D.T2.2.7 – PILOT EVALUATION REPORT - PILOT ACTION NO. 3 - TRIESTE

Bottleneck analysis of the Port of Trieste

Version 1.0
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INTRODUCTION

Over the last few years, the railway traffic of the Port of Trieste has increased considerably, passing from 5.980 trains in 2015 to 9.770 trains in 2019 (+63.4%). The economic crisis due to the COVID19 pandemic caused a decline in 2020, which is currently being recovered – the number of trains increased by 19.5% during the 1st semester of 2021, if compared to the same period of the previous year.

Moreover, modal shift from road to rail plays an important role in the environmental strategy of the Port Authority: it already shows remarkable results – 52% for TEUs and 27% of semi-trailers in 2020 – which will need to grow further in order to meet the decarbonization goals at local, national and EU level.

Yet, despite the increase in rail traffic flows, the railway infrastructures of the port of Trieste have remained the same.

Therefore, the main challenge this pilot action aims to tackle is identifying the existing infrastructural bottlenecks, aiming to envisage the most suitable solutions as to further increase the modal share on rail.

WHAT IS A BOTTLENECK?

A bottleneck is a limit/constraint in transport system. The inefficiencies brought by the bottleneck often create delays and higher transport costs. The term bottleneck refers to the typical shape of a bottle and the fact that the bottle's neck is the narrowest point, which is the most likely place for congestion to occur, slowing down the flow of liquid from the bottle. A bottleneck can have a significant impact on the transport flows, and can sharply increase the transport time and expenses. Moreover, last but not least, it can limit possible growth in transport flows and therefore in economic development of entire Regions. For this reason the identification of bottlenecks is definitely important in order to define possible improvements in network and/or service configuration.

Picture 1: Principle of the bottleneck in transport

The analysis of bottlenecks shall include all types of bottlenecks, even if they may not be relevant everywhere:

- transport infrastructure,
- rolling stock,
- services & operations and
- legislation & administration.

1. BOTTLENECKS ANALYSIS IN TRIESTE PORT

Bottlenecks analysis has been performed in Trieste Port according to the methodology proposed in D.T1.3.1 – METHODOLOGY FOR IDENTIFICATION OF BOTTLENECKS IN INFRASTRUCTURE AND SERVICE and the structure of this chapter is compliant to that document. According to the main goals of Port Network Authority of the Eastern Adriatic Sea, the analysis has focused on the railway sector whose role is crucial for port competitiveness.

A.1. (TRANSPORT) RAIL INFRASTRUCTURES

Reasons for bottleneck at the rail infrastructure are:

