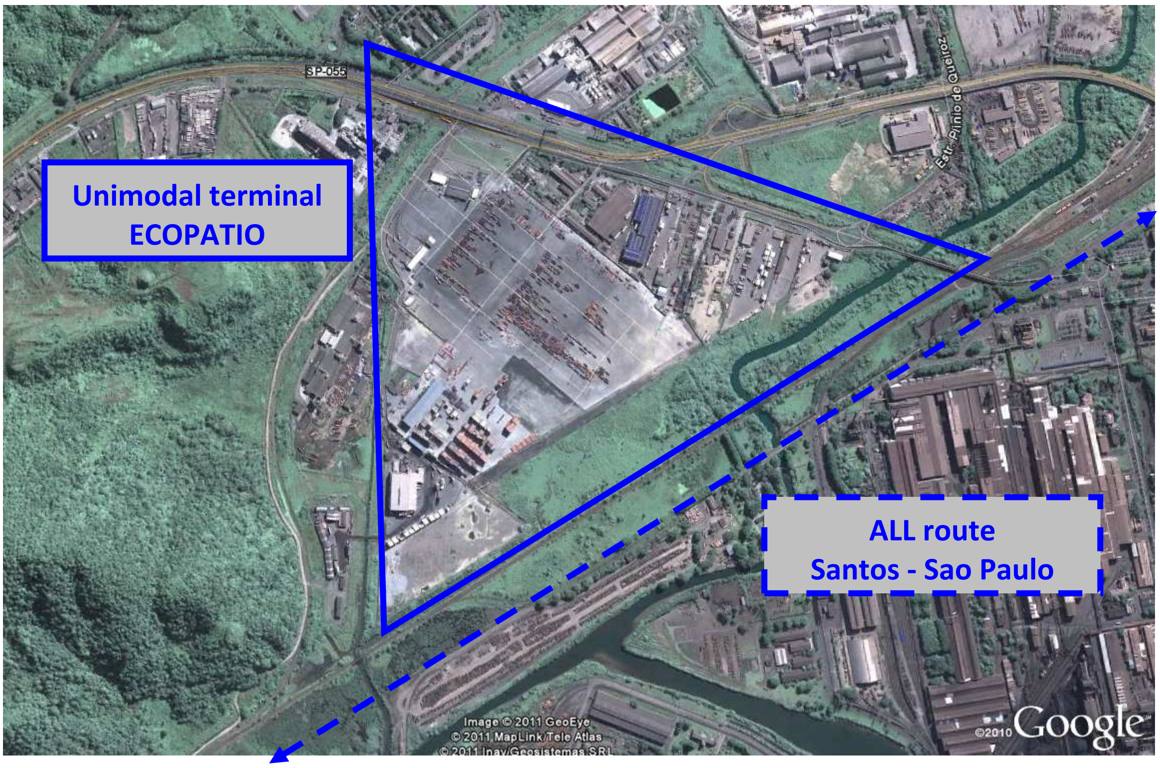


Figure 5: Unimodal terminal Ecovia

The unimodal terminal lies at the foot of the mountain, accessed via the motorway. The area is approx. 500,000 m2 in size. About 1500 trucks are processed at the in/out gates every day. The current processing time per truck is 4.5 hours on average. The costs for this service are borne by the container terminal on behalf of the shipping companies, predominantly MSC, HAMBURG SÜD and HAPPAG LLOYD. The ship owners thereby control the intake of the trucks to the port terminal in order to counteract the TERMINAL HANDLING CHARGES, which are relatively expensive in international terms. ECOPATIO offers a complete container service (x-ray scanning, inspection, cleaning, repairs, empty container depots, stuffing). This also includes the inspection of the loading papers. The trucks are recorded in the EDP with all relevant data after telephone registration. The terminals recall the load by email. This is passed on to the waiting trucks by mobile phone, indicator panel and loud-speaker announcement.

The in-gates will be extended to 10 gates and the out-gate area enlarged during 2012. Also important is the considerable reduction of the processing time using new OCR software in order to make even better use of available capacities.

ECOPATIO plans to extend its terminal by one rail terminal (cf. Figure 25).

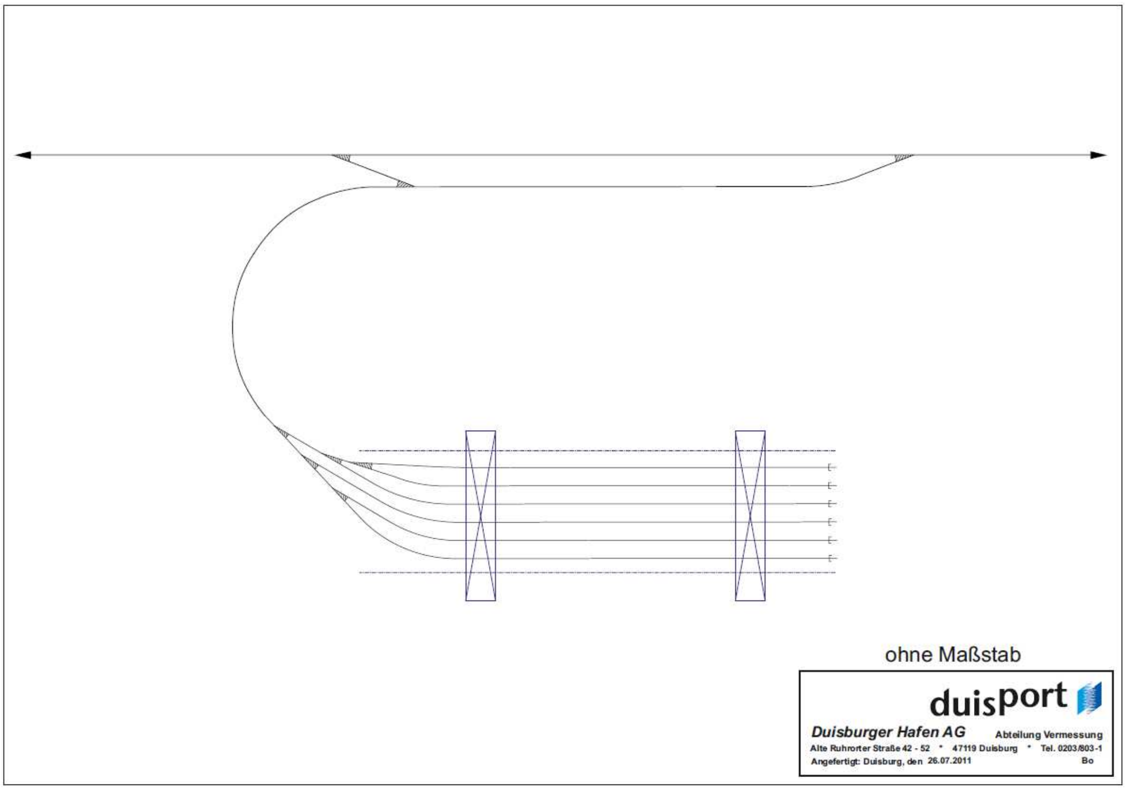


Figure 6: Layout of rail terminal Ecopatio

3.1.6 Terminal operators

BTP

Stockholders: Brasil Terminal Portuário

Location	Right bank
Area	440,000 m²
Quay length	1,500 m
Number of moorings	3
Depth	Up to 15 m
Equipment	12 superpost Panamax container bridges, 53 RTG
Container spaces	Total of 30,880, 1,960 spaces for reefers.
Storage capacity	50,000 m³ for liquid goods

Table 1: Characteristics of the BTP terminal

The terminal is not yet finished. In its initial expansion phase, which will commence operation in February 2013, the terminal will have a capacity of 690,000. A capacity of 1,800,000 TEU is forecast for the terminal incl. all expansion phases in 2024 (cf. Future challenges for the Port of Santos).

No rail connection is scheduled for the terminal. However, management has recognised that a rail terminal could be useful given the previous infrastructure problems for road traffic. As it is now impossible to retroactively implement a rail terminal directly in the container terminal, the leasing of an additional area on the other side of the road is being considered in order to arrange a waiting area for trucks and, alternatively, to preserve the possibility of also processing containers by rail with the construction of at least 2 rail tracks. A tunnel is to be constructed under the city street for this purpose, which is designed so that the containers to be moved can be shuttled using a stacker.

It must be emphasized that the lack of spatial equalisation between rail and road and the resulting performance problems arising in the past few years have led to a negative attitude towards rail traffic. The lack of rail infrastructure and the lack of sufficient shunting-yard capacities in conjunction with the bad state of the railways has certainly also contributed to this. In addition, the relationship between the rail operators and the terminals has suffered sustained damage due to the disproportionate rail service and costs.

Libra

Stockholders: Libra Group

Location	Right bank
Area	170,000 m² (extension to 215,000 m² by 2013)
Quay length	1,100 m (extension to 1,700 m by 2013)
Number of moorings	(4 moorings equipped with container bridges)
Depth	Up to 13.50 m (15m by 2013)
Equipment	7 post Panamax container bridges, 20 RTG and 22 reach stackers
Container spaces	1,200 spaces for reefers.
Storage capacity	2,800 m² of covered storage area

Table 2: Characteristics of the Libra terminal

The Libra terminal consists of quays 33, 35 and 37. The current capacity lies at 915,000 TEU per annum and is to be extended to 1.7 million TEU by 2013 through the construction of quay 36 (Prainha). A capacity of 2.39 million TEU is forecast for 2024 (cf. Future challenges for the Port of Santos). The terminal has no direct connection to the ALL and MRS rail network as the rails bypass the terminal entirely.

Expertise:

- operation of containers and loose cargo (warehouse specialized),
- cargo positioning and stripping,
- storage of dangerous cargo.

Santos Brasil

Stockholders: Santos Brasil Participações S.A.

Location	Left bank
Area	596,000 m²
Quay length	1,294 m
Number of moorings	4
Depth	Up to 13.50 m (15m by 2013)
Equipment	34 RTG, 22 reach stackers, 14 gantry cranes and a mobile crane.
Container spaces	2,000 spaces for reefers.
Storage capacity	12,000 m² of covered storage area

Table 3: Characteristics of the Santos Brasil terminal

Current capacity amounts to about 2 million TEU per annum. The potential capacity on extending the terminal (Conceiçãozinha project) could lie at up to 4.7 million TEU per annum (cf. Future challenges for the Port of Santos). The terminal has a rail connection with its own rail terminal including 4 tracks at the terminal, a 22 wagon capacity and 2 rail-bound gantry cranes with a lifting capacity of 30.5 t. This means that by using a spreader, the carrying capacity is not sufficiently dimensioned to also operate 40 foot containers. In addition, the terminal has a vehicle terminal with a total area of 164,000 m² (quay length: 310 m) and a capacity of 290,000 vehicles.

According to management, the railway companies are too inflexible and expensive. It is expected that the rail terminal will be repositioned outside the terminal area. According to Santos Brasil, the rail operation constantly disrupts the traffic flow in the terminal as the gates are blocked during shunting and the overall shunting movements take up too much time. The gate area is blocked for at least 30 minutes when shunting to the bulk terminal takes place in the pre-stacking area, resulting in up to 100 trucks accumulating in the terminal and on the street within this time frame. An average of about 3000 moves/day occur in the truck area and up to 4,500 moves/day are possible at peak times. 88% of the trucks are dispatched within 2 hours and in the remaining cases processing time takes up to 4 hours. A particular problem according to Santos Brasil is the legally prescribed control of agricultural products. All containers have to be opened. If anything is wrong, clarifying the queries can take up to 7 days as the

state inspectors are only available 4 hours a day. If the intake of seagoing vessels and customs clearance were optimised it would be possible to handle up to 3,000,000 TEU/a with the current equipment. This represents a performance increase of approximately 50%.
An online booking system has been in operation since the spring 2011 in order to transmit all the necessary information to the PA. Over 60 companies at the port have access to this.

Embraport

Stockholders: Odebrecht Transport, DP World and Coimex-Group

Location	Left bank
Area	200,000 m² (1st expansion phase) 800,000 m² (2nd expansion phase)
Quay length	650 m (1st expansion phase) 1,100 m (2nd expansion phase)
Number of moorings	2 piers for liquid bulk cargo.
Depth	-
Equipment	-
Container spaces	-
Storage capacity	342,000 m², 60,000 m³ for liquid goods

Table 4: Characteristics of the Embraport terminal

The terminal has not yet been completed and should commence operation in its first expansion phase at the end of 2012-start 2013. Final completion is planned for 2015. Apart from containers, the terminal primarily intends to process ethanol. The capacity is expected to lie at about 1.74 million TEU and 2 billion m³ of ethanol in 2024. (cf. Future challenges for the Port of Santos) The possibility of integrating a rail terminal is provided for with a reserved area of 100,000 m².

Tecondi

Stockholders: Terminal para Contêineres da Margem Direita S./A.

Location	Right bank
Area	150,000 m^2
Quay length	-
Number of moorings	3 private and 3 public moorings
Depth	-
Equipment	8 mobile cranes, 31 reach stackers
Container spaces	348 spaces for reefers.
Storage capacity	5,700 m^2 of covered storage area

Table 5: Characteristics of the Tecondi terminal

The terminal has rail facilities with a total length of 1,150 m. Capacity is expected to be about 930,000 TEU in 2024.

The management sees the development of the interaction between the rail and truck traffic on entering the port as the main problem. For this reason the entire traffic flow is to be completely reviewed and reorganised in the port area. This obviously also involves investment in new and efficient infrastructure. According to Tecondi, a logistics platform is not currently a solution to the traffic flow problem and may even aggravate the problem. In addition, a logistics platform, with its additional handling, is not seen as an economical alternative. Furthermore, according to Tecondi, this will lead to a distortion in competition if this type of platform is not provided to everyone in a neutral manner, free from discrimination. To this extent, any potential operator must be free of any conflicts of interests.

Rodrimar

Stockholders: Grupo Rodrimar

Location	Right bank
Area	70,000 m²
Quay length	325 m
Number of moorings	-
Depth	10.80 m-11.50 m at low tide, max. 12.20 m
Equipment	3 mobile cranes, 14 reach stackers
Container spaces	6,500 spaces for containers, 220 spaces for reefers
Storage capacity	3,000 m² of covered storage area for general cargo, 890 m² of covered storage area and a high-bay warehouse for 1,000 palettes.

Table 6: Characteristics of the Rodrimar terminal

The Saboó project terminal of the Grupo Rodrimar has not yet been completed and is expected to extend the existing terminal from 2013. Capacity is forecast at 500,000 TEU for 2024. Apart from containers, general cargo and project cargo can be processed in the terminal.
According to Rodrimar a problem with regard to the use of rail logistics is that there are, as yet, no regular rail connections, i.e. timetables. In addition, the present frequency of rotation is far too low in order to shift the pending volume to the railway in a sustainable manner. This is aggravated by the fact that the present cost structure of private providers with regard to the truck agents is not competitive due to the costs and inefficiency. The reason for this is primarily the additional handling/moves required. As a result, the railway is not considered an alternative to road transport for distances of up to 500 km due to the additional costs. Furthermore, according to Rodrimar, the capacity of suitable rolling stock is too low and not adapted to the actual needs of the terminal customers. As a result, a truck takes 3-4 hours to run between Campinas and Santos and 20-24 hours by rail.

Night loading and night bookings should be possible in order to optimise the rail system. However, this has not previously been offered by the railway operators.

In addition, the bureaucracy connected with rail logistics is far too time-consuming. Trucks are much more flexible in this regard.

Expansion of container terminals[13]

In the following sub chapter the capacities of the terminal for 2010 and the forecast capacities for 2013, 2019 and 2024 will be shown.

Currently the port of Santos has four container terminals. The market participant Libra Terminais has its location on the right bank[14] and currently has an annual capacity of approx. 915,000 TEU. Up river on the opposite side is the Santos Brasil Terminal. This terminal currently has a capacity of 2,000,000 TEU. Further up river the Tecondi and Rodrimar terminals are on the right bank. The Tecondi terminal has a capacity of 600,000 TEU and the Rodrimar terminal a capacity of 200,000 TEU. The total capacity for 2010 thus amounts to 3,715,000 containers. In addition to the expansion of the existing container terminals Santos Brasil, Libra and Tecondi, new terminals are also going to be built. By 2013 the terminals of the market participants BTP on the left bank and Embraport on the right bank will be completed. The concession of the terminal operator Rodrimar will expire so that this terminal will not provide any capacity any more. Instead of this the Saboó terminal will be rebuilt. At the current point in time however, the terminal is still in the project planning phase, so that it cannot be conclusively said whether it will be realized. Furthermore, the two terminals Prainha and Conceiçãozinha, which are intended to expand the Libra and the Santos Brasil Terminal, are in the project planning phase. The capacities of the projected terminals have been included in the calculation of the total capacity. Thus a total capacity of 7,600,000 TEU is expected in 2013. The distribution of capacities to the individual terminals can be taken from the table below (cf. Table 7). A renewed expansion of the terminals to a total of 11,640,000 TEU is foreseen for 2019. The available capacity will only be

[13] Source: Port authority.
[14] For further information regarding to the location of the terminals see the “Detail plan of Santos” in the appendix.

increased minimally from 2019, so that in 2024 a capacity of 12,060,000 TEU is forecast. The slight decline in the capacities of the Libra, BTP and Embraport terminals is attributable to the corresponding perspective of the forecast. (cf. Table 7, Figure 7)

Terminal	**Capacity**			
	2010	**2013**	**2019**	**2024**
Santos Brasil	2,000,000	2,200,000	2,300,000	2,500,000
Conceiçãozinha (project)	-	*1,500,000*	*2,200,000*	*2,200,000*
Santos Brasil + Conceiçãozinha	**2,000,000**	**3,700,000**	**4,500,000**	**4,700,000**
Libra T35 und T37	915,000	1,420,000	1,410,000	1,390,000
Prainha (project)	-	*200,000*	*800,000*	*1,000,000*
Libra + Prainha	**915,000**	**1,620,000**	**2,210,000**	**2,390,000**
Rodrimar	200,000	-	-	-
Saboó (project)	-	*300,000*	*450,000*	*500,000*
Rodrimar + Saboó	**200,000**	**300,000**	**450,000**	**500,000**
Tecondi	**600,000**	**600,000**	**920,000**	**930,000**
BTP	**-**	**690,000**	**1,810,000**	**1,800,000**
Embraport	**-**	**690,000**	**1,750,000**	**1,740,000**
Total	**3,715,000**	**7,600,000**	**11,640,000**	**12,060,000**

Table 7: Capacity of terminals[15]

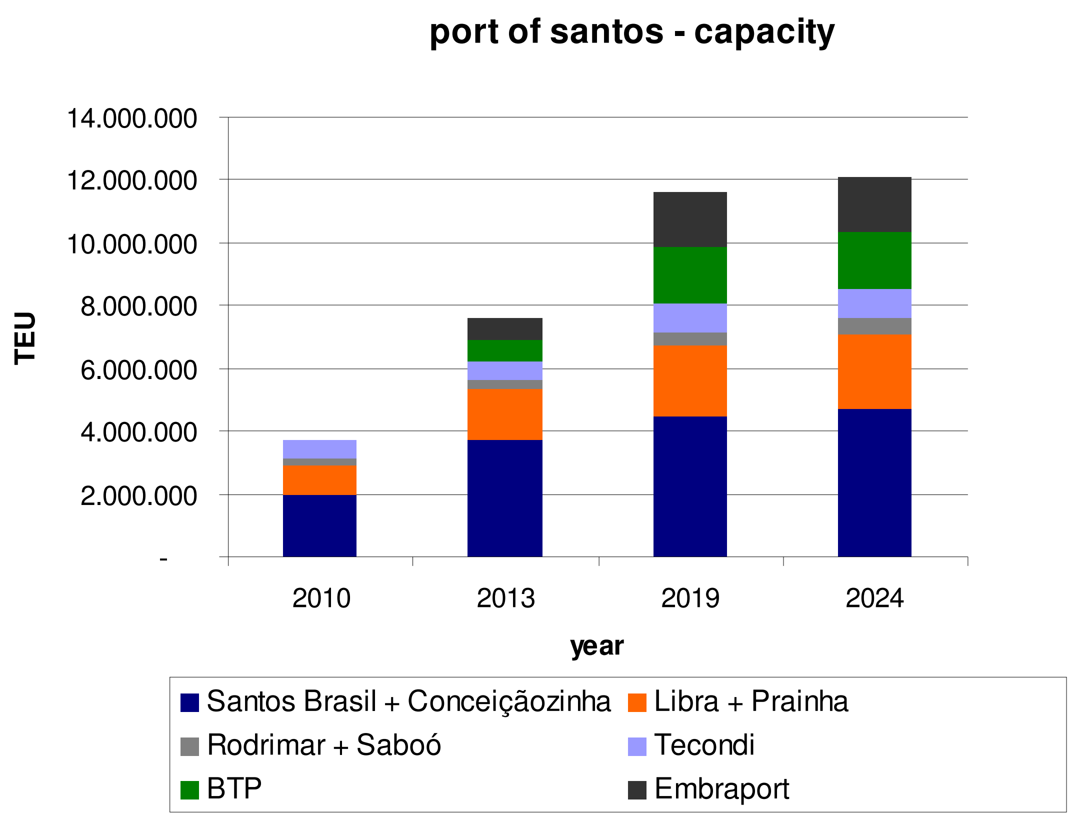


Figure 7: Capacity of terminals

[15] Source: Port authority.

3.1.7 Characteristics and interrelationships

With the acquisition of the EICHENBERG Group in July 2011, KÜHNE & NAGEL extended their road transport route offer and thereby the trend to multi-modal logistics. The optimisation of multi-modality under one roof was certainly also the reason for the merger of the OURO VERDE Group with ALL, in road transport, to the joint venture company RITMO LOGISTICA. The merger of STANDARD LOGISTICA with ALL resulted in BRADO LOGISTICA, the largest logistics company in Brazil. At the end of 2010, ECOPATIO acquired the logistics company COLUMBIA-LOGISTICA INTEGRADA as part of a restructure. COLUMBIA operates 11 bounded warehouses, numerous distribution centres and has several truck companies. This has turned a pure financier and operator of motorways into a complete logistics chain provider. After the complete integration of COLUMBIA, whose share of sales accounts for approx. 50% in the new Group, this share is expected to increase to 70%. The focus is clearly on the construction and expansion of logistics.
This means that more and more integrated logistics groups or corporate alliances are arising that have direct access to infrastructure. This allows these groups to exercise considerable and constant influence on the market in that, for example, group-owned trucks are not charged a toll on the group-owned motorways, while competitor truck traffic is made significantly more expensive by the toll charges. All of these activities would then no longer be able to be controlled by a central authority.

Deutsche Bahn AG / Berlin can be taken as an example. With the sub-group Deutsche Bahn Netz AG, the Group controls about 38,000 km of the public rail network as well as almost all important hubs such as shunting yards and bi-modal terminals. At the same time, DB Energie AG provides power to the overhead rail lines. The payable energy costs are a further instrument that allows group-owned trains to travel with cheaper electricity while the almost 400 European private railways have to pay regular prices. With its subsidiary DB Schenker AG, the Group also owns one of the largest trucking companies in Europe, which means that it is in a position to ensure supply and removal in the area. This leads to an ongoing distortion of competition in Germany, which should be remedied by the European Anti-Discrimination Law.

Shifting effects in land container traffic

The transport of containers to and from the terminals currently lies at about 140,000 TEU/a. For a total throughput of about 3,150,000 TEU/a in 2010, this corresponded to a rail/road modal split of approx. 4.4%. According to information currently available, the infrastructure expansion planned by ALL and MRS should result in at least approx. 3,000,000 TEU/a being carried by rail in 2024. As both CODESP as well as others have previously assumed that a throughput of more than 9,000,000 TEU/a would be possible in 2024, this corresponds to a railway increase by a factor of 22 between 2010 and 2024. From a purely mathematical point of view, this would result in a modal split share of about 30 % of total container traffic. This percentage shift from road to rail would be a notable advantage for the realisation of the planned volume growth for SANTOS. However, at the same time, it must be considered that approx. 6,000,000 TEU/a will continue to be transported by road. This would correspond to an increase of road transport compared to 2010 of currently approx. 3,000,000 TEU to more than 6,000,000 TEU/a. This represents an increase of 100 %: Neither the existing motorways nor the inner-city road system in SANTOS would have the capacity to support this increase. The collapse of the road system is therefore apparently inevitable if considerable funds are not invested in the expansion of the road infrastructure and its highly efficient traffic control.

The current plans of ALL, MRS and ECOPATIO must be considered with regard to the effects of the road/rail shift described above. The previous planning by ALL on the expansion of the bi-modal railway terminal in Cubatao provides for the shuttling of the containers to and from the port and terminal via truck. This would mean an approx. 1,000,000 TEU/a additional trucks in the port area. If MRS evaluates its future container traffic as exclusively rail-related then this must at least be recalculated for trains to/from the ECOPATIO. ECOPATIO also expects that its previous concept with regard to the exit to the port will not change. This shift from the rail back to the road for the last mile also increases the truck traffic on the roads in the port area.

3.2 Current projects to increase capacity

3.2.1 Projects planned by MRS Logistica S.A.

Rolling stock investments

MRS Logistica S.A. has ordered 7 Stadler Rail locomotives incl. one option for further locomotives for use on the Santos-Sao Paulo-Jundiai rack railway route. The locomotives have a capacity of 5,000 kW and a tractive force on starting of 350 kN. This means that the locomotives are 50% more powerful than those currently being used. Furthermore, the locomotives have two gear drive systems and two additional adhesion drives that provide up to 25 % of the traction in the rack operation. The regenerative ability also means that significant energy saving will be possible. The locomotives are to be delivered in 2012-2013. (cf. Website of Stadler Rail[16])

The delivery of a total of 90 type AC44i locomotives is scheduled by the manufacturer GE in 2011. In addition, 522 type HAT and GDT wagons have been ordered from the manufacturer AmstedMaxion. (cf. Immediate Release 2Q/11 and 3Q/11[17])

[16] http://www.stadlerrail.com/media/uploads/news/2010-02-26_Stadler_baut_Mega-Lok.pdf
[17] http://www.mrs.com.br/ingles/interna.php?nomPagina=noticias/index.php&IdSecao=6

Infrastructure investments

MRS is primarily investing in existing infrastructure and signalling technology. The new technology ensures higher safety in the rail operation and enables the capacity extension of the existing rail routes. The so-called MRS 2015 plan exists in addition to this. The following projects are set out in this plan, which is a continuation of the MRS 2012 plan:

- construction and development of the Japeri connection infrastructure.
- construction of a second track for the Guanda connection.
- construction of the Brisamar connection.
- construction of the Vargem Alegre and Volta Redonda route.
- construction of the P1-5A crossing station.
- the construction of a third P1-06 line.
- the construction of a second track between Casa de Pedra and Caetano Lopes and the connection to Ferrovia de Aço.
- the construction of a second track for the connection to Ferrovia de Aço.
- elimination of electrical impairments between Jeceaba and Arrojado Lisboa and the construction of a second track to this connection.

Depending on the future appearance and the survey of the "Serra do Mar crossing", the capacity of the Santos-Sao Paulo-Jundiai rack route will be increased by the construction of crossing stations. In a further phase, the total route could be extended to a double track. However, this depends on approvals that are not yet available.

3.2.2 Projects planned by ALL Logistica

Rolling stock investments

New wagons for transporting sugar will be procured in coordination with Rumo. These have up to 30% more capacity and allow for unloading that is 30 times quicker. In addition, 50 AC-44 locomotives will be procured from GE by the end of 2011.

Infrastructure investments

ALL Logistica is planning and will realise the following projects with regard to the extension of infrastructure:

- new construction of a connection between Araguaia and Rondonopolis to a total of 260 km in length (ALL Malha Norte division).
- construction of a logistics platform in Itirapina to consolidate the rise in sugar and transport from Sao Paulo to the Port of Santos in cooperation with Rumo (cf. rolling stock investments). In addition, a new terminal for loading and unloading sugar at the Port of Santos is to be developed. For example, a roof construction at the landing point is being tested in order to be able to carry out the loading process regardless of the weather conditions.
- the provision of transport logistics (iron ore) by ALL for the Corumbá route to the port of Santos and Rio de Janeiro by revising the North Metric route network.
- the currently existing bi-modal terminal in Cubatao is to be expanded in cooperation with Standard Logistics (Brado Logistica). This will result in investment in the railway infrastructure and in the expansion of the deep freeze warehouse, among others.
- ALL is planning the construction of another shunting station at the southern border of Santos.

- the increasing arrival of containers requires an extension of capacity. ALL is planning to establish consolidation platforms (cf. Figure 42) in order to bring together containers from the hinterland and transport them from there to the Port of Santos and other ports using double stack wagons. The platforms will also enable integrated logistics services.

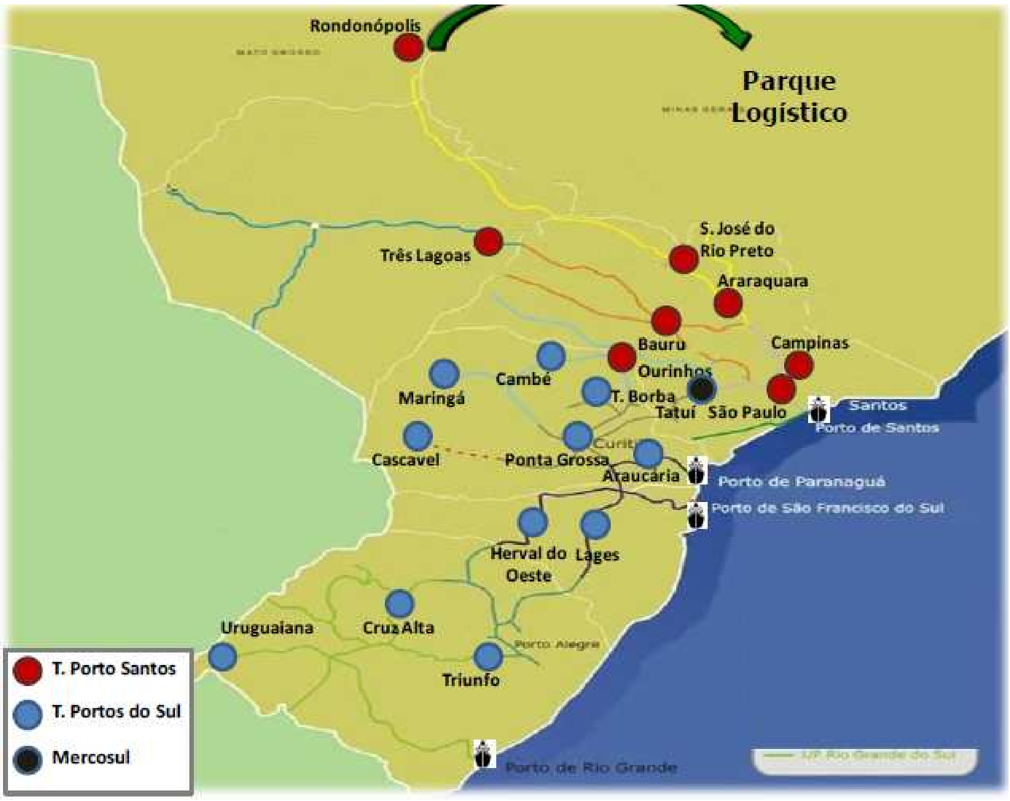


Figure 8: Potential locations for consolidation points[18]

[18] Business presentation ALL: http://ir.all-logistica.com/all/web/arquivos/Apresenta%E7ao%20Paulo%20Bas%EDlio%20eng.pdf

3.2.3 Projects planned by state of Sao Paulo

Road projects

Road Ring Sao Paulo

To meet the future requirements of infrastructure, various future infrastructure projects have been planned. The road ring (Rodoanel Mário Covas) around the city of Sao Paulo is the largest project planned. The ring (cf. Figure 9) has already been partially completed. This concerns the West (yellow line) and South section (dark blue line). The East section is currently under construction (bright blue line). The overall length of the road ring is set to be 176 km. (cf. Germany Trade and Invest[19], Rodoanel[20])

Figure 9: Rodoanel Mário Covas[21]

[19] http://www.gtai.de/DE/Content/__SharedDocs/Links-Einzeldokumente-Datenbanken/fachdokument.html?fIdent=MKT200905258001
[20] http://www.rodoanel.sp.gov.br/portal.php/sobre
[21] http://www.socioambiental.org/website/noticias/brasil/imagens/rodoanel.jpg

In addition, the following infrastructure projects are planned:

- SP-150 (Rodovia Anchieta) and SP-05: Development and adaptation of the interchange of the motorways SP-150 (km 55) and SP-055.
- SP-055: Development of the route section at km 270-274 (Rodovia Padre Manoel da Nóbrega), the route section at km 262-270 (Rodovia Cônego Domenico Rangoni) and the section at km 274-292 (Rodovia Padre Manoel da Nóbrega).
- SP-150: New construction of the Rubens Paiva Bridge at km 60 of SP-150.
- SP-055 and BR-101: Development and adaptation of the interchange of the motorways SP-055 (km 248) and BR-101.
- New construction of the Santos-Guarujá Bridge: Development of a bridge between Santos and Guarujá (to date could only be reached via ferry link or with detours).

Rail projects

In addition to the optimization of the road network, the rail network in the state of Sao Paolo is also to be optimized. The rail ring around the city of Sao Paolo is the largest project planned. The "Ferroanel Metropolitano de Sao Paulo" was originally developed in the 1960s / 70s and is to complement the existing CPTM, MRS and Ferroban routes so that a rail ring around Sao Paolo is created. To date the project has not been completed. In particular the sections to the North and South (cf. Figure 10, dashed red and green line, red line) have not been realized e.g. due to high costs of property expropriation. The development of the northern route network is set to start in 2012 and respectively be completed in 2014. Only then shall the development of the southern section of the Ferroanel commence. This section will partially run parallel to the motorway ring (red line). (cf. Germany Trade and Invest[22], Revisto Ferroviaria[23])

Figure 10: Road and rail ring of Sao Paulo[24]

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[22]http://www.gtai.de/DE/Content/__SharedDocs/Links-Einzeldokumente-Datenbanken/fachdokument.html?fIdent=MKT200905258001
[23]http://www.revistaferroviaria.com.br/index.asp?InCdEditoria=11&InCdMateria=14596
[24] http://img204.imageshack.us/img204/4161/14smtf080904t01.png

In addition, the following projects regarding rail systems are planned[25]:

Track section Paratinga-Perequê, ALL (cf. Figure 11)

Figure 11: Track section Paratinga-Perequê[26]

Measures for 2010

- Removing market entry barriers
- Increase of the permissible speed to 50 km /h.
- Implementation of central traffic control (CTC)
- Authorization for trains with a total weight of 8,000 t or 85 railway carriages per train.

Measures for 2011-2012

- Dual track development of the section Gladson de Moraes and Perequê for 10 km
- Authorization for trains with a total weight of 10,000 t or 100 railway carriages per train.

Measures for 2013

- Dual track development of the section Gladson de Moraes and Paratinga for 8.5 km.

[25] CODESP, 2009, item 4.2, ALL-Portofer, 2008
[26] ALL track map

Track section Perequê-Valongo, ALL (cf. Figure 12)

Figure 12: Track section Perequê-Valongo[27]

Measures for 2010

- Increase of the permissible speed to 40 km /h.
- Authorization for trains with a total weight of 8,000 t or 85 railway carriages per train.

Measures for 2011-2012

- Dual track development of the overall track section for 19 km
- Increase of the permissible speed to 50 km /h.
- Authorization for trains with a total weight of 10,000 t or 100 railway carriages per train.

Measures for 2013

- Authorization for trains with a total weight of 12,000 t or 120 railway carriages per train.

[27] ALL track map

Track section Perequê-Conceiçãozinha, ALL (cf. Figure 13)

Figure 13: Track section Perequê-Conceiçãozinha[28]

Measures for 2010

- Increase of the permissible speed to 30 km /h.
- Authorization for trains with a total weight of 8,000 t or 85 railway carriages per train.

Measures for 2011-2012

- Increase of the permissible speed to 40 km/h in 2011 and to 50 km/h in 2012
- Development of a lay-by track between Piacaguera and Ilha do Barnabé
- Authorization for trains with a total weight of 10,000 t or 100 railway carriages per train.

Measures for 2013

- Authorization for trains with a total weight of 12,000 t or 120 railway carriages per train.

[28] ALL track map

4. Main Bottlenecks

4.1 Lack of capacity of hinterland connections

4.1.1 Introduction

To determine the future challenges of increasing volume of Port of Santos until 2024 a model will be created first of all. The model is based on a feed hopper model explaining the impact of increasing tonnage volume on the mode of transport. The feed hopper should clarify that the forecast volume of bulk goods and containers will have effects on the rail and road transportation. In other words an input of tonnage volume will cause an output of tonnage volume. With the help of the import for example, bulk goods and containers have to be transported from Port of Santos to Sao Paulo or the hinterland. But today's capacity of the mode of transport will not be sufficient to handle the amount of tonnage in the coming years.

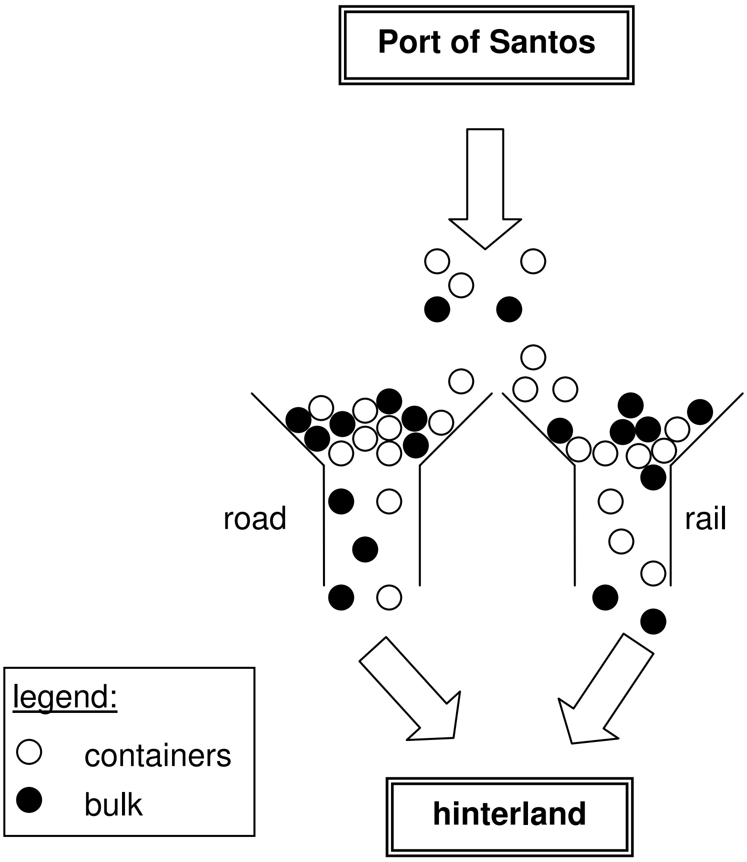


Figure 14: Feed hopper model to map the flow of goods

4.1.2 Assumptions of the calculation

In the next step a calculation is used as a basis to determine the volume of tonnage that has to be handled. The calculation is mainly based on the assumptions given in the Louis Berger study[29]. The results of the calculation should determine the amount of containers that cannot be carried on rail or road. In other words, a difference indicates that the capacity of the transport mode is exhausted and that alternative options for transporting containers to the port of Santos and the hinterland should be identified (cf. chapter 10).

The calculation is based on four scenarios. At first it the flow rates and capacities of 2010 and 2024 will be considered. Within a given period it will be differentiated in two different scenarios. In scenario I for 2010 and 2024 it is assumed that only bulk is transported by rail (if there is enough capacity). If capacity is not sufficient bulk will be transported by road. In the event of spare capacity containers will be transported by rail. Otherwise, containers will be transported by road. In the event of insufficient capacity the existing modes of transport will have to be extended or an alternative transportation system should be clarified. In scenario II bulk goods are separated under the restriction of 80 % on rail and 20 % on road. According to this containers are distributed to 20% on rail and 80% on road. It will be assumed that remaining capacity will be charged with additional capacity. Due to the fact that the results are the same as in scenario I for each year but the distribution of the amounts on the transport mode can diversify in the two scenarios. Furthermore, the calculation will reconcile the target amount one the one hand and the actual amount on the other. The target volume is the amount that must be provided by the mode of transport. The actual volume is the amount that is provided by rail or road.

[29] Cf. chapter 3

The following assumptions are used to calculate the target amount:

The average weight of one container in 2010 will be assumed to be 10 tons for imported containers and 10 tons for exported containers. The values[30] are the result of the tonnage volume determined by containers in 2010 (cf. Figure 15) and the amount of containers in 2010 (cf. amount of containers below). In 2024 the average weight will be assumed to 10 tons for imported containers and 12 tons for exported containers. The increase of the average weight of exported containers is due to the substitution effect of containerizing bulk goods. The average weight of one container is necessary in order to calculate the amount of containers in an overall tonnage volume of containers (vice versa).

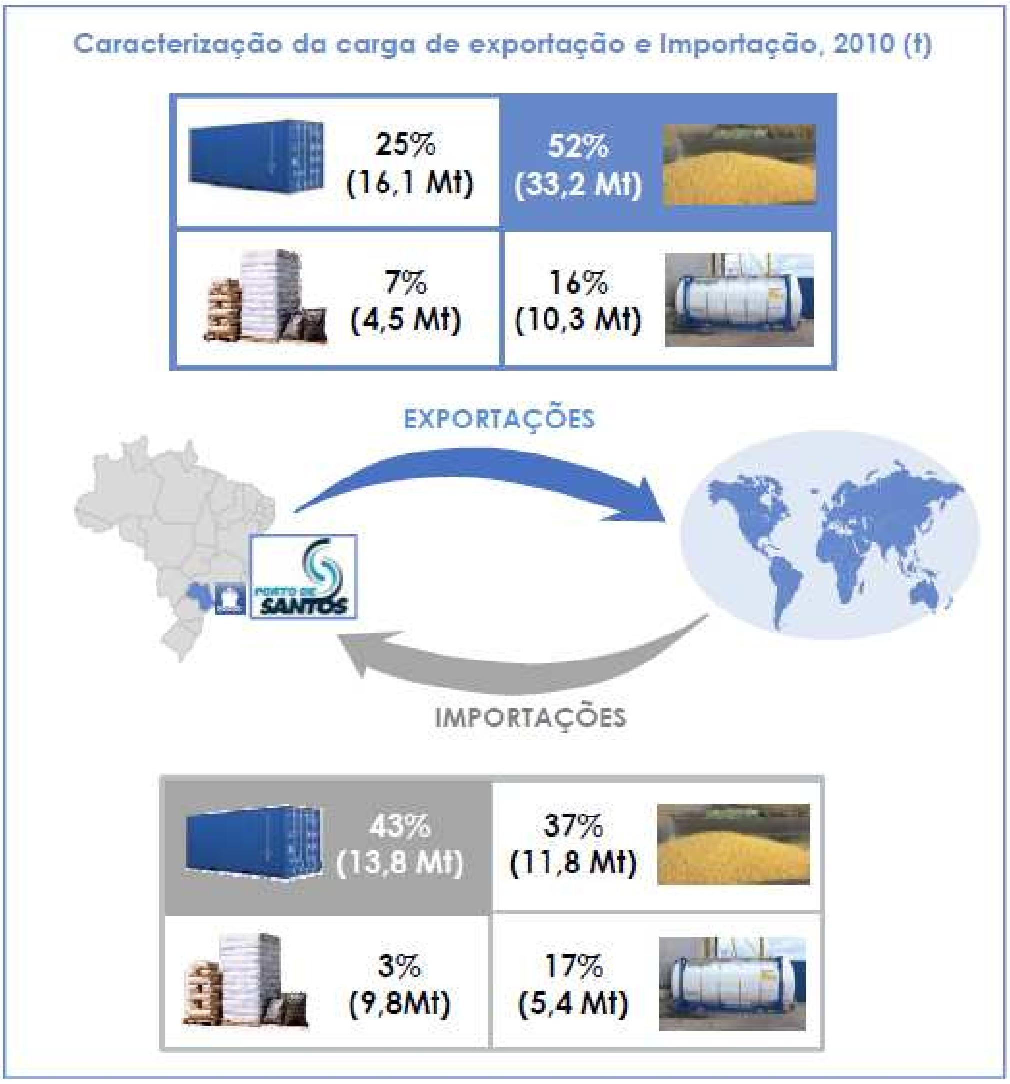
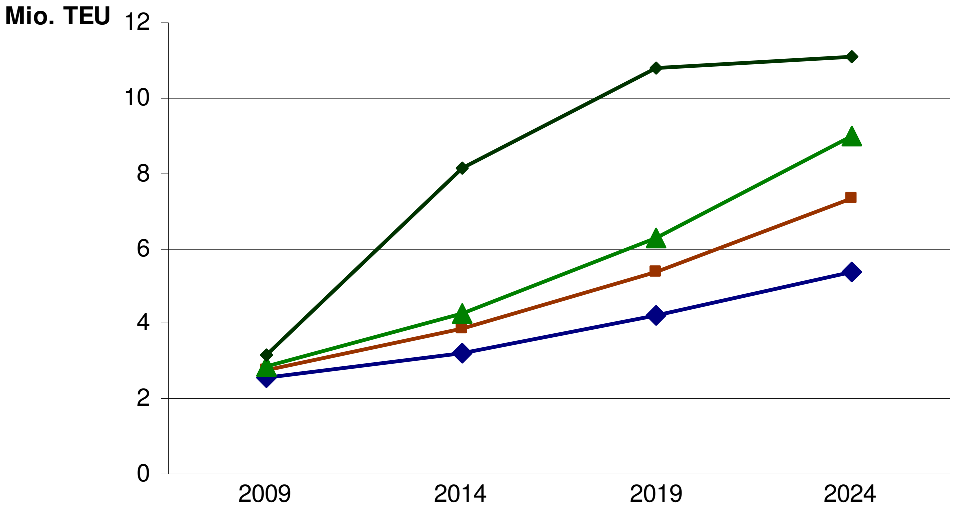


Figure 15: Trade balance of port of Santos[31]

[30] Rounded up values.
[31] Feasibility study ZAL, p. 23

To determine the volume of bulk goods in port of Santos the balance of trade in 2010 will be used (cf. Figure 15). The total bulk volume results from the addition of bulk solids, palletized goods and liquid materials. Thus a total bulk volume of 75 million tonnes in 2010 and 194 million tons in 2024 will be calculated. The 2024 value is based on the optimistic growth given by the Louis Berger study.

The forecasted amount of containers in 2010 and 2024 is also given in the Louis Berger study (cf. Figure 16).



	2009	2014	2019	2024
pessimistic	2,57	3,19	4,22	5,39
base	2,74	3,86	5,38	7,32
optimistic	2,87	4,25	6,29	9,01
installed	3,14	8,11	10,81	11,11

Figure 16: Forecasted amount of containers[32]

The calculation is based on the optimistic growth given in the chart. The amount of containers projected for 2010 is up to 3.15 million TEU. The overall volume in 2024 can be seen in the chart. One of the main drivers of the forecasted amount of containers is the effect of containerizing bulk goods (see above). It is assumed that the volume of bulk goods carried in containers will increase. Thus the containerized bulk goods will be established to a value of 5% in 2010. In 2024 the contingent of containerized bulk goods will be 20%. To split the amount of bulk goods and containers to import and export flows, it will be assumed that bulk goods are allotted to 36% import and 64% export. The

[32] Cf. Louis Berger Study, p. 449

amount of containers will divided into 46% import and 54% export. These values have been calculated on the basis of the balance of trade given in Figure 15.

The following assumptions have been used to calculate the actual amount:

To calculate the actual amount of bulk goods and containers that is provided by rail and road per year working days will be assumed to 350 days on rail and 300 days on road. The reason of fewer working days on road is due to statutory regulations. The transport performance on rail will be assumed as follows:

	ALL	MRS
2010	10 trains per day/direction	7 trains per day/direction
2024	20 trains per day/direction	12 trains per day/direction

Table 8: Transport performance provided by rail

Furthermore, it has been assumed that one ALL train can carry 3,000 tons on average and one MRS train 1,500 tons on average. The transport performance on road is based on a traffic count in 2010[33]. It will be assumed that 3,000 trucks will move to the hinterland in each case per day on the highways Imigrantes and Anchieta. On the way to the Port of Santos 6,000 trucks will move on average to Anchieta. On the Imigrantes highway it is not permitted to drive with a truck towards Santos because of the downhill gradient (6.5 %). The useful load of a truck is assumed to 30 tons on average.

Working days			
Rail [days/year]	350		
Road [days/year]	300		
Transport performance provided by rail	Number of trains (upward run/import)	Number of trains (downward run/export)	tonnage carried by one train [t]
ALL	20	20	3.000
MRS	12	12	1.500
Transport performance provided by road	number of trucks (upward run/import)	number of trucks (downward run/export)	tonnage carried by one truck [t]
Anchieta (SP-150)	3.000	6.000	30
Imigrantes (SP-160)	3.000	0	30

Table 9: Basic assumptions

[33] 11.000 trucks and 65.000 cars per day each direction.

4.1.3 Results and analysis

The calculation can be seen in the Excel sheet (see appendix). The results of the calculation are presented below.

First of all it the reconciliation target vs. actual (scenario I) for 2010 will be presented (cf. Table 8). As described above it has been assumed that the tonnage of bulk amounts to 75 million tons per year and the overall container volume amounts to 3.15 million TEU per year. On the one hand a negative value denotes additional required capacity that must be provided by mode of transport. On the other, a positive value denotes that there is remaining capacity that could be provided by rail or road.

Remaining capacity respectively additional required capacity (in total)	Import	Export
Capacity of tonnage (bulk + containers) [t/year]	28,035,000	5,565,000

	Import	Export
Remaining capacity respectively additional required capacity of containers [TEU/year]	2,803,500	556,500

Table 10: Reconciliation target vs. actual of the year 2010 (scenario I)

In the table it can be seen that there is enough capacity for both import and export. This denotes that additional capacity, numerically 2.8 million import containers and 0.55 million export containers could be provided by rail or road (cf. Figure 17).

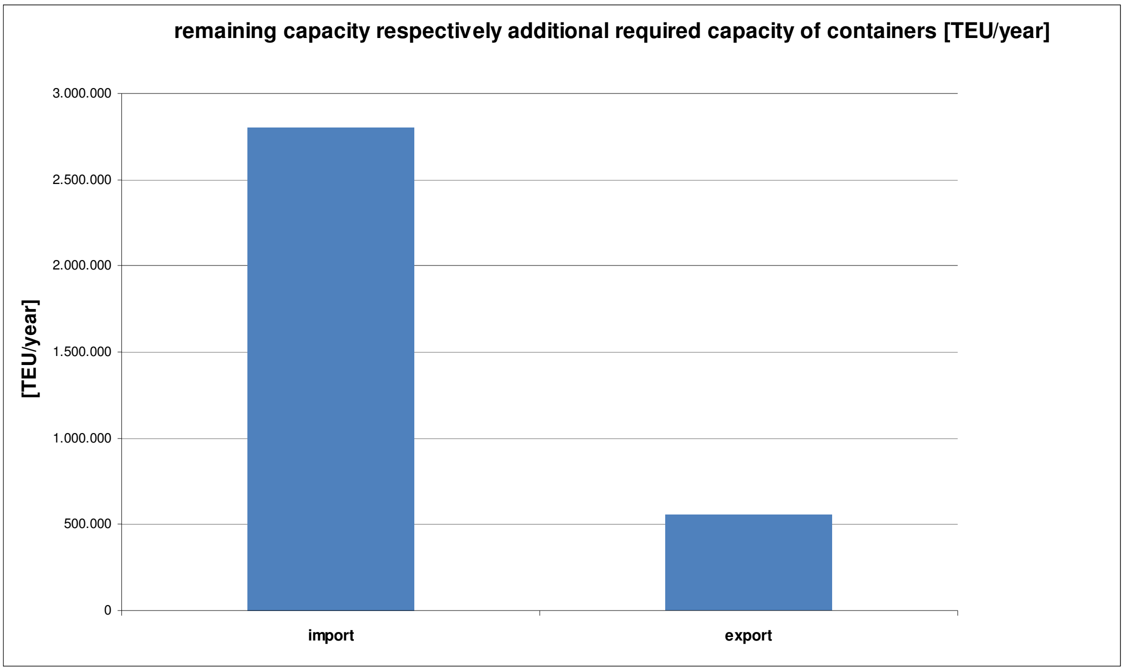


Figure 17: Remaining capacity respectively additional required capacity of containers in 2010 (scenario I)

The second scenario adopting the restriction described above will be presented in the table below (cf. Table 11).

Remaining capacity respectively additional required capacity (in total)	Import [t/year]	Export [t/year]
Capacity rail (80 % bulk and 20 % containers on rail)	-9,243,000	-25,707,000
Capacity road (20 % bulk and 80 % containers on road)	37,278,000	31,272,000

Table 11: Reconciliation target vs. actual of the year 2010 (scenario II)

If bulk goods and containers are separated under the restriction 80% bulk and 20% containers by rail as well as 20% bulk and 80% containers by road the capacity of the rail system is insufficient (cf. Figure 18). In case of charging remaining capacity with additional required capacity the capacity would be sufficient and the results would be the same as in scenario I.

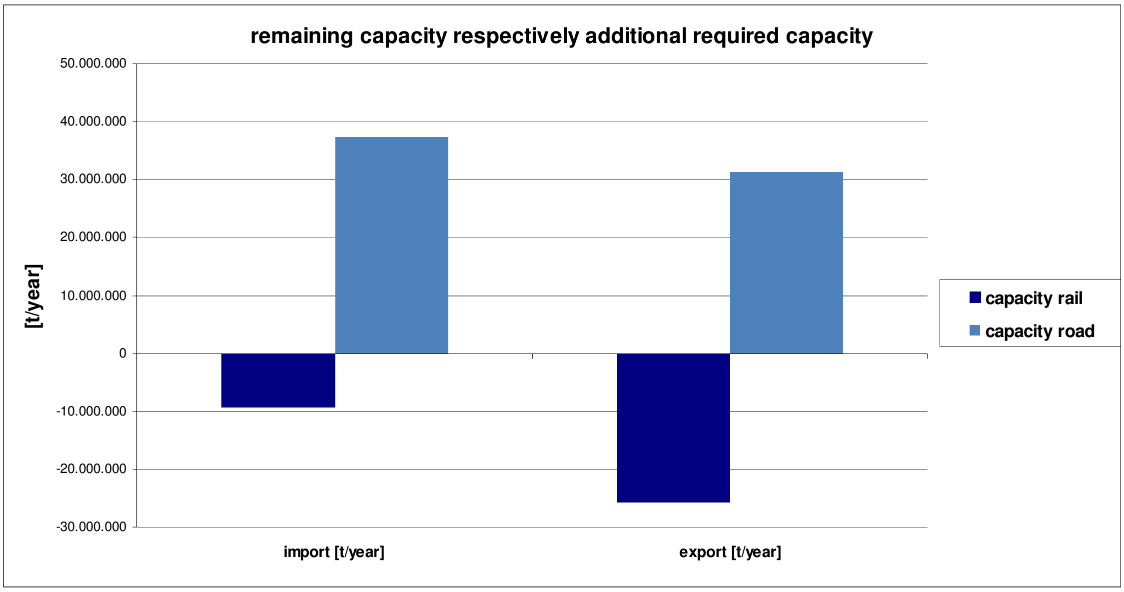


Figure 18: Remaining capacity respectively additional required capacity in 2010 (scenario II)

Next the reconciliation target vs. actual (scenario I) for 2024 will be presented (cf. Table 12). The calculation of the results is same for 2010 but some assumptions differ. As described above, it has been assumed that the tonnage of bulk amounts to 194 million tons per year and the overall container volume amounts to 9 million TEU per year.

Remaining capacity respectively additional required capacity (in total)	Import	Export
Capacity of tonnage (bulk + containers) [t/year]	-15,972,000	-76,348,000

	Import	Export
Remaining capacity respectively additionally required capacity of containers [TEU/year]	-1,597,200	-6,362,333

Table 12: Reconciliation target vs. actual of the year 2024 (scenario I)

The table shows that the capacity provided by rail and road is insufficient; numerically 1.6 million import containers and 6.36 million export containers (cf. Figure 19). This means that additional capacity is needed and the existing modes of transport must be extended or an alternative transportation system has to be clarified.

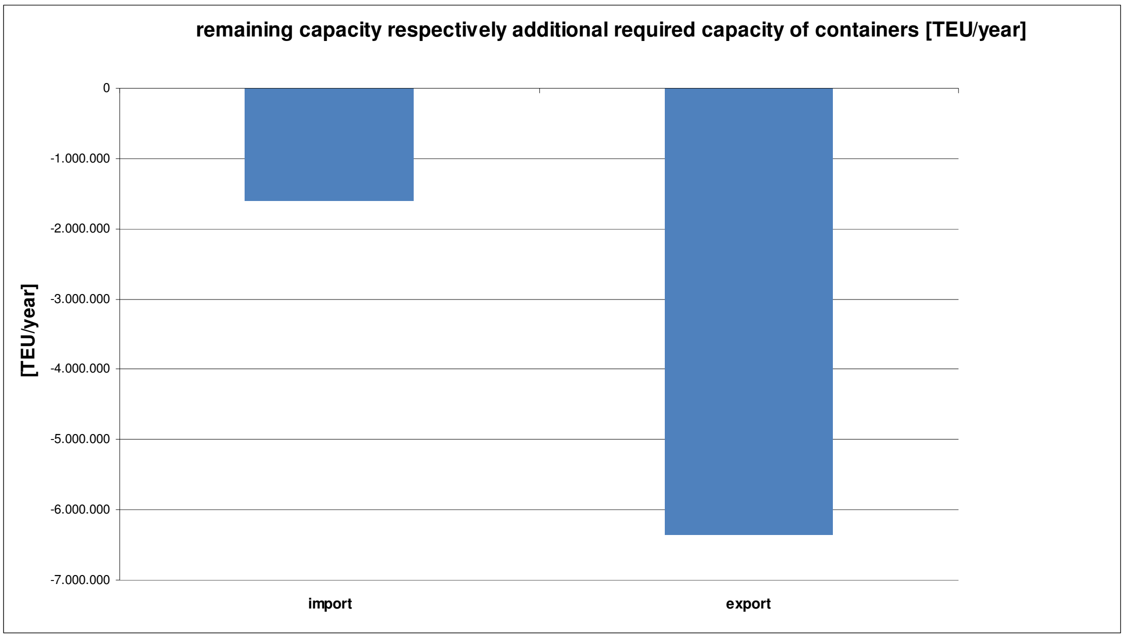


Figure 19: Remaining capacity respectively additional required capacity of containers in 2024 (scenario I)

The second scenario adopting the restriction will be presented in the table below (cf. Table 13).

Remaining capacity respectively additional required capacity (in total)	Import [t/year]	Export [t/year]
Capacity rail (80 % bulk and 20 % containers on rail)	-25,677,600	-63,826,400
Capacity road (20 % bulk and 80 % containers on road)	9,705,600	-12,521,600

Table 13: Reconciliation target vs. actual of the year 2024 (scenario II)

If bulk goods and containers are separated under the restriction 80% bulk and 20% containers by rail as well as 20% bulk and 80% containers by road the capacity of the rail system is similarly insufficient with the exception of road import capacity (cf. Figure 20). In case of charging remaining capacity with additionally required capacity the amount of containers is as shown in scenario I for 2024 (see above).

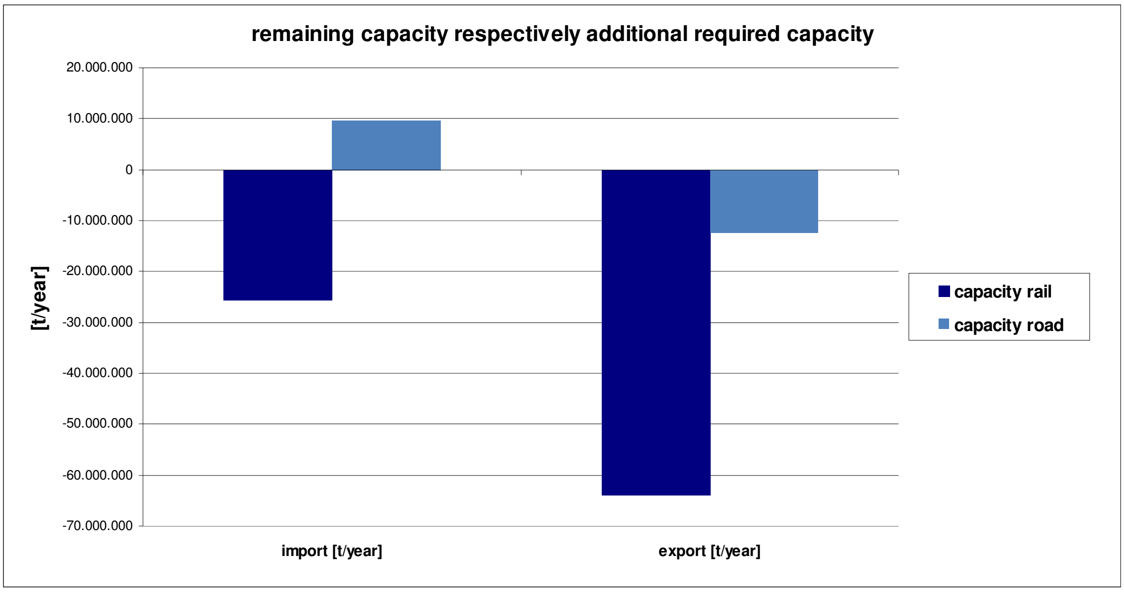


Figure 20: Remaining capacity respectively additional required capacity in 2024 (scenario II)

Number of additionally needed trains or trucks in case of insufficient capacity

The table below shows how many trains or trucks hypothetically have to be provided to eliminate the insufficient capacity if no alternative transportation system is available (cf. Table 14).

	Import	Export
Number of trains ALL per day or	15,2	72,7
Number of trains MRS per day or	30,4	145,4
Number of trucks per day	1774,7	8483,1

Table 14: Number of trains or trucks that must be provided in 2024 (scenario I and II)

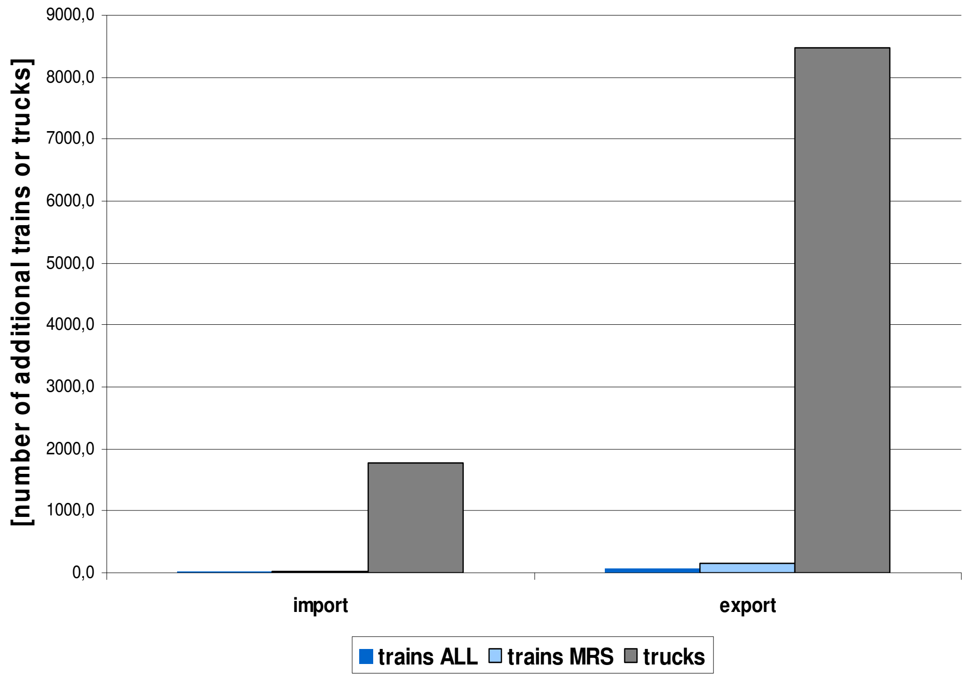


Table 15: Number of trains or trucks that must be provided in 2024 (scenario I and II)

→ The depicted scenario will lead to a sharp increase in traffic

4.1.4 Conclusion

It is obvious that the current rail and road access systems cannot handle these upcoming volumes:

→ **Road access will reach its capacity limits in 2014, no extension of capacity planned**

→ **Rail access has actually reached its capacity limits, planned extension of capacity will not be sufficient.**

Example MRS:

- Current capacity approx. 8 mill. tons
- Extension of capacity with new locomotives up to 12 mill. tons
- About 5 million tons capacity blocked on behalf of Usiminais.

4.2 Road access to the Port

Analysis of the road access to the Port – status quo

- The already finished duplication of the Imigrantes Highway within the Serra do Mar section has been the only feasible alternative to extend the road capacity between the Port of Santos and the metropolitan region of São Paulo[34]
- The existing road system will reach its capacity limits in 2014[35]
- Problem of connectivity and accessibility of the terminals (No direct connection right bank / left bank)
- Inadequate connection of the terminals with the hinterland and logistics hubs.

[34] Inter-American development Bank, Ecovias dos Imigrantes Toll Road Project BR-0312, environmental and social impact report
[35] Accessibility study University of São Paulo

Analysis of the existing highways Imigrantes and Anchieta

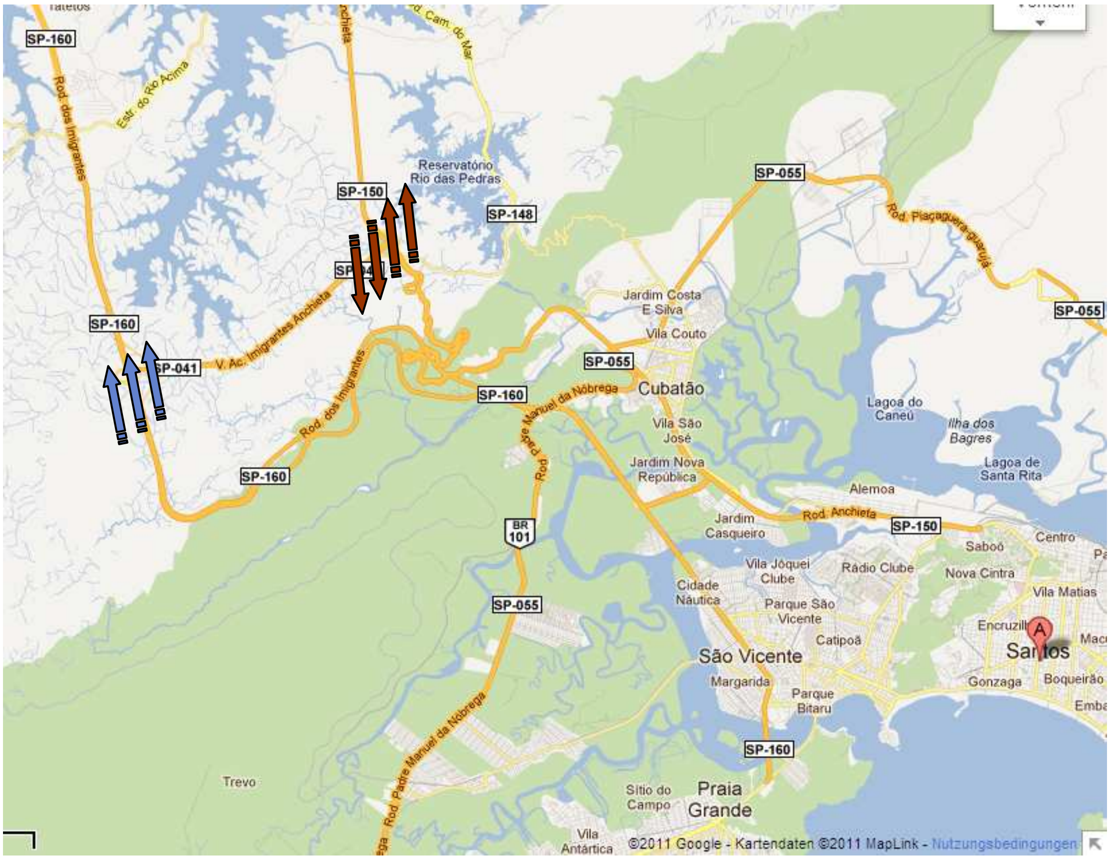


Figure 21: Highways Imigrantes and Anchieta

Imigrantes

- Highway with 3 lanes in each direction
- Includes a longer tunnel
- Trucks are only allowed in the direction to São Paulo (from Port / Import)

Anchieta

- Highway with 2 lanes in each direction
- Narrow road and many curves
- Trucks are allowed in both directions

Connection of right and left bank towards the Port

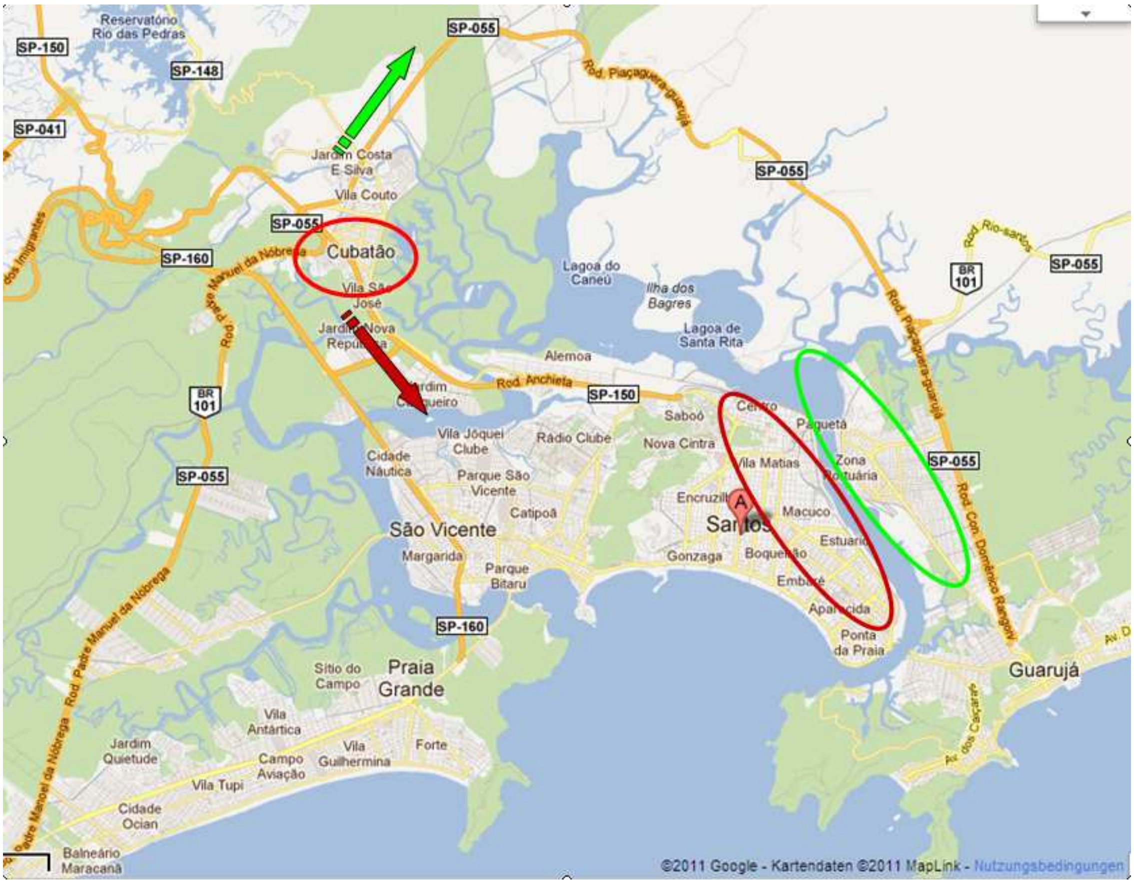


Figure 22: Connection of right and left bank towards the Port

- Both highways ends/starts in Cubatão
- In Cubatão, the traffic will be divided to direction east (SP-055) and west (SP-150) part of the Port.

4.3 Rail access to the Port

Analysis of the rail infrastructure towards the Port – Example MRS Serra do Mar

Figure 23: Rail infrastructure towards the Port

MRS Serra do Mar incline is a bottleneck because of its limited capacity. The transport of iron ore for Usiminais, in Cubatão, represents the larger part of the transported cargo compared to cargo to and from the Port of Santos. MRS carried out a study for the construction of a long Distance Conveyor Belt (LDCB), which would be used for the iron ore transport from Paranapiacaba to Cubatão, and the rack rail would be released to container and general cargo transport. The project was cancelled due to the high cost, MRS ordered now locomotives for the rack tracks to increase capacity. Nevertheless this will not reach the potential capacity increase of the LDCB. Furthermore there are existing inufficient shunting yards and loading tracks. Altogether there is a need for investment of the rail infrastructure.

Figure 24: MRS rack railway

4.4 Conflict of road and rail within the Port

Interferences of transport modes – Examples

Libra example

With regard to the dependencies for the LIBRA terminal as an example (cf. Figure 27), it is easy to see that track shunting movements to the bulk terminals behind LIBRA significantly impair the truck container traffic to and from the terminal. This causes problems at the ingate (cf. Figure 29 and Figure 26) and outgate (cf. Figure 28, Figure 30 and Figure 31), as the trucks cross the tracks on entering and leaving. There is also congestion at the ingate as no pre-stacking areas are available (cf. Figure 25).

Figure 25: Situation ingate b

Figure 26: Situation ingate c

Figure 27: Libra terminal overview

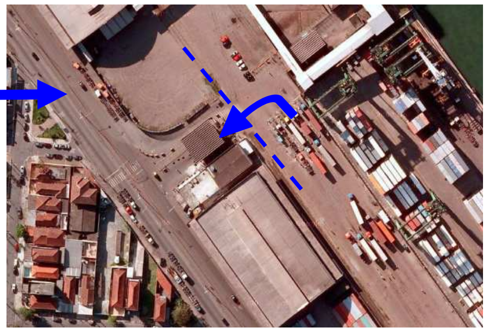


Figure 28: Situation outgate a

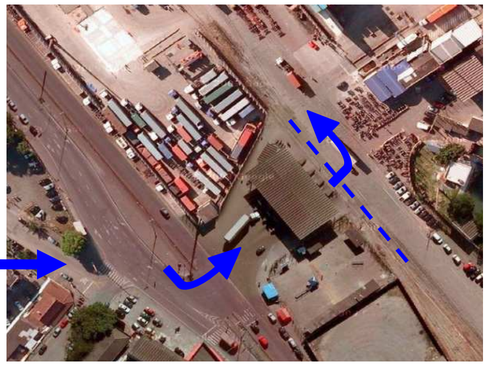


Figure 29: Situation ingate a

Figure 30: Situation outgate b

Figure 31: Situation outgate c

At our first on site visit, the terminal's in/out gates were also blocked for at least 30 minutes due to the slow speed of the shunting movement. This obviously doesn’t just influence the traffic in the terminal but also causes significant disruptions to the infrastructure in the SANTOS urban area in the flow of traffic, as no pre-stacking areas are present on the terminal premises for the incoming trucks as can be seen in the image (cf. Figure 25). This has resulted in the city streets becoming a free waiting zone for the trucks.

Santos example

Figure 32: Santos terminal overview

Figure 33: Extract 1 (traffic routing)

Figure 34: Extract 2 (traffic routing, street crosses rails)

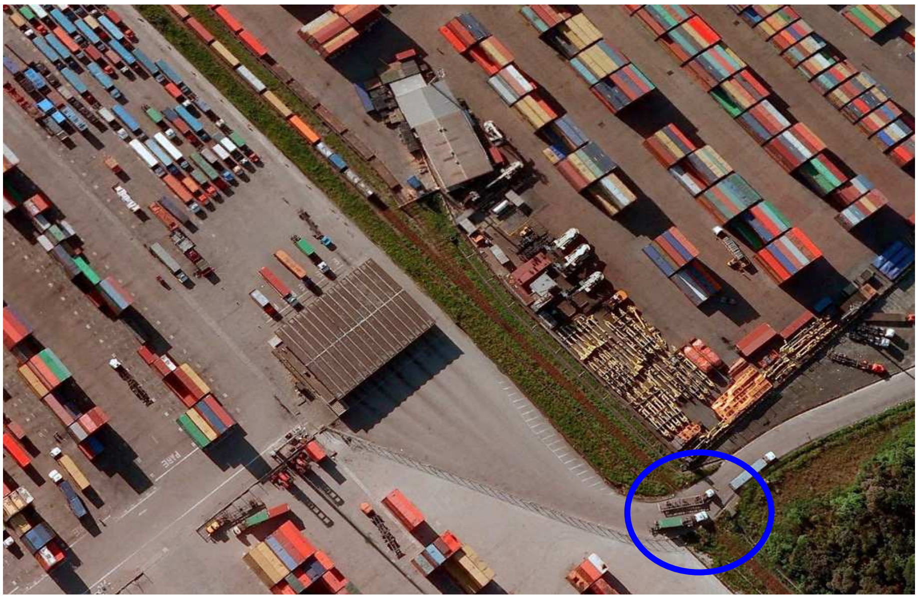


Figure 35: Extract 3 (outgate, street crosses rails)

Figure 36: Extract 3 (outgate, waiting trucks)

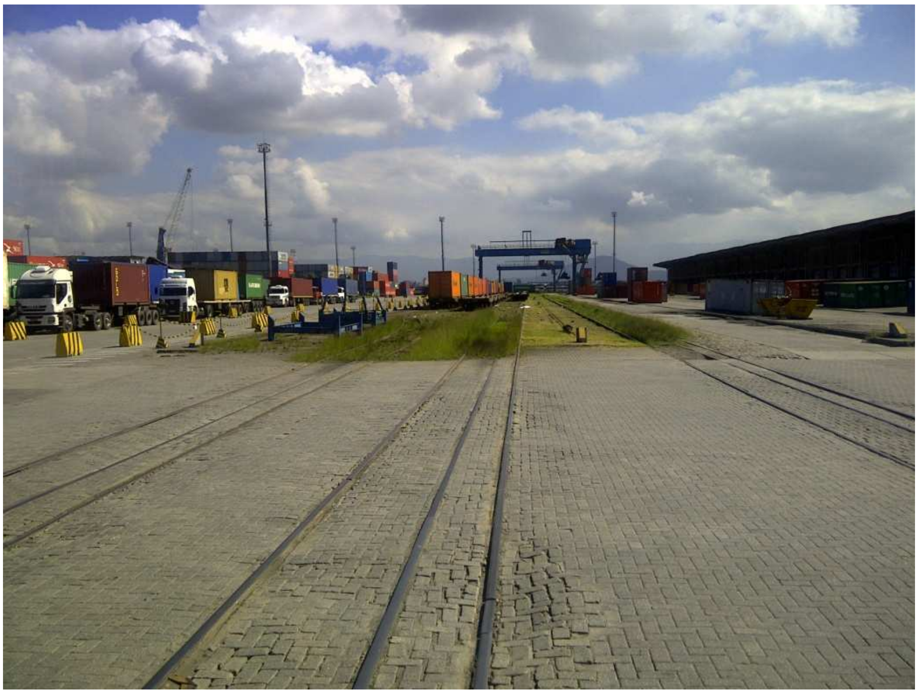


Figure 37: Extract 3 (outgate, street crosses rails)

It is also noted that, while a handling system for rail traffic is present at the Santos Brasil terminal, this is only marginally used.

Figure 38: Handling system for rail traffic

In order to remedy this situation, truck waiting areas must be established at the approach roads to the port/city area as per the ECOPATIO operating concept (cf. Detail plan Santos). With electronic indicator panels and self-operated registration terminals such as in the Rotterdam port, this allows the incoming trucks to be temporarily stored in order to allow them to enter the terminal just in time. This could reduce the permanent congestion on the city streets in front of the terminal.

There is an identical situation at the traffic connection of the SANTOS BRASIL terminal. As the joint shunting yard for the bulk and container terminal is located behind the container terminal street connection, each shunting movement blocks the access to the terminal. In addition, the delivery tracks to the integrated rail terminal intersect the entire terminal so that even the traffic flow in the terminal itself is constantly affected.

To solve this solution it is recommended that the necessary yard is arranged to the north of SANTOS BRASIL. The terminal could then be accessed by rail without further influencing its internal traffic flow. The planned shift of SANTOS BRASIL's rail terminal to the yet to be expanded area would be sensible.

Conclusion

- **Difficult access to terminals / gate situations**
- **Intersections of rail / road in the gate area**
- **Waiting times and traffic jams**
- **Insufficient buffer zones for both modes of transport (rail and road) available**

4.5 Modal split situation and benchmark

4.5.1 Modal split situation

Benchmark with other ports

In the following paragraph the ports considered above will be considered on the basis of the modal split. The modal split describes the division of total goods volumes across the various modes of transport[36]. In this specific example the division of goods across the modes of transport road, rail and inland waterway will be analyzed in the individual ports (cf. Table 16 and Figure 39). The basis of the comparison is 2010. For example, in the port of Santos 94% of the goods that are processed in the port are transported by road and 6% by rail. There is no transshipment, i.e. handling from seagoing vessels to inland waterway vessels (and vice versa).

Port	Share of road [%]	Share of rail [%]	Share of transshipment [%]	Ranking
Shanghai[37]	52	13	35	1
Rotterdam[38]	59	11	30	3
Los Angeles[39]	58	42	0	2
Nhava Sheva[40]	64	26	10	4
Santos[41]	81	19	0	5
St. Petersburg[42]	-	-	-	-

Table 16: Modal split of selected ports

The port ranking has been done initially on the basis of the division of goods by road. A high carriage proportion on the roads has a negative effect on the ranking. In contrast, a high carriage proportion by rail or inland waterway has a

[36] http://www.logipedia.de
[37] Source: http://www.tudelft.nl/live/binaries/4de0d195-5207-4e67-84bb-455c5403ae47/doc/2003Kuiken.pdf
[38] Source: Dr. Padideh Gützkow et al.: *Intermodal Yearbook 2010. Strategies, Statistics, Terminals and Players*, Brüssel, 2010
[39] Source: http://www.portoflosangeles.org/pdf/Rail_Workshop_Presentation.pdf
[40] Source: Business Plan by KPMG, 2005-2006
[41] Source: Study Louis Berger Group, 2008
[42] Data not available.

positive effect on the ranking. This produces the ranking presented in the table. The port of St. Petersburg is not included in the ranking because there is no data available about the port's modal split.

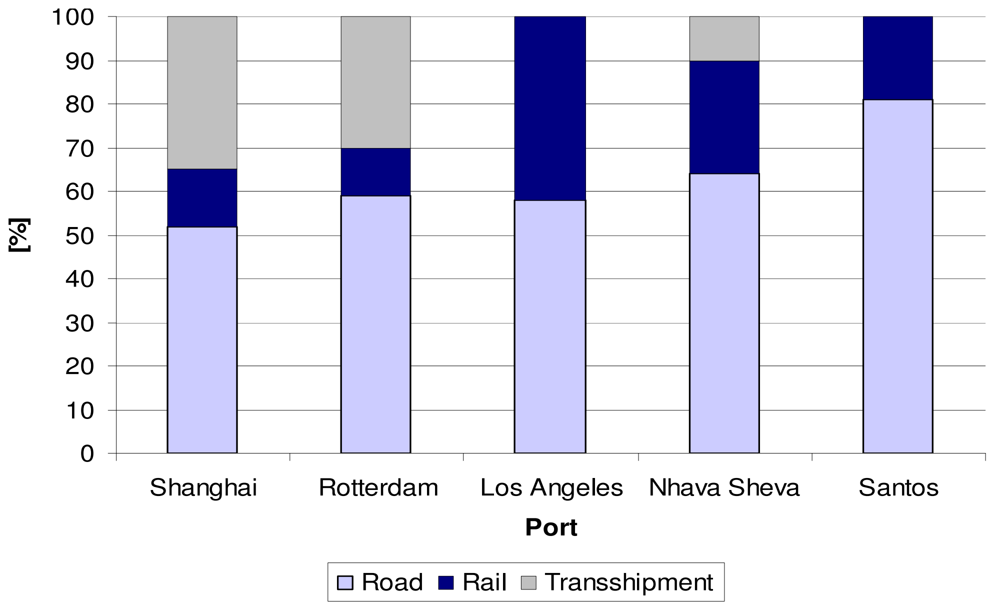


Figure 39: Modal split of selected ports

Analysis of the modal split of container transportation in 2010 and 2024

Key facts:

- With the current volume of 2.722 Mill. TEU, rail has a share in modal split of 6% only
- Recommendation according to NPLT: aim at a share of 35% → 35% of 9 mill. TEU in 2024 → 3 mill. TEU
- Available rail capacity in Santos will not be sufficient for the volume increase 160,000 TEU →mill. TEU and the road transport is already congested with the current volume
- Huge demand increase projected 3 mill. → 9 mill. TEU in 2024
- However, the projected demand of 9 mill. TEU in 2024 is still ~20% less than the installed capacity.