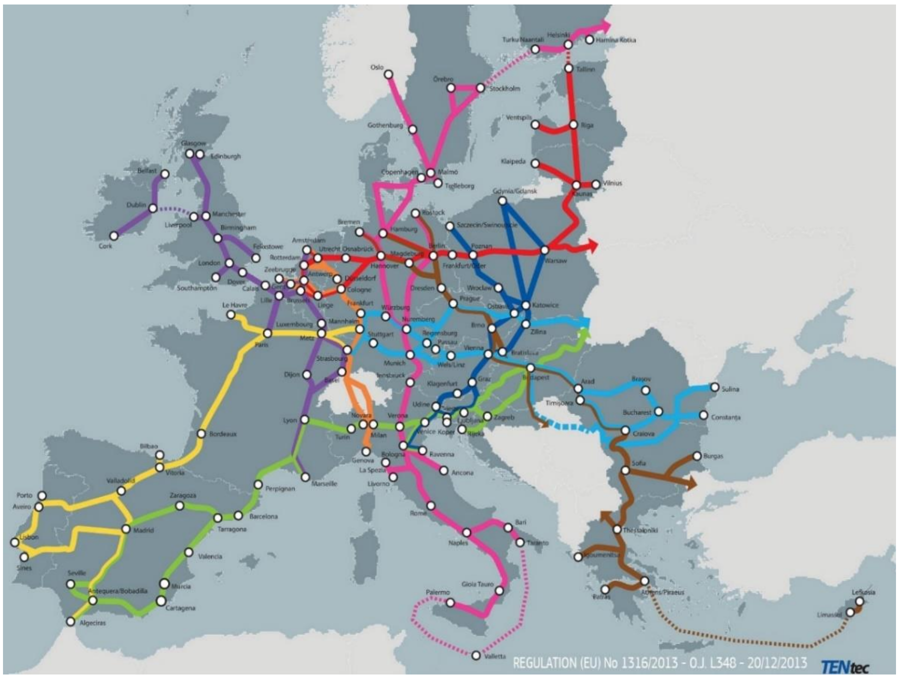
- Lack of capacities railway lines
- Speed restrictions on the rail infrastructure
- Railway lines regarding technical parameters:
  - track gauges
  - traction systems
  - signal systems
  - axle load
  - train length
  - loading gauge
  - station sidings
  - loading ramps
- Cargo road/rail/sea/river terminals:
  - Lack of storage areas
  - Access to the terminals
  - Railway station sidings
  - Lack of storage capacities
- Sea/river port infrastructure
  - Lack of berths
  - Short length of the berths
  - Short draft at the berth
  - Lack of storage capacities

Situated in the Northern Eastern part of the country, the Port of Trieste lies in a strategic position in the heart of Europe and represents the crossroads of various maritime routes and transport corridors. Indeed, it constitutes an important international hub for the land-sea flows concerning the marketplaces of Central and Eastern Europe, and more recently also of Far East. Thanks to its location along the Silk Road and to its great water depth, reaching up to 18 meters, in the latest years the Port of Trieste has recorded a significant increase in traffic volumes, which are expected to grow even further in the future.

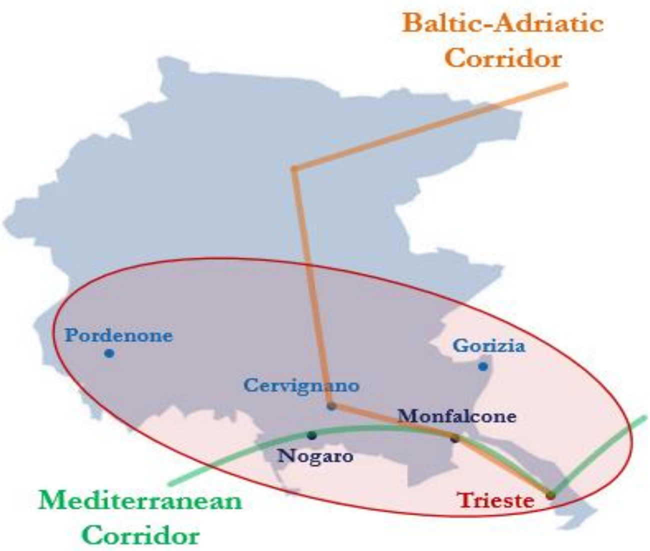
At infrastructural level, the Port of Trieste has available an internal railway network which is efficiently connected with the national and international ones. The development of intermodal transport in the Port of Trieste is sustained also by the presence of two of the nine TEN-T (Trans-European Transport Network) Corridors in the territory of the Friuli Venezia Giulia region, which is the area it belongs to. More in detail, as illustrated in Figures 2 and 3, the Port of Trieste is engaged by traffic flows transferring freight along the Baltic-Adriatic and the Mediterranean Corridors, which connect, respectively, the Northern and the Southern areas of Eastern Europe and

South-Western Europe with Eastern Europe. The ultimate goal of the TEN-T network aims at implementing and developing a Europe-wide network including a multiplicity of routes and facilities for all transport modes, in order to not only eliminate bottlenecks and technical barriers, but also to strengthen the social, economic and territorial cohesion in the European Union. In addition to the backbone Core Network which the nine main Corridors pertain to, TEN-T encompasses a Comprehensive Network composed by a series of secondary transport connections to cover all European regions. To further foster intermodality in freight transport, for each Corridor some financial investments have been planned considering the realization of new links and of infrastructural and technological modernization interventions, on both railway line sections and nodes.