→ **The rail capacity has to be extended disproportionately and on top additional/alternative transport means have to be explored and determined**

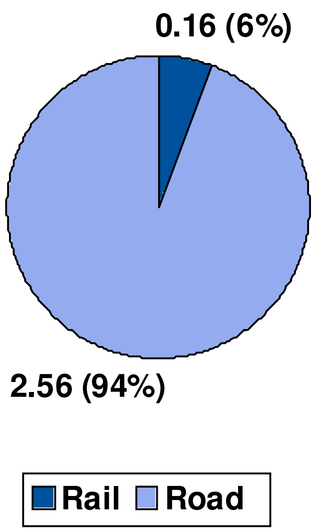


Figure 40: Modal split in 2010 (Overall volume: 2.7 mill. TEU)

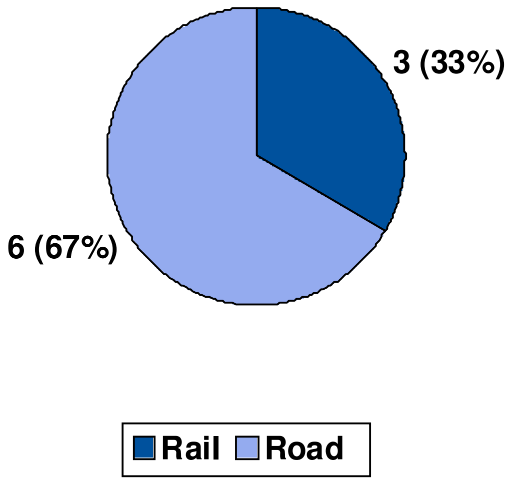


Figure 41: Modal split in 2024 (Projected volume 2024: 9 mill. TEU)

Benchmark with Port of Rotterdam and Port of Hamburg: Modal split proportion of train hinterland transportation (container)

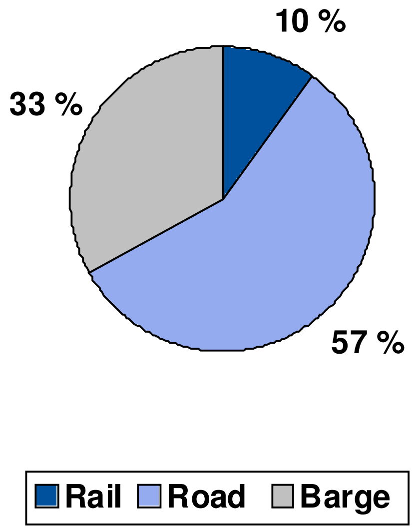


Figure 42: Container modal split (Rotterdam)

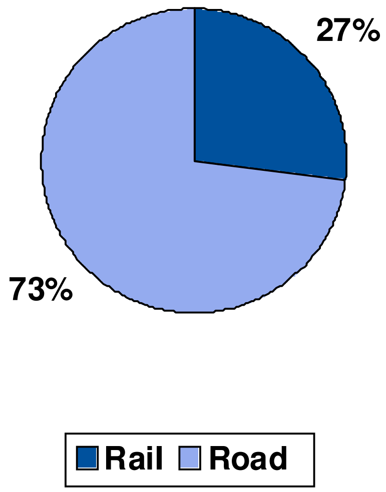


Figure 43: Container modal split (Hamburg)

Importance of soy and sugar through rail transport

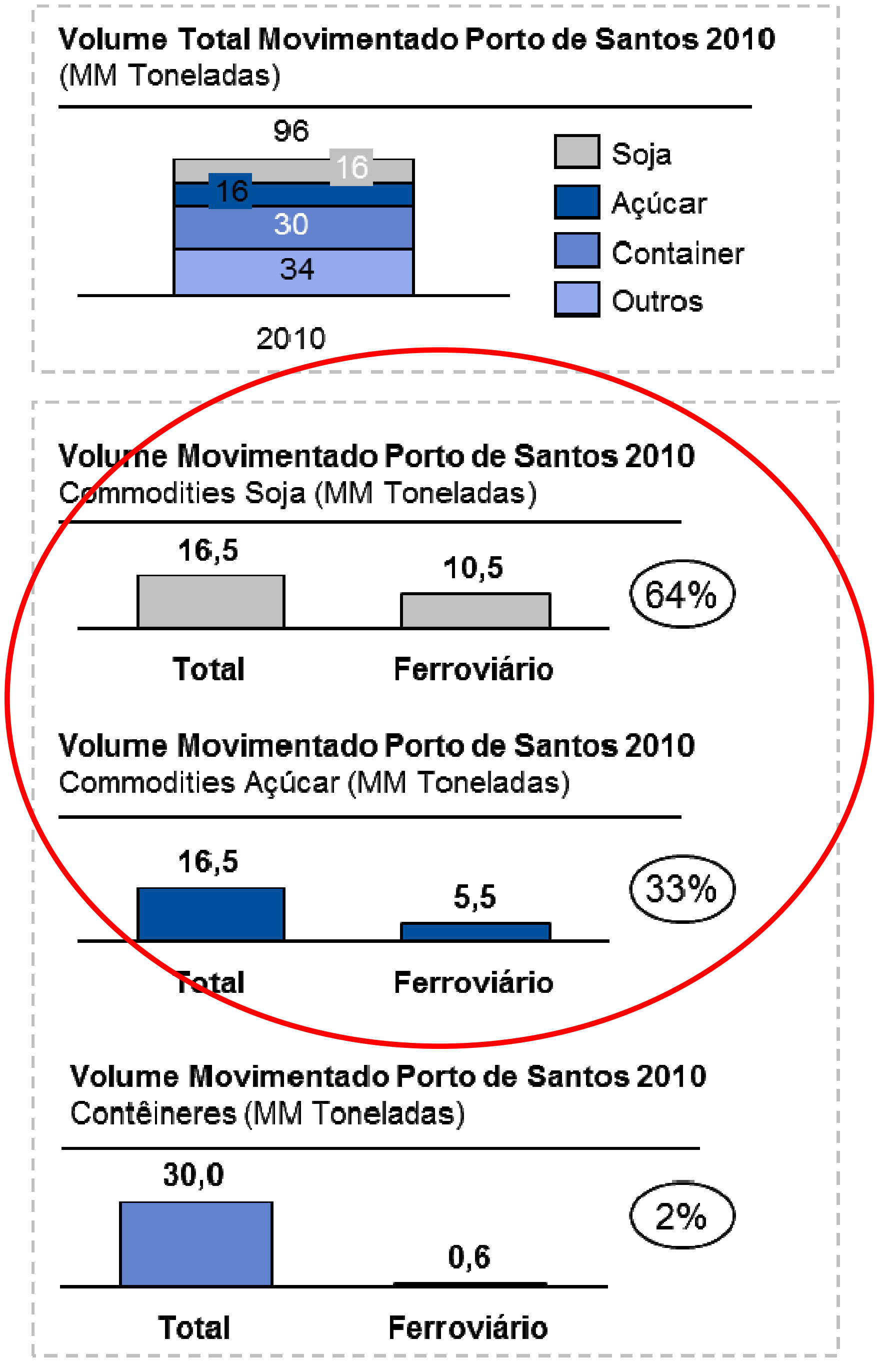


Figure 44: Importance of soy and sugar through rail transport

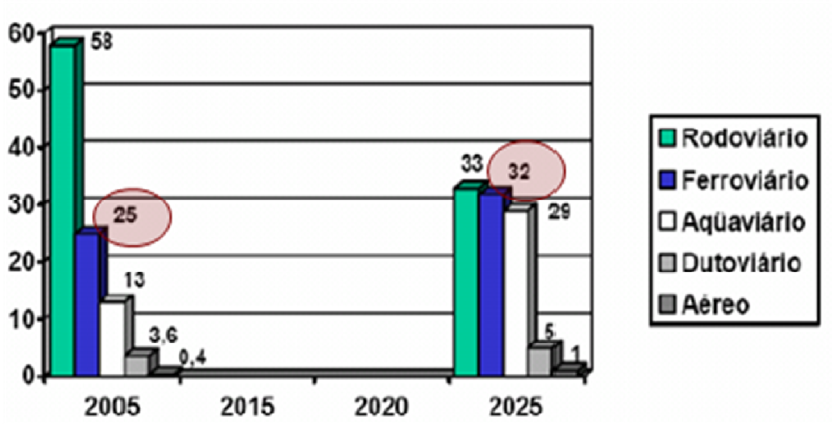


Figure 45: Transport matrix Brazil

Facing the prospects of growing and facilitating as much as possible the traffic road on the access to Port of Santos, the change of the transport matrix becomes everyday more necessary.

Conclusion Modal Split

- Development potential of modal split
- Based on the Louis Berger study, the share of bulk goods on rail will be increased to 52 million tons by the year 2024. The transport of bulk by rail is without any alternative (conveyor belt not realistic)
- Capacity of rail is not sufficient to carry additional container volumes (the transport of containers by rail is secondary). It would be necessary according to Louis Berger and the modal split targets to carry up to 3 million TEUs (equivalent to 52 container trains a day in addition) → Additional routes needed
- Bulk is the natural for the train transportation
- Modal split targets are needed to shift transports from road to rail

  → Todays rail infrastructure is not sufficient to achieve the target.

➔ **Rail has an important share in bulk transportation and is also essential to handle future container amounts.**

4.5.2 Benchmark with BRIC, USA and Europe

Amount of containers

In the following paragraph the port of Santos will be compared with other ports in the BRIC states, in the USA and in Europe. For this purpose the ports in Russia, India, China, the USA and Europe with the largest container volumes in 2010 have been selected. Accordingly the ports with which Santos has been compared are:

- St. Petersburg,
- Nhava Sheva,
- Shanghai,
- Los Angeles and
- Rotterdam.

Initially the ports were considered on the basis of container volumes from 2008 to 2010 as well as the percentage change of container volumes on the previous year (cf. Table 17 and Figure 46). The ports have been classified on the basis of container volumes in descending order.

Port	Throughput 2008 [TEU]	% Change '09/'08	Throughput 2009 [TEU]	% Change '10/'09	Throughput 2010 [TEU]
Shanghai	28,006,400	-11%	25,002,000	16%	29,069,000
Rotterdam	10,783,825	-10%	9,743,290	14%	11,142,000
Los Angeles	7,849,985	-14%	6,748,995	16%	7,831,902
Nhava Sheva	4,175,794	-8%	3,860,000	11%	4,276,212
Santos	2,674,975	-16%	2,255,862	21%	2,722,225
St. Petersburg	1,967,056	-32%	1,343,672	44%	1,929,842

Table 17: Throughput of TEUs from 2008 to 2010[43]

[43] CM World Top Container Ports

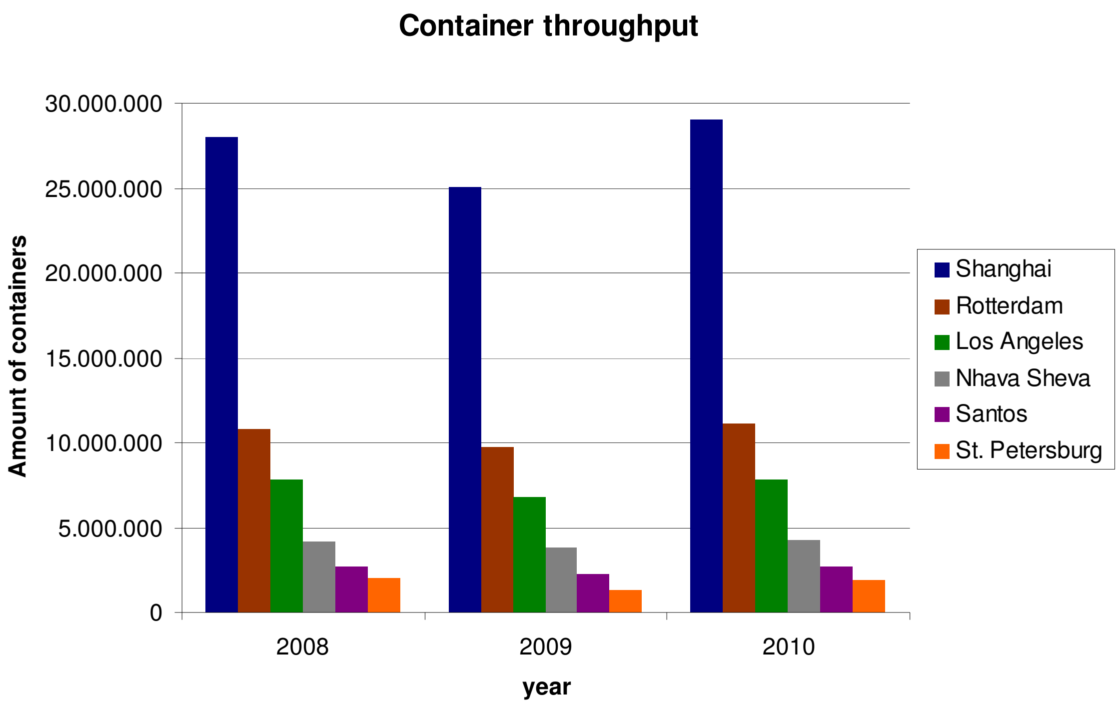


Figure 46: Throughput of TEUs from 2008 to 2010

Initially it can be taken from the tables and illustrations that the port of Shanghai has the largest container volumes by some distance. Seen in absolute terms the ports of Rotterdam, Los Angeles, Nhava Sheva, Santos and St. Petersburg follow in descending order. As a result of the worldwide financial crisis all the ports considered posted a decline in container volumes from 2008 into 2009. However, with the exceptions of Los Angeles and St. Petersburg, all the ports were able to reach their 2008 level again in 2010. In percentage terms the ports of St. Petersburg and Santos demonstrated the highest growth from 2009 to 2010. However, this is due to both ports posting the highest losses in 2008 and 2009.

In the overall ranking of the "World Top Container Ports"[44] in 2010, the ports of St. Petersburg (from place 73 to 64), Santos (from place 46 to 42) and Shanghai (from place 2 to 1) gained, while Rotterdam (place 10) and Los Angeles (place 16) did not change. The port of Nhava Sheva (from place 25 to 27) dropped two places in the Container Management Magazine ranking.

[44] Cf. Container Management Magazine

Amount of total tonnage

In this paragraph the ports already compared above will be compared on the basis of the total tonnage volumes.[45] The comparison has been carried out for 2009 and 2010 (cf. Table 18 and Figure 47).

Port	Throughput 2009 [t]	% Change '09/'10	Throughput 2010 [t]
Shanghai	590,000,000	10%	650,000,000
Rotterdam	387,000,000	11%	429,900,000
Los Angeles	157,400,000	0,3%	157,800,000
Nhava Sheva	60,760,000	6%	64,300,000
Santos	83,194,126	15%	96,025,258
St. Petersburg	50,400,000	15%	58,000,000

Table 18: Throughput in total of years 2009 till 2010[46]

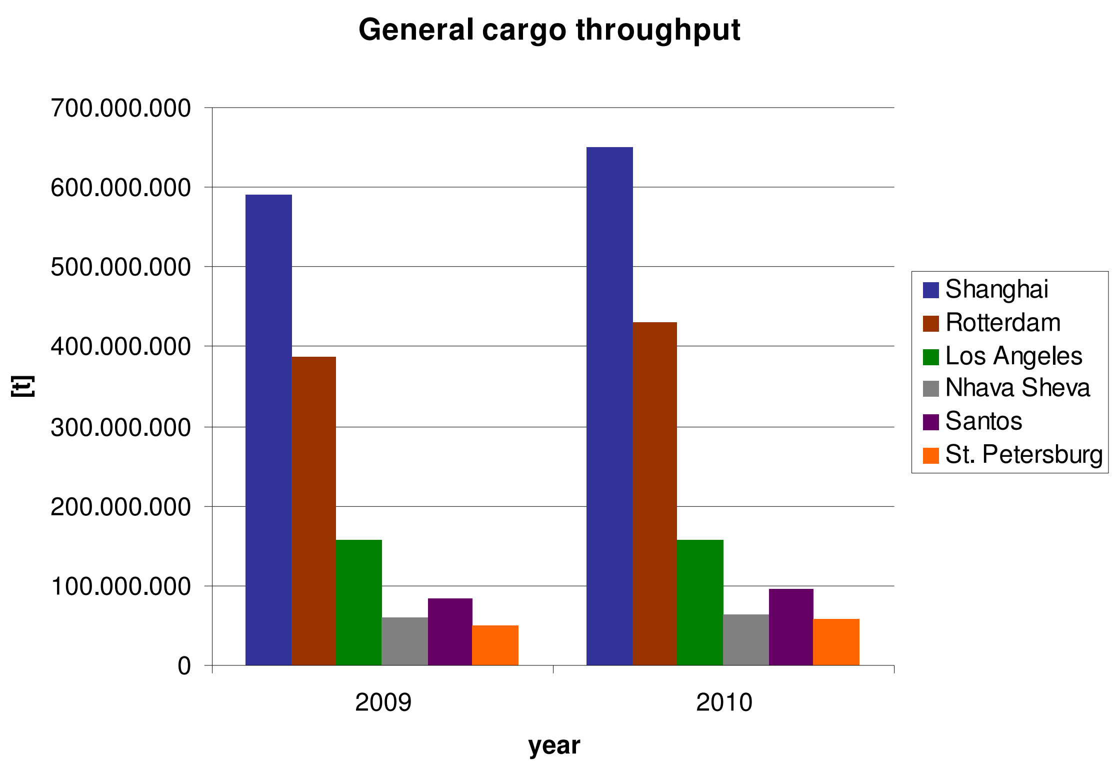


Figure 47: Throughput in total of from 2009 to 2010

45 Incl. allotment of containers
46 Port authorities

From the table and the illustration it can be seen that the port of Shanghai handled the largest tonnage volumes in 2009 and 2010 by some distance. The port of Rotterdam and the port of Los Angeles follow a long way back. While the Indian port of Nhava Sheva is ahead of the port of Santos in container handling, this port has a lower handling volume overall that the Brazilian port. This is because the proportion of bulk cargo is lower. At 83.19 million t in 2009 and 96.03 million t in 2010 the port of Santos has a lower tonnage volume than the port of Los Angeles. The port of St. Petersburg has the lowest handling volume of the ports compared. In percentage terms the ports of Santos and St. Petersburg demonstrated the highest growth (15%) when comparing the years under consideration 2009 and 2010. They are followed by the ports of Rotterdam and Shanghai with percentage growth of 11% and 10% respectively. The port of Nhava Sheva is in fifth place in the ranking of the six ports with growth of 6%. In last place follows the port of Los Angeles, which was only able to demonstrate growth of 0.6% during the period under consideration.

Dwell time

A further criterion with which the different ports in this paragraph will be compared is the dwell time. The dwell time describes the average holding time (in days) of a container in the storage area of the ports until onward transport. In the following table a differentiation has been made between the dwell time for import and export containers (cf. Table 19). The dwell time should be as short as possible in order to achieve a high handling rate[47].

Port	Import dwell time [days]	Export dwell time [days]	Ranking
Shanghai[48]	7	6	4
Rotterdam[49]	4	3	1
Los Angeles[50]	4	6	3
Nhava Sheva[51]	2	6	2
Santos[52]	12	8	5
St. Petersburg[53]	12	-	-

Table 19: Dwell times of selected ports

From the table it can be seen that the port of Nhava Sheva with two days has the lowest dwell time for import containers and the port of Santos the longest dwell time by some distance (12 days). For export containers the port of Rotterdam demonstrates the lowest dwell rate (3 days) and the port of Santos the longest dwell time (8 days). However, it should be noted that there is no data for the export dwell time available for the port of St. Petersburg. In the overall ranking including both dwell times the port of Rotterdam is in first place. It is followed by the port of Los Angeles, the port of Nhava Sheva, the port of Shanghai and lastly the port of Santos. Here too it should be noted that the port of St. Petersburg is not included in the overall ranking, because there is no data available for the export dwell time. The dwell times of the ports are also compared again in the illustration below (cf. Figure 48).

47 Source: http://www.logipedia.de
48 Source: Duisport packing logistics (dpl) shanhghai (approximation)
49 Source: http://infrastructure.gov.in/pdf/FinalCargo.pdf
50 Source: http://www.portoflosangeles.org/Press/REL_Tarrif_Increase_July_2005.pdf
51 Source: Business Plan by KPMG, 2005-2006
52 Source: http://www.mzweb.com.br/ecorodovias/web/arquivos/EcoRodovias_Noticia_Curimbaba_20100910_en.pdf
53 Source: http://www.container.ru/en/press/ncc/news_detail.php?ID=339 (2008). Data for export not available.

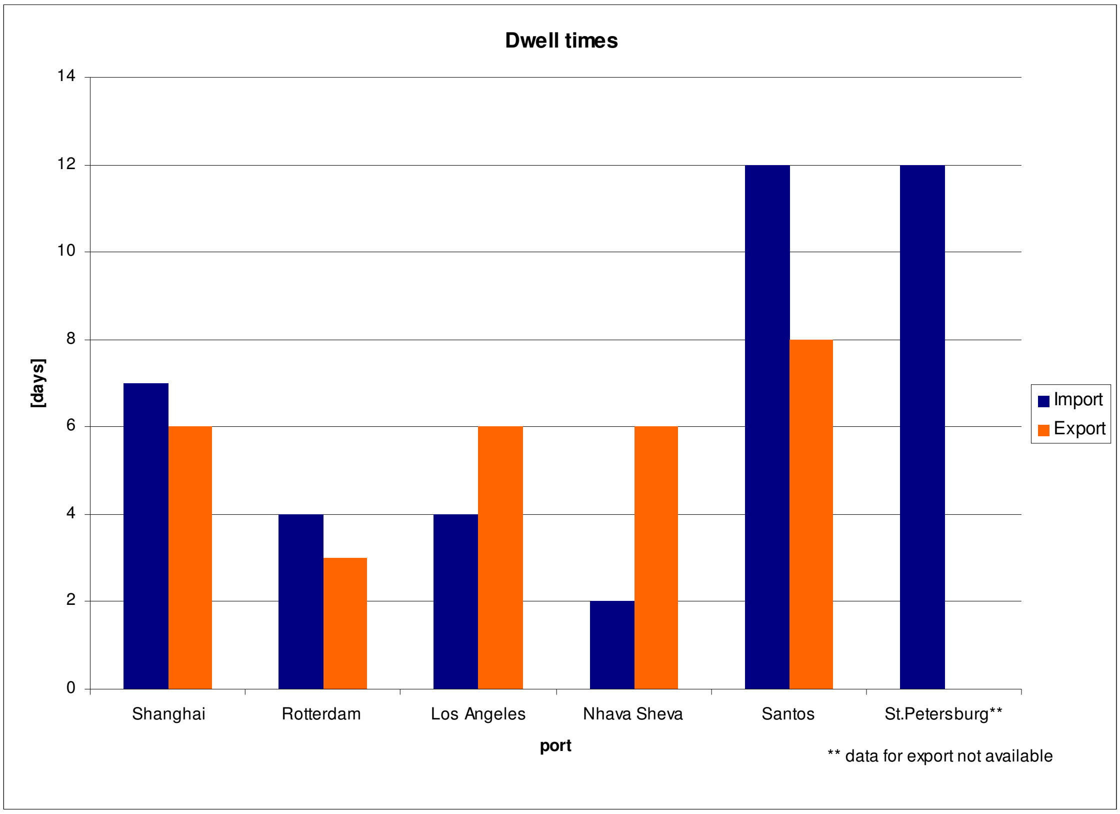


Figure 48: Dwell times of selected ports

4.6 Conflict of city and Port

Problems

- Lack of expansion capabilities of terminals
- City of Santos requires additional living space
- Excessive mixing of passenger and freight traffic (Passenger & cargo transport on the same road).

Figure 49: Conflict of city and port

4.7 Competences of public (Port) authorities

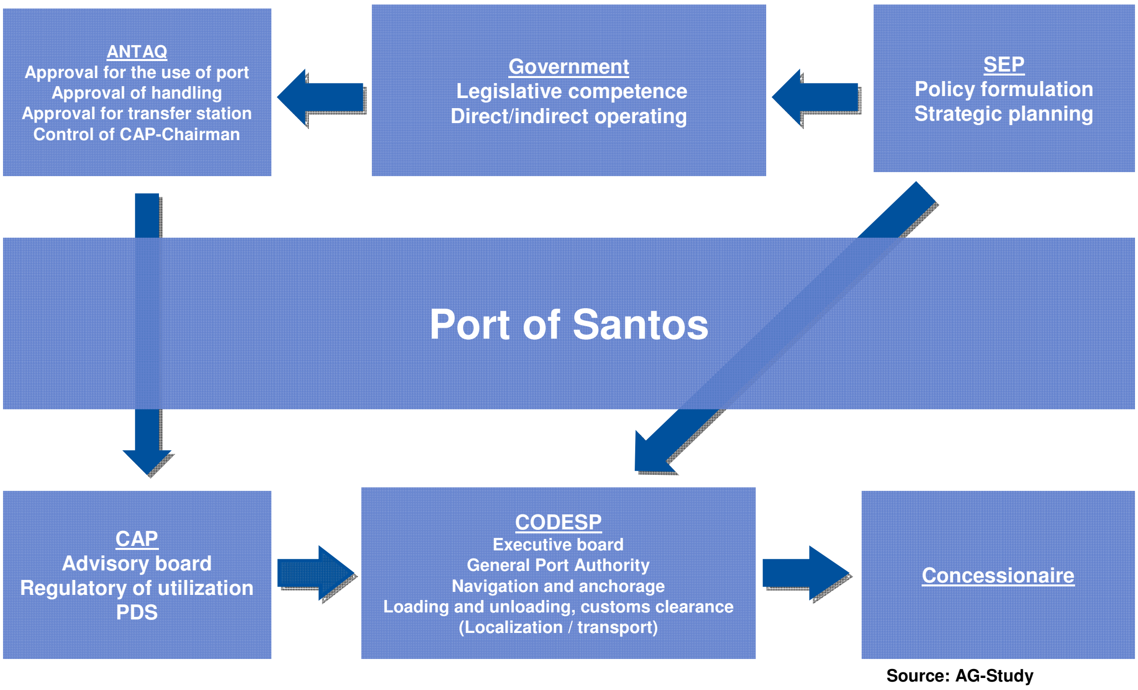


Figure 50: Organizational chart Port of Santos[54]

The duration of decision-making processes within the Port of Santos as well as the decision-making authority of the relevant public (port) authorities does not correspond with the requirements resulting out of the fast and fundamental changes of the shipping industry and the growth of volume handled in the Port of Santos.

→ The decision processes and the role and competences of the public (port) authorities have to be reviewed

[54] Source: AG study

4.8 Conclusion of the main bottlenecks

Identified bottlenecks

- The forecasted amount of tonnage will lead to additional capacity required on rail and road in 2024
- The depicted scenario will lead to a sharp increase in traffic
- Tremendous lack of capacity of hinterland connections already exists and will significantly grow up to 2024
- The infrastructure of rail and road within the Port is insufficient
  - Difficult access to the terminals
  - Intersections of rail & road
- No expansion capabilities of the terminals
- Mixing of passenger and freight traffic.

5. Results and recommendations of the project

5.1 Principal remarks

5.1.1 Integration of the São Paulo – Santos Logistics Corridor

Introduction

- Exorbitant increase of container and bulk volume by 2024
- Port of Santos is essential for brazil (40% of brazil's total container volume handled at Port of Santos)
- The sustainable response to the current and future challenges for the Port of Santos within the São Paulo – Santos Logistics Corridor Program is the mandatory and fundamental precondition to handle the future volumes

→ **But** in light of the outstanding importance of the Port of Santos for the economy of Brazil it would be not sufficient to focus only on this corridor. The measures of the program will only deploy their full impacts in combination with other important projects of the Brazil government to improve the superordinated transport and logistic network within the State of São Paulo and beyond. The integration of the São Paulo – Santos Logistics Corridor can not be a stand alone project but has to be integrated in an overall program.

Interferences of projects planned by state of São Paulo

- A concept for Port of Santos must be adapted to other infrastructure projects in the country

- Role of government is to involve the Port concept in a total logistic concept including all Ports and all stakeholders (cf. examples rail and road-ring below) → meeting brazil’s growth in a integrated way

Figure 51: Railway ring Sao Paulo

Figure 52: Highway ring Sao Paulo

5.1.2 Review of the role and competences of public authorities

Coordination of the relevant stakeholders

- Privatization of Ports and railways in the 1990ies have significantly improved the quality and performance of terminal operations within the Port of Santos

- Most of the relevant stakeholders within the Port of Santos develop their own plans – and each of these plans is correct and valuable - for extension and logistic connections to the hinterland – but all on their own without any coordination or framework

- Examples: ALL (Brado), MRS and Ecorodovias are currently developing plans for huge intermodal facilities in the Cubatão region (cf. figures)

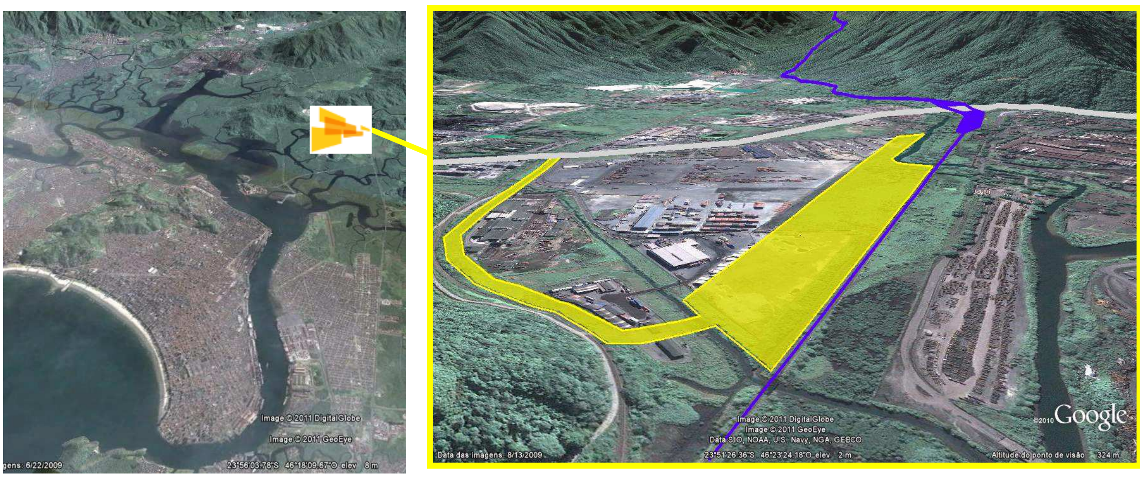


Figure 53: TIPS: Terminal Intermodal do Porto de Santos (MRS)[55]

[55] Source: MRS

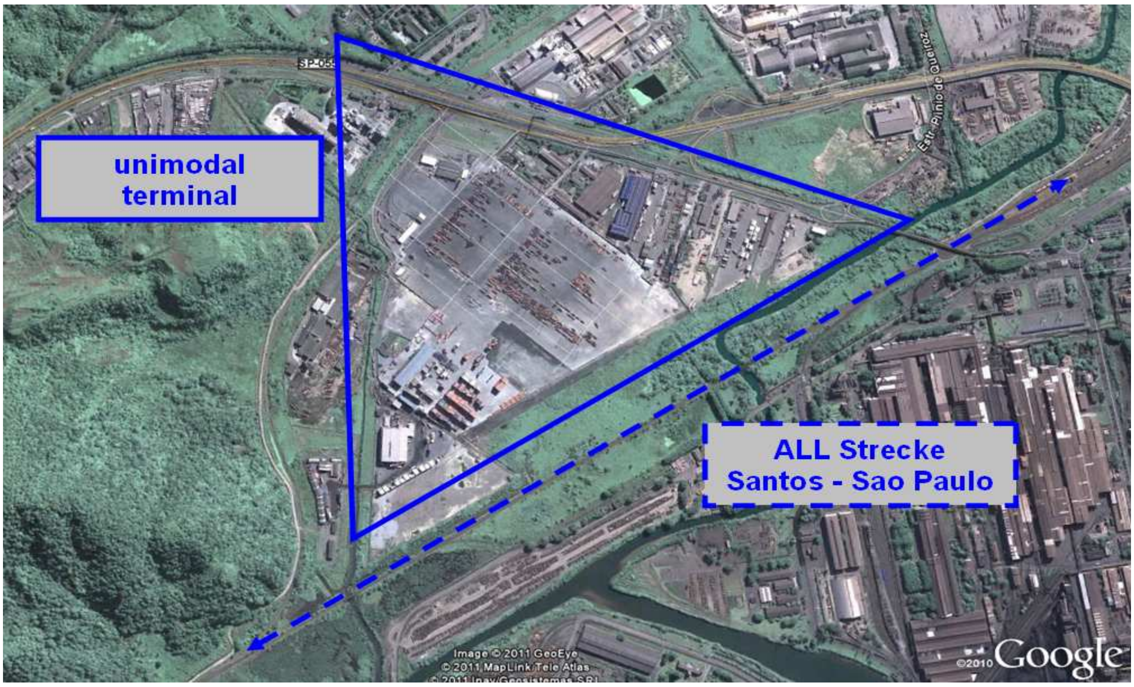


Figure 54: Unimodal Terminal (Ecorodovias)

Most of these approaches are – which is comprehensive – primarily focused on the business needs of the individual stakeholders and not on potential effects on public infrastructures

- Risk: Parallel and non-coordinated plans to improve the current situation might cause the contrary and create even more congestion. E.g. on the access routes to and from the Port terminals
- Example: It is intended to serve the deep sea terminals by rail but a rail connection is not yet available → road congestion will be increased

→ Individual plans of stakeholders might lead to an uncoordinated approach and create the opposite of the intended effects

Figure 55: Overview TIPS[56]

Role and competences of public authorities

To avoid this an integrated logistics and infrastructure concept has to integrate all this stand-alone approaches (= The São Paulo – Santos Logistics Corridor Program as principle guideline and framework for the different approaches) It has not to affect or influence the private sector, but to avoid interferences between the development of the private sector and public needs and to ensure the basis for the further expansion of private business.

The operational situation has significantly changed since the privatization due to the strong economic growth of the Brazilian economy and the following significant volume increase in the Port of Santos (= The challenges following from this development are the motivation for the São Paulo – Santos Logistics Corridor Program).

[56] Source: MRS

It is in the nature of things that private entities invest primarily to optimize their economic benefit and to strengthen their business activities. It is not, cannot and will never be the challenge of the private sector to invest in superordinated infrastructure or to coordinate and consolidate various developments in an integrated approach to meet the demands of the social and economic development of the society.

Review of role and competences of public authorities: **duisport** therefore recommends to revise the role of the public authorities within the process of infrastructure planning and the balancing of private and public interests

The current role of the public authorities within the Port, rail and logistic operations in Brazil are resulting from the privatization process in the 1998, which has significantly improved the quality and performance of terminal operations within the Port of Santos

Nevertheless due to the growth of the brazil economy followed by rapidly increasing volumes within the Port of Santos, the challenges for the public authorities regarding the provision of sufficient public infrastructures and securing public interest have significantly changed
Some of the proposed measures in this study, which are found to be mandatory for the success of the São Paulo – Santos Logistic Corridor Program presume the ability of the public authorities to implement these

Recommendation

Review of the role (and powers) of the relevant public authorities:

- To ensure their ability to implement measures which are necessary to secure public interest

- To coordinate the respective plans of the private operators with the development of the logistic corridor

5.1.3 Challenge to integrate all relevant stakeholders

duisport has developed the recommendations and actions which are mandatory from the point of view of objective and neutral logistic experts. **duisport** is fully aware that a multiplicity of stakeholders has to be convinced and integrated in the process, otherwise most of the recommended actions will not be realizable. The current legal positions of all stakeholders shall be respected but have to be integrated in an overall logistics concept.

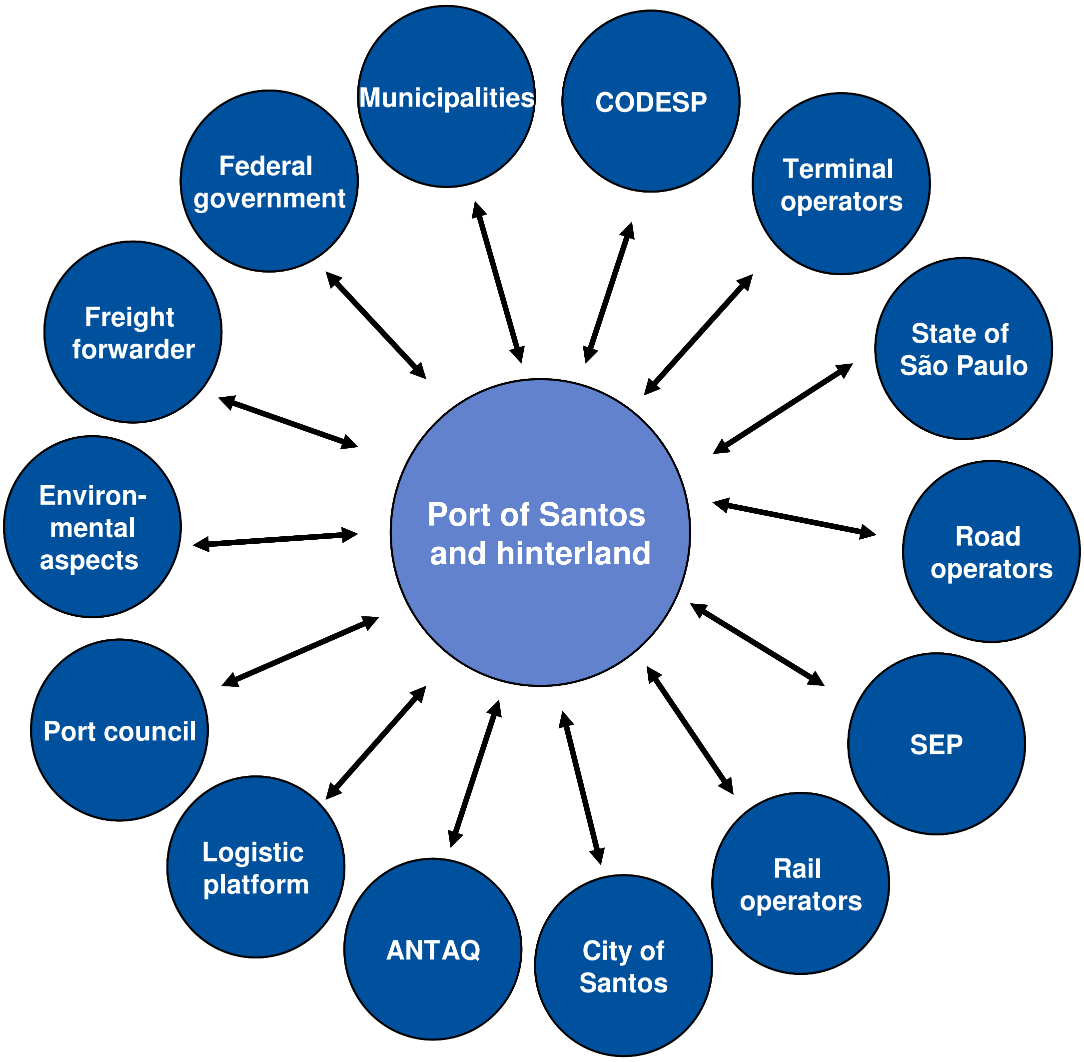


Figure 56: Interferences of the relevant stakeholders

The current legal positions of all stakeholders shall be respected, which means:

- <u>No</u> rail access to the terminals without the terminal operators etc.
- <u>No</u> pre-gates / novel transport technologies without terminal operators, concessionaires for rail operations and Portofer etc.
- <u>No</u> IT-platform without terminal operators, road concessionaires, Municipalities and State of São Paulo
- <u>No</u> road connection between Saboó and Ilha Barnabé without State of São Paulo
- <u>No</u> improvement of rail access without Portofer and rail concessionaires
- Etc.

5.2 Recommendations

Strong economic regions need efficient, reliable and thus environmentally friendly and safe transport connections. These are decisive for the attractiveness of the location and for long term success. The pre-condition for further growth is efficient and high quality infrastructure. All modes of transport here are facing great challenges to master the flows of goods between Santos and the hinterland.

The central control and coordination of all logistics processes in the port and its surrounding area including the players involved has a decisive role here. This can be carried out through a neutral port authority and is the task of a state authority. This should also control all future new construction and development measures and coordinate the active players.

In addition to the legal framework, the basis for this is setting up an IT link of all the players in an IT port management system. The neutral/state port authority will take over linking and controlling the hinterland with the port (logistics zone, logistics nodes, truck waiting areas etc.). Furthermore, the currently individual planning of the individual market participants should be incorporated in an overall port concept urgently.

We believe that for sustainable growth an economy requires an efficient logistics industry to be able to ensure provision of raw materials and the distribution of finished products sufficiently and sustainably.
To create transport chains, the logistics sector needs an excellently developed infrastructure that is thus capable of high performance. Alongside an expanded road network it is, however, also important further to develop both the rail network and the waterways, taking environmental aspects into consideration. Integral components of functioning logistics chains are intermodal hubs where goods can be consolidated and transports can be retailored. These hubs have to be optimized in terms of location and their portfolio of services.

Since infrastructure projects usually do not make financial sense in themselves due to the high investment necessary, their provision is by its nature a basic task of the state. The Ministry of Transport of the Federal Republic of Germany prepared a “Master Plan for Freight Traffic" between 2004 and 2006, which defined the most important transport corridors within Germany with connections to neighbouring European countries. With the “Master Plan for Freight Traffic” the Federal Republic of Germany has thus declared that its priority is developing and thus strengthening the most important transport corridors and their integral hubs. Duisport made a considerable contribution to the “Master Plan for Freight Traffic". In this respect it was consistent to reinforce the master plan with an additional study. The master plan “Sea Ports Hinterland Traffic” defines in particular the connection of the sea ports with the hinterland and was produced in close cooperation between Deutsche Bahn AG (=German Railways) and duisport.

Having worked on the factors that made the master plan necessary we realized that the very first step is to start thinking outside the box, i.e. to look not only at the our own location as an isolated project, but to consider a wider perspective. For us it was this development involved moving from a concentration on Duisburg towards thinking on a German-wide level and furthermore, considering relations to neighboring European countries.

Here we see analogies for Santos.

Development of an overall concept Santos and hinterland

- Need for an efficient and high quality infrastructure as a basis for growth in Port of Santos
- Central control and coordination of all logistics processes in the Port and the environment, including stakeholders (segregation of transport, terminal-based delivery)
- Basis is a legal framework and the establishment of an link to all stakeholders in a IT Port management system
- The neutral/governmental Port Authority assumes the connection and control of the hinterland with the Port (logistics zone, logistics hubs, truck waiting areas, etc.)
- It is recommended to include the current individual plans of the stakeholders in a total Port concept.

➔ **duisport has determined actions for development of the Port and the link with the hinterland**

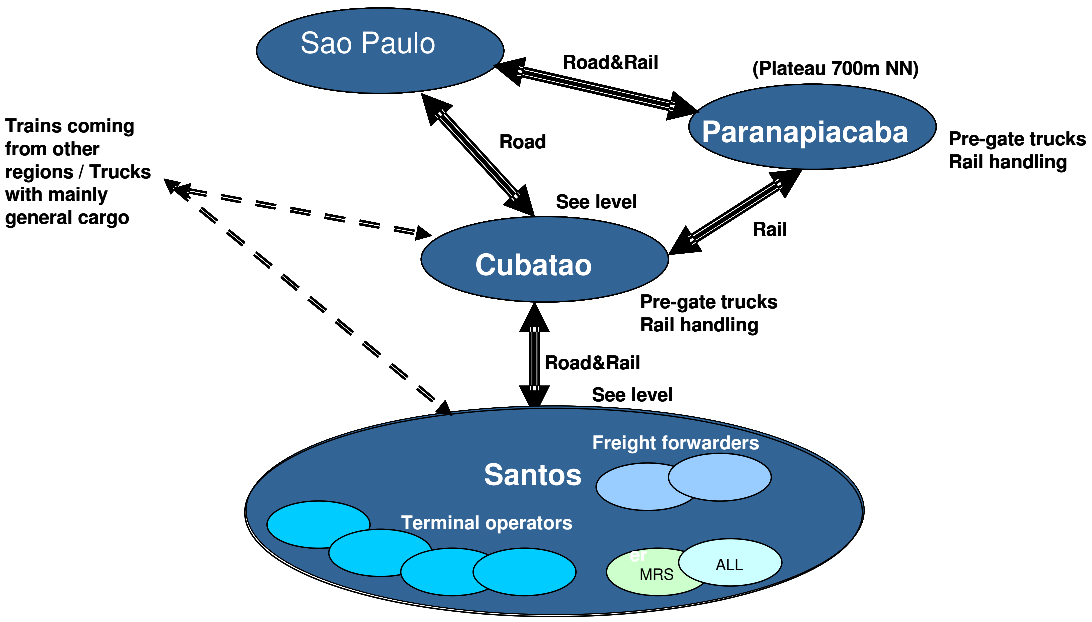


Figure 57: Overview Santos and hinterland

5.3 Core fields of action

Preamble

The presented recommendations have to be seen in an integrated context. Some measures can be implemented individually and independently, but most measures are feasible only in a larger context. The terminal Santos Brasil is for example the only terminal with rail and road connections. In order to build a logistics system it is necessary that all terminals have the same infrastructure requirements. Intermodal interfaces are mandatory to carry out the later presented measures.

Identified core fields

- Increase capacity & efficiency of existing road & rail infrastructure
- Implementation of a road connection between left bank and right bank of the port
- Implementation of an IT-platform for Traffic & Cargo Management (Transport-Logistics-Platform)
- Modal split optimization
- Retrial of potential further development of Rail and Road Accessibility to Santos / Serra do Mar
- Implementation of a pre-gate system in port of Santos and hinterland
- Implementation of a novel container transport technology
- Development of a Port Logistics Platform (Logistics Activity Zone)

5.3.1 Increase capacity and efficiency of existing road and rail infrastructure

Current situation: Concerning infrastructure within the Port

- CODESP has already started to unbundle Port and city roads, e.g. public and Ports traffic, by the construction of Port roads. Nevertheless rail still crosses in various parts of the Port the entry gates of terminals, which causes delays, traffic jams and congestions during rail services in these parts of the Port.
- Infrastructure defects hinder processes (gate access, lack of buffer and shunting areas, track facilities require renovation thus only low speeds are possible)
- Too strong mixing of passenger and goods transport, consequently “Blockage of the port and Santos city“
- Individual activities and non-coordinated planning and development of all participants in the port (terminals, port railroad, forwarders etc.) → considerable influence of individual players on the infrastructure and thus potential competition impairments
- Unstructured feed of traffic to the terminals (hardly any terminal related provision)
- High shunting activities, lots of traffic jams, long waiting times, inefficiency in processes and procedures, raised costs, long throughput times
- Lack of information technology connection/linking all participants
- Insufficient signposting, signal technology within the port
- Insufficient physical connection of all participants to the port railroad
- Example: Due to storage space becoming scarcer, containers partly have to be dropped kilometers away from the terminal for interim storage. Then these containers have to be transported back to the terminal by truck again to reload them → long participant waiting times (shipping lines, forwarders) → truck traffic to be avoided

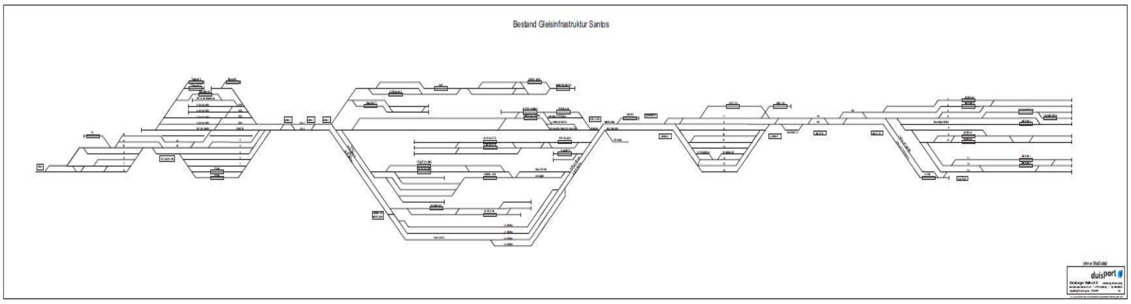


Figure 58: Rail infrastructure within the Port of Santos[57]

Conclusion

The expansion of capacity of the Serra do Mar rail crossing will not have the needed positive impact as long as the rail infrastructure in the Port is not able to accept the forecasted amount of trains. Despite existing projects to improve the infrastructure within the Port (e.g. construction of Port roads) the current operational modus does not ensure the most efficient use of the existing infrastructure. Furthermore all stakeholders involved in rail operations within the Port of Santos confirm that the current operational modus does not ensure the most efficient use of the existing infrastructure. On the one hand rail infrastructure within the Port of Santos does not meet the demands of modern terminal operation. On the other hand the lack of sufficient rail infrastructure is intensified by the current operational scheme between Portofer and the serving railway companies.

[57] See also appendix.

Best practice: Port of Duisburg

To the extent that the focus in all countries has previously been exclusively on the expansion of the long-distance sections – this also relates to Germany – rail infrastructure will only be effective if appropriate shunting yards are available for disconnection, formation and entry/exit into the respective port structures.

As a result, for example, the logport I project in Duisburg has received a central role in the expansion of the pre-shunting yards. The logport 1 pre-shunting yard (cf. Figure 59) has 10 block train length platforms. In Germany, this relates to a construction length of at least 750 m.

Figure 59: Logport I pre-shunting yard

Both inbound tracks (cf. Figure 60) are electrified as long-distance traffic predominantly travels by electric locomotives in Europe.

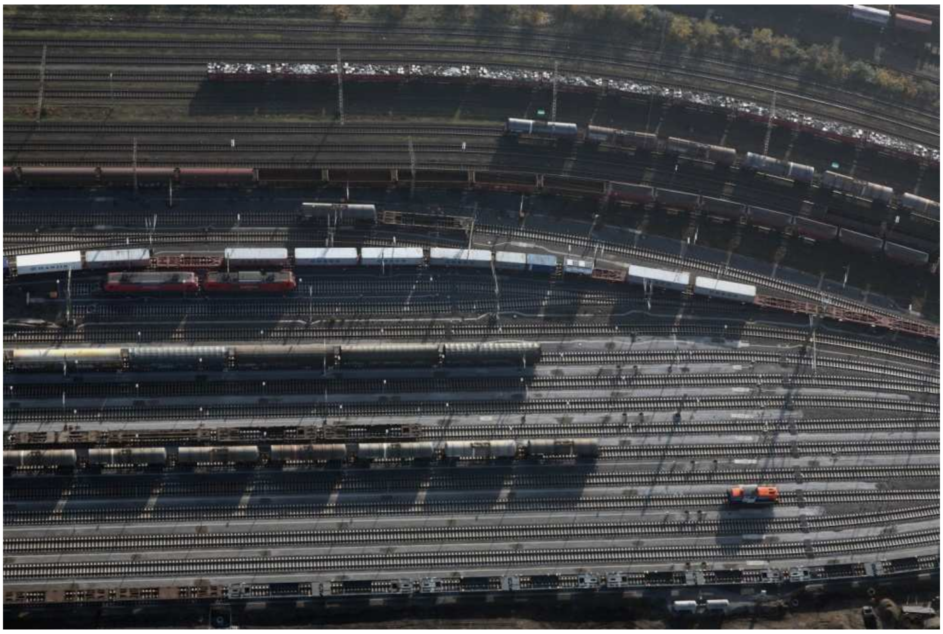


Figure 60: Electrified inbound tracks

The other tracks are not electrified. The shunting service is provided by diesel locomotives in this area. As soon as a train has entered under the wire, the entire train, including electric locomotive, is driven into the terminal with a diesel locomotive (cf. Figure 61).

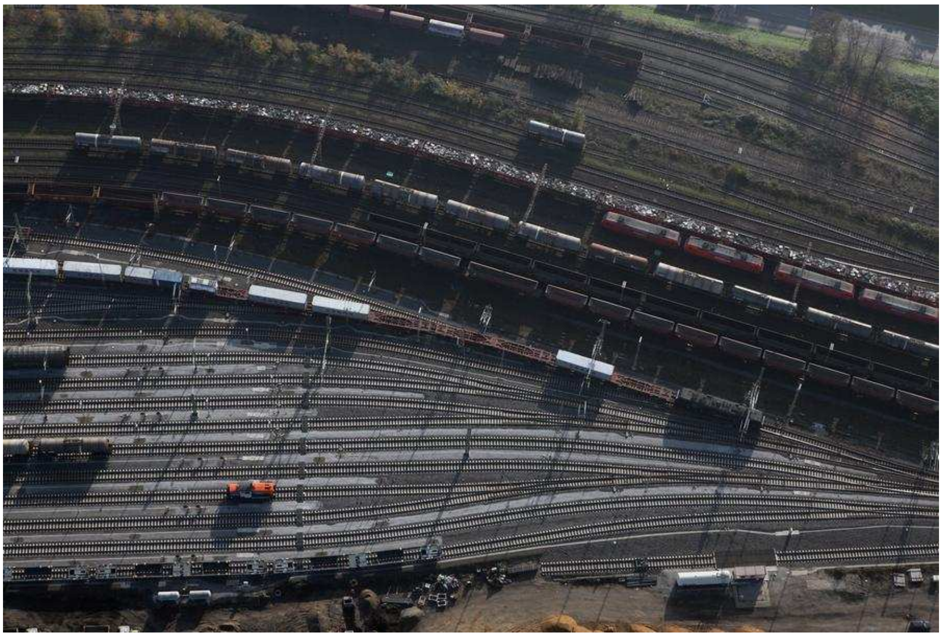


Figure 61: Entrance of train with diesel locomotive

The track lengths in the terminals are identical to the track lengths in the marshalling yards if this is possible with regard to the provided geometry of the property and the terminal.

If this is not possible, such as for the *Duisburg Trirmodal Terminal* (D3T), then at least 2 half-train length tracks have been constructed (cf. Figure 62).

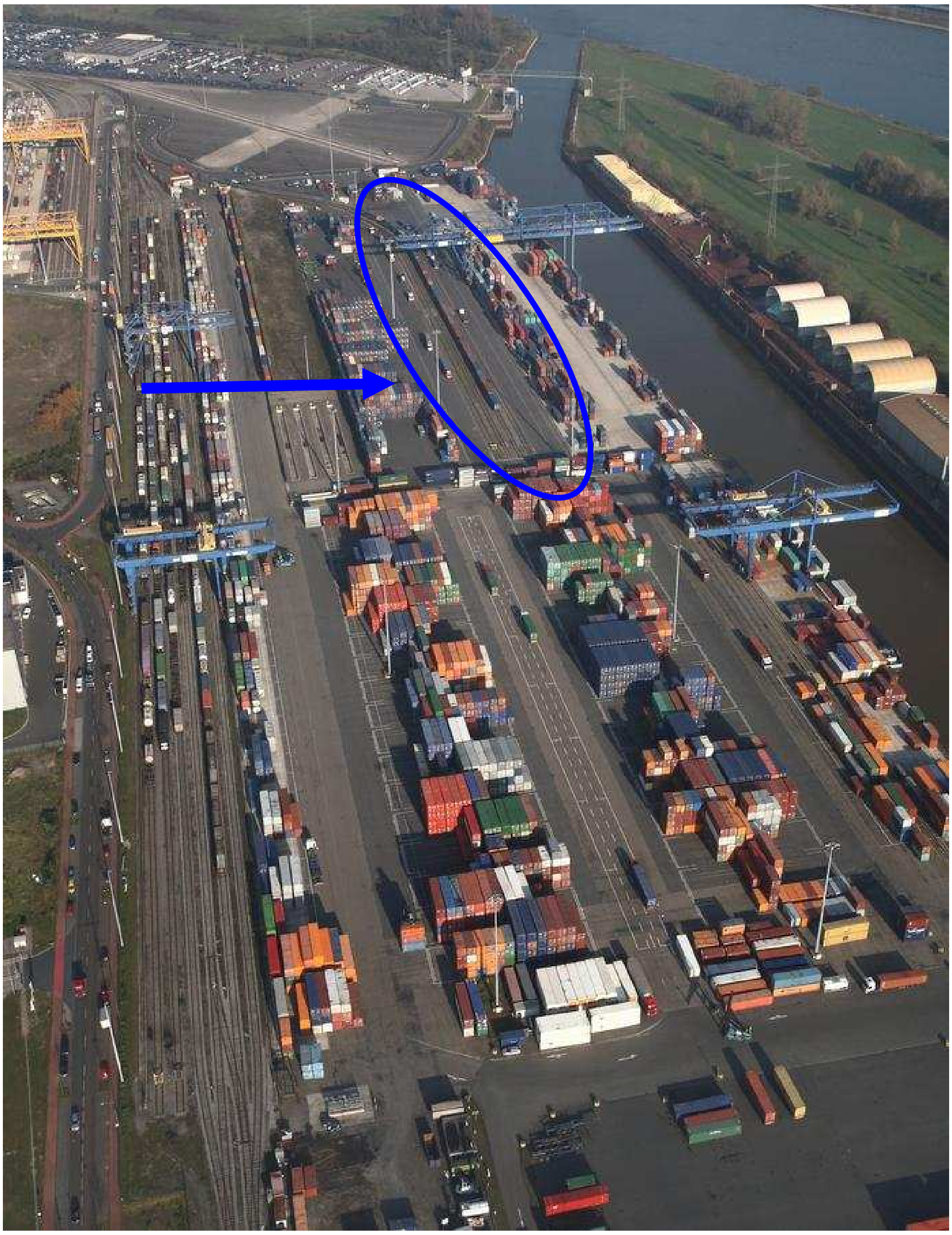


Figure 62: Duisburg Trimodal Terminal (D3T)

The advantage of the block train lengths is that the trains do not have to be shunted separately and they do not have to be subjected to another wagon brake test as prescribed in Europe during subsequent shunting to the marshalling yard.

The following is tested during a wagon brake test, while at a standstill:

a) required load change setting (full/empty)
b) brake type change (G/P)
c) brake switch (on/off)
d) state of the friction elements (minimum force of the brake pads, unbroken)
e) whether the friction elements of all activated brakes are raised from the steel tyre in the "release brake" position and are fitted tightly to the steel tyre in the "apply brake" position.

So-called brake testing systems are installed in all terminals in Duisburg in order to shorten the coupling times for the diesel locomotives. These systems allow the wagon inspection to be performed for the brake system with compressed air prior to the arrival of the shunting locomotive. This shortens the operating time of the shunting locomotive.

A high-speed cargo route was established between the Rotterdam/Netherlands sea port and the Ruhr region in Germany between 1997 and 2007. The high-speed cargo route has 3 tracks and allows cargo trains to reach a speed of over 120 km/h.

Another performance increase is the so-called block processing in order to significantly increase the route's capacity efficiency: the introduction of the "variable succession of trains", which is determined by the length of the trains, speed and rail station capacity at the respective end point of the route, among other things. This monitoring system is controlled by the ETCS (**E**uropean **T**rain **C**ontrol **S**ystem).

The basic requirement for this type of system requires a highly efficient shunting yard at both ends of the high-speed route.

Furthermore, in Europe, the containers are currently sent to a hinterland area from the sea terminals by train without being sorted, as they have a considerable shortage of space. More and more so-called KV megahubs (especially in Germany) are being established in order to sort the various, unsorted flows in terms of customers or terminals, as required. These are pure rail-rail systems that allow incoming trains to be sorted amongst themselves, using crane technology, in order to be able to travel to their destination correctly sorted after a period of max. 1 hour. If this is not provided, additional sorting facilities are entered so that the trains can finally travel to the customer or to the terminal for further processing correctly sorted.

Another development in continental traffic in Europe is the reintroduction of trailer trains (cf. Figure 63 and Figure 64). Trailers that are suitable for lifting by cranes are driven to the container terminals and set on special wagons using crane technology. These trains travel point-point transport. This makes it easier to couple with tractor units at the end station and transport the goods to the receiver. This also requires appropriate rail infrastructure.

Figure 63: Trailer train a

Figure 64: Trailer train b

It must be noted that this infrastructure currently does not exist in the Port of Santos area. The following port rail infrastructure can be found on the right bank (cf. Santos detail plan). As can be seen, only the main entrance track has been constructed with a length of 1,500 m. All subordinate tracks are considerably shorter. Even the shunting yards have no other similar train lengths.

The following figure presents the state of the port's rail infrastructure (cf. "State of Santos' rail infrastructure" in the appendix). This shows that there are insufficient marshalling yards and a lack of track lengths. This will inevitably lead to a huge amount of shunting. This leads to high time and financial expense.

In our view - and according to the port customers - the main problem in the port area relates to the dependency on infrastructure between the transport carriers. At the Duisburg terminals it was strictly observed that the rail and truck transport carriers were constructed separate from each other (cf. Figure 65 and Figure 66) so that both transport carriers did not interact with each other in the terminal flow path.

Figure 65: Duisberg Combiterminal (DKT)

Figure 66: DUSS-Terminal Duisburg

Best-practice: Rail infrastructure in Hamburg Maschen

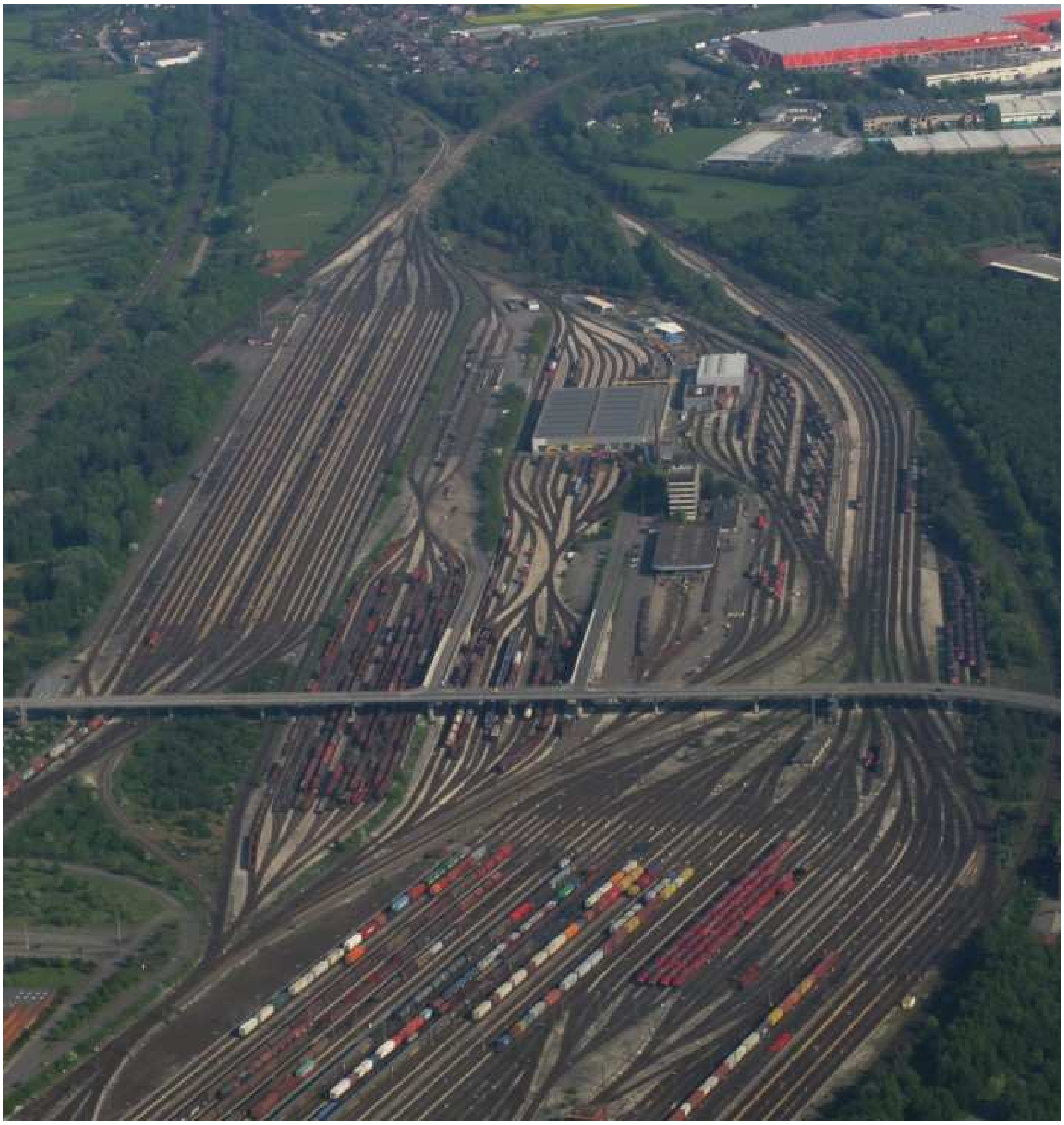


Figure 67: Shunting yard Hamburg-Maschen

Figure 68: Shunting yard Duisburg

Best-practice: Regulation of railway access and operations

Especially in case of restricted capacity of infrastructure the most efficient utilization is mandatory to exhaust the capacity to the maximum level. One potential solution to solve this issue is the regulation of railway access & operations within Ports by law.

Directive of the European Union in Railway Infrastructure (2001/12 EG)
Article 10 (6)
Track access to, and supply of, services in the terminals and Ports linked to rail activities referred to in paragraphs 1, 2 and 3, serving or potentially serving more than one final customer, shall be provided to all railway undertakings in a non-discriminatory manner, and requests by railway undertakings may be subject to restrictions only if viable alternatives under market conditions exist.

→ **Regulation of railway access and operations can be a possible solution to counteract restricted capacity of infrastructure**

Recommendations

Segregation of traffic flows

Segregation of traffic flows: Continuation of the already started program to unbundle rail and road infrastructure and to unbundle Port and public traffic. Modernization and further development of rail and road infrastructure within the Port of Santos (further development of investment plans with a volume of 487 mill. US$ to optimize the road access to the Port).

→ **Despite the existing program to optimize the road access there are further investment programs necessary**

Figure 69: Investment programs

Optimizing the processes within the Port of Santos

- Setting up a traffic management system and traffic guidance system by the port authority for all modes of transport starting from terminal and logistics zone information, traffic steering, traffic control in real time IT systems.
- Central signal control including hinterland/terminals by neutral port authority
- Equipping the whole port infrastructure with traffic guidance technology, signposting and traffic light controls
- Block consolidation → costs reduction and increases in efficiency by consolidating purely terminal shuttle trains through which consolidation and shunting activities in the port railroad network will be reduced.

→ In particular, the parallel planning of the players involved should be brought together by a neutral port authority and incorporated in an overall port concept. Otherwise the actions of these individual market participant projects could lead to an inefficient logistics process and thus to an increase in traffic volumes in the whole port area.

Improvement of existing infrastructure within the Port of Santos

- Setting up additional buffer areas on and around the terminals and in front of the port (cf. Detail Plan Santos)
- Building up the existing roads and track facilities better and equipping them with sensors and information boards (traffic jam reports, text boards, traffic light controls)

Optimizing rail operations within the Port of Santos

- Information technology connection of the participants (common IT platform, see below), railroad software from a neutral third party for issuing slots/optimization
- Using a train guidance system to record and control train traffic in the port and surrounding area (e.g. systems such as ARKOS/VICOS)
- Setting up automated handling facilities on the terminal/platform (cf. Novel container technology) → quicker and more efficient handling
- Setting up shunting yards, pre-stacking areas
- Investing in guidance and safety technology and improving efficiency using electronic signal boxes (active traffic guidance systems)
- Renewing the existing track facilities in the port and/or to Cubatao so that it is possible to transport quicker and more safely.
- Constructing additional and longer tracks in the terminals → less shunting effort
- Sorted delivery – terminal related – preventing shunting effort and increasing process speed

Development of the rail access to & from the Port

Approach to agree on a modified system of rail operations within the greater Santos area with the relevant stakeholders in order to achieve a joint steering and development of the rail access to and from the Port on left and right bank (which is mandatory regarding the recommended implementation of novel container transport technologies, see below), e.g. by including a neutral partner in Portofer operations as a regulatory body.
Including a neutral partner can be a solution to optimize the rail access and rail operations within the Port of Santos

MRS Logística S.A.

fca Ferrovia Centro-Atlântica

ALL

PORTOFER

Figure 70: Market participants

5.3.2 Implementation of a road connection between left bank and right bank of the port

Current situation: Missing connection of left and right bank

Santos city is closely linked with the port. To date the only possibility of crossing the river and thus connecting the parts of the port is via ferry link. A more efficient connection via tunnel and respectively a bridge is planned to develop the port area in terms of access and transportation. Both banks of the port basin are currently being accessed via ferry links which means that only a low transportation capacity can be achieved. In addition, the crossing ferries disrupt the routes of the arriving and departing seagoing vessels. As a result potential reserves of the Highway Systems on left and right bank of the Port cannot be used (for example within an above mentioned Traffic Management System) in case of incidents or traffic jams on the respective access system. There is no possibility for a real traffic management and circulation of traffic within the Port.

→ **As long as this connection does not exist, the Port of Santos has to be treated – regarding road accessibility – like two different Ports**

Recommendations

Construction of a road connection between Saboó and Ilha Barnabé

The construction of the connection between Saboó and Ilha Barnabé is mandatory for the development and implementation of a single, efficient and sustainable traffic management system for the Port of Santos and the surrounding cities. Furthermore the maximum capacity of the road access systems to the Port of Santos will only be usable with this connection.

→ **A road connection (via bridge or tunnel) is mandatory for a traffic management system and allows a maximum capacity of the road access**

Figure 71: Possible solution bridge

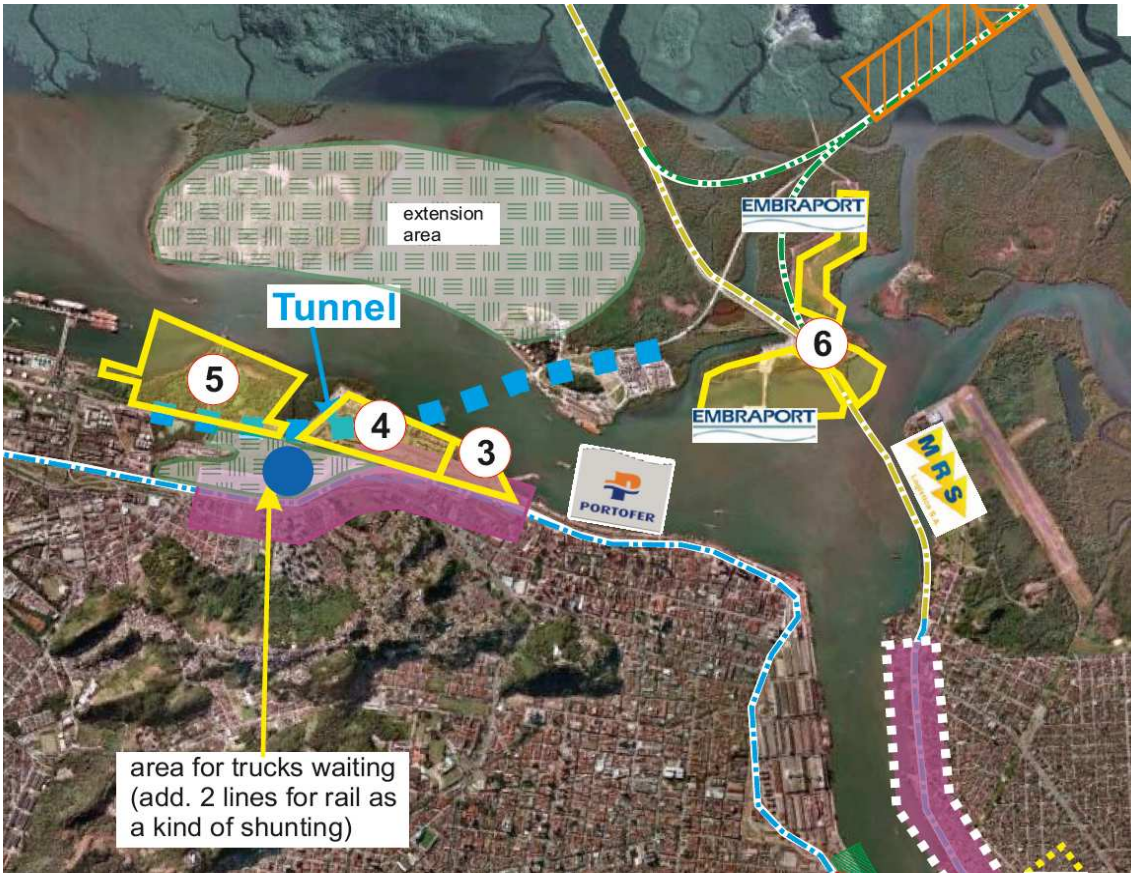


Figure 72: Possible solution tunnel

Using a "Port Feeder Barge[58]" additionally to connect left and right bank

Floating infrastructure for Brazilian ports

The urgently needed expansion of port infrastructure requires huge financial resources and takes a while to be realised. Hence it is worth to think about smart alternative solutions for the handling of container which could help to by-pass overloaded port facilities and could be realised very quickly and cost efficiently.

Consequently a self propelled container barge with its own high performance cargo gear could serve as a very flexible combination of:

- 'Floating (and self sustained) container truck' for the haulage within ports or to nearby locations (e.g. container freight stations)
- 'Floating terminal' for deep sea container vessels at anchorage
- 'Floating terminal' for coastal shipping at anchorage or within ports
- 'Floating terminal' for inland navigation within ports
- Floating crane for non containerised cargo

The Port Feeder Barge concept

The internationally patented **Port Feeder Barge** concept is a self-propelled container pontoon with a capacity of 168 TEU (completely stowed on the weather deck), equipped with its own state-of-the-art heavy-duty container crane mounted on a high column. The crane is equipped with an automatic spreader, retractable from 20ft to 45ft, including a turning device. A telescopic over height frame is carried along on board. The barge is of double-ended configuration, intended to make it extremely flexible in connection with the sideward mounted crane. Due to the wide beam of the vessel no operational (stability) restrictions for the crane shall occur. The crane has a capacity of 40 tons under the spreader, at an outreach of 27 metres (maximum outreach: 29 m).

[58] Source: http://www.portfeederbarge.de/de/59777-English

The unique vessel is equipped with 2 electrically driven rudder propellers at each end in order to achieve excellent manoeuvrability and the same speed in both directions. While half of the containers are secured by cell guides, the other half is not, enabling the vessel to carry containers in excess of 40ft as well as any over-dimensional boxes. The vessel shall fulfil the highest environmental standards. A diesel-electric engine plant with low exhaust emissions has been chosen to supply the power either for propulsion or crane operation. The vessel can be operated by a minimum crew of three.

The key element of the worldwide unique **Port Feeder Barge** concept is its own full scale container crane. While it looks like a standard shipboard crane for deep sea vessels, all its mechanical components have been especially designed for continuous operation – unlike standard shipboard cranes, which are designed for operation only every few weeks when a typical deep sea vessel is in port. Due to its nature, the **Port Feeder Barge** is continuously in port – seven days a week. Hence the load cycle requirements are even higher than for many quayside cranes, which have significant consequences on the layout of its mechanical components.

Main Data	
Length o.a.:	63.90 m
Beam o.a.:	21.20 m
Height to main deck:	4.80 m
Max. draft (as harbour vessel):	3.10 m
Deadweight (as harbour vessel):	2,500 t
Gross tonnage:	approx. 2,000 BRZ
Capacity:	168 TEU (thereof 50% in cellguides), 14 reefer plugs

Table 20: Main data of the port feeder barge concept

When berthed, the **Port Feeder Barge** is able, without being shifted along the quay, to put or pick 84 TEU in three layers between the rails of typical quayside gantry cranes. This is more than sufficient, with a total loading capacity of 168 TEU. That is why the full outreach of the crane is not always needed. Berthing the vessel with the crane on the opposite side of the quay would speed up crane operation as the turning time of the outrigger is minimised. The height of the crane column is sufficient to serve even high quays in open tidewater ports at low tide while stacking the containers in several layers or to serve deep sea vessels directly.

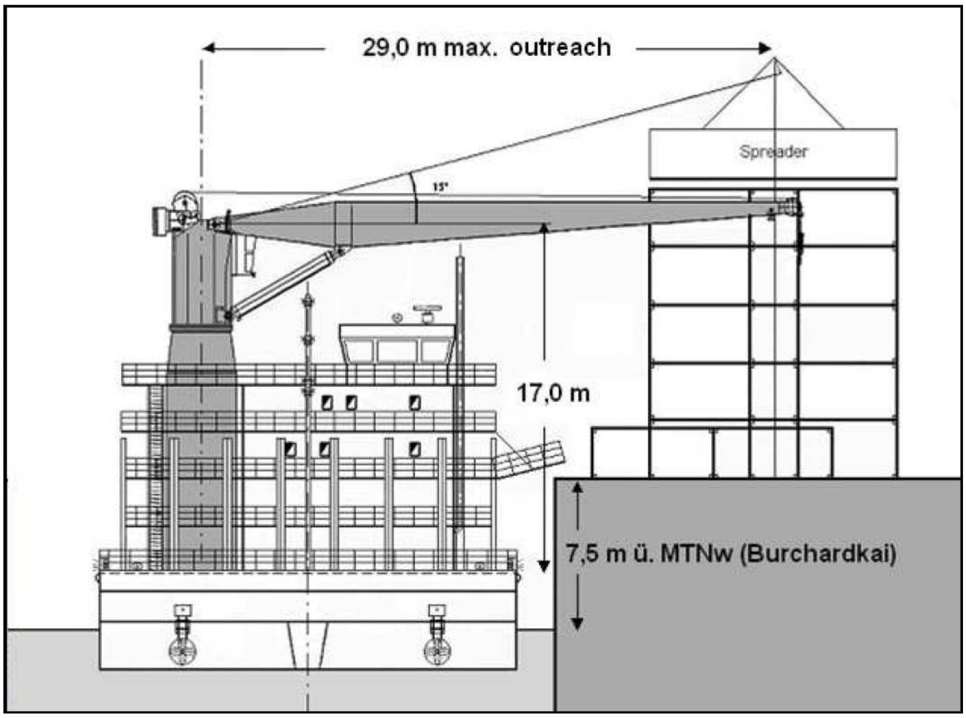


Figure 73: Dimensions of the port feeder barge concept

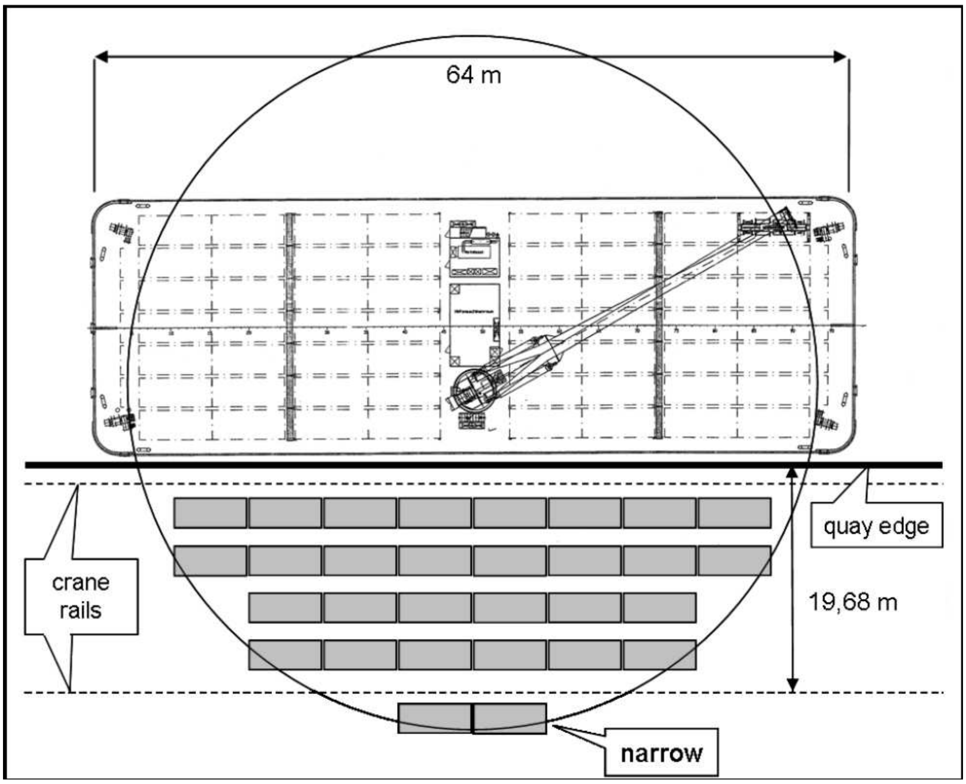


Figure 74: Working radius

As more and more terminals are operating on their capacity limits separate container freight stations are being built in the neighbourhood of the ports to remove the stuffing and stripping activities to offdock facilities which often have their own (shallow) water access, but no cranes, resulting in additional road haulage. These transports cause an increase of box movements more than proportionally to the general growth of container traffic.

A self sustained **Port Feeder Barge** being independent from quayside equipment could shift these containers from road to waterway. Compared to trucking, the **Port Feeder Barge** does not cause any additional work for the deep sea terminal. Instead of carrying a container to the pick up area for the trucks a terminal vehicle carries it to any quayside zone in terminal's option. If the terminal has the possibility to grant the **Port Feeder Barge** a permanent berth – for example where the water depth is not sufficient for any seagoing vessel – there is even the possibility to reduce the terminal’s expenses, as the boxes could be brought directly to the berth without being put into intermediate container stack, hence avoiding double handling. This should be the case with many terminals of jetty-type deep water berths.

Connected to container trucking in multi-terminal ports is assisting the feeder operations. The common feeder vessels either have to call at all the various deep sea terminals where their customers are berthing or feeder operators have to contract road hauliers for intra-terminal transports (see above). If the **Port Feeder Barge** would collect and distribute containers for the feeder vessels, the feeders could concentrate on the major terminal(s) only, thus reducing the number of vessel shiftings, reducing their time in port and related costs, improving safety and increasing terminal and berth efficiency.

<u>'Floating terminal' for deep sea vessels</u>

Without huge investments in land based infrastructure deep sea container vessels could be served at anchor by the **Port Feeder Barge** which also would shuttle the boxes on its own between the anchorage and ashore requiring only simple and small facilities with only shallow water in port to handle the boxes.

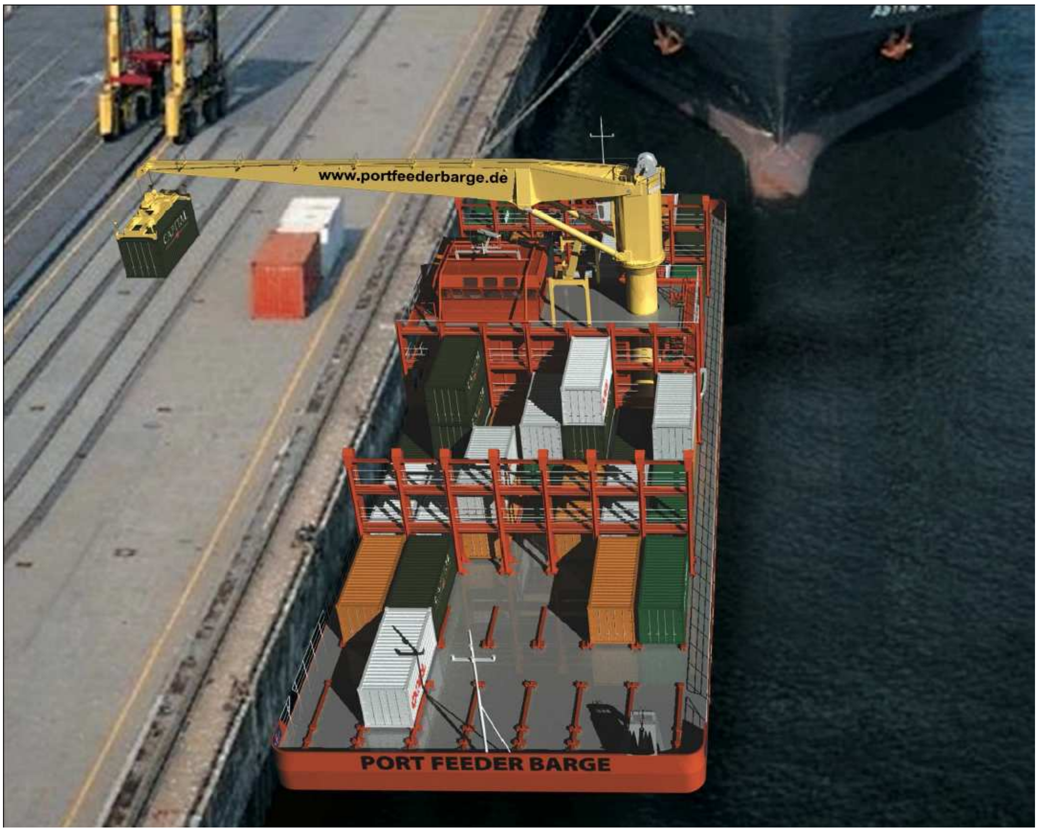


Figure 75: Operation at a terminal

'Floating terminal' for coastal shipping

Coastal shipping has a bigger role to play if coastlines have to be exploited and regional container hubs have to be developed. However development of coastal container shipping suffers from the fact that it has to compete for space with international forces. Major ports and container terminals continue to be congested and berthing for coastal vessels is a real nightmare according to coastal operators. Lack of container handling facilities at minor ports, and restrictions, are additional major obstacles. As well as with deep sea vessels from abroad **Port Feeder Barges** could serve also coastal vessel directly as a 'floating terminal' in minor ports.