Picture 2 - TEN-T Corridors



Picture 3 - TEN-T Corridors present in the Friuli Venezia Giulia region

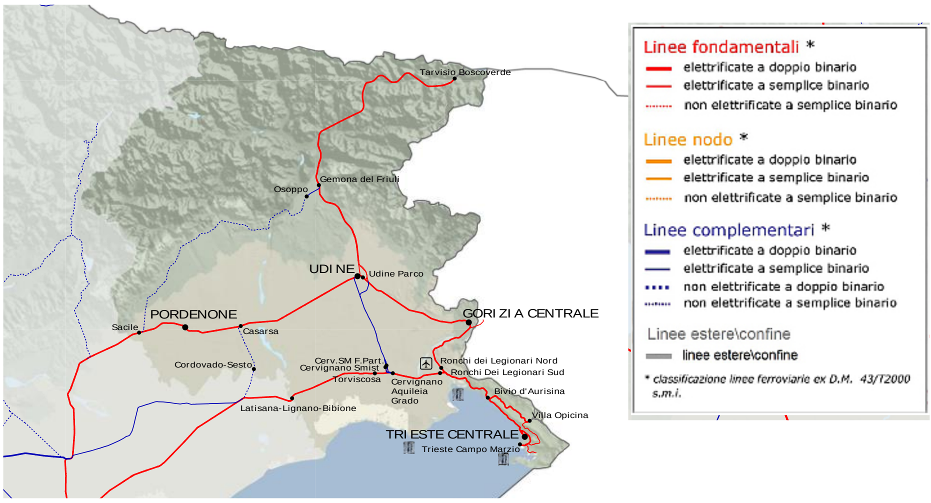


As illustrated in Picture 4, the Port of Trieste is composed by two main parts, which distinguish themselves for the type of activity they are dedicated to: on one side, the commercial port, including the area called Punto Franco Nuovo, and on the other side, Scalo Legnami, Ferriera, Punto Franco Oli Minerali, and the industrial port, which is located in the area of the Canale Navigabile.

Picture 4 - The Port of Trieste

The railway network, which connects the port of Trieste and Italian borders, is shown in figure 5 (Source: RFI S.p.A.).

Picture 5: Railway network (Source RFI S.p.A.)



It may be divided into the following main sections (which are shown in the schematic map in Picture 6):

1. Trieste junction
2. Trieste-Bivio Aurisina
3. Bivio Aurisina – Villa Opicina – Italian Border (Slovenia)
4. Udine – Tarvisio – Italian Border (Austria)
5. Bivio di Aurisina – Bivio San Polo
6. Bivio San Polo – Udine
7. Other connections between FVG and Veneto regions.

These main sections are described in the following:

- Trieste junction, which includes a number of stations and rail yards, is connected to the main railway network through a double track tunnel under the city of Trieste; this tunnel solves all potential traffic problems related to the location of the port within the city and its electrified line is equipped with a modern electric automatic block system;

- Trieste-Bivio Aurisina is a double track electrified line equipped with a modern electric automatic block system;

- Bivio Aurisina – Villa Opicina – Italian Border (Slovenia) is a double track electrified line equipped with an electric axle-counting block system;

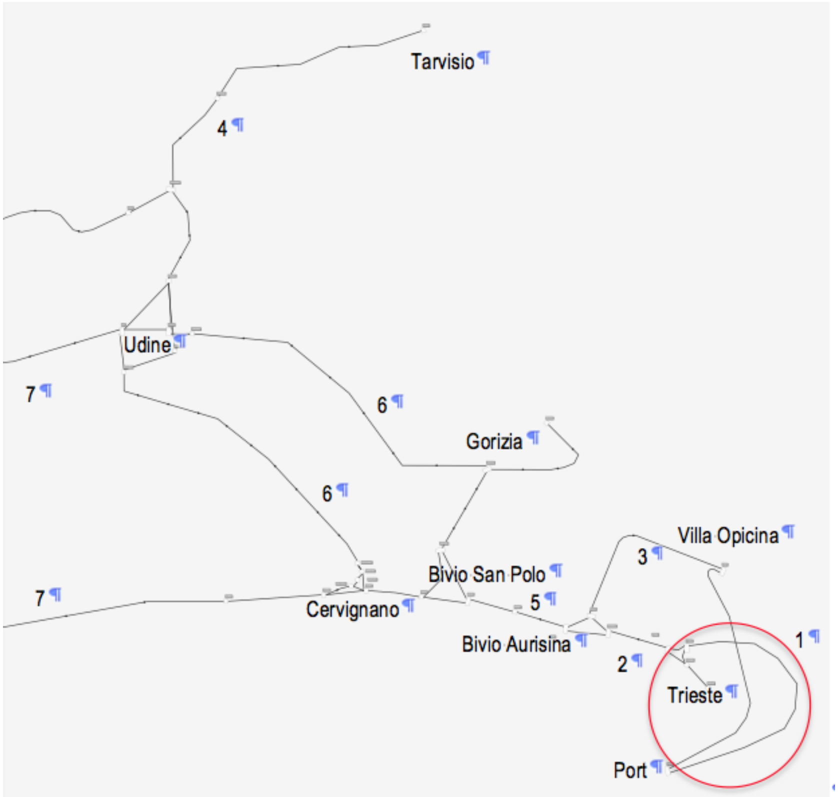
- Udine – Tarvisio – Italian Border (Austria) is a double track electrified line equipped with a modern electric automatic block system;

- Bivio di Aurisina – Bivio San Polo is a double track electrified line equipped with a modern electric automatic block system;

- Bivio San Polo – Udine: this section is divided into two possible itineraries: more in particular, it can be travelled through the line Bivio San Polo – Gorizia – Udine or using the line Bivio San Polo – Cervignano – Udine. The first alternative is a double track electrified line equipped with an electric axle-counting block system, while the second one is a double track electrified line equipped with modern electric automatic block system until Cervignano and it is a single track, electrified line equipped with an electric axle-counting block system from Cervignano to Udine.

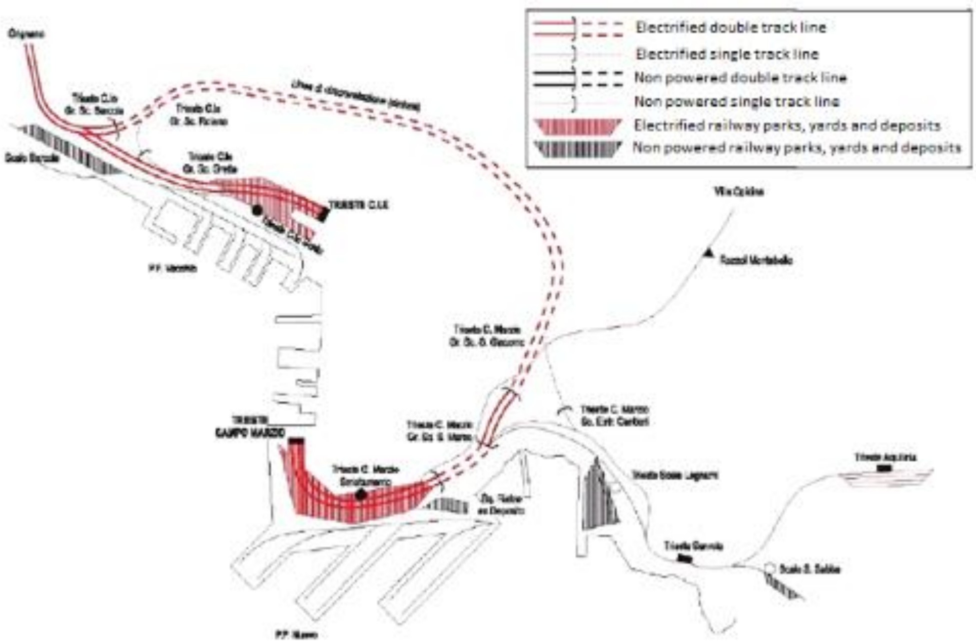
- Other connections between FVG and Veneto regions: there are two main lines from FVG towards the other Italian regions through Veneto (the Mestre-Padova four-track line and the Treviso-Vicenza double track line) and a railway network connecting the port of Trieste to Mestre and Treviso respectively.