'Floating terminal' for inland navigation

Inland waterway shipping is destined to take a bigger portion of hinterland traffic even in container transport. To avoid berthing of the small inland waterway vessels at all the deep sea container berths (which would be a waste of valuable terminal capacity) and not to be forced to build dedicated inland barge terminals the **Port Feeder Barge** could act as a floating and movable terminal for inland navigation. The containers would be exchanged ship-to-ship, independently from any shore side facility. Not even a quay is needed but transhipment operation can take place somewhere midstream at the dolphins. Such operation would strengthen the competitiveness of inland navigation resulting into an increased share in hinterland transport.

Figure 76: Operation at a container barge

Operating **Port Feeder Barges** is also affecting urban issues. With respect to investment, availability of land, building approval, flexibility and not to forget environmental and townscape issues a 'floating terminal' is much cheaper, smarter and easier to realise than any land based facility. In addition it could be financed privately.

The **Port Feeder Barge** concept can be considered as a logistic innovation especially for Brazilian ports that could help to ease congestion and to reduce the impact of heavy container trucking in many container ports. In minor ports which suffer from a lack of sufficient shore based container facilities and/or very limited water depth such vessels could in the first place facilitate container handling. This would strengthen the potential of coastal shipping substantially. Employing **Port Feeder Barges** is less costly and quicker to realise than the erection of comparable shore based facilities not to mention that less parties have to be involved for approval.

5.3.3 Implementation of an IT-platform for Traffic & Cargo Management (Transport-Logistics-Platform)[59]

Current situation

- Today the terminal operators do operate state of the art Terminal Operating Systems (TOS)
- There is no common IT-platform and no Port Operating System (POS) within the Port of Santos
- There is no superordinated control and steering instrument for the traffic and cargo flows.

→ Need for implementation of IT-systems

Best practice: Traffic concept

The Port of Santos, the city area and the hinterland must form a coordinated system. This is the only way to ensure that the increasing freight can be transported to the hinterland or respectively the Port of Santos. The so-called static traffic management cannot solve this problem; the infrastructure capacity for this maximum load is simply insufficient. As a result, the in- and out-going traffic often generates a bottleneck in the port which should be avoided. Due to the costs, time and effort involved, it is not always possible to increase the capacity by constructing new developments. Respectively, due to nature conservation legislations it is not possible to build new developments everywhere in the hinterland of Santos and thus, building new developments to increase traffic capacity is difficult to implement.
An intermodal solution which operates with reliable data on predicted traffic growth from the port's own information systems and which calculates the ideal management of the port-hinterland traffic is a particularly promising solution to increase efficiency. This means: the containers are delivered and removed quicker whilst having only a minimum impact on the rest of the traffic.

[59] The recommended technical solutions and equipments were developed with industrial partners (Siemens AG)

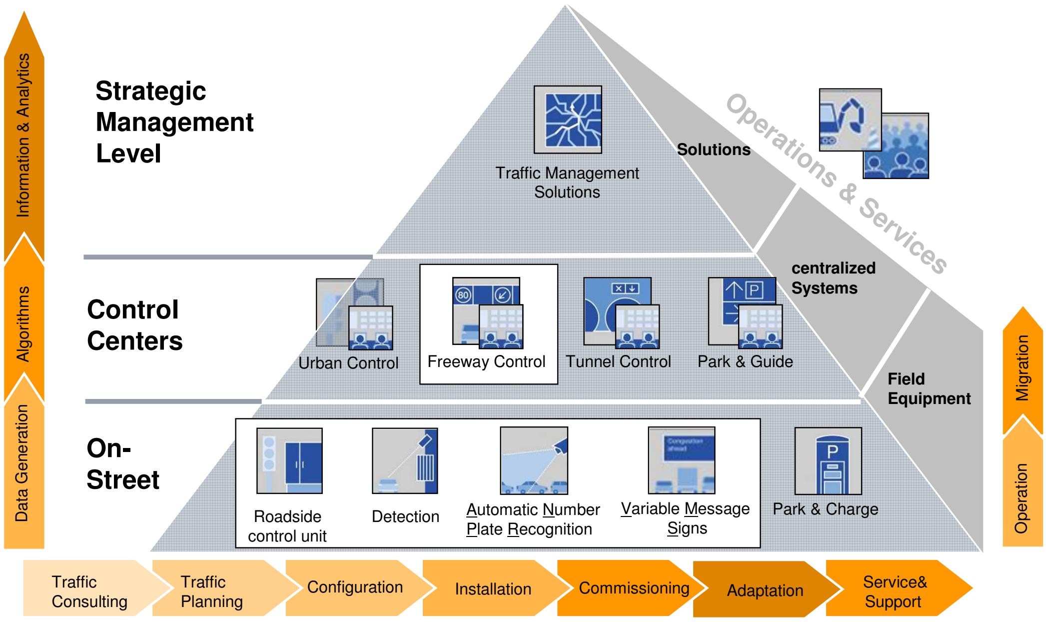


Figure 77: Intelligent traffic system

Challenges

The topological conditions have a big impact on the Port of Santos' traffic situation. Firstly, the river divides the port area into two parts and secondly, the transportation connection to the hinterland is extremely hindered due to the high plateau. Currently, approximately 90% of freight transportation is effected via HGVs. The objective is to develop the rail-bound freight transportations so that the modal share rapidly develops in the direction of rail transportation. However, due to the predicted rapid growth of the port the HGV traffic will by 2024 still increase by almost 100%.

The challenges related to an ideal transportation connection to the port can be sub-divided into the following systems:

- Connection to the hinterland and the city of Santos
- Port area
- Gate systems

The road connection to the hinterland is effected via the two motorways Immigrantes and Anchieta. The new 3-lane motorway, Immigrantes, is closed for HGV traffic in the downhill direction due to the steep gradient. Downhill means in the direction of the Port of Santos. The older road, Anchieta, is very winding and also has many sections with steep gradients. However, this motorway can be used by HGVs in both directions. There are no other routes available. Due to the topology, the development of the existing routes proves to be costly and time-consuming. It is almost impossible to construct new routes because the Atlantic Rainforest needs to be crossed and it is under natural conservation.

Santos city is closely linked with the port. To date the only possibility of crossing the river and thus connecting the parts of the port was via ferry link. To develop the port area in terms of access and transportation, a more efficient connection via tunnel and respectively a bridge is planned. The historic port has an acute lack of space resulting in incoming and exiting trains blocking the HGV traffic flow for hours.
A future tunnel or bridge crossing across the port basin could be upgraded to a control system and would presumably increase the traffic capacity.

Solutions

The accommodation of double the HGV traffic volume requires a package of measures divided into structure-related and traffic-related measures. Firstly, the infrastructure should be upgraded to significantly increase the capacity. Secondly, through intelligent traffic management, the cost-effective alternative to structural measures, the in- and out-going traffic is channelled in a better manner and through this, the capacity of the existing port infrastructure is used more efficiently.

→ *Connection of hinterland and Port of Santos*

Without any traffic disruptions, a typical two-lane motorway (according to European standards) can manage 1,800 vehicles per lane and per hour. Based on this and assuming that there is a minimum HGV proportion of 15%, the motorway can manage approx. 540 HGVs per hour. This figure may vary depending on the topology, incline, bends and gradient. Thus, in theory, almost 13,000 HGVs could drive on this kind of motorway per day. However, in practice, the figure is more likely to be around 9,500 HGVs per day. In Santos, the assumption was made that 12,000 HGVs use the motorways per day.

Furthermore, if a hard shoulder exists, it is recommended to develop this. By releasing the hard shoulder temporarily, this can then be used as an additional lane.

→ *Crossing port/river*

Crossing the river clearly reduces the HGV traffic in the city centre of Santos. Furthermore, crossing the river makes traffic-based routing via the access routes possible.

→ *Urban and interurban Traffic Management System*

A modern traffic management system with integrated strategy management optimizes the cooperation between the different modes of transportation and thus also the management of different sub-systems. In the framework of the strategy management, situations are defined such as removing a container ship from a specific terminal. The inner-city traffic light control system can be optimized specially for this situation, e.g. by switching the green light on for longer periods for the out-going traffic from the port.

Based on the respectively current traffic conditions, active traffic management or corresponding control systems are capable of handling congestions. Active traffic management improves the vehicle flow and has an active warning system through which road safety is increased. Innovative technologies assist in obtaining this objective. Automating procedures prevents delays that would arise through manual input. This so-called "incident management" (congestion management) is based on a combination of strategies that optimize the infrastructure and create a measurable added value for the transportation network.

Amongst other things, active traffic management also includes:

- Speed harmonization through route management on motorways
- Temporary use of hard shoulders through route management on motorways
- Congestion alert system through route management on motorways
- Environmental information through route management on motorways
- Alternative route management via panels
- Lane release, specially for truck cargo
- Optimized green waves for increased traffic
- Ramp metering

Advantages of active traffic management:

- Better synchronised traffic and increased capacity during rush hour
- up to 35% less accidents
- up to 30% less injured motorists
- up to 20% less hours in congestion
- up to 20% increased capacity on motorways

An increase in capacity of 20% due to active traffic management means that approx. 1,900 more HGVs use the route per day; see the capacity calculation above.

→ Incident management

By analysing the traffic situation in a quick and reliable manner and identifying the traffic disruptions, it is possible to decrease the number of secondary accidents and to reduce the mean travel time. In addition, emergency services can be notified and be led to the site of the accident sooner. All of these increase the network capacity and prevent the road from being prematurely developed which would thus lead to all the negative effects that road works have on the traffic situation. Various assessments of operating traffic control systems with regard to the number of secondary accidents as well as the reduction of deaths and injured persons have shown that incident analysis and incident management have a big impact on socio-economic advantages of systems with active traffic control.

Using the data from existing information systems of the port or from the corresponding operators to predict the traffic growth poses a cost-effective solution. Alternatively, the required data can also be acquired via own sensors.

Sources of information for travel time:

- ANPR automatic number plate recognition
- Bluetooth acquisition of electronic devices' Bluetooth ID
- FCD Floating Car Data GPS based vehicle locating
- local detection measurement of the speed and calculation of the travel time

→ Dynamic traffic information

Based on the different types of traffic detection and traffic-related additional information such as road works sites and other traffic disruptions, modern traffic management systems are able to calculate the current traffic situation for the entire network. To transmit the relevant information in a targeted manner to the motorists and to reduce the congestions and emissions through this, the multi-modal traffic information systems can be used. They combine the current data of all transportation systems. Ideally, the motorist is already provided with information via comprehensive multi-modal real-time information prior to commencing travels and not just during his trip. Information can be accessed via corresponding internal portals prior to commencing travels, e.g. information on the traffic situation on the road network or respectively on the planned route.

Figure 78: Intelligent lane assignment

The main aspects of multi-modal traffic information are:

- Real-time traffic information for motorists
- Dynamic and (multi-modal) routing information
- Additional travel services via devices carried along, e.g. PDAs/Smartphones or systems installed in the vehicle

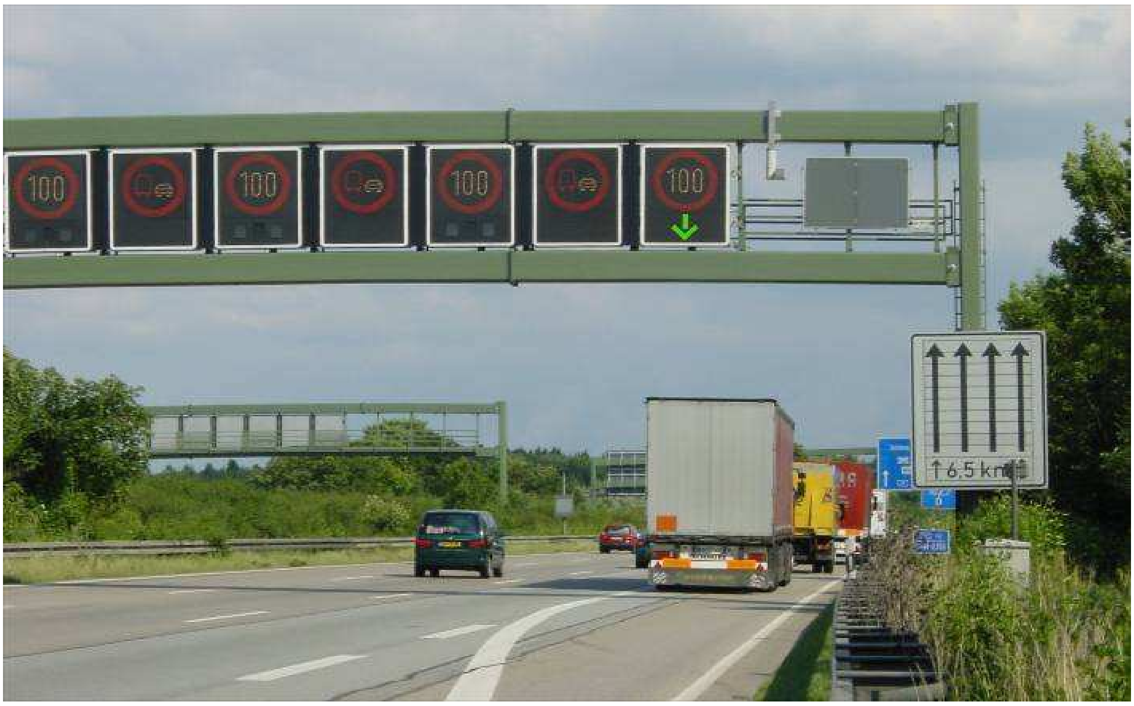


Figure 79: Intelligent speed management

→ *Toll for cars / trucks*

Efficient toll systems are not only able to reduce traffic growth and the congestions resulting from this but the environment also indirectly benefits from a smooth traffic flow. By implementing dynamic and traffic-based toll charges, car and HGV traffic can be managed in terms of time and reserve capacity.

→ *Intelligent linkage to the logistics centre*

By linking the logistics centre with the traffic management system, the HGV flows are routed to Santos in an ideal manner in terms of timing and in the event of disruptions of the city traffic, the HGV flows are temporarily stopped. Current travel time information to all terminals optimize the acceptance of the system. Releasing special lanes on the motorway and in the city can clearly increase the capacity when required. Through this, throngs of HGVs can be routed to the terminals through the city in an ideal manner.

Gate system

→ Preregistration of the truckers and containers

By preregistering, truck drivers are informed about traffic bottlenecks in the handling area and respective trucks are only routed to the port once loading or unloading can be ensured. This makes it possible for unnecessary waiting periods to be avoided and congestions due to waiting HGVs to be reduced.

→ Automation gate handling

The automation of the gate handling process reduces the handling time when entering the area. By carrying out automatic registrations, manual checks are no longer required. The vehicles with access authorization are entered in the system before and if the vehicle number plate is recognised, the barrier opens automatically. Furthermore, this system can be coupled in a way that only HGVs that have been authorised for loading and unloading are granted access.

Port area

→ Flyover across the port area

The truck cargo link road to the port area should be designed with a flyover junction. Freight trains must not hinder the HGV road link.

→ Dynamic loading position allocation

On the port grounds, HGVs are routed to the parking position via dynamic loading position systems and signs. This reduces the HGV search time, the manual organisation and the HGV traffic on the grounds.

→ Strategic traffic management on the port grounds

By managing the traffic lights on the port grounds strategically, different loading situations such as RoRo are handled in an ideal manner at a terminal. The traffic lights are managed in a traffic-based manner via detection of the traffic flows at the junction via induction loops, video cameras or IP detectors. This means, the green periods are prolonged based on traffic for the decisive direction.

Best practice: IT transport platform

Description of the problems

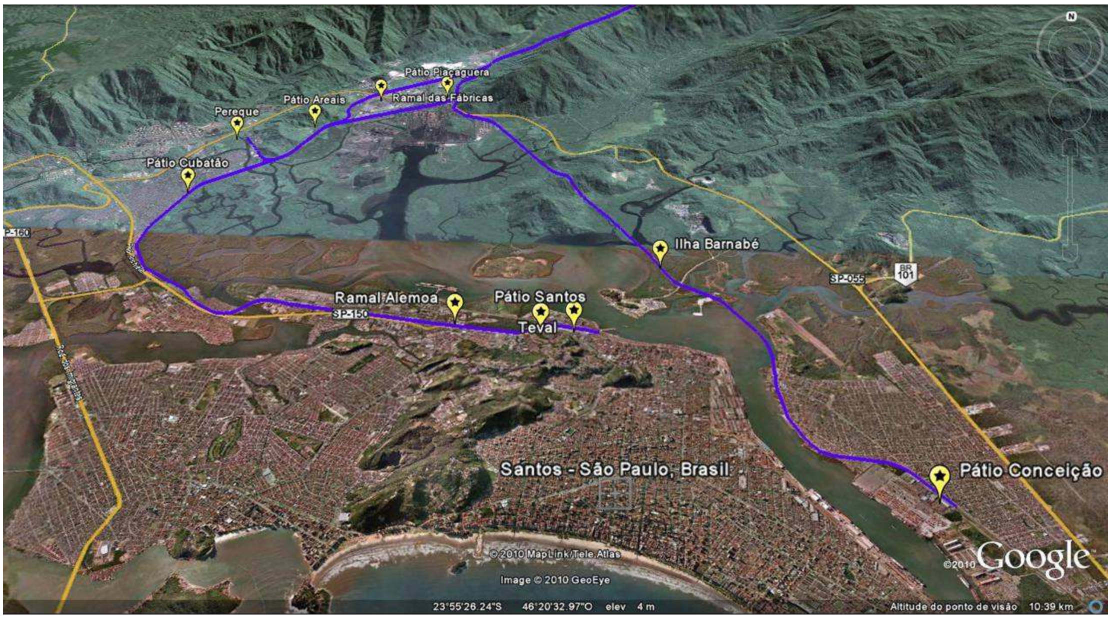


Figure 80: Topography of Santos

Requirements

The situation at the Port of Santos is currently characterised by the following factors:

- Each year, around 3 million TEU containers are loaded at the 3 terminals (import and export)
- Until now only one terminal is equipped with a with a rail connection for 120k TEU
- A 700m height difference is to be overcome between the Port of Santos and the associated commercial region of Sao Paolo

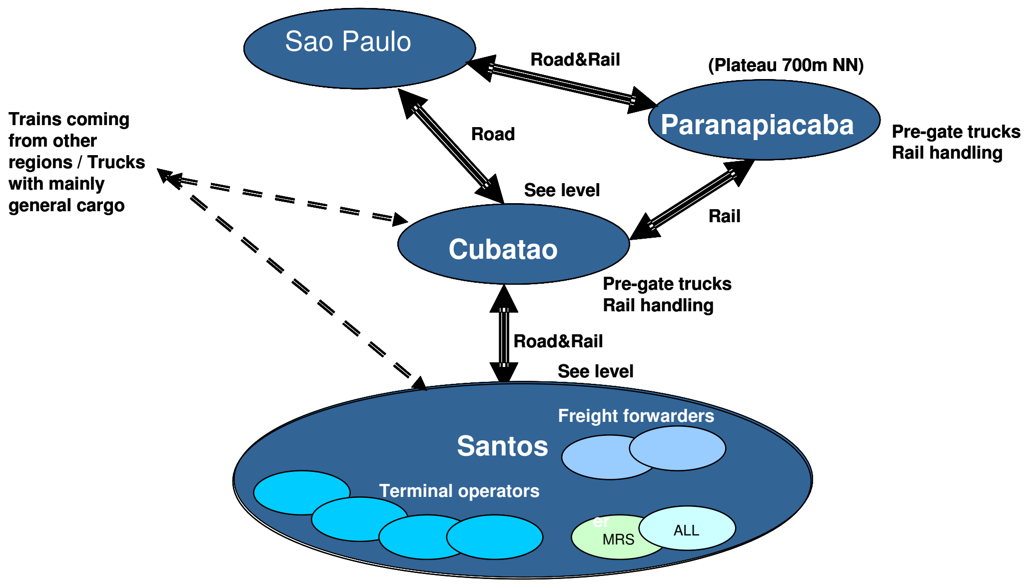


Figure 81: Transport connections Santos

The Cubatao industrial area is at the same level as Santos and is nowadays used as a type of pre-gate. Waiting times in this area are up to 18 hours. The remaining route to the port takes up to 3 hours.

- The projections for 2025 are for 9m TEU on 6 terminals, of which 3m TEU are to be transported by rail
- There are two main bottlenecks
- Truck cargo within the port and from Santos
- Transportation of containers from sea level (Cubatao and Santos) to a height of 700m at Sao Paolo.
- The terminals are now already using state of the art TOS systems, although these are not coordinated with each other
- There is no port-wide exchange of information (such as Dakosy)
- There are already pre-gates in Cubatao from which bulk trucks are already partly processed in slots. However, these are ineffective because there is no coordination for the allocated slots between the terminals and the traffic situation in Santos.

Objective

- With regard to the situation described above, we see potential for TLP as an open transport logistics platform in the following areas in particular:
- Better data integration and planning coordination between logistics service providers, terminal operators and the port authority
- Accelerated truck handling within the port using information available in advance regarding the cargo being transported
- Coordination between terminals in relation to entry and flow control from Cubatao
- Improved traffic flow through Santos by combining transport logistics data with traffic management.

General description of a transport logistic platform (TLP)

Reasons for developing a TLP

Nowadays there are insufficient options for integrating data and processes in intermodal transportation chains across company boundaries. It is neither possible to manage transportation chains (logistics chains) uniformly, nor to optimise key distribution centres (logistics nodes). The level of information available to the shipper decreases with each party concerned. This has serious disadvantages for the traceability and availability of the logistics chain. Deviations and problems within processes are not recognised early on and information is not actively disseminated.

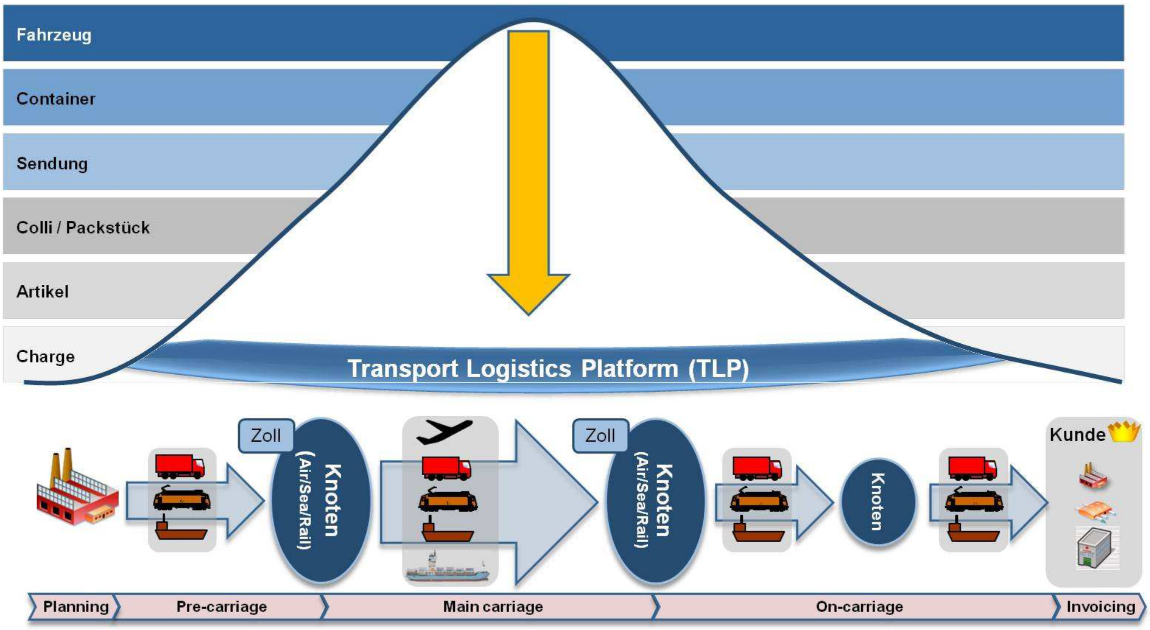


Figure 82: Loss of detail

This figure shows the loss of detail and availability of logistics information along the process chain without the support of a targeted data exchange.

TLP's innovative approach

Up until now IT logistics contained exchange platforms for locally confined logistics chains (e.g., exchange platform for all parties involved in the processes relating to a port) and internal company solutions for intermodal logistics chains (e.g., from large CEP service providers), which take a single full-service supplier into account.

One of the special features of TLP is the IT platform's open and flexible approach across all transport modes. The platform provides the ongoing use of data aggregation and facilitates the use of track & trace, for example, in real time. The openness of the platform incorporates specific solutions for individual process partners and it provides specific optimisation levers and, if necessary, additional companies.

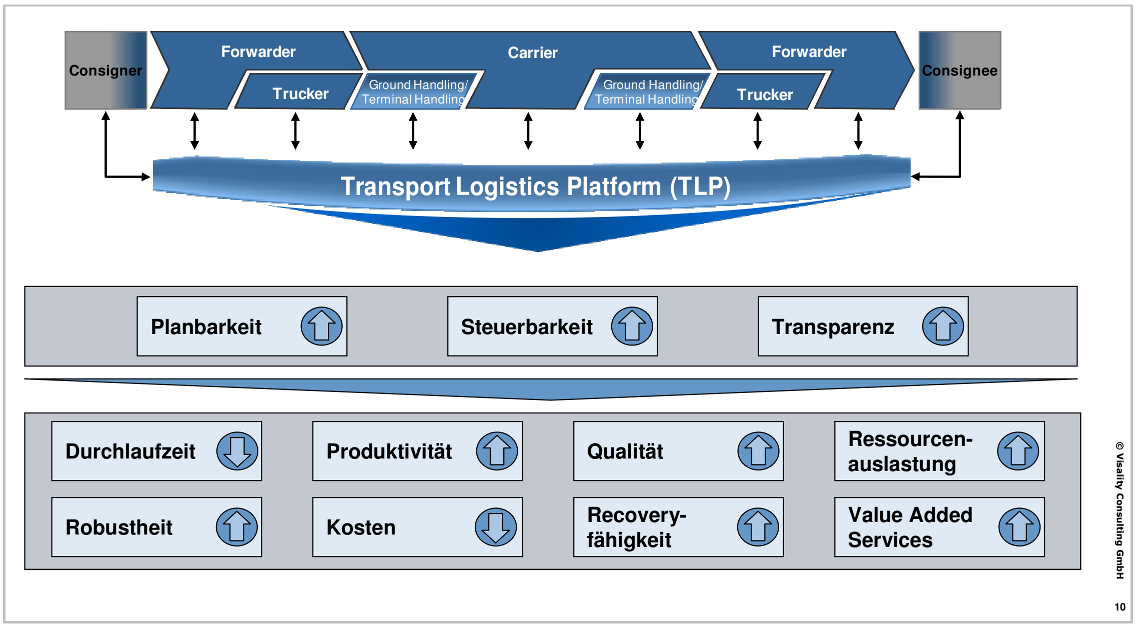


Figure 83: System-wide exchange

This diagram shows the realisable benefit of using targeted data exchange across system partners.

In addition to the logistics chain, the transport logistics platform provides comprehensive data integration for extensive services, which are combined in various products. These products implement various levels of 'intelligent' data processing and range from simple data exchange to planning algorithms and management services, and to logistics chains for comprehensive optimisation processes. The products focus both on services which facilitate the integration and improvement of processes throughout the logistics chain, and on services which improve services in the logistics nodes.

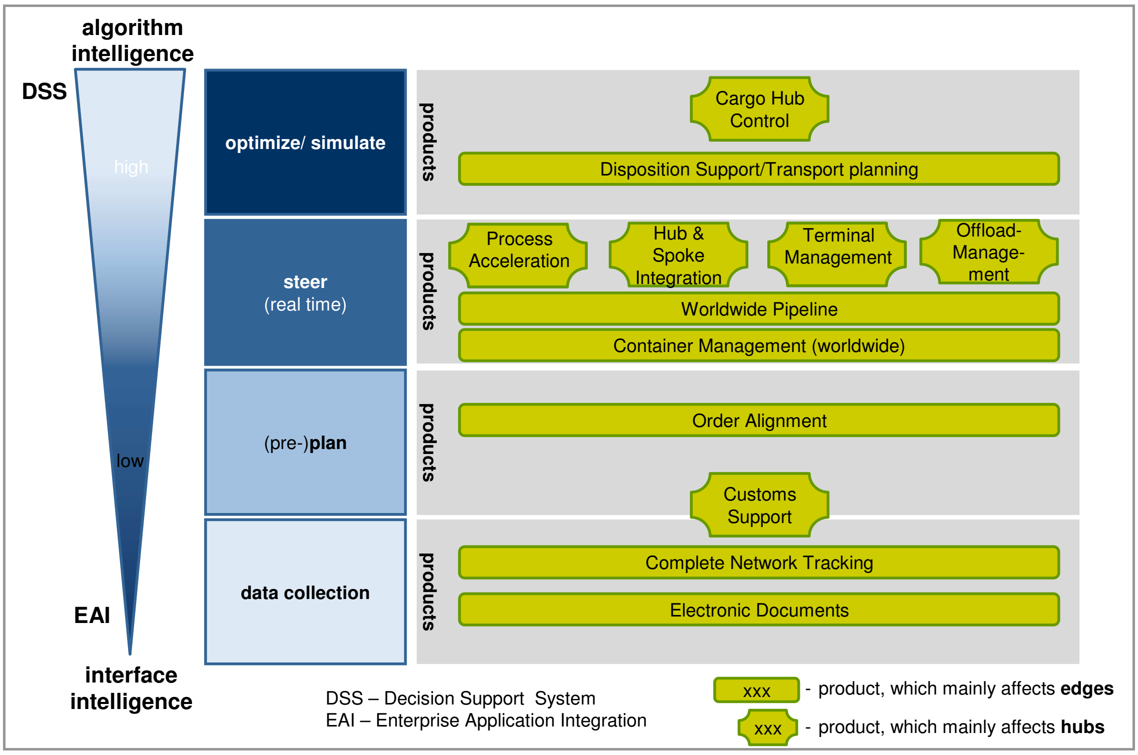


Figure 84: Classification of TLP-products

The classification of TLP products in relation to the algorithmic complexity of the services implemented

Exemplary description of TLP-products

Exemplary TLP products are described below. These have significant potential to greatly increase the productivity and efficiency of the logistics processes at the Port of Santos, its terminals and the connection to Cubatao.

Complete Network Tracking

Although track & trace has been a basic logistics requirement for customers for a long time, there are still weaknesses in the consistency of the tracking points for all partners involved in a supply chain, and in the intelligent evaluation of the tracking data obtained. Many higher value services cannot be implemented profitably without the relevant data.

The data exchange platform enables companies to freely define a logistics chain and its tracking points, to which desired values can be assigned. Building on the previous practice allows the documentation not only of programme-related/temporal events, but also of document-related/content events, with which a logistics workflow can be mapped. Depending on the availability of data, drill downs, such as from consignment reference to article or vehicle level, can be carried out.

Hub & Spoke Integration

Due to the grouping function in the flow of traffic, inter-modal hubs suffer from constant bottlenecks in the waiting area, in the intermediate buffer, as well as in the immediate handling process. The consequence of unregulated supply and flow is backlogs, waiting times, unnecessary routes and up to four times more handling of containers.

Based on a data exchange platform, the carrier registers their deliveries on the hub with their own route planning and obtain reliable slots as time frames, according to defined rules of priority. In this way, in parallel to the scheduled dispatch, important data can be exchanged in the preliminary stages (hazardous materials, customs duty etc.) and corresponding documents can be prepared, so that processing the delivery can be carried out quicker. In this respect, forwarders, carriers and handling agents profit equally from streamlining the process.

Container-Management

International carriers in particular represent a big challenge for container management. It must be ensured that in each depot enough empty containers are available and that the loaders offer them to their customers to transport the goods. Different types of container and local organisation e.g. seasonal variation in container requirements are taken into account. The container control system tracks the current location of each container and takes into account the maintenance cycles.

Product container management is determined by historical data, and customers' container requirements as well as local events and the number of containers needed at each depot and conforms to the appropriate container control system. Therefore the current location and status of every container and integrates the maintenance dates into the container's route.

The product can be used by a carrier as well as a neutral service provider, who has taken on container management (where necessary for many carriers).

Best practice: DAKOSY (Port of Hamburg)[60]

The Port of Hamburg is a "paperless Port". All companies and authorities involved in the export, import and transit processes can handle their transport processes rapidly and with electronic assistance by using the B2B services and applications of DAKOSY.

The export-relevant transport and (transit) processes have been supported for many years by the communication services of DAKOSY, these meanwhile having been brought together under the term “EMP - Export Message Platform". All documents necessary for processing the transport (e.g. transport orders, customs applications, hazardous goods notifications and other official documents, harbor orders, bills of lading, manifests, delivery notifications through to status information for everyone involved) are transferred in internationally standardized message formats.

In April 2010, the last loophole in the import-relevant communication processes was closed after the launch of the "IMP - Import Message Platform". The IMP supports the individual sector requirements of the carriers, terminals, haulage and transport companies and all relevant authorities, while optimizing the overall process from the ship's entry to the Port of Hamburg through to delivery of the goods at the customer in the hinterland.

[60] Source: http://www.dakosy.de/

Figure 85: DAKOSY Portal

IMP - Better planning capabilities: Hamburg seaport transport business benefits from commissioning of the Import Platform

The clearance processes in the Port of Hamburg are set to speed up with the launch of the Import Platform (in short IMP). The IMP is an intelligent, electronic platform, enabling information to be exchanged between the parties involved faster and more or less automatically, which means the import process can be handled more efficiently overall. Early and extensive status information to all transport partners - e.g. altered ship arrivals - improves the planning and scheduling options. Follow-up processes can be initiated in a targeted manner and planned in line with resources and location. Bottlenecks, which typically result from delays and unscheduled arrivals of container ships, can be recognized in good time – in the product context - and extensively mitigated.

The Import Platform complements the service range from DAKOSY, where it is implemented in the computing centre enabling it to be accessed without any problem by all companies involved. As a single window, it supports the individual sector requirements of the carriers, quay operators, haulage and transport companies as well as all authorities involved and the relevant importers. A data pool is formed for each import process, in which all information is included under a fixed IMP reference and compiled again for all follow-up orders (official registrations, transport handling etc.). Current status information supplements the information base. Workflows can be saved as well as automated by definite follow-up processes (e.g. official registrations).

The IMP results in advantages for all transport partners. If, for example, the terminals already know before arrival of the ships when and with which transportation strategies the hinterland transport is to be carried out, a further optimization of the yard planning is possible. If the truck drivers are also informed about the readiness of the containers for collection via status information, they can synchronize their operation with the terminals. Congestion at the terminals can be reduced and the road capacity utilization improved overall. The haulage contractors are provided with a large amount of status information by the IMP, which they can use to integrate their partners more effectively in the sequences, initiate follow-up processes in a targeted fashion and inform customers.

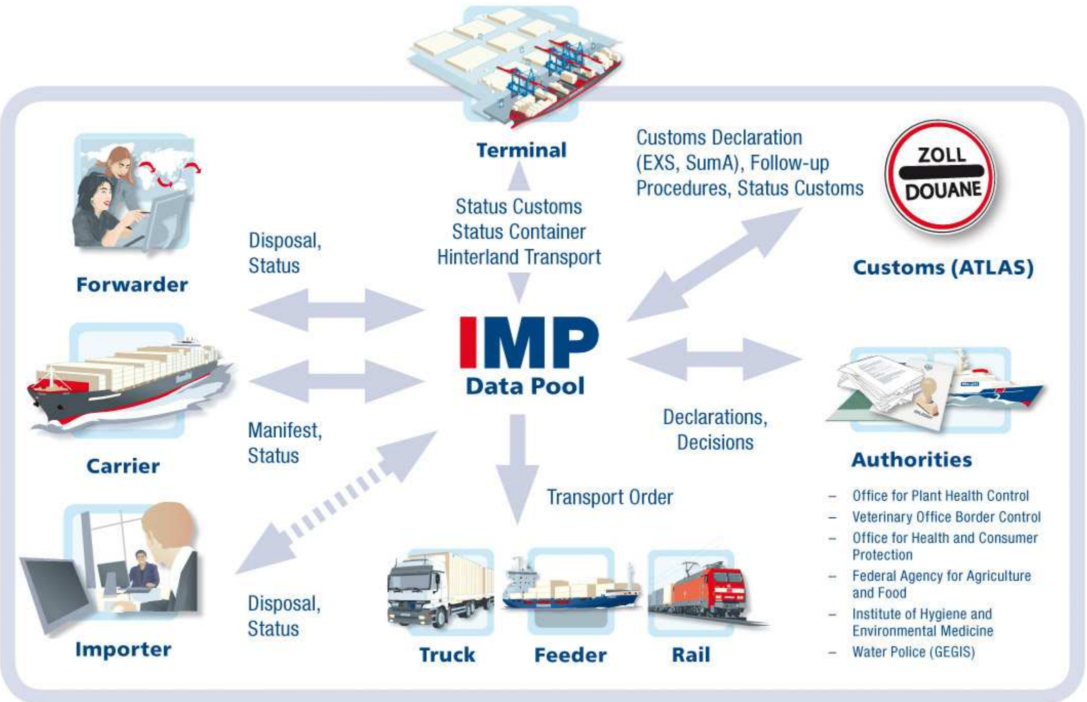


Figure 86: IMP Data Pool

EMP - rapid and efficient clearance processes using the intelligent IT services and applications of DAKOSY

The export-relevant transport and transit processes have been supported comprehensively by the communication services of DAKOSY for many years. All messages which the business partners exchange with one another and with the involved authorities as part of the export or transit process via DAKOSY are grouped together under the EMP (Export Message Platform).
All messages can be implemented and used by the customer as an EDI service. DAKOSY also supports customers with customized solutions, e.g. UNIBOOK for booking at ship owners, ZAPP for electronic export presentation to customs in the Port of Hamburg, ZODIAK for customs processing with the German customs system ATLAS, GEGIS for electronic hazardous goods notification to the Hamburg harbour police, the Harbour Data Record (HDS) or the German Port Order (GPO) for registration at the terminal and electronic processing of the bill of lading between the haulage company and ship owner. Far in excess of 600 million data records are communicated monthly.

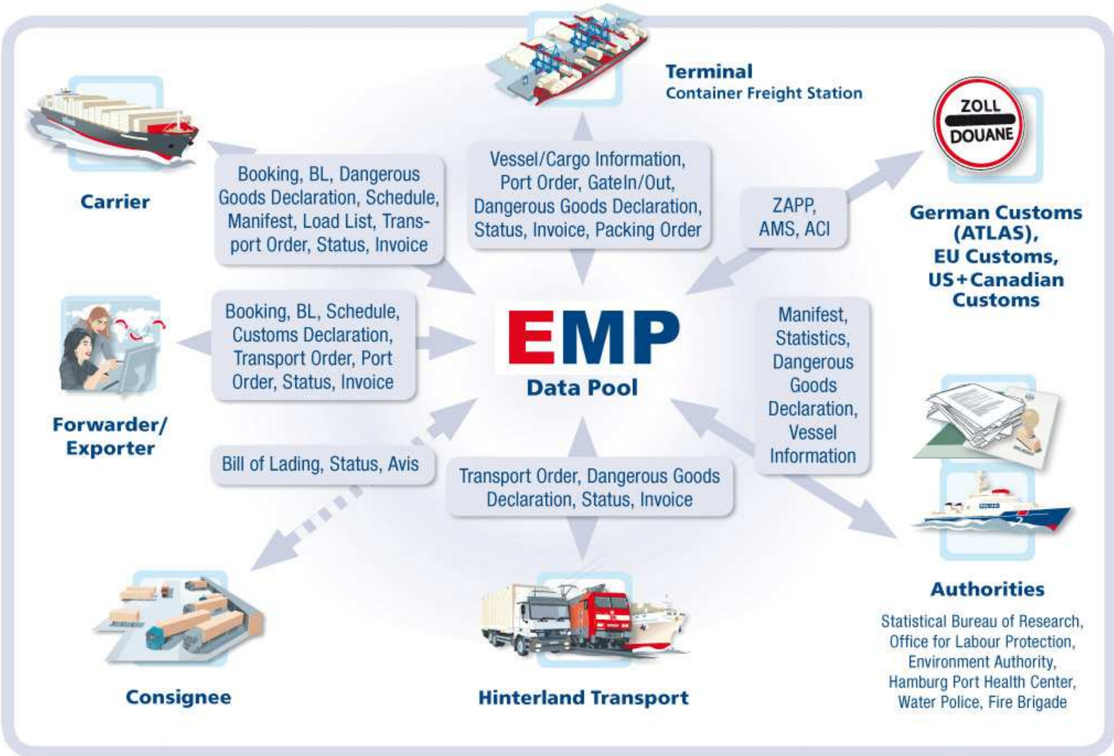


Figure 87: EMP Data Pool

PRISE makes Hamburg faster – DAKOSY implements new platform for Port of Hamburg

The number of ship movements on the Elbe – including large ships – is set to rise again over the medium-term, which means greater complexity in the processes for planning and implementation. Faster access to information for all the companies involves, and hence greater transparency over the entire process, are called for.

A new IT platform specially tailored to the needs of the Port of Hamburg, entitled PRISE ("Port River Information System Elbe") can and will help here. This is intended to bring together information on the areas of ship arrivals, cargo processing and clearance and ship departures, in order to provide up-to-date data to everyone involved. In this way, the ship arrival and departure planning can be facilitated, while improving the response times to short-term incidents.

Figure 88: PRISE

Best practice: PORTBASE (Port of Rotterdam)

Portbase – home of logistics intelligence

Portbase is the neutral and reliable hub for all logistics information in the ports of Rotterdam and Amsterdam. Via Portbase's port-transcending Port Community System, companies can benefit from a multitude of intelligent services for simple and efficient information exchange, both between companies and between the public and private sector. This enables all the participants to optimise their logistics processes, thereby improving their own competitive position and that of the ports. Portbase belongs to and serves the port community and is a non-profit organisation.