Picture 6: Main sections



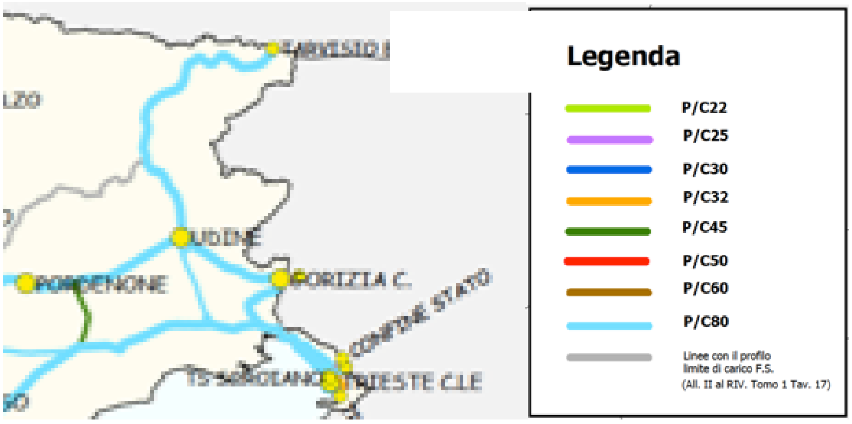
Picture 7 shows a more detailed configuration of Trieste junction.

Picture 7 – Trieste junction



The whole FVG railway network is characterized by a standard track gauge and has a Gabarit P/C80 as shown in Picture 8. No significant speed restrictions exist and only secondary sections present a reduction in axle load form 22,5 t/axle to 20 t/axle.

Picture 8: Gabarit on FVG railway network (Source RFI S.p.A.).



At present, investments are on-going (both in stations, line and terminals) to increase up to 750m the length of trains circulating over the network, according to Core Network European Standard.

As known, the presence of gradients may negatively affect freight traffic, leading, for example, to trainloads limitations or to the need of additional locomotives. For these reasons, a specific focus has been performed on the gradient situation of the itineraries from/to the port of Trieste.

Data have been collected from official RFI documentation (FL 62-68), which shows in particular the gradient and the gradient classification for each portion of any line (see appendix for details).

Picture 9 graphically shows the profile of the main line from Trieste to Tarvisio, while Table 1 shows the detailed values.

Picture 9: Profile of the main line from Trieste to Tarvisio

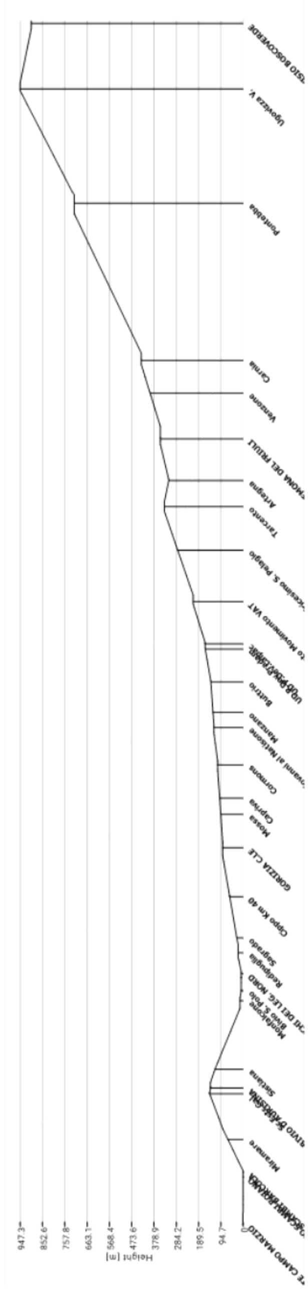


Table 1 - Gradients

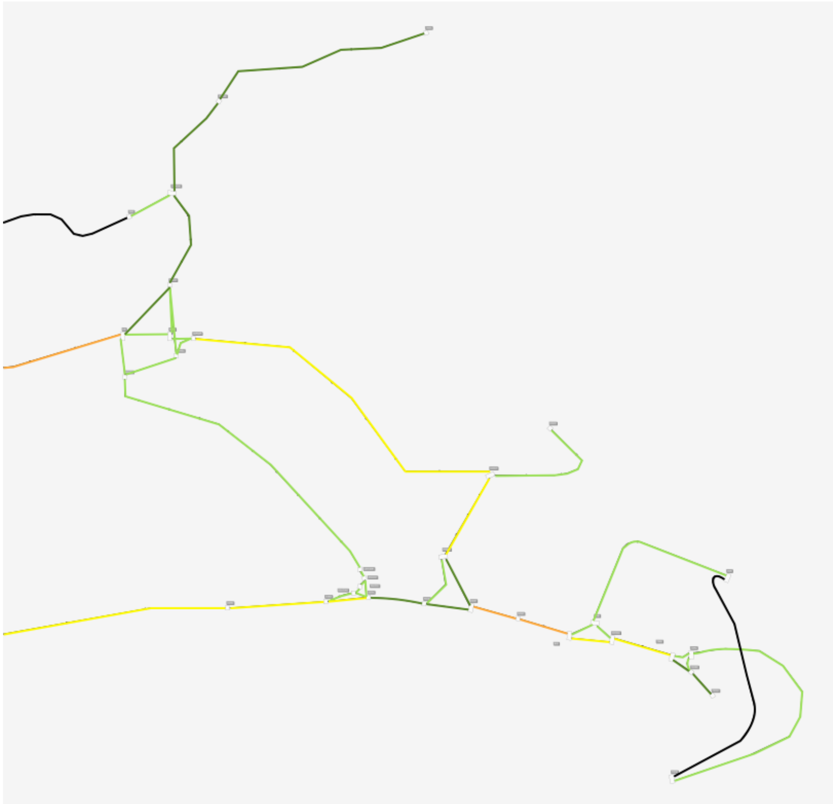
<table>
<tr><th colspan="10">Section</th></tr>
<tr><th colspan="2">Trieste C.le- Bivio D'Aurisina</th><th colspan="2">Bivio D'Aurisina - Villa Opicina</th><th colspan="2">Bivio D'Aurisina - Bivio S. Polo</th><th colspan="2">Bivio S. Polo - Udine</th><th colspan="2">Udine - Tarvisio</th></tr>
<tr><th>Gradient [‰]</th><th>Lenght [km]</th><th>Gradient [‰]</th><th>Lenght [km]</th><th>Gradient [‰]</th><th>Lenght [km]</th><th>Gradient [‰]</th><th>Lenght [km]</th><th>Gradient [‰]</th><th>Lenght [km]</th></tr>
<tr><td rowspan="3">14</td><td rowspan="3">8,5</td><td rowspan="2">15</td><td rowspan="2">0,8</td><td rowspan="3">-10</td><td rowspan="3">2,7</td><td>-5</td><td>2,5</td><td>7</td><td>4,5</td></tr>
<tr><td>6</td><td>5,2</td><td>10</td><td>13,9</td></tr>
<tr><td>11</td><td>0,6</td><td rowspan="2">5</td><td rowspan="2">13,1</td><td>-6</td><td>3,8</td></tr>
<tr><td rowspan="3">11</td><td rowspan="3">5,2</td><td rowspan="2">12</td><td rowspan="2">2,1</td><td rowspan="3">-12</td><td rowspan="3">10,0</td><td>7</td><td>6,1</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">12,1</td><td>9</td><td>11,5</td></tr>
<tr><td rowspan="2">13</td><td rowspan="2">7,3</td><td>14</td><td>22,9</td></tr>
<tr><td rowspan="3">-6</td><td rowspan="3">0,9</td><td rowspan="3">-5</td><td rowspan="3">1,5</td><td>4</td><td>5,5</td><td>19</td><td>1,6</td></tr>
<tr><td rowspan="2">15</td><td rowspan="2">4,8</td><td>2</td><td>6,7</td><td>15</td><td>15,0</td></tr>
<tr><td>5</td><td>8,7</td><td>-6</td><td>9,5</td></tr>
</table>