Wide support

Portbase was created by a merger between Rotterdam's Port infolink (est. 2002) and Amsterdam's PortNET (est. 2000). The new organisation was set up in 2009 by the Port of Rotterdam Authority and Port of Amsterdam and enjoys wide support amongst the port business community. Its aim is to make the logistics chains of the ports of Rotterdam and Amsterdam as attractive as possible by offering a one-stop-shop for logistic information exchange. Portbase hopes to become the national Port Community System within the foreseeable future. It also wants to play a key role in port-related logistics networks both in the Netherlands and abroad. To this end, the organisation combines knowledge of the ports with ICT know-how in an atmosphere of personal co-operation.

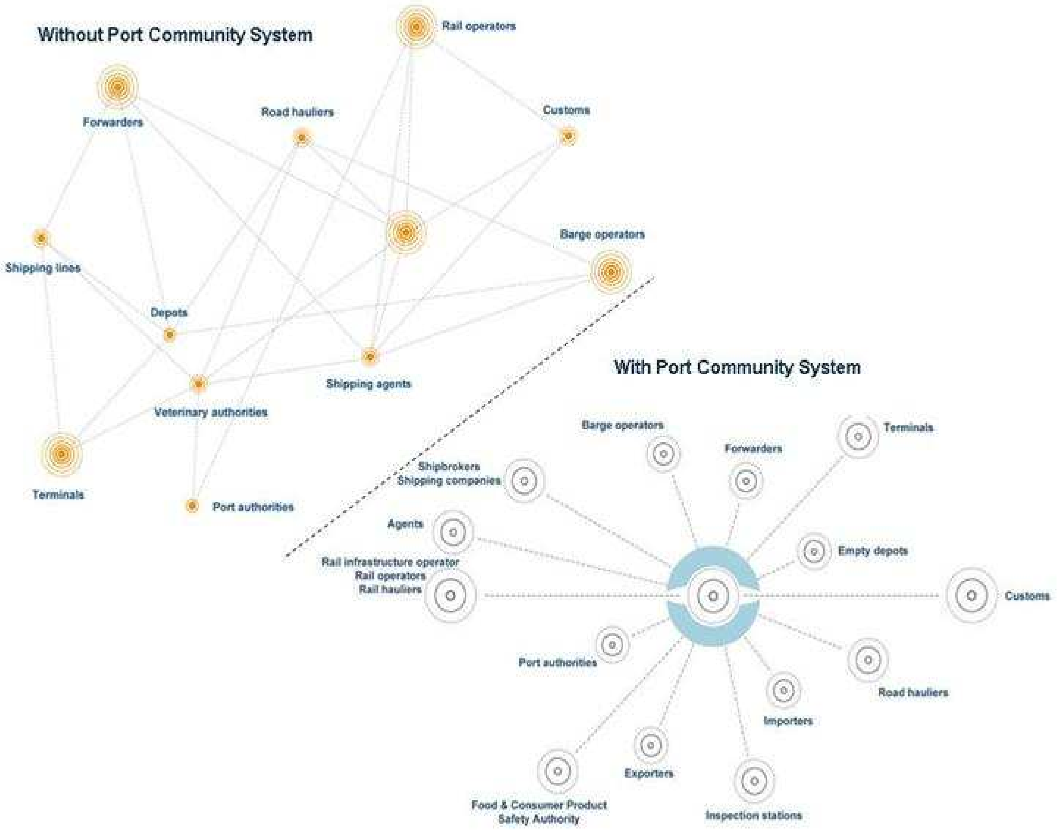


Figure 89: PORTBASE

Advantages

Thanks to the Port Community System, the days when companies had to develop and maintain a whole range of bilateral connections are over. All the information exchange in the ports now runs efficiently through a single hub. The services available in the Port Community System provide concrete savings in time and money from day one. The advantages in a nutshell:

- Greater efficiency;
- Lower costs;
- Better service provision;
- Better, more transparent planning;
- More rapid throughput times;
- Fewer mistakes;
- Optimal re-use of information;
- Available 24/7

Who is it for?

The services in the Port Community System are aimed at all port sectors: containers, general cargo, dry bulk and liquid bulk. All the links in the logistic chains can exchange information easily and efficiently:

• agents	• inspection stations
• barge operators	• shipping companies
• shipbrokers	• rail infrastructure operators
• Customs	• rail operators
• empty depots	• traction suppliers
• forwarders	• terminals
• exporters	• inspection authorities
• port authorities	• road hauliers
• importers	

Table 21: Links of PORTBASE

How the Port Community System works

The Port Community System consists of three parts:

- The application layer with the services;
- A platform with the facilities common to all services;
- A central database in which all the information that companies and government authorities exchange via Portbase is gathered.

Within the platform, there is also a further distinction according to:

- *Domain-related services* specifically aimed at the port, like for instance reference tables with ship names;
- *Generic services* with general basic functions, such as security, authorisation, management and logging;
- *Implementation services* with the building blocks for making new services.

How the services work

Each service includes several service processes. These processes describe the desired message exchange and interaction between parties. This involves messages to and from systems (system messages) and messages between people (notifications). The platform ensures that the processes run in accordance with the established rules. Thanks to the central database, the re-use of information is made possible in this connection. Companies need only enter data once.

Security

Portbase considers the security of the Port Community System to be a top priority. Clients' data may never end up in the wrong hands. Based on risk analysis, some thorough measures have been taken in order to keep information safe:

- Regular training of employees in information security;
- The use of a renowned ICT security company to periodically investigate potential security problems in the ICT infrastructure and software of the Port Community System;
- The setting up of the Port Community System in such a way that service provision can continue in the case of malfunctions;
- Proper physical security and access control for all Portbase locations.

Costs

Portbase is a non-profit organisation. Companies only pay a contribution for the use of services with a clearly demonstrable added value. When set off against the advantages, these costs are relatively small. The financing of services that are of particular strategic interest to the port is done using the general income of shareholders of the Port of Rotterdam Authority and the Port of Amsterdam. On the pages in this website listing the services, an indication is given for each service whether a contribution is charged or not.

Choice of two subscriptions

For each service, clients can choose between two different subscriptions:

- Portbase Basis Plus: a fixed amount per month and a payment per transaction;
- Portbase Basis: just a (somewhat higher) payment per transaction. This is especially attractive to clients who do not work through the Port Community System very often.

Invoicing

Invoicing is done on a monthly basis. For each client, Portbase makes as realistic as possible an estimate of the expected number of transactions. Settlement takes place once a year (similar to the invoicing method used by energy companies).

Barge planning	Discharge information	Notification dangerous goods Internet
Cargo declaration export EDI	Discharge list	Notification local clearance
Cargo declaration export Internet	Discrepancy list	Notification of arrival ECS cargo
Cargo declaration import EDI	ECS notification	Notification of arrival ECS containers
Cargo declaration import Internet	E-invoicing	Notification SafeSeaNet
Cargo declaration status report	IMA notification EDI	Notification waste disposal
Cargo information	Loading list	Pre-arrival cargo declaration import (24h)
Customs scan process	MRN notification EDI	Pre-arrival cargo declaration import (4h)
Declaration Food and Consumer products EDI	MRN notification Internet	Rail planning
Declaration Food and Consumer products Internet	Notification bonded warehouse	Road planning EDI
Discharge confirmation report	Notification dangerous goods EDI	Road planning Internet

Table 22: Available services of PORTBASE

Recommendation

Implementation of an IT-platform

- Implementation of an Port Information System by CODESP
- Integration of the existing TOS
- Implementation of an Traffic Management System (TMS) for Port roads and railroads
- Connection with TMS in the surrounding cities and Ecovias even up to São Paulo
- Implementation of an overall Transport-Logistics-Platform (TLP) by CODESP

→ **Installation of an overall IT-platform is recommended and a precondition to connect all the stakeholders in the Port and the Port with the hinterland**

5.3.4 Modal split optimization

Current situation

- Overloading the modes of transport, especially the roads
- Large increase in container and bulk volumes
- Rail access to container terminals in Santos needs improvement
  → Today only the rail access of Santos Brasil is used on a regular basis
- Development potential of modal split
- Modal split targets are needed to shift transports from road to rail
  → Rail infrastructure is not sufficient to achieve the target

Figure 90: Status quo rail access of the terminals

Best practice Duisburg

Figure 91: Terminal DeCeTe

Figure 92: Terminal DUSS

Recommendations

- Implementing of a rail access to all terminals

Figure 93: Rail access Rodrimar (3 alternatives)

- Strengthening existing track and road infrastructure → higher speeds
- Increasing utilization and raising efficiency of the existing modes of transport/modernizing the infrastructure (e.g. actuation and control unit technology)
- Organizational and structural improvements of the existing nodes
- Setting up additional hubs, buffer areas and pre-stacking areas
- Transferring traffic from the roads onto rail (e.g. using regulation measures by the authorities by setting modal split guidelines in the concessions for new projects).

- Best practice Port of Rotterdam: Modal Split guarantees determined in terminal concessions

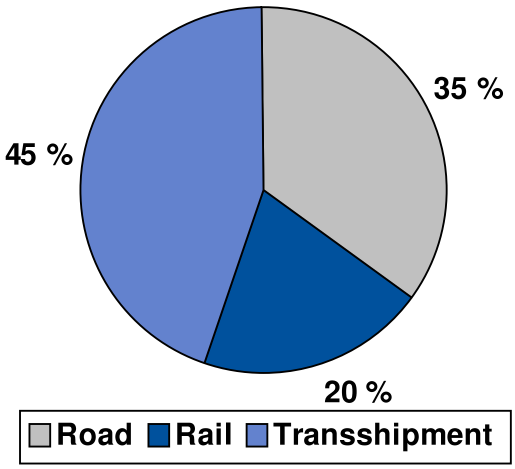


Figure 94: Port target modal split 2030

5.3.5 Retrial of potential further development of rail and road accessibility to Santos/Serra do Mar

Current situation: Bottleneck Serra do Mar

The rail and road crossing of Serra do Mar is the most critical bottleneck for the further development of the Port of Santos and the whole São Paulo-Santos Logistic Corridor. In accordance with the Accessibility Study of the University of São Paulo the current highway system will reach its capacity limit in 2014, and the current rail system will – despite all efforts – not be able to handle the additional volume. The modal split target to shift transports from road to rail will tighten the problems (target: container transport on rail from 6 % to 33 %). Furthermore there are no buffer and pre-stacking areas in and around the port. The connection of the terminal with hinterland stations and logistics nodes is insufficient.

Traffic Volume (Equivalent paying vehicles - thousand)	2011	2010	Chg.
Commercial			
Ecovias dos Imigrantes	24,669	24,131	2.2%
Ecopistas	27,795	23,375	18.9%
Ecovia Caminho do Mar	10,307	9,223	11.8%
Ecocataratas	15,499	13,763	12.6%
Ecosul Rodovias do Sul	16,715	14,855	12.5%
Total	**94,985**	**85,347**	**11.3%**

Figure 95: Increasing traffic volume on Imigrantes[61]


Figure 96: Traffic jams

[61] Source: Press release Ecorodovias

Recommendations

- Necessity of a holistic concept that incorporates all modes of transport and analyzes access/reachability

- New investigation of possible alignments for road connection between metropolitan São Paulo and Santos by Inter-American Development Bank

INTER-AMERICAN DEVELOPMENT BANK

Brazil

ECOVIAS DOS IMIGRANTES TOLL ROAD PROJECT
BR-0312

ENVIRONMENTAL AND SOCIAL IMPACT REPORT

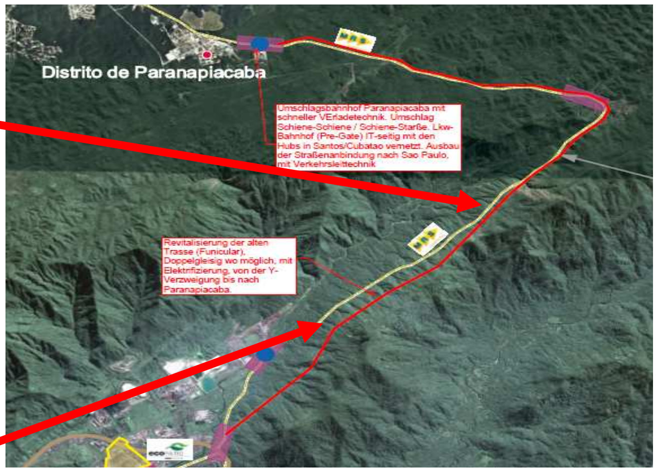
October 1999

Project Team: Margaret Walsh (Team Leader, PRI), John Graham (PRI), Robert Montgomery (PRI), Luis Rubio (Chief of Group I, PRI), Decio Freire and Ione Mueller (Environmental and Social Consultants)

Figure 97: Environmental and social impact report by Inter-American Development Bank

- Reactivation of the old funicular for new „conventional“ rail technologies
    - The São Paulo Railway was first proposed in the 1830s by Brazilians looking for a method of transporting their large coffee crops to the coastal Ports
    - It was not until 1856 that the Brazilian government gave a concession for the construction of the railway from Santos to Jundiahy, 70 km north of the city of São Paulo.

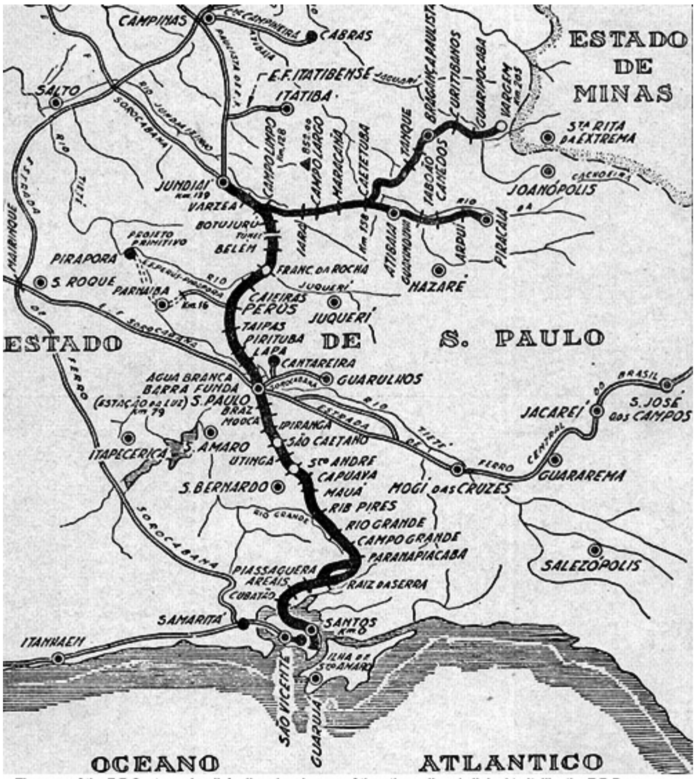
      → **Reactivation of this route could an option to expand rail capacities. Detail studies are necessary**



Facts cable railway (Serra Nova Incline):

- Operation from 1901 to 1982 (partly parallel operation with cog railway)
- Length approx. 10.400 m
- Divided into 4 sections, maximum gradient 8 %

Figure 98: Old funicular



The map of the E.F. Santos a Jundiaí railroad and some of the other railroads linked to it, like the E.F. Perus a Pirapora and E.F. Bragantina. This map was originally published in the book *Traçado de Ferrovias* (Railroad Building), by Jerônimo Monteiro Filho, edited in 1955. Used with the kind permission of Antonio Augusto Gorni, São Vicente, São Paulo, Brazil.

Figure 99: Map of the E.F. Santos a Jundiahy railroad

- Increasing capacity by implementing new technology “powered container wagons[62]”

Figure 100: Powered container wagons[63]

- Various construction measures:
    - Setting up shunting yards and truck buffer areas in front of the terminal etc.
    - Developing existing roads better and equipping them with sensors (traffic jam reports, text boards, traffic light controls)
    - Better traffic guidance technology on the Anchieta and Imigrantes.

- Linking the port and the terminal with the hinterland

- Separating the modes of transport

[62] The recommended technical solutions and equipments were developed with industrial partners (Siemens AG), see also in chapter “Implementation of a novel container transport technology”

[63] Exemplary structure, not implemented yet.

5.3.6 Implementation of a pre-gate system in port of Santos and hinterland

Current situation: Connection of Port of Santos with the hinterland

- Rail and road capacities are insufficient
- Traffic jams in city of Santos, Port of Santos and hinterland
- Uncoordinated traffic flows to the terminals
- Example: The travel time by trucks from Cubatão to the terminals takes up to 10 hours

Recommendations

Development of a pre-gate system[64]

Solutions to improve the container transport between the Port of Santos and the hinterland (vice versa) are presented hereinafter. For this, both potential road and rail transport as well as innovative handling technology for containers are presented.

Overview of connections Santos-Sao Paulo via Cubatao and Paranapiacaba

- The individual container terminal operators and truck companies in Santos network with the logistic centres in Cubatão and Paranapiacaba via rail and motorway connection (TLP Transport Logistics Platform + traffic control systems for trains and railway)

[64] The recommended technical solutions and equipments were developed with industrial partners (Siemens AG)

Road access and locations of pre-gates

- Pre-gates in Cubatão largely reduce the HGV traffic from Sao Paolo by already carrying out the handling process in Cubatão and thus only a controlled commuting traffic, mainly focussed on railway transportation, flows between Cubatão and Santos.
- Another pre-gate can be set-up in Paranapiacaba where the container trains are handled by MRS. Thus, the HGV traffic can partially be diverted to Paranapiacaba so that HGVs can handle their containers there and not just on the two motorways to Santos via Cubatão, which in turn unburdens the motorways. The road connection from Sao Paolo to Paranapiacaba can be developed for the HGV traffic (branch connection of the Anchieta motorway) and be equipped with traffic control systems.
- HGVs coming from regions other than the area around Sao Paolo drive directly to Cubatão.
- From the logistic centres in Cubatão to the port, the containers are primarily transported via railway to the respective port terminals. The remaining containers and mainly bulk that are then transported between the logistic centres and in the port via road, are transported by HGVs and delivery trucks authorised to access the port area through the commuting traffic. These vehicles can then also be managed via the traffic control system and are detected by the individual automatic gates in the port and by the container terminals and can then pass these without having to wait, which in turn results in congestion being largely avoided.

Train concepts/technologies and railports

- If possible, it would be useful to load direct trains to Sao Paolo from the individual container terminals in the Port of Santos and respectively otherwise shuttle trains between the port terminals and the larger logistic centres (pre-gates) located in the Santos/Cubatão periphery. In this process, if possible, the existing and intended shunting yards and railports should be used and set-up in a way that permits the containers to be loaded via crane bridges and faster handling devices.
- As currently mainly MRS container trains from and to Santos drive to and from Sao Paolo via Cubatao and Paranapiacaba and in this process, shift to rack and pinion railway on the sections with steep gradients, it is suggested, if possible, to develop a second railway track between the Port of Santos (on the right and left bank) and Cubatao so that train borne oncoming traffic is made possible. It would be recommended to electrify this track section. For technical and commercial reasons, it is advised not to implement an elevated solution or suspension track as it would be too cumbersome, costly and time-consuming to gain access to the trains / load carriers in the event of a fault and to carry out maintenance work. Supporting loads hold an additional risk. For this reason, it is recommended to develop the railway track in a way that makes it possible for higher speeds to be used.
- This way, MRS could maintain its existing operating concept and, if possible, drive its trains at a higher speed in the Santos plain. The existing concept can also be maintained for loading and unloading, although, we recommend installing a quicker train handling system at the junction, which in turn increases the flow capacity.
- In addition to MRS (and ALL/BRADO which currently preferably operate on the right port bank with bulk + containers), we suggest a solution with a "gradient-compatible train" which is loaded in the port (if possible, directly at the container terminal) and then without being shifted or reloaded drives directly from Santos to Sao Paolo without stopping. This train should drive

on the same tracks as MRS, whereby the "old route" (funicular) is reactivated on the gradient track section to eliminate capacity bottlenecks.

- This train consists of two "hauling engines", one at each end, and powered container wagons. Through this, sufficient driving power and frictional resistance wheel / rail are provided to handle the gradient of the old route, or respectively, the train can also opt to use the new rack and pinion railway route without using a rack and pinion locomotive. Through the increased speed of this train and the increased load capacity, it is possible to resolve the container-transportation bottlenecks with this concept.
- To make full use of the additional capacity, it makes sense to drive this train peer-to-peer, without stopping, from Santos to Sao Paolo. However, with a quicker train loading system under the overhead traction line, intermediate stops in Cubatao and / or Paranapiacaba are possible to reload the container so that full flexibility is offered here too.
- Multiple trains of this type could then be used on this track section and on the old gradient route (funicular) there are also several points where a double route is possible (cf. Figure 101) so that trains can move in opposite directions (increased flow capacity).

Figure 101: Dual routing on „old line“ Funicular

Rapid handling technology

- Container handling at the end and intermediate train stations onto rail-rail / rail-road can be effected with conventional technology (crane bridge / reach stacker), depending on the existing infrastructure and the required flow capacity or via a fast handling system so that flexibility is also ensured here.
- The quick handling device moves parallel to the train in the terminal and lifts the container from the wagon by placing a mobile frame over the container wagon. A standard spreader in this frame attaches to the container and lifts it from the shank until it is parallel to the wagon and can be removed through the handling device to the other side, where, if desired, the container can then be loaded onto a HGV chassis or onto a different railway wagon. As the reloading device can be moved, it is not necessary to position both carriers precisely and a new container sequence is also provided. Operation is possible both under the overhead traction line and without the overhead traction line. As the container is only briefly lifted before being placed to the side, only short periods and little actuating power are required; there is no necessity for hoisting winches (energy and maintenance savings).

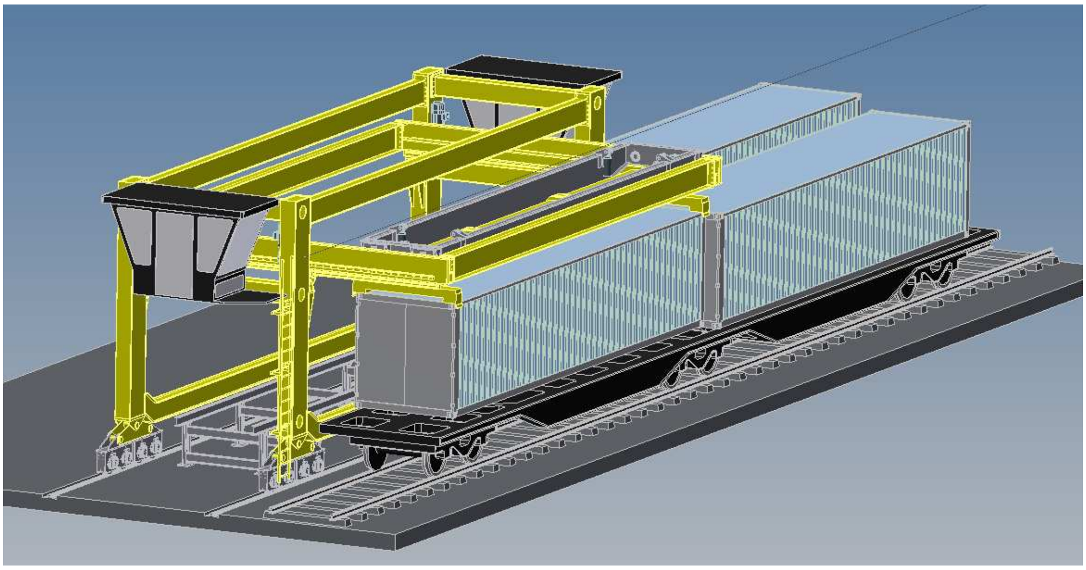


Figure 102: Rapid container handling equipment rail-rail / rail-road

- As the container can also be set down between the quick handling device, logistic solutions are possible, such as a HGV crossing under the device to load and unload the container, a storage space for intermediate storage or for a container handling equipment that makes it possible to load the containers in the rail / HGV handling sequence or respectively to transport it directly to the warehouse.
- For this, individually driven "trolleys" that together can handle a 20 feet or 40 feet long container are used. The trolleys drive through the reloading device and automatically position themselves next to the device so that the spreader can either lift the container from the trolleys or place a container on the trolleys. The trolleys have their own drive system and drive autonomously, controlled from a control centre, from and to the container warehouse so that a smooth, logistics process flow takes place in the terminal.

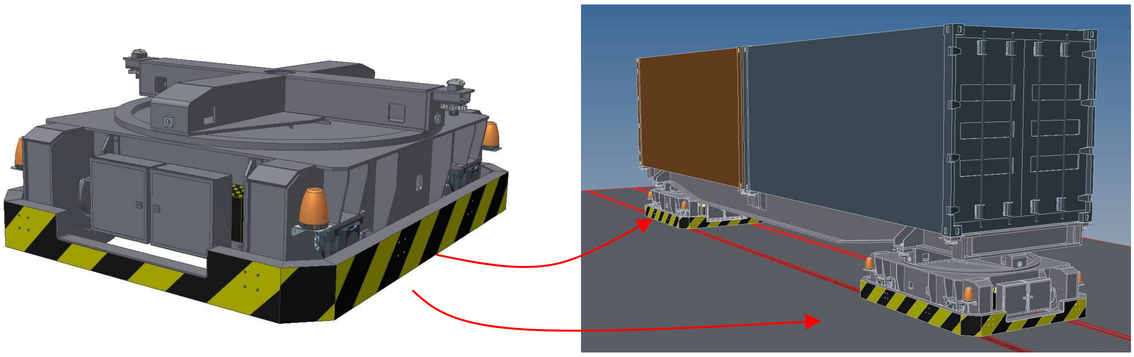


Figure 103: Trolley for acceptance and transport of 20'/40' containers

- If the trolleys are not used, they drive close together, in a space saving manner to a parking position. The track width of the trolleys corresponds exactly to the standard railway track width so that the trolleys can also be moved on railway tracks, ensuring additional flexibility.
- Rotary plates that are inserted in the ground, are covered and can be driven over ensure that containers can also be moved diagonally so that an ideal layout design can be realized.

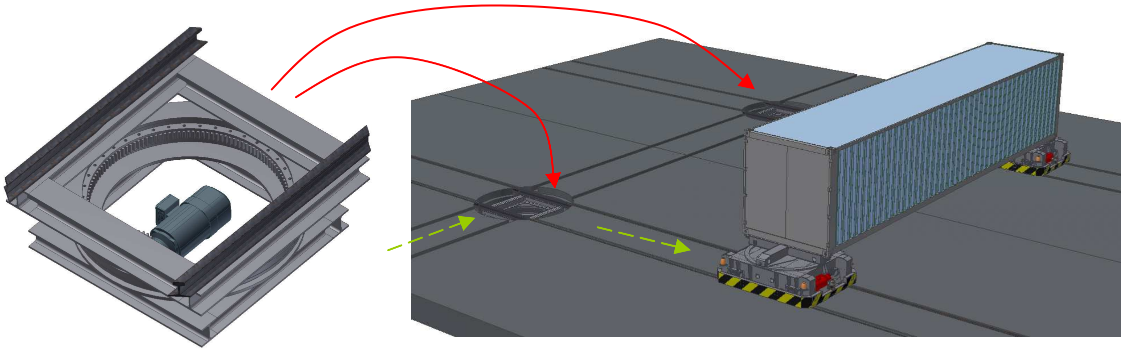


Figure 104: Rotary plate

- The developed concept allows for the containers to be loaded onto the "trolleys" via the existing infrastructure (gantry crane, straddle carrier, reach stacker) at the respective container terminals, if the train does not come directly into the terminal and instead has to be handled at the nearest railport or shunting yard. In this case, the container trolleys can transport the containers from the terminal directly to the train and even directly from the quay (direct ship to rail) to the train where they are then loaded with the reload device (or vice-versa). This ensures that no train/HGV waiting periods or congestions arise in the terminal and the entire port traffic can be equalized.
- The container warehouse can also be accessed through this concept at the end of the train run, or respectively, at the intermediate stops (larger logistic centres in Santos/Cubatão), with rail-rail handling (loading of various trains, e.g. direct train and rack and pinion rail, containers that are to be transported across the ALL / BRADO railway track) or respectively, rail-road handling onto the HGVs that no longer need to access the port.
- This system is also ideal for Paranapiacaba: quick handling of the rack and pinion railway containers onto other wagons (or HGVs) so that the train combination that drives up and down hill can remain together, which means that brake tests and shunting trips are no longer required which in turn speeds up the entire container traffic.

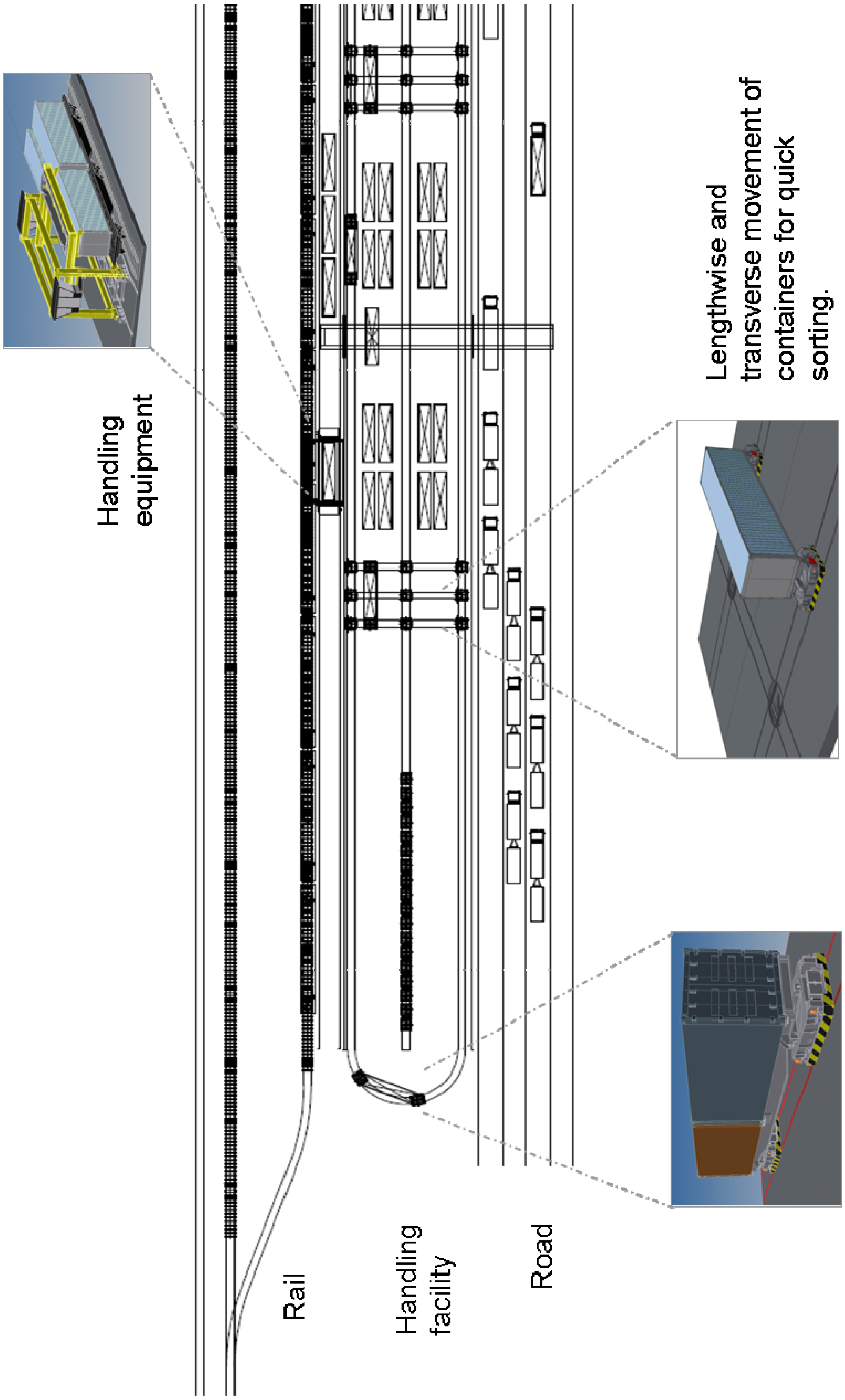


Figure 105: Exemplary layout of a rail-hub

- Through the quick handling, the container storage surface area can also be reduced with a coordinated data management system (TLP - Transport Logistics Platform) and a traffic control system that largely reduces congestions, which in turn decreases the investment costs for grounds and other infrastructure.

- The individual logistic centres also act as pre-gates for HGVs that need to access the individual terminals in the actual port area. In addition to the image analysis systems that have nowadays become standard equipment and procedures in port terminals, these gates are equipped with number plate and container number recognition systems (ANPR/OCR technology – automatic number plate recognition / optical character recognition) so that HGVs, drivers and the load are automatically recognised. Empty chassis' are also identified. The incoming HGV is immediately allocated a space where its freight can be unloaded / loaded. The data is collected electronically and processed (TOS – Terminal Operating System) and, if required, also communicated to the traffic control system and the port terminal. The HGV driver is then assigned a slot (time slot) in which his truck can be handled as well as the time for the route that is to be driven via a display panel, mobile or another type of medium, so that he knows when he needs to leave in order to get to the port gate on time. The dynamic traffic control with TMC congestion notification and display panels directs the driver to the destination and in the event of congestion, it highlights alternative routes. Once the port terminal has been reached, access is given and handling is effected immediately as was advised and arranged. Through this, the congestions in the port area are minimized.

- The following image shows a schematic diagram of the mode of operation of the interconnected logistic centres that serve as gate / pre-gate solutions and that are interconnected as well as controlled in a coordinated manner via a Transport Logistics Platform (TLP).

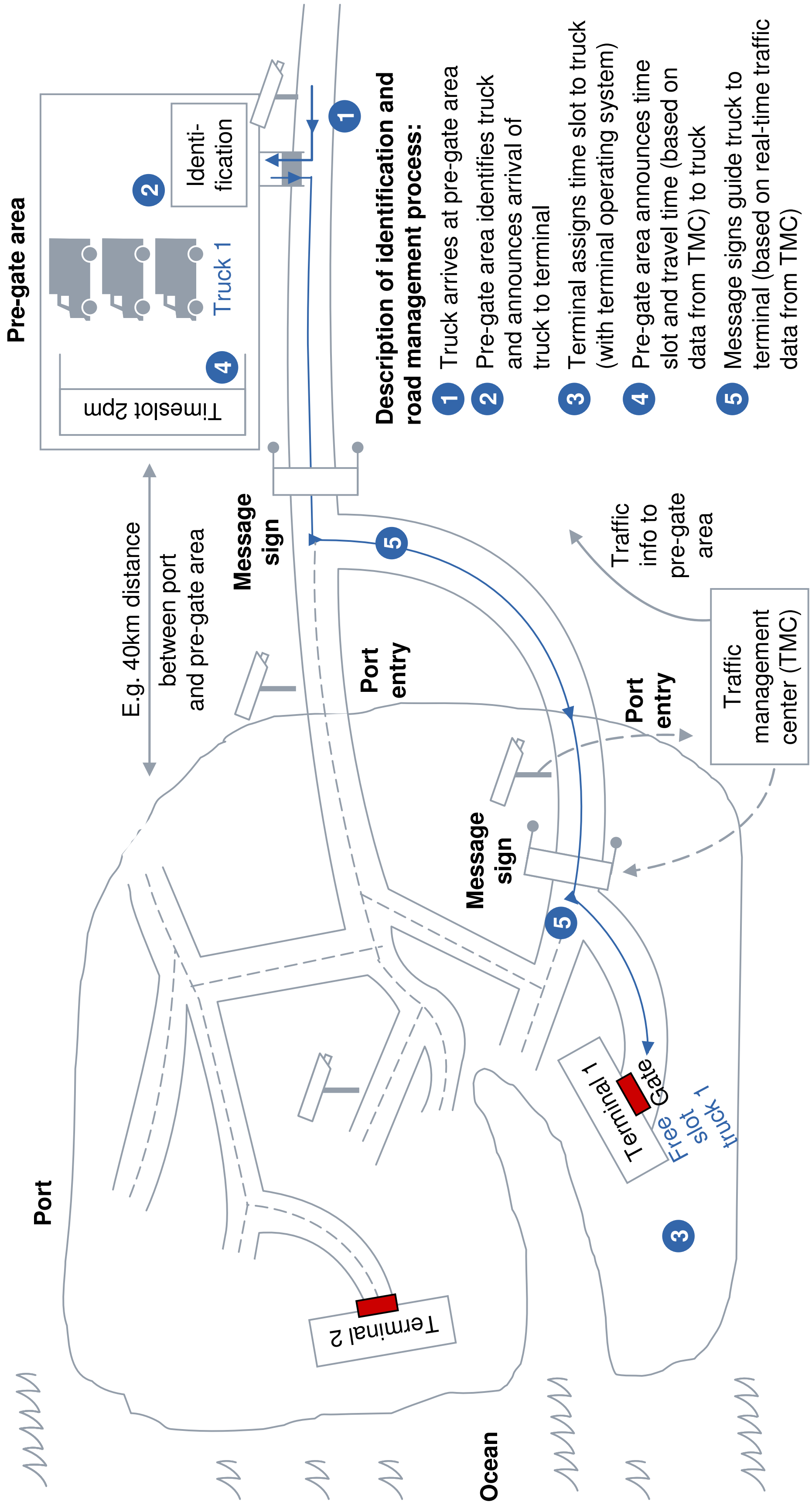


Figure 106: Solutions of networked gates/pre-gates

A similar principle also applies for in- and out-going trains and train movements that are detected via a control system (Vicos) so that the operators of the logistic centres and terminals have both an overview of the train movements as well as of rolling stock that is at their station. The automatic train gates (Arkos) not only monitor and register the wagon and train numbers, but also automatically identify the container numbers, take a surveillance image and assess the state of the container and automatically notify of problems. This is also done as a preventative measure for future claims for damages.

Figure 107: Pre-gates (rail, road)

Summary of recommended pre-gates

- Development of pre-gates
- Possible locations
  - Between Port of Santos and Cubatão
  - Between Cubatão and Paranapiacaba

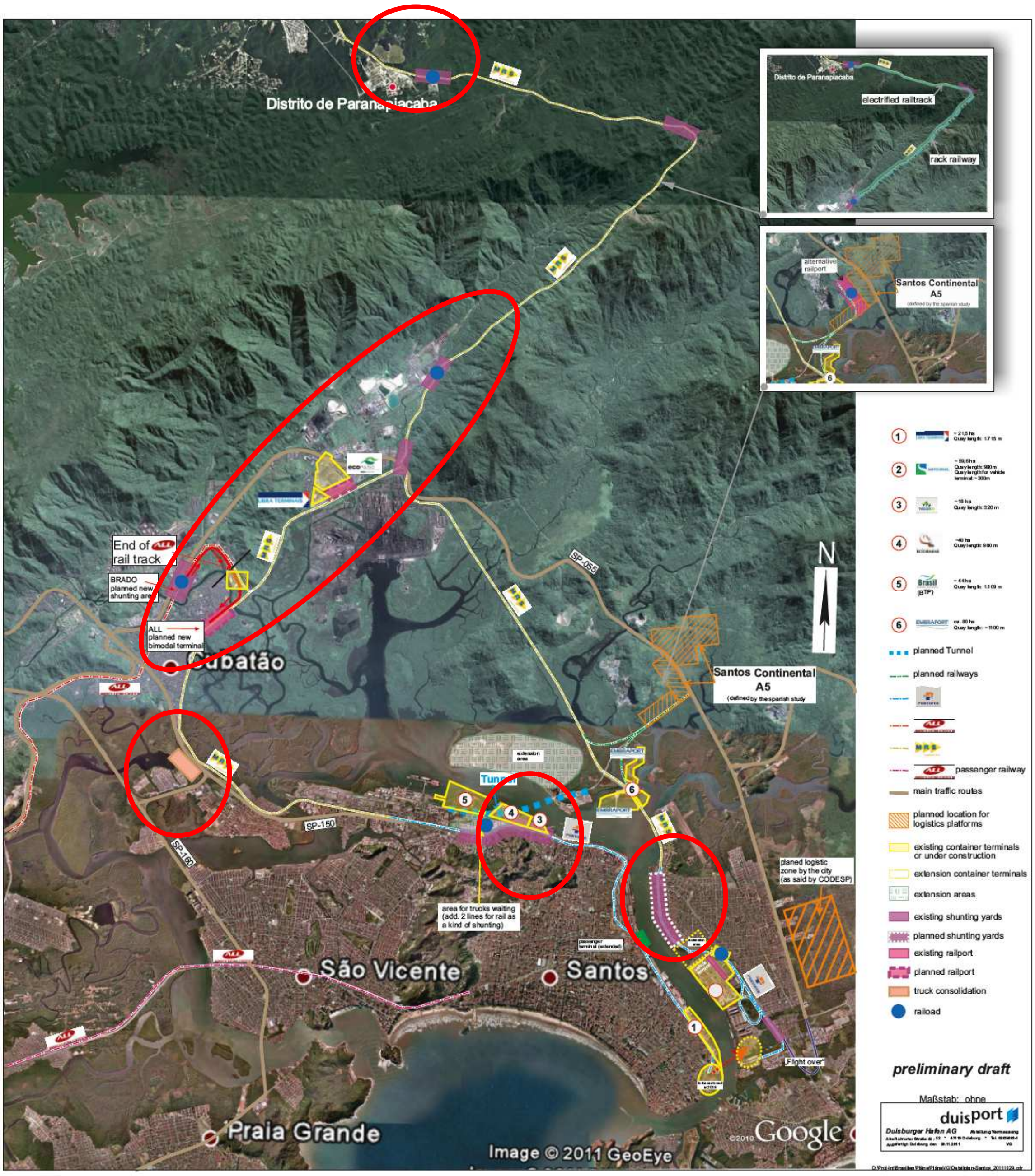


Figure 108: Pre-gate system between Port of Santos & hinterland

- Integration of plans of all relevant stakeholders to develop intermodal facilities in Cubatão (Unimodal Terminal by Ecovia and Terminal Intermodal do Porto de Santos by MRS = natural given pre-gates)
- Implementation of a pre-gate system in the recommended logistics activity zone up the hill (cf. Port logistic platforms in chapter “Development of a Port Logistics Platform (Logistics Activity Zone)”)

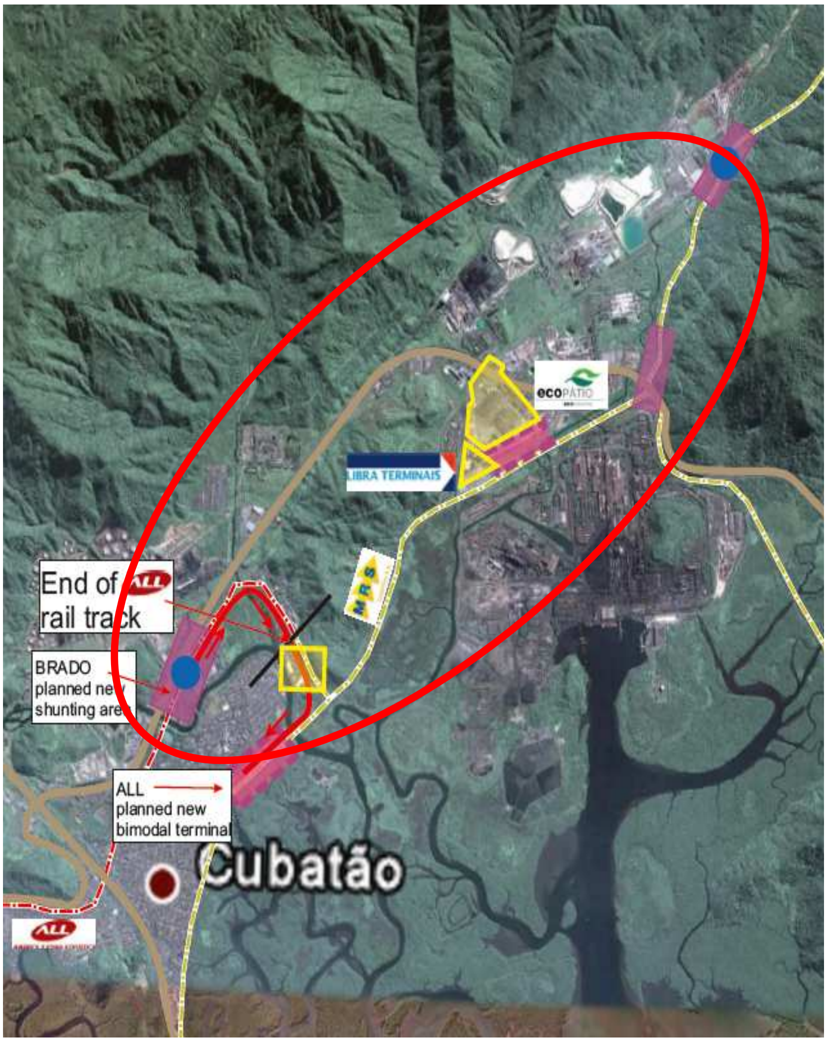


Figure 109: Identified corridor for main pre-gate area

Figure 110: Pre-gate system in Paranapiacaba

5.3.7 Implementation of a novel container transport technology

Current situation

All the above mentioned actions will not prevent that the Rail and Road Access Systems to and from the Port – the connection between Cubatão and left/right bank of the Port as well as the Serra do Mar crossings – will not be able to absorb the expected cargo volumes in the upcoming years.

In light of the already existing interferences and conflicts between Port operations and urban development / residential areas it seems to be impossible to obtain additional traffic areas especially on the right bank of the Port. Furthermore most of the current and upcoming container terminals will not have dedicated rail access or rail modules to load or unload containers directly on the terminal.

Consequently all relevant stakeholders (MRS, ALL-Brado, Ecopatio) are currently developing plans for intermodal rail terminals in Cubatão , from where containers will be feedered by truck or conventional rail to the terminals. On the one hand this might defer the modal split towards rail transportation, on the other hand it will not change anything regarding the congested infrastructures within the Port area nor regarding the Serra do Mar – crossing.

Furthermore:

- Generally no existing automation
- Hardly any connection between the players in the port and hinterland either organizationally or in the infrastructure
- Too few logistics nodes available
- No overall concept recognizable.

→ **A further increase in capacity can only be achieved by a novel container transport technology**

Recommendations

- Implementation of novel container technology:
  - Between the terminals and intermodal terminal / pre-Gates in Cubatão
  - Between Cubatão and the crest of Serra do Mar to relieve the "conventional" rail and road infrastructure

  → The contribution of all relevant stakeholders like terminal operators, rail operators and logistic companies is mandatory

- The feasibility studies of duisport and Andrade Gutierrez for this novel technology showed potential systems being offered by manufactures:
  - **Suspended mono rail**
  - **Powered container wagons concept**
  - **PortShuttle**

- Call for proposals for the implementation of novel container transportation technology between terminals and Cubatão (the contribution of all relevant stakeholders like terminal operators, rail operators and logistic companies is mandatory)

- Utilization of quick container handling technology at the logistics nodes/rail hubs

- Intermodal transport (utilization of a quick container loading vehicle for rail and truck)

- Setting up an automated logistics network (cf. Detail Plan Santos) with the support of a traffic concept

Potential solutions

- Implementation of novel container transport technology between **Cubatão and Paranapiacaba** by using the existing alignment of MRS and / or the alignment of the former funicular. **Why Paranapiacaba?**

- The suggested location Paranapiacaba allows several options:
  - using the existing system of MRS
  - duplication of MRS tracks
  - using the old funicular

- Other possible routings require the construction of long distance tunnels

→ High risks and economically not feasible (cf. suspended rail through tunnel below)

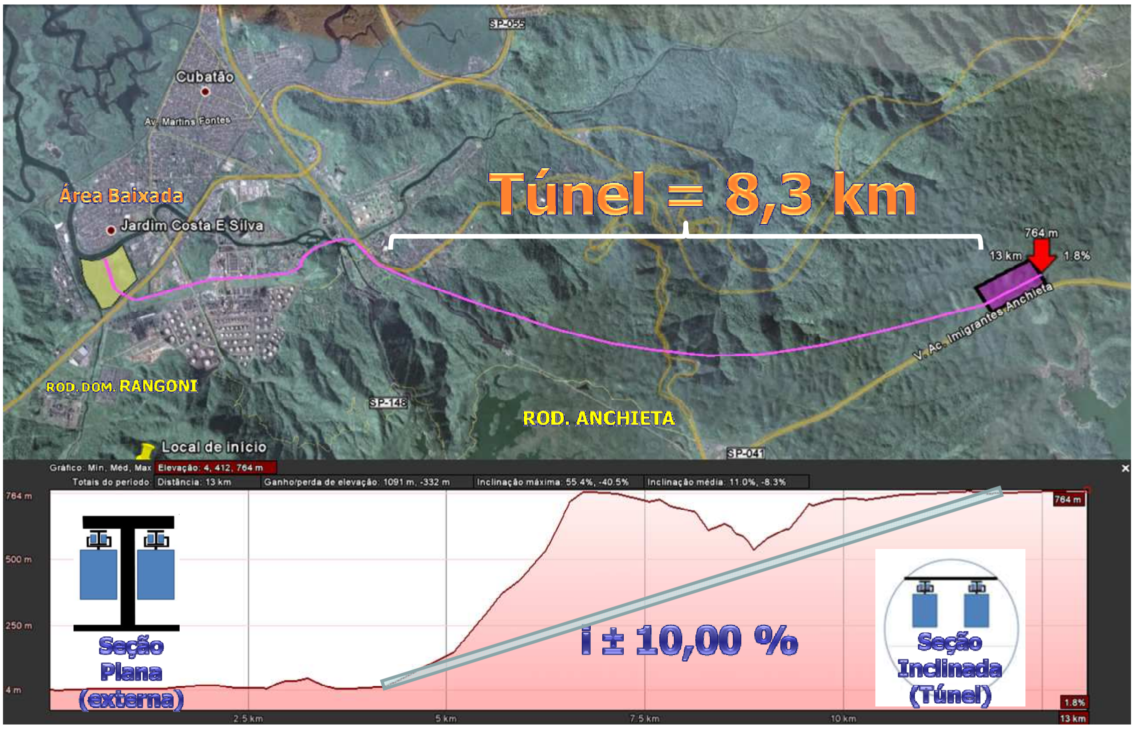


Figure 111: Solution: Suspended rail through tunnel – Anchieta Imigrantes[65]

[65] Proposal by AG

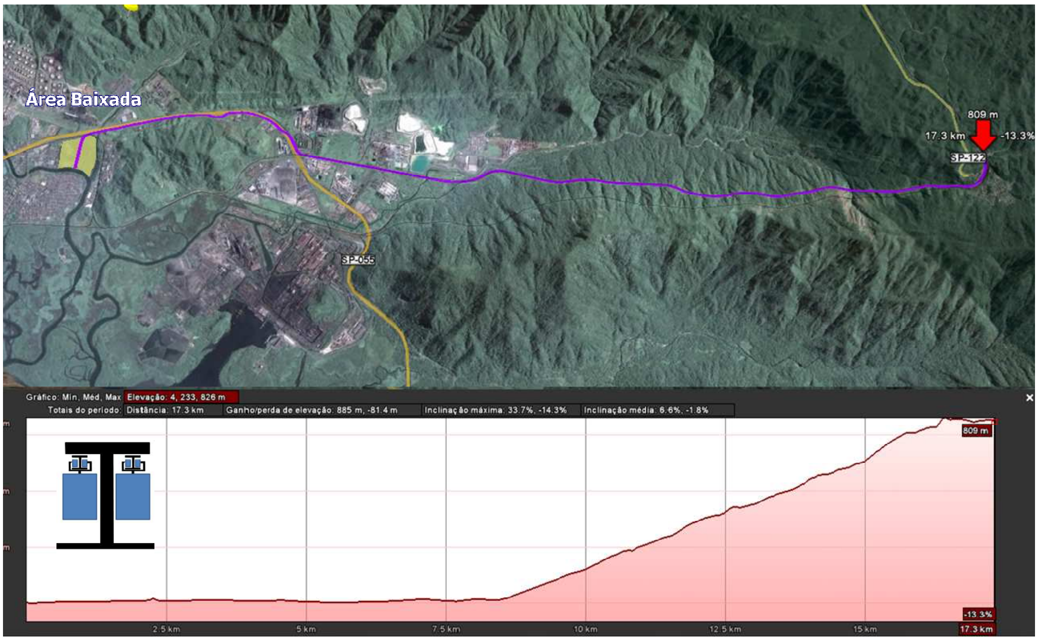


Figure 112: Solution: Suspended Mono-Rail – Paranapiacaba[66]

Figure 113: Solution: Powered container wagons concept

66 Proposal by AG

Suspended rail (Mono-Rail[67])

Specifications:

- Mean transport capacity: 6,000 container/day
- Uniform composition of containers
- Average speed: 45-60 km/h
- Maximum slope: 10 % (with passengers)
- No distance limitation

Figure 114: Suspended Rail (Mono-Rail)

[67] Source: EAGLERAIL

Powered container wagons[68]

Introduction

Possible solutions, primarily focused on the track section Santos-Cubatao-Paranapiacaba-Sao Paulo (cf. Figure 115) for the optimization of freight transportation via rail are presented in the following. A significant increase of transportation capacity is possible with the help of these innovative solutions, especially the use of new technology **(powered container wagons)**. This leads to an increased utilization of the existing track sections. Furthermore, improving the efficiency of the old parallel track (cable railway) is a substantial part of the new plans. The objective of this is to make double routing and train movement in opposite directions possible. A new route seems to be not feasible due to environmental limitations. This solution also takes into account that during upgrading of this part, current operation can continue. The gradient of this route has been explored with 8% gradient. However, all calculations have been made also for the gradient of 10.6 %.

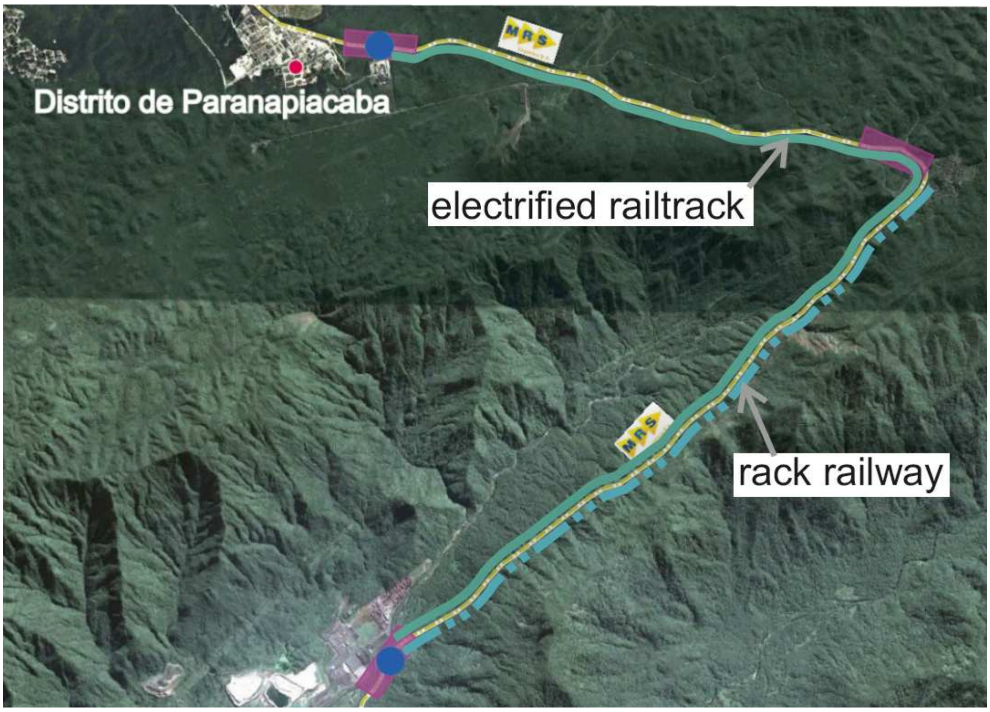


Figure 115: Rack railway MRS

[68] The recommended technical solutions and equipments were developed with industrial partners (Siemens AG)

Assumptions

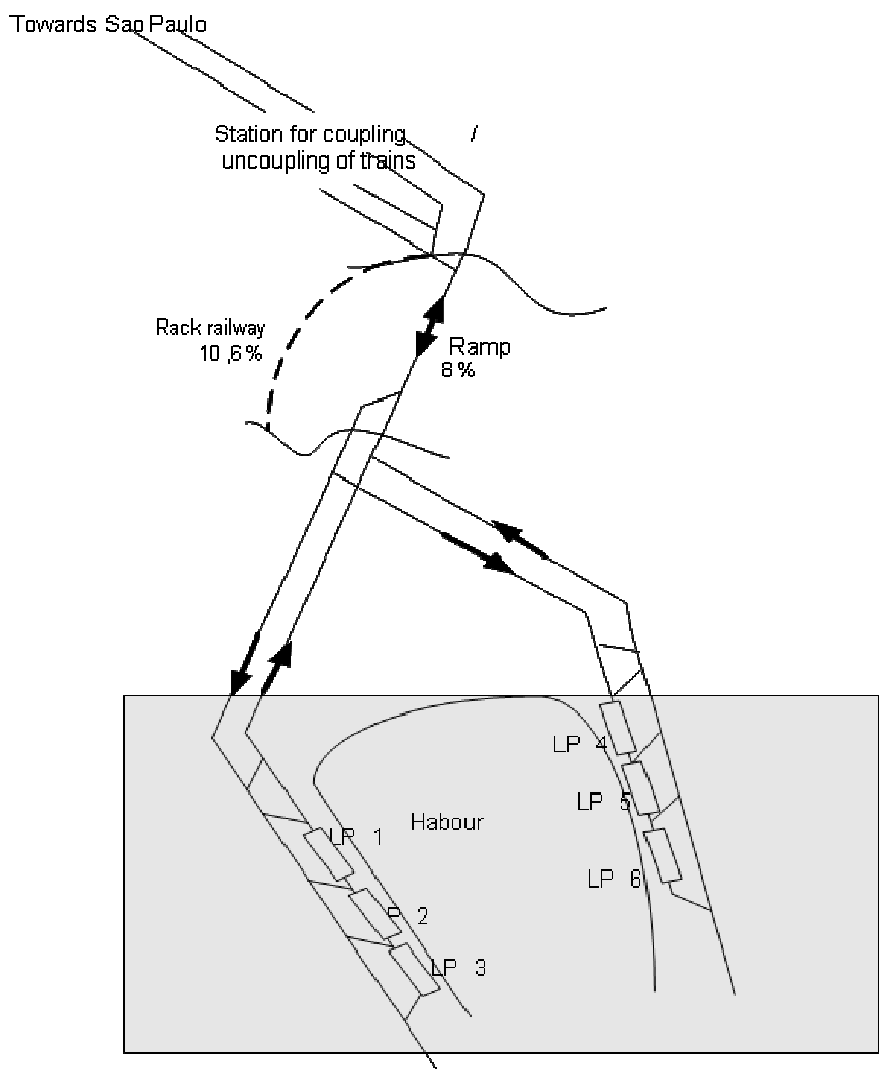
Single track operation is the reasonable method to pass the ramp with a height of approximately 800 meters change in altitude.

In order to create an efficient railway system the realization of the following operations mission is envisaged:

- Adhesion railway shall be used,
- The maximum speed uphill is envisaged with up to 50 to 60 km/h,
- Downhill the speed shall be around 35 km/h,
- The train configuration shall be proposed in a way to avoid reloading between Santos and Sao Paulo, but also allowing intermodal change at both ends of the 8% in- declination track.
- The performance shall be significant higher than the one of the rack railway.

The concept developed in the following chapters allows performing the exposed mission. The following figure provides a general schematic overview on the railway (cf. Figure 116).

Schematic Overview for freight railway in Santos



LP 1 .... Loading Point (1)

AD/SH 291111

Figure 116: Schematic overview of the railway

Technical pre-conditions – Assumptions

The adhesion coefficient which has to be ensured is the quotient of necessary tractive effort and weight over the driven axles. The following assumptions have been made (cf. Table 23):

Description	Dimension	Note
gauge	1600 mm	(1435 mm possible, too)
axle load	28 tons	(other values can be discussed)
containers per vehicle	2 containers a 40 tons	
minimum curve radius (horizontal)	300 m	(reflecting the worst case)
maximum gradient	10.6 % (if applied for track route)	8% for this proposal
maximum speed in gradient (uphill)	50 - 60 km/h	
Voltage	15 or 25 kV AC	DC on horizontal tracks
Needed tractive effort=	Downhill-slope effort	+ acceleration effort
		+ driving resistance
		+ curve resistance.

Table 23: Technical assumptions (rail system)

Distributed drive system

Ratio of driven axles = driven axles / sum of axles (if the weight per axle is constant), or weight over the driven axles / sum of weight needed adhesion coefficient= needed tractive effort / weight over the driven axles.

330% more acceleration force

A typical 1000 to train with a 300 to locomotive only allows the use of the normal force of the 300 to x the friction coefficient to produce horizontal forces. A distributed drive system allows using all 1000 to produce horizontal forces.

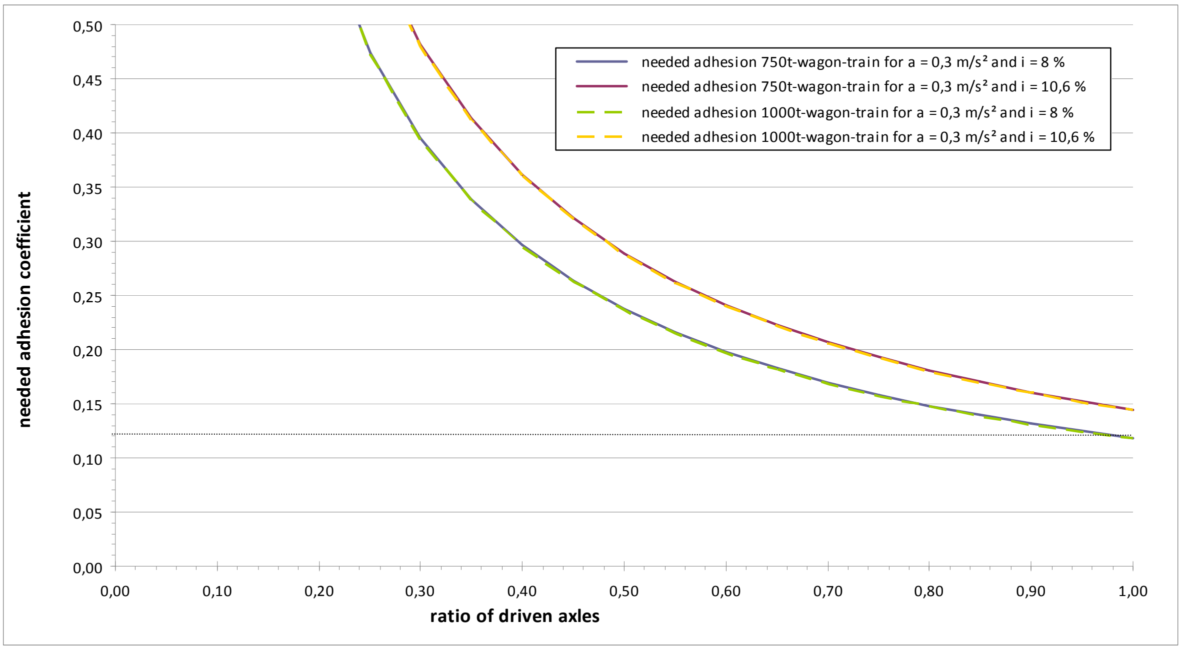


Figure 117: Required adhesion coefficient on ratio of driven axles

Solution locomotives and powered container wagons

In order to increase the friction and make use of the whole train load, not only the weight of the locomotive for acceleration power, we propose to implement a combination of locomotive and powered trailer system.

Key system innovations

This solution is marked by the following characteristics:

- Each vehicle is powered (this is valid also for the wagons to carry freight/containers).
- The power of each vehicle is sufficient to provide the force to pass the ramp in both directions.
- The locomotive at both ends is powered too. Each of those parts contains the driver work place, electrical equipment including pantographs, control and signalling equipment.
- Each of the freight wagons contains traction motors including electrical equipment and local control-equipment.

- Regular operational brake is electrical brakes with recuperation to minimize wear of brake pads.
- Second brake: pneumatic brake; the pneumatic brake shall also serve as holding brake.
- Magnetic rail brake as additional brake (e.g. for slippery rails).
- Sanding.

Operational considerations

The tropical conditions, especially in combination with leaves to be expected on the rails require for the steep gradients special attention.

While the friction coefficient is part of the calculations done in the previous chapters additional measures are listed in order to be prepared for the worst environmental conditions reasonably occurring.

The following measures will be considered:

- Sanding will be provided in order to increase the friction coefficient, if necessary,
- Magnetic rail brake will be especially used to support downhill braking in case of negative environmental influence,
- Maintenance shall focus on proper rail conditions (e.g. by rail grinding),
- Stops on the ramp shall be avoided as far as possible,
- Support operational measures for critical cases (e.g. to provide space for roll back for critical locations),
- Brake and control equipment self-test,
- Special training for the operational staff shall be provided.

The brakes as described will be able to hold a train for nearly 24 hours on the ramp in case of power loss. During the project phase it will be investigated whether this is sufficient or additional measures need to be implemented.

Operational Performance of the powered container wagons

- The 15 / 25 kV AC solution enables the transportation of about 18 containers per train.

> - Ramp performance: 180,000 tons per day
> - Capacity: 3,150,000 TEU/year
> - (Assumptions: 20 t per loading unit, 350 days)

- Dependent on the organization of the operations it is possible to achieve on the ramp by means of single track operations a performance of up to 90 000 tons per day per directions (that means total both directions 180 000 tons per day).

- The basis is to use not more than 10 hours in 1 direction in order to enable also the transportation of trains in the downhill direction.

- At least 4 hours are considered for maintenance works per day, too.

Mono-Rail vs. Powered container wagons

Suspended Rail (Mono-Rail)

- Can only be implemented in one step → expensive
- Need for completely new infrastructure
- Need for a road access for heavy lift possibilities in case of interruptions below the suspension → expensive, environmental issues
- No experience with this technology in container transport systems → only used for passenger transport

Powered container wagons

- Easy to implement in an existing system ◊ reactivation of old funicular
- Can be established in several steps ◊ limited costs
- Can be started with manual equipment and updated later to an automatic system
- Not used for cargo but common standard for high-speed trains

→ **At this stage of these feasibility we suggest to prepare a call for proposal: Powered container wagons**

PortShuttle[69]

In the following section, another innovative system to supply the Port of Santos as well as the hinterland, is presented.

PortShuttle™ Network Concept

The plans of Port do Santos call for a fourfold increase in container flow as of 2014. The plans published so far by terminal investors count on solving the transport service problems of an already crowded transport system. There is a common understanding that presently existing transport infrastructure within and around the Port do Santos cannot handle that volume without further investments. The PortShuttle™ Network concept addresses that demand with a complementary approach reflecting the magnitude and challenges for the port transport community as such. In so far supports this project the presently known plans from seaport terminal investors.

For that reason, a PortShuttle™ [PS] Network is suggested to address first the congested terminal vicinity as well as the City of Santos which hamper the activities of everybody in that region.

This concept will support the actors in the Port do Santos with the following benefits:

1. Decongestion of traffic within the City of Santos and the terminal vicinities.
2. Provisions of neutral operated, efficient, cost competitive rail and sustainable transport and logistics services in Santos and to all terminals within both banks of Port do Santos.
3. Flexible transport services when terminals call for high volume peak container transports.
4. Un-interrupted automated transport service to and from terminals on 24/7/365 hrs basis.
5. Seamless tracking of any container transported within the PS Network.

[69] The recommended technical solutions and equipments were developed with industrial partners (Unseld Cargo Technologies)

6. Scalable building block concept, highly adaptable to existing infrastructures.
7. Implementation can start at most severe bottlenecks, demonstrate planned cost/benefits and start roll-out from there.
8. Temporary installations can serve for a period of time at one location and then being transferred to an alternative one.
9. Modular concept with interfaces allows further growth in technology and performance.

This new technologies' concept helps to resolve that conflict within the least possible transport infrastructure investment, manages the throughput required in full compliance with international security regulations and masters the implementation within the time required.

The base concept has three dimensions and features the following benefits listed and explained:

Dimension 1: Container transport volume throughput flow with truck and rail between terminal border city border and Hinterland.

The concept respects the present transport flows as a starting point and provides means to control the flow of container-loaded trucks in a structured way. As a result of those strategic and tactical activities, traffic congestions within the City of Santos will be reduced (Benefit 1).

For the same reason of decongesting the roads within in the City and the vicinity around, a significant share of the container flow between Terminals and outskirts of Santos is shifted to rail transport on a dedicated high efficient and high volume rail-based PS Network.

This network consists of PS Trains and dedicated rail tracks between PS Stations. These stations interface systems to storages or other types of trains via raiload. PS Trains are powerful container transport machines equipped with all means to ensure flexibility and remote control at any state of service operation, i.e. drive and transport, road crossing and container loading (Benefit 2).

Furthermore, this PS Network ensures capacities for a very high peak flow of containers between selected seaport terminals and off-terminal container storages for serving these terminal in case of disturbances on roads when vessels calling (Benefit 3).

The dynamics of container flows requires decent areas for storing the containers close to terminals in an orderly manner and are supported by a controllable and reliable flow between seaport quay and place of storage. The PS Network is designed in such a way that remote controlled highly flexible flows of containers are able to serve all PS Stations (terminals, block storage, freight villages and interfaces to off-site truck loading facilities) in an un-interrupted 24/7/365 hrs service (Benefit 4).

Dimension 2: Security measures and traffic control between seaport terminal, passing City of Santos and the hinterland.

Modern security measures suggest seamless tracking and tracing of containers as one of the key measures along with fully trusted gateways for any freight handling. Here, the PS Network with its strict requirements applied to comply with automated operation, can serve the handling of clients by providing a kind of security belt between hinterland and quay operations (Benefit 5).

Dimension 3: Investment, timing and implementation measures for supporting the expansion plans confirmed and the future demand to come.

The concept of PS is built on the following groups of modules: infrastructure modules, logistics machines modules, rolling material modules and control modules. The key advantage is a flexible and step-wise implementation following the dynamics of the container transport industry, the growing demand for services and the financial resources available (Benefit 6).

As first step, the most pressing demand should be served. As an example, the present Paranapiacaba main shuttle services could start a first full shuttle service, operating with one train equipped with latest locomotion in frequent transport operations. The expected transport volume can be as large as 600 tsd

TEU p.a. in both directions between two PS Stations for interfacing the trains with logistics facilities. The PS Station at Raiz da Serra could form the kernel for serving the PS network by rail in future. This selected case could turn into MRS's core rail transport path to Santos terminals with a total capacity of more than 2 Mio. TEU p.a. for transport services between port terminals and Sao Paolo and hinterland (Benefit 7).

The next step could be focussed on the decongestion of City of Santos. The estimated annual volume till 2018 on rail between terminals on the right side bank and the hinterland is less than 400.000 TEU. If the pressure on decongestion of the city remains high, a PS service is suggested to bundle the volumes at a PS Station close to the source of the road SP-150. The module structure of the PS concept allows the installation of PS Network branches for a period of time with option to extend or reduce it when necessary (Benefit 8).

In total, the modules of the PS concept are flexible in their implementation structure. Requirements of the local topology will be taken into full consideration. The proposal presented includes a highly flexible installation with up-to-date technology modules to handle 1/3 of the container prognosis volume as maximum. However, the concept is open for embarking new technologies as they emerge and for further expansion if needed (Benefit 9).

PortShuttle™ Network

A first schematic draft for a full PS Network is shown in Figure 118. The network concept follows the strategies of a Dryport development with dispersed activities and locations and terminals close to a city and will bring about all benefits listed in the previous chapter.

The core piece is a rail based PS Network with interfaces to all vital locations, such as terminals, block stores and loading facilities at freight villages and other logistics facilities with access to seaport terminals. The characteristics of the PS Network are as follows:

- The PS Network handles all container transport traffic on rail and road and all rail based logistics services with source and drain of any seaport terminal in the Port do Santos.

- The PS Network itself is part of a port monitoring and management system, which manages the container traffic flow on roads between terminals and the hinterland, including all rail and road transports
- The rail based transport services include the transport of more than 2 Mio. TEU between Paranapiacaba Station and any terminal on MRS network tracks, the transport of more than 1 Mio. TEU to a new rail terminal in Cubatão and further services to the ALL network. Furthermore, transport services will be provided between any PS Station on a highly flexible time table schema basis.
- The logistics services include the container loading at trains and transfer to storage blocks and other trains on same or different gauges and to truck loading facilities.
- Some of the logistics facilities are under the PS Network management control, these are: block storages, any train loading and reloading facilities and interfaces to any terminals.
- All logistics services are performed with remote control, automation support and with state-of-the-art technology and control strategies. All transports services are performed with trains with remote and in some cases on-board driver control.
- Management of the PS Network is performed at a neutral location by a neutral operator.

This PS Network will master the following strategic goals:

- Goal 1: Transferring 1/3 of the container volume to rail in the Port do Santos location
- Goal 2: Guaranty terminals unrestricted and high peak container flows on alternative routes
- Goal 3: Decongesting traffic in the City of Santos and their vicinity
- Goal 4: Support containers' flow monitoring and control between Port do Santos and hinterland.

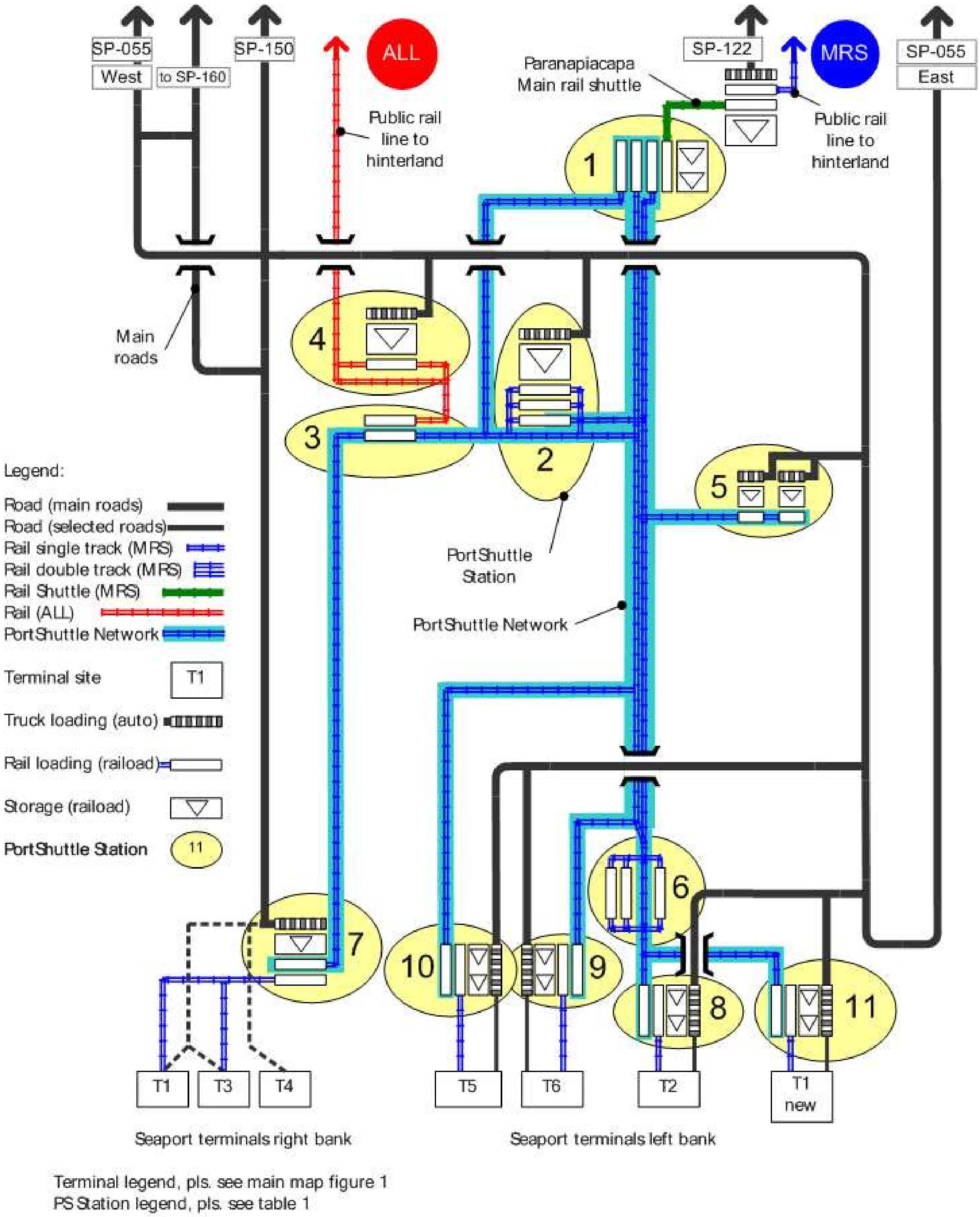


Figure 118: Port Shuttle Network serving hinterland main lines and seaport terminals[70]

[70] Source: Unseld (2011)

PortShuttle™ Technologies

The PortShuttle™ Network has been designed as modules in order to assure flexibility in functionality, performance and interoperability with existing rail transport systems, such as standardized wagons, infrastructure dimensions, operating rules and processes. Actual standard rail technologies are complemented by new developments and inventions, such as the raiload loading process, which enables fast and cost efficient transfers of containers between rail wagons and logistics facilities.

As an example, the technologies applied in the hill station Rio Grande da Serra are explained in this chapter. This functional layout shows all elements of a PS Station including a rail loading zone, an integrated buffer storage zone, an advanced shunting yard and automated truck loading bays. Each of the previously listed PortShuttle™ Stations takes advantage of minimal two of those zones.

The key principle applied is a highly efficient container loading function as shown in the insert of figure 3. It represents a raiload machine in operation as train loading gear in combination with a pre-positioned service vehicle. The loading gear facilitates a lift-move-and-place operation between two rail-bound service vehicles. This automatic process takes place with the main train at halt and with raiload machines' taking the lead (via their search algorithms) for an autonomous execution of the loading operation below the catenaries over one or more rail tracks. The service vehicles or service trains standing by handle all transport operations for container u.l.o (under load operation: import or export) within the intra-terminal network. This concept of autonomous service vehicles supports automatic train operations and includes sophisticated processes, like positioning, moving, loading as well as path security functions. The complete process is remote controlled, and any movement is monitored, registered and archived for potential use in future. The key advantage of the described loading function lies in its high potential for installing high performance rail logistics facilities within restricted topologies and with significant higher productivity levels than any other rail loading concepts known so far.

This performance is demonstrated with the process flow oriented layout for the hill station Rio Grand da Serra. The intake flow starts with the main flows from hinterland by rail or truck and both flows end up in hill station. The trains are positioned in the shunting yard always next track to a full terminal export service train awaiting exchange of load with raiload machines. The truck gets their exchange in one of the automated truck loading zone adjacent to the buffer store. Both transport means leave the hill station after receiving the load in an efficient manner.

In order to achieve lowest costs for the Main shuttle, every transport to Raiz da Serra carries the absolute MAXIMUM load an numbers of containers. A loading algorithm determines the exact loading sequence of the exporting service train being positioned alongside the Main shuttle at the Shuttle train loading zone. The physical sequencing of containers when preparing the service train is carried out primarily by raiload operations at the shunting yards, and completed by a selective load process direct from buffer stores. These export containers are physically exchanged with the import containers at the Main shuttle within less than 20 minutes. This operation is repeated every 60 to 90 minutes at the hill station. All other process resources are managed to match the conditions of that precious high productivity element of the transport chain.

Every PS Station follows the same process flow oriented pattern in layout, technology and philosophy. The throughput (volume and flexibility) required determines the number of individual equipment modules and the dimension of the logistics related equipment. The area productivity level achievable is more than ten times higher then with any other container handling concept.

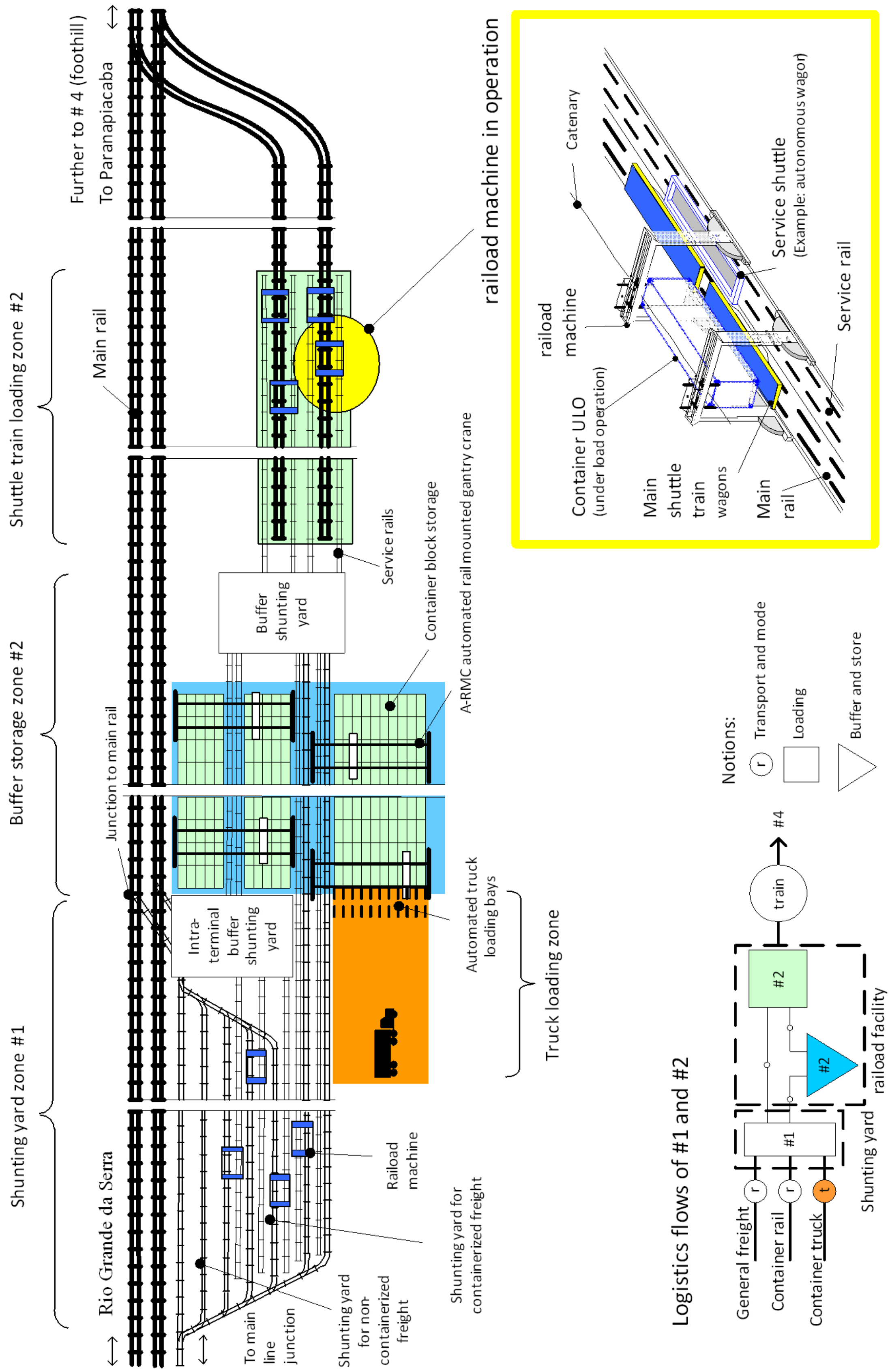


Figure 119: Functional layout of the Hill station Rio Grande da Serra for the Main rail shuttle

PortShuttle™ Stations

The selection of the location of PS Stations resulted from an analysis of the data from presently existing rail and road infrastructures and logistics sites as far as they are available to pubic access. The analysis revealed the listed 11 locations with their functions, which are suitable for implementing the PS Network as described in the previous chapter. All data are valid for bi-directional flows.

PS Station		**Short service description**	**Function and services**	**Key performance data in TEU p.a.**	**Present owner**
No.	**Name**				
1	Raiz da Serra	Transfer hinterland containers between Para-napiacaba Main rail shuttle and PS Network (MRS-Part), including some logistics services	Loading service to Main rail shuttle, buffer and storage services, loading service to PS Trains	Throughput: max. > 2 Mio, storage: ~ 5,000	MRS
2	Cubatão East	Serving RS Network (MRS part) with transport and logistics services for rail (MRS) and road (Brado)	Core container logistics and distribution station, highly efficient storage & truck loading facilities	Throughput: max. > 2 Mio, storage: ~ 25,000	? / Libra, Brado
3	Cubatão Central	Transfer containers between rail networks from ALL and MRS	Efficient exchange of containers between ALL and PS Trains	Throughput: max. ~ 1 Mio, storage: buffer only	ALL
4	Cubatão West	Serving ALL networks with rail and road logistics	Efficient loading of containers between ALL trains, storage and logistics facilities and truck loading	Throughput: max. > 1 Mio, storage: ~ 10,000	Brado
5	Santos Continental A5	Serving MRS networks with rail and road logistics	Efficient loading of containers between PS Trains, storage and logistics facilities and truck loading	Throughput: max. > 1 Mio, storage: ~ 10,000	? MRS
6	Shunting left bank	Serving RS Network with RS Train buffer facility	Buffer and parking RS Trains; maintenance yard	Storing RS Trains	?
7	Santos City terminals	Serving MRS networks with rail and road logistics	Serving terminals with flexible rail & road transport	Throughput: ~ 300 tsd.	? MRS
8	Santos Brasil terminal	Serving Santos Brasil terminal with rail & road logistics	Highly flexible and high volume rail transport service between terminals and an off-site facility which serves as a terminal integrated buffer store for terminal operations with flexible and cost efficient rail & road transport services towards the hinterland (Dryport concept).	Throughput: ~ 400 tsd. to 1,5 Mio, off site storage: ~ 10,000 variable, truck loading: very high	? Santos Brazil
9	Embra port terminal	Serving Embraport terminal with rail & road logistics			? Embra
10	BTP terminal	Serving BTP terminal with rail & road logistics			? BTP
11	Libra terminal, new	Serving new Libra terminal with rail & road logistics			? Libra

Table 24: PortShuttle™ Stations

What is raiload?

Raiload represents an integrated technology and system concept for enabling standard rail operations to match high performance logistics requirements for standardized load units within a cost-efficient approach. It serves any rail infrastructure and rolling stock suitable to transport load units by rail. Furthermore, it provides any logistics services required by present known logistics processes and functions for load units. Raiload's design and construction is cost effective, adaptable and compact, and respects existing terrain conditions with regard to curves and other peculiarities. The rules of rail freight transport operation are also acknowledged standards for raiload. Raiload is attractive to deploy in existing rail lines, as well as in green field rail infrastructures. The key advantages comprise up-grading of performance, throughput and attractiveness. Raiload is scalable both in construction and performance.

Raiload systems provide all core functions for automated operations as modules which enable a controlled focus on utilisation and process management of capital intense resources; logistics services needs and requirements being the main objectives. The integrated raiload approach has been designed for the management of one site only but the interaction with temporary accessible resources (i.e. trains) is also part of the methods as well as the management of networks. This enables raiload to achieve high levels of throughput at least costs, which is a key essential in transport of high volumes of load units, like the hinterland transport from seaport terminals.

Raiload systems deliver novel and innovative technologies to rail freight transport operations. The loading function at the trains is performed below the catenaries and during an operation stop according to time tables and plans. The objective is to manage service flexibility and to keep utilisation of trains and tracks at high levels. The innovative loading technology has the ability to re-configure itself according to the next function to perform. Loading is complemented by an autonomous transport function within an intra-site rail transport network. All functions are remote controlled – a challenge that is met by selected qualified suppliers and operators.

Raiload contributes to this PortShuttle™ project with following functions:

1. Exchange of containers between two trains, i.e. the Main shuttle and intra-site transport at foothill and hill site as well as between any other trains at other sites.

2. Loading and unloading containers at shunting trains, sourced by buffer or other stocks. Loading services are versatile, e.g. also for one or two stack rail wagons and for crossing multiple rail tracks.

3. Scalable transport management [regarding throughput and flexibility] between seaport terminal quays and neighbouring buffer and stocks as well as port operation service providers.

4. Transport of containers (in wagon groups or trains) on selected tracks between sites.

5. Raiload offers also scalability at module level by re-deployment and re-use at different sites.

6. Operations are performed with low energy consumption and low emission levels gear.

7. Providing all handling and transport services in a planned, remote controlled and monitored manner, including re-routing due to traffic jamming and accident.

5.3.8 Development of a Port Logistics Platform (Logistics Activity Zone)

Current situation

One of the most important challenges for the São Paulo-Santos Logistic Corridor is – especially in light of the expected restrictions on the bottleneck Serra do Mar crossing – to develop an intermodal Port Logistic Platform to connect the Port of Santos with Metropolitan São Paulo and its hinterland.

Furthermore:

- Current port facility capacity almost fully exhausted
- Almost no free port space or capacities available
- On the basis of forecast quantity growth there is an urgent need for additional logistics space

General information about logistic platforms

According to Arnold et al., logistics centres or cargo distribution centres are industrial areas with a continuous area of 100 to 200 ha. In addition, a logistics centre is characterised by its convenient location as regards traffic facilities, with connection to at least two carrier types. This means that logistic centres are multi-modal interfaces for discontinuous traffic. In the ideal case, these multi-modal interfaces are connected to inland waterways or airfreight nodes. The main function of a logistics centre is to link long-distance haulage with short hauls and thus form efficient multi-modal transport chains. A further task of a cargo distribution centre is to concentrate transport and logistics companies that are based in one location. The physical proximity allows the legally independent companies to cooperate with their different services. Another function is to deliver value-adding services, such as storage and picking. For this reason, areas are set aside in logistics centres for use by all the logistics companies involved (e.g. cold store, hazardous goods store). Furthermore, infrastructure equipment such as cargo-handling and transport facilities, rail systems, customs offices, workshops are set up in logistics centres. (cf. Compendium of logistics[71], p. 778-781)

71

Purpose and structure of a logistic platform for the Port of Santos[72]

The following subchapter is mainly based on the feasibility study for setting up a logistic zone – prepared by ALG – and will illustrate the necessity of a logistic platform, its structure and characteristics, layout and geographic positioning. The last section will deal with recommended courses of action and supplements to ALG study by Duisport.

Imperative of logistic platforms

In order to cope with the growth in quantities predicted for the next few years and avoid excess load on the traffic infrastruture, a logistic platform and a network of further hubs should be established. The primary requirement of the port on a logistic platform is to be seen in improving the loading operations between the port and the hinterland. In addition, the setting up of the logistic zone generates positive socio-economic effects, since it results in better order and concentration of the goods flows.

The benefits of logistic platforms are summarised below. Logistic centres serve as cargo-handling, storage and logistic centres related to shipping activities which connect the port via a frequent shuttle service and high load capacity (cf. Future technologies). A network of logistic centres in the hinterland of Santos can support the efficient and environmentally friendly distribution of goods in large conurbations and megacities. The goods are consolidated and distributed on the "last mile" in the city.[73] Concentration avoids transport, saves costs and reduces the number of delivery vehicles and trucks in the city and port. This in turn leads to pressure being taken off the traffic networks and to lower emissions. Logistic platforms are set up in the hinterland to exchange loads, consolidate and concentrate these. This allows sorting work and reloading

[7273] Siemens AG Sektor Infrastructure & Citites Division Mobility and Logistics: *Hubs in future: an integrated mobility network for people and goods (Drehkreuze der Zukunft: Ein integriertes Mobilitätsnetzwerk für Menschen und Güter)*, München, 2011 between the terminals in the port to be avoided and increases transport performance. It is also possible to transfer tasks that are currently being done in the terminals to suitable specialised terminals in the hinterland. The decisive factor is IT-related connection to the overall system. Costs can be reduced and efficiency increased by putting together shuttle trains which only serve one terminal, thus reducing consolidating and shunting within the port train network. With space rare in the port, it is to be assumed that storage costs in the hinterland are significantly lower than in the Port of Santos, so that costs can be reduced within the transport chain. Hinterland zones leads to the decoupling of the port functions cargo handling and storage, and thus to an increase in process speed.

Integration of the logistic platforms

The logistic platform or respectively several logistics platforms are to be integrated into the existing port logistics and hinterland network. For this reason, potential locations are to be set up in convenient locations as regards traffic facilities. In addition, these are to be integrated in planned infrastructure projects such as the construction of the rail or road ring.

Institutional modelling of the logistics platforms

A potential logistic platform must be seen as part of the port infrastructure. The relocation of activities that are currently carried out within the port to the logistic platform is supported. This mainly means value-adding activities, such as empty container management, stuffing and stripping etc.. The relocation helps to manage traffic flows and increase cargo-handling capacities in the port facilities.

Alongside a logistic zone in the Baixada Sanista supported by public funds, further platforms are to be set up in the hinterland of Santos. These could then be set up and operated by private investors. ALG recommends a concession model as a management model for the logistic zone. The concession should also enable the control and intervention of the public sector in the management and administration of the logistic zone. The company entrusted with the administration should be independent of potential customers and be experienced in the field of promoting logistic zones and/or similar infrastructures. The company should be obliged long term to guarantee the perfect development of the construction of the logistic zone and support the introduction of value creation measures.

Location and number of logistic platforms

In view of the size of the hinterland market, the construction of a single platform is not sufficient. On the basis of the morphology of the hinterland and the bottleneck of the seaward approach to the port, we recommend setting up a platform in the Baixada Santista and further supplementary platforms in the hinterland. Platforms only outside the Baixada Santista would not eliminate the bottleneck at the seaward approach to the port. A network of further platforms is necessary to support the function of a logistic platform. ALG determined six potential nodes for this in the feasibility study.

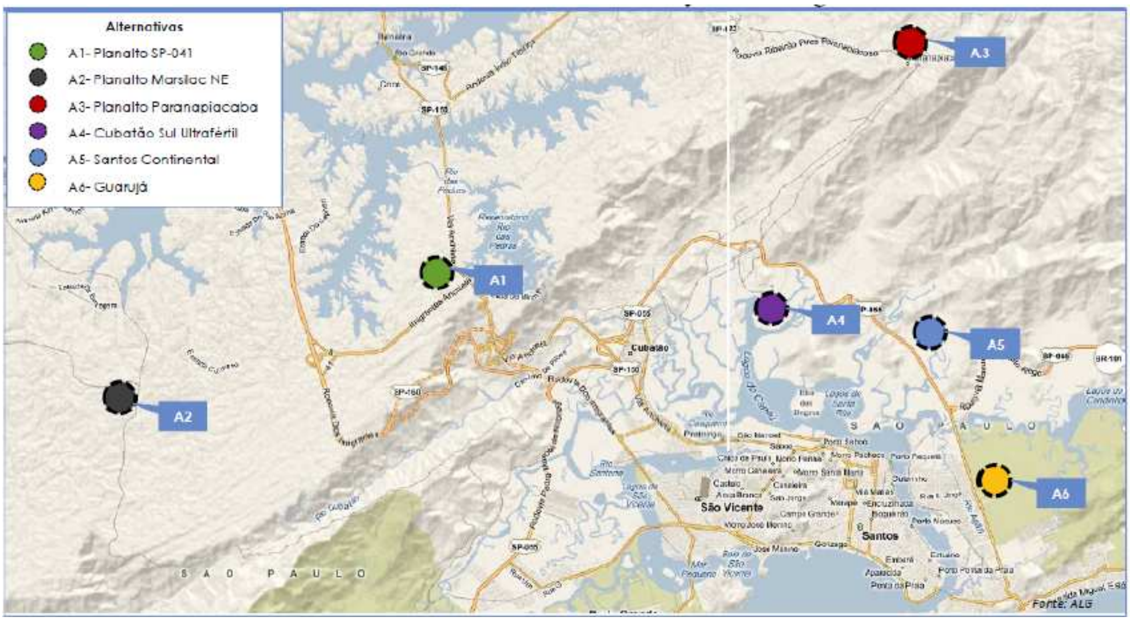


Figure 120: Possible locations for logistic platforms[74]

747576

Potential users of logistic platforms

Logistic platforms should enable the concentration of transport and logistics companies that are based in one location. The physical proximity allows the legally independent companies to cooperate with their different services. The companies are also characterised by the delivery of value-adding port and logistics services such as empty container management or container stuffing and stripping etc.

Layout of a logistic platform

According to ALG, a logistic platform should have the following components (cf. Figure 121)

- Logistic areas
- Truck Centre
- Service Centre
- Offshore terminal
- Potential multi-modal terminals (rail terminals).

The individual areas of the logistics platform are optional and depend on the functional focus. The areas adjacent to the platform should be reserved for possible future expansion.

Figure 121: Functional layout of a standard logistic platform[75]

In an initial phase of platform set-up, imports should be the main consideration. Since the number of imports with general load (mainly containers with industrial goods as well as finished goods with high value density) has increased by 260 % in the past 10 years, a logistic platform makes value-adding logistic operations necessary.

In the planned scenario, it is assumed that the construction and marketing of the initial phase of the platform will begin in 2013. The platform is to go into operation in 2015. The initial phase should be concluded in 2019. It is assumed that in the long term up to 2 million TEU will be turned over in the storage sector.

The land suggested for the logistic platform (cf. Figure 122) should have an area of around 101 ha, divided into the four business sections logistics, offshore terminal, truck centre and service centre. The size of the areas of the individual business sections is as follows:

- Logistic section: 614.873 m²
- Offshore terminal: 185,515 m²
- Service Centre: 10,616 m²
- Truck Centre: 194,692 m².

Around 16 ha are to be covered with buildings in the logistics section. The logistic lots of land are created in modules in order to cover all customers' requirements. Potential customers can be found in the transport and logistics sector (freight carriers who offer storage facilities and crossdocking, forwarding agents etc.) as well as in the production sector (companies with freight volume destined for export, importers and exporters). Accordingly, the most important services are: storage, crossdocking and distribution, consolidation / deconsolidation, loading and unloading containers, managing stock levels and delivery chains, value-added services such as labelling and packaging.

Figure 122: Layout of the logistic platform[76]

The offshore terminal has a static capacity of 12,150 TEU. Its function is to organise the flow to the terminals. The implementation of a customs office in the offshore terminal speeds up processing in the terminals, since customs procedures have already been dealt with. The offshore terminal operator also organises the transport between the offshore terminal and the port terminal. The truck centre and the service centre supplement the range of services offered by the logistic platform through services for the public and vehicles. The truck centre has been sized so that the traffic volume created by all functional areas of the logistic zone can be coped with. Up to 30 companies can be based in the service centre. The size is such that the demand for companies in the first phase of implementation of the logistic zone is covered.

The potential location has sufficient space for future expansion of the logistic platform. This means it is possible to enlarge all the business areas. In addition, areas for a multi-modal terminal (railway station and inland port) have been planned. (cf. Figure 123)

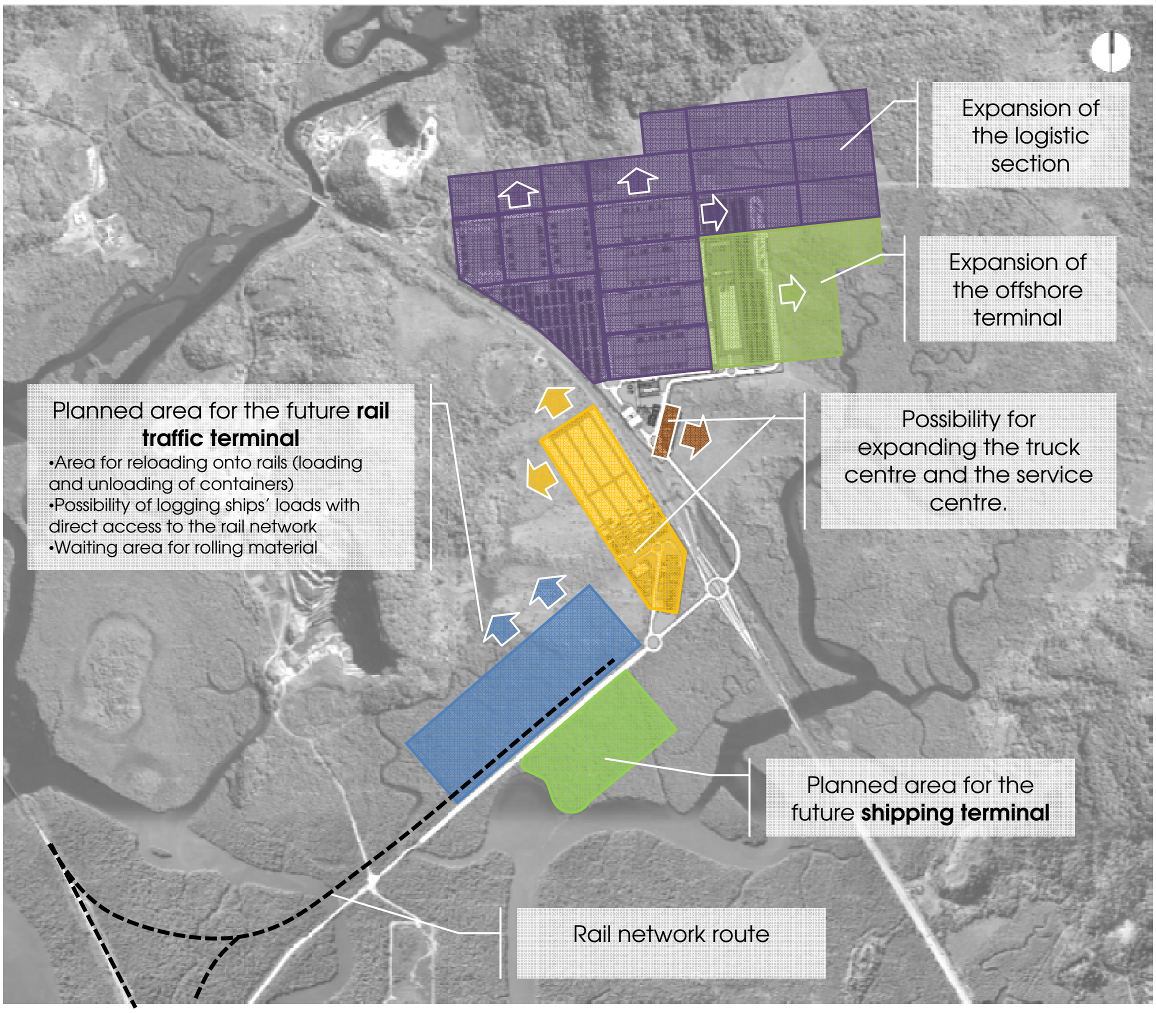


Figure 123: Arrangement of future expansions[77]

[7778] Cf. also detail plan Santos in the appendix.

Financial, economic and operational study

According to ALG the overall investment required is currently 509.6 million Brazilian Reais, whereby ALG suggests dividing this so that 324.58 million are borne by the concessionaire and 266.34 million by the public sector.

Comment Duisport. In Europe, state funding of up to 80 % is available for projects of this magnitude.

Integration of logistic platforms into an innovative system of container transport

Concepts for innovative systems of container transport to and from the terminals are presented in chapter 10 “Future solutions and technologies to boost the Port of Santos”.

Analysis of an implemented logistic platform based on logistic zone "logport I" in Duisburg, Germany

Logport I in Duisburg, Germany, is a good example of an implemented logistic platform. On the grounds of the former Krupp ironworks in Duisburg-Rheinhausen (cf. Figure 124), one of the fastest growing European logistic centres with tri-modal transhipment terminal has been set up within a very short time. In 1998, the plot was purchased on the grounds of the former ironworks.

Figure 124: Area logport I in 1999

The areas on the grounds were developed and marketed from 1999 onwards. The higher-order aim of marketing is to settle companies who operate or require cargo handling between the carriers rail, road and/or water within the context of their responsibilities.

The overall area of the plot is 265 ha, whereby 90 % were sold or leased by 2009 (cf. Figure 125). The number of jobs created by the companies settling was 3,000 in the year 2009. The total investment so far is around 1 billion €.

Figure 125: Area logport I in 2009

Logport I is now the centre of modern contract logistic and part of the duisport strategy to convert and expand a classic bulk cargo port into an internationally linked, high-performance logistic hub. duisport is responsible for development and control and linking up the market participants via the port railway run by duisport.

Numerous international operating logistic service providers have settled, e.g. NYK, CMA CGM, Wincanton Trans European, Kühne & Nagel, Rhenus, DB Logistics Schenker. The handling of containers and high-quality bulk goods is particularly important, since this sector, most notably in connection with so-called value-added services, is regarded as especially labour-intensive.

At the heart of logport I is the tri-modal container terminal DIT which was put into operation in October 2002 with a capacity of 200,000 TEU. It creates ideal conditions for processing cargo flows to a significant degree via water, rail and road. In January 2008 the second container terminal in logport I was put into operation – container terminal D3T. In December 2009 a further container terminal went into operation in logport I: the DKT terminal. The Swiss chemicals logistic company Bertschi uses this terminal for combined rail traffic. The second expansion stage of the shunting yard logport, which currently has ten tracks, was connected to the public rail network in September 2007. The shunting yard has been expanded to a total of ten tracks on account of the positive development of rail traffic in the logport area.

Figure 126: Area logport I in 2012

Every day, trains leave the logport for Amsterdam and Rotterdam in the Netherlands, Antwerpes and Zeebrügge in Belgium, Manchester/UK, Vienna and Enns/Austria, Budapest/Hungary, Wiler/Switzerland, Novera/Italy, Slawkow, Posen and Warsaw/Poland, as well as Vostoktrans and Moscow/Russia. In addition, inland ship shuttles travel every day to Rotterdam and Antwerpes, and there are regular connections to Amsterdam and Zeebrügge. Thus the location in combination with the three containers or KV terminals DeCeTe, RRT and DUSS on the right bank of the Rhine have developed into the most important hinterland hub of the two North Sea ports with gateway function for the Central European markets.

In the logport port, a Ro/Ro system has been set up which makes the shipping of cars, trailers and rolling containers possible between Duisburg and other European ports. The cutting edge plant consistently implements the tri-modal concept of the logport project: There was investment in a high-performance railway loading facility for cars in the immediate vicinity, allowing cars delivered by ship can be transported onwards by rail. The equipment was put into operation on schedule in October 2003. The first user is the global automobile logistics company Cobelfret, which operates a car terminal directly next to the equipment. E.H. Harms Automobile Logistics, part of the BLG Logistics Group, also has a car terminal including a pre-delivery inspection centre located in the direct vicinity of the Ro/Ro system on a surface of 160,000 m² for the treatment and tuning of import vehicles. All in all, more than 100,000 vehicles from a wide range of different manufacturers have been handled through Duisburg.

To sum up, the following services are provided at logport I:

Services provided at logport I

- port planning (considering operational and economical aspects), construction and operation
- rail planning (considering operational and economical aspects) and operation
- architecture studies
- surveying
- structure static analysis / static analysis
- specialist monitoring engineering / building services (HVAC/R)
- crane and handling technology
- geology
- fire prevention / water pollution control
- waste water management
- dangerous goods and water pollution control officers, ISPS officers
- ISPS officers, health & safety at work officers
- project- / construction management
- underground engineering, hydraulic engineering, turnkey construction
- financing
- training
- commercial & technical facility management
- measures for protection of the environment.

Recommendations

The feasibility study prepared by the Advanced Logistic Group (ALG) on the function and necessity of setting up a logistic platform is endorsed to a major extent. The content developments are evaluated positively. However, the lack of consideration of connection to the rail infrastructure can also be seen. In addition, the overall area assignment and integration of the rail connection need further development. duisport has drafted a modified suggestion for this. The following diagram shows the location planned by ALG modified by connection to the carriers (in particular the railway).

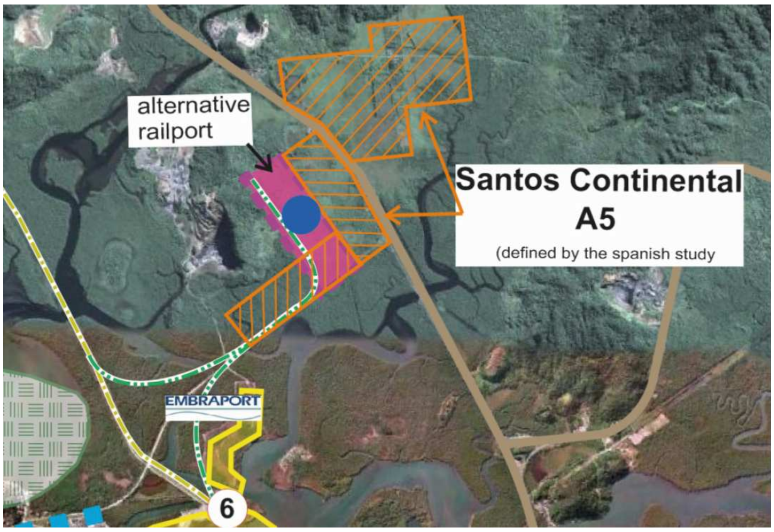


Figure 127: Layout of a modified logistic platform

The location of suggestion 5 favoured in the study has disadvantages in terms of its position. The location is insufficiently integrated into the existing traffic network. This means the use of the inland waterways planned in the study is not possible. In addition, a logistic platform in this location will not relieve the strain on the traffic routes around Santos, which would be a disadvantage. Relief would be possible if the logistic platform (analogue to the Port of Barcelona) was set up in the direct vicinity of the terminal and the terminal-related traffic flow via truck, rail and terminal vehicles did not affect public carriers. Since this is not the case with the area selected (suggestion 5), there would be a significant increase in traffic on the public routes between the port and the logistic platform.

Selecting a new location

A logistic zone on the plateau is favoured as the new location. If there were enough space available, this could be set up in Paranapiacaba near the existing shunting yard, providing an excellent base for distribution in the direction of the port or the hinterland. This location would be connected both to the road and rail networks. The goods arriving from the hinterland can be bundled within the logistic zone, thus reducing unnecessary trips down the valley towards Santos. Setting up the logistic zone makes the realisation of the infrastructure projects rail and road ring necessary, and involvement in project planning.

Set-up and operation are to be financed using a PPP model (customers to be settled). The organisation and control via CODESP rather than through the market participants is considered absolutely necessary. It is only this neutral function and a close link to the logistic port network – both physically (rail and port infrastructure, cargo-handling equipment etc.) and in terms of information – that makes the discrimination-free distribution of the material flow possible (see below: Function of duisport at the logistic centre logport I). The logistic platform must be seen as part of the organised port. This guarantees that optimum control of the traffic flows is carried out via this platform between Santos and the hinterland, taking the strain off the traffic infrastructure. In terms of organisation, this can be regulated in the course of the concession allocation process.

The logistic zone enables optimum supply to the port (both right and left bank) with terminal-related supply and discharge of cargo and goods flows, leading to increases in capacity through relocating value-adding services to the hinterland. Processing times are also reduced. Setting up the largest logistic zone between Sao Paulo and the Port of Santos and the flanking logistic nodes/hubs (shunting yards, truck waiting areas cf. Detail Plan Santos) will generally achieve a higher handling volume via or out of the Port of Santos. In addition, the share of goods transported by road can be reduced significantly.

Conclusion

Development of logistic zones

- In view of the dimension and importance of the Port of Santos and its economic hinterland it is obvious that one single logistic platform will not be sufficient. It is rather necessary to complement the (one or more) logistic platforms with a network of intermodal dry Ports throughout the hinterland.

- There are two potential areas for the development of the first intermodal Port logistic platform, the area Baixada Santista / Santos Continental (only in case of realization of the Saboó-Ilha Barnabé – connection) and the Area of Paranapiacaba (only in case of realization of the container transport system).

- In light of the development of an integrated intermodal approach it is only consequent to develop the first Port logistic platform in Paranapiacaba

- Setting up several logistics nodes necessary, because these guarantee an important contribution to rectifying, structuring and controlling all participants' traffic (cf. Detail Plan Santos)

- Both the right and left bank terminals will be served via a central logistics zone.

- Pre-Gates are one of the several services of the logistic platform.

→ **It is essential to develop a network of logistic platforms in the hinterland;**
The first Port logistic platform shall be constructed in Paranapiacaba

Derivation of the proposed location for a logistic zone by duisport

- Focus of ALG study was not on the implementation of intermodal modules in the Terminals, pre-Gates and a novel container transport technology but on solutions for the current “truck driven” situation. Consequently the “intermodal extension” of the Logistic Platform is expected to be “phase 2” of the project
    - From this point of view the recommendation of Area 5 is consequent and sustainable and also in line with the assessed demand of stakeholders within the Port of Santos
- But if combined with the findings of the other relevant studies also the ALG-model will result in the recommendation that the Paranapiacaba region as pre-Gate of the Terminals and component of an alternate system to transcend Serro do Mar is the “given” area to develop a Port Logistics Platform

→ **The development of a Port Logistics Platform within the Paranapiacaba region does expressly not imply to abstain from the development of a logistics platform as suggested by ALG**

→ **In light of the integrated intermodal approach of the São Paulo – Santos Logistic Corridor Program the public (Port) authorities should focus first on the development of an Port Logistic Platform within the Paranapiacaba region**

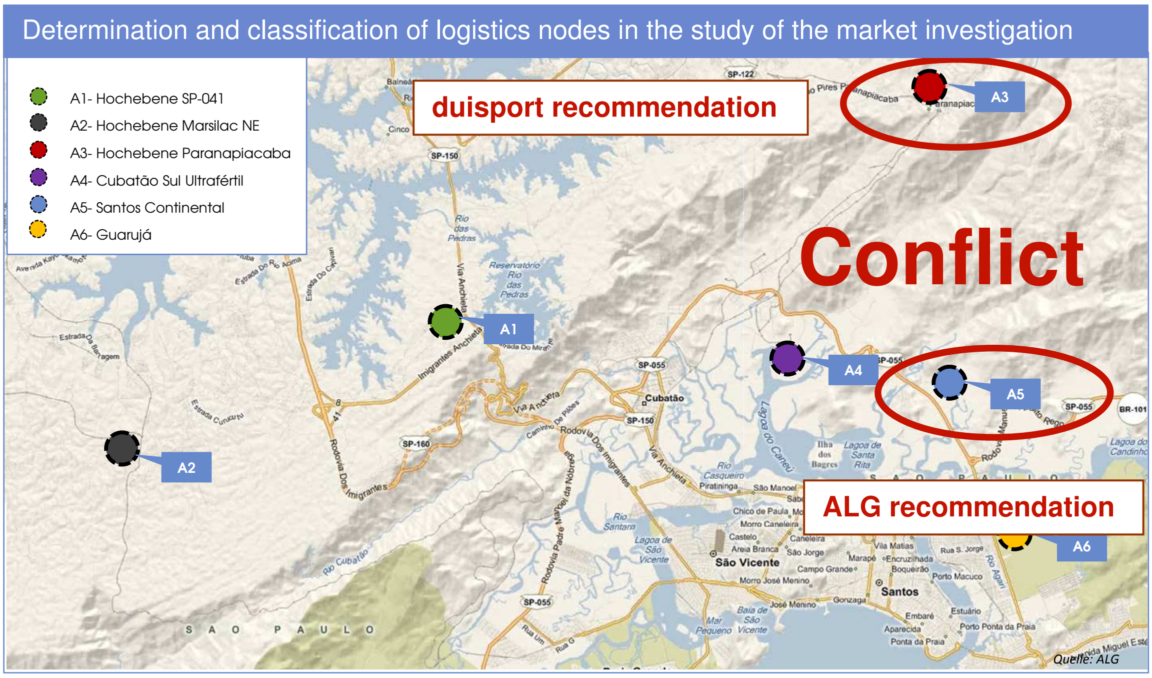


Figure 128: Comparison of the proposed locations by ALG and duisport

Organizational structure of the logistic platform

- Development of the first intermodal platform in the area of Paranapiacaba combined with a container transport system and integration of IT-systems

- To ensure a consistent development the Port Logistics Platform should be part of the organized Port

- The partial outsourcing of certain value creating activities (empty container management etc.) would make a large contribution to rectifying traffic flows and increasing handling capacities in the port facilities

- Development in PublicPrivatePartnership
  - Property acquired by the public authorities (SEP/CODESP)
  - Shareholding of SEP/CODESP also in the Management Company to ensure public interest
  - Participation in operations

→ **The organizational structure of the logistic platform has to be developed together**

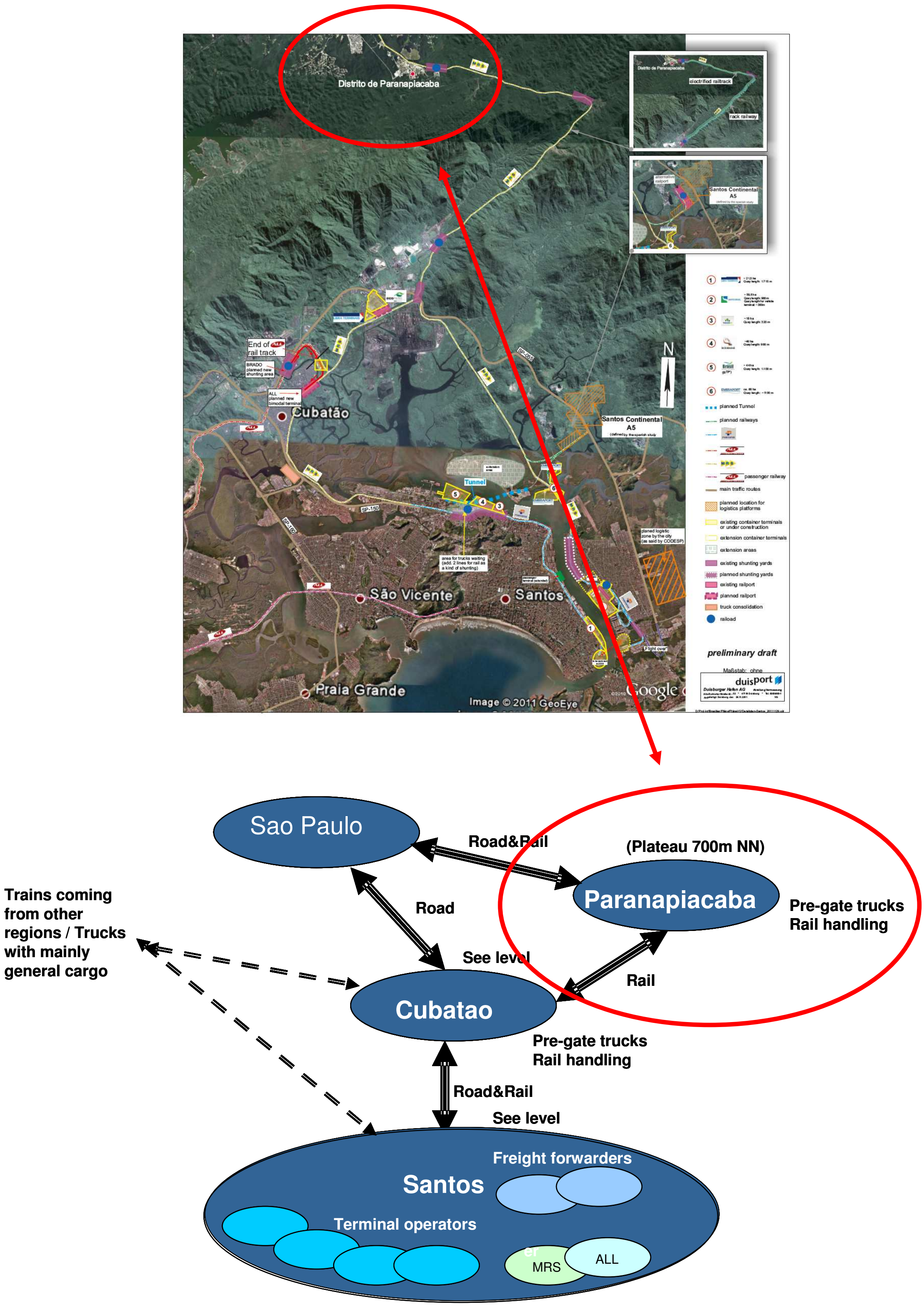


Figure 129: Overview of the first logistic platform in Paranapiacaba[78]

5.4 Sustainable milestone concept for the Port of Santos

Focal points of future action areas

A total of 5 focal points detailed below can be put together from the previously identified future action areas. These focal points have been placed in chronological order.

1. Organizational measures

Organizational measures within the ports/terminal

- Reorganizing the tasks and role of the port railroad und port authority.
- Preparing a master plan to develop the port of Santos and the hinterland.
- Integrating the players in current planning and in the master plan
- Central control of traffic flows and development activities (utilizing signal and control technology to control traffic flows)

Organizational measures rail/road

- Increasing utilization and capacities of rail and road
- E.g. enlarging the permitted access points, introducing double decker container carrying wagons
- Transferring traffic from the roads to rail

2. IT systems and communications platform

- Includes the quickest possible introduction of central port management software, which will be incrementally adjusted to the additional development projects (TOS, POS, TLP). IT systems make networking with each other possible at all as well as process administration. IT traffic systems form the basis for a management system with traffic guidance and traffic management headquarters.
- Connecting all port participants (shipping lines, forwarders, terminal operators, port railroad, logistics area operators, rail and road players) in a central IT platform is urgently necessary.
- On the basis of this data, the neutral port authority will control traffic flows within the port as well as between the port and hinterland in real time.

3. Modernizing and supplementing the existing infrastructure in the port

Immediate measures, terminal/port measures:

- Upgrading the port railroad, e.g. increasing efficiency through “slot procedures”
- Developing and new construction of rail handling facilities, expanding the marshaling yard capacities (buffer tracks), setting up locomotive parking possibilities and a locomotive scheduling point
- Construction adjustment of roads and terminals (access roads, gate situation)
- Setting up central buffer areas and shunting yards, that are part of an organized overall port concept (cf. Detail Plan Santos).

4. Planning and developing a central logistics zone

- Building up a logistics platform on the plateau and developing a network of hubs and logistics nodes including automated handling facilities.
- Providing additional value creating activities within the logistics zones, such as warehousing, picking, empty container management, container stuffing and container stripping → this will lead to a rectification of traffic, make possible considerably shorter throughput and handling times making considerable increases in capacity possible.

5. Expanding the logistics network in the hinterland

- Development and new construction measures are required at numerous points, in particular in the port area and its access routes (cf. Detail Plan Santos)
- Connection between the port and hinterland (realizing rail/road infrastructure projects)
- Utilizing innovative technologies to increase efficiency (compare port shuttle network, locomotives and powered container wagons, quick truck and rail loading technologies and automatic pre-gate solutions)

Modernizing and expanding the port and hinterland has to be accompanied by parallel optimization of the accessibility of the port. As a general principle a holistic concept is necessary here incorporating all modes of transport and players. Against this background, in the course of the presentation an initial proposal for a “Master Plan Port Santos and Hinterland“ will be made, in order to show action areas and to make dependencies and interactions recognizable. This consideration will be made holistically by incorporating the port of Santos, its direct surroundings and the whole network alongside the growing flows of goods. Individual measures are counter productive and would generate new bottlenecks at other points.

The Master Plan will be developed taking green port or green logistics ideas into account. The most efficient levers for Green-Logistics concepts are transport avoidance, shifting transport mode, freight consolidation (pooling) through hubs and packing optimization[79]. Advantages of a green logistic focus are independencies from rising energy prices, marketing as a “green port” and compliance with policies, laws and regulation. Efficiency and environmental friendliness in ports can be achieved for example, with improved handling facilities, CO_2 free transport systems and continuous terminal management solutions.[80]

Measured by the forecast of installed capacities of the terminal for 2010-2024 and the forecast of quantity growth it will be possible to meet future challenges by implementing this master plan. The implementation of master plan measures will be carried out taking the green port/logistics approach into account. A cost estimate for this master plan can only be made after further detailed investigations.

[79] Siemens AG
[80] Siemens AG Sektor Infrastructure & Citites Division Mobility and Logistics: *Hubs in future: an integrated mobility network for people and goods)*, Munich, 2011

Milestone concept

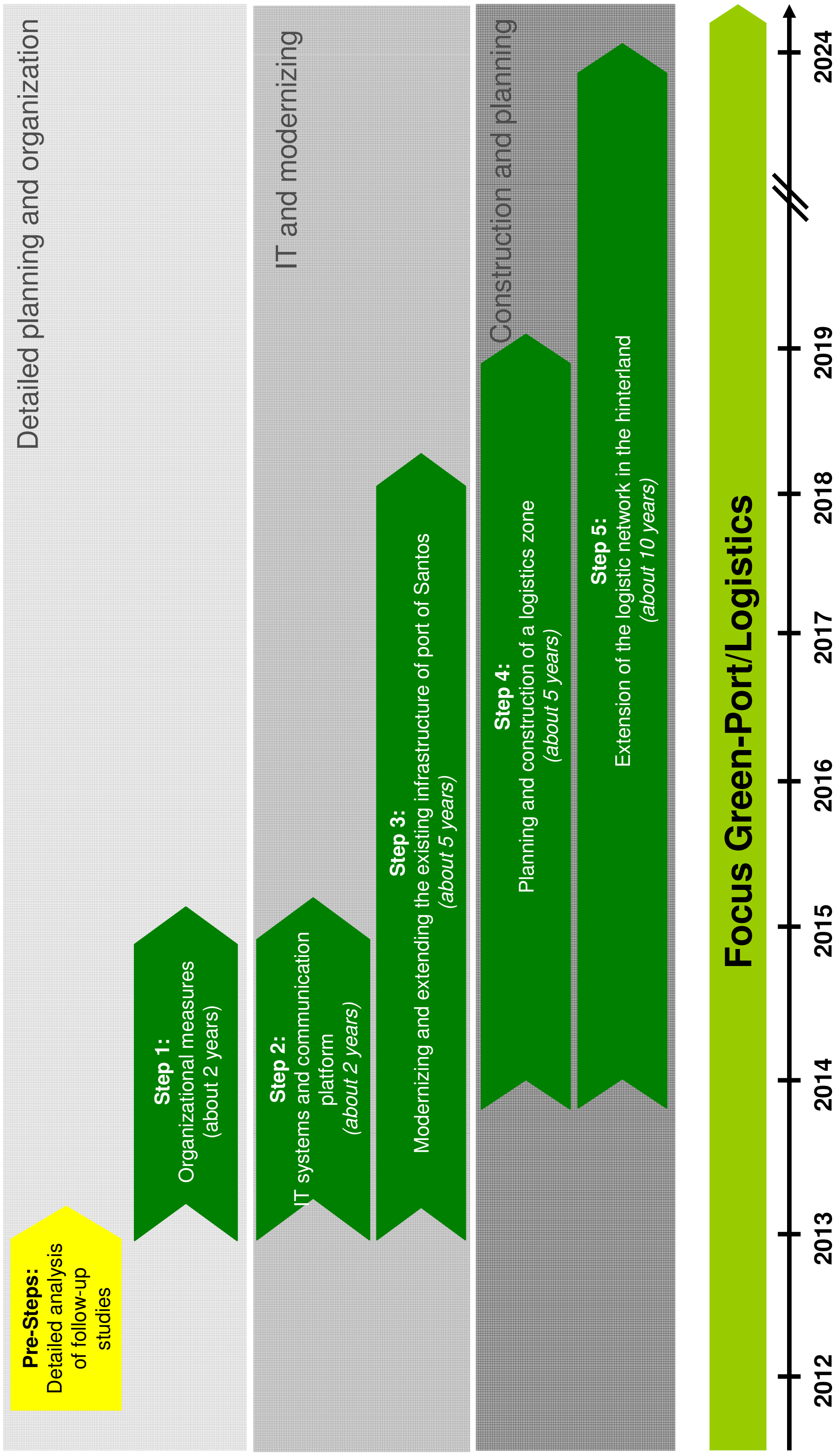


Figure 130: Milestone concept Port of Santos

Appendix

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