A number of methods exists for capacity and residual capacity estimations (see for example Fiche UIC 405, 406, and other technical reports). It is well known that it depends on a number of elements, such as alignment, infrastructure configuration, block system and signalling, timetable and train mix, etc… Moreover, the modern approach suggests considering explicitly the trade-off between capacity and operations reliability. In this first document, capacity values have been estimated according to the official documentation published by the Italian Infrastructure Manager (RFI S.p.A.) and residual capacity figures have been determined as the difference between the capacity and the actual line utilization according to the official planned timetable referred to a working day in the middle of the week. A specific and very detailed analysis on residual capacity on the main line is presented in the document referred to the operations model.

Picture 10 shows the same schematic representation of the considered railway network. Each link has been coloured according to the percentage of its residual capacity. In particular, the meaning of the colours is the following:

- Light green used capacity between 0% to 40% and residual capacity between 100% and 60%
- Dark green used capacity between 40% to 60% and residual capacity between 60% and 40%
- Yellow used capacity between 60% to 75% and residual capacity between 40% and 25%
- Orange used capacity higher than 75% and residual capacity lower than 25%
- Black line almost un-used (this section was re-opened a couple of months ago)

Picture 10 – Residual capacity



As stated before, different links are equipped with different block systems, therefore the percentage of residual capacity leads to a different number of additional trains available on each railway link. According to these values and considering the itinerary from Trieste port to the Tarvisio border, the most critical section is the section between Bivio di Aurisina and Bivio San Polo, where both north-south and east-west traffic converges. In this section the residual capacity can be roughly estimated in a range from 40 up to 60 additional trains per day. These values have been estimated as the difference between the maximum capacity (given by RFI documentation) and the actual number of planned trains in the most crowded day of the week (Wednesday).

These trains may be added to the current traffic of the port of Trieste (estimated 8000 trains/year in 2020), leading to a possible total amount of around 20-25 thousand trains per year.

As a result, the railway system from/to the port of Trieste allows a complete itinerary for freight trains with a gradient of 15%, Gabarit C and a residual capacity between 40 and 60 trains per day. A deeper estimation may be performed in a second stage, also considering the trade-off between capacity and reliability through stochastic micro-simulation.

Additional capacity may be offered through the realization of a portion of the new Venice-Trieste-Ljubljana railway line, in particular in the section between Ronchi Airport and Aurisina. This new section could remove the most critical bottleneck in the railway network on the Adriatic-Baltic corridor and could also increase the capacity on the Mediterranean corridor from/to Villa Opicina. Further investments in Cervignano (as a capacity buffer) could complete the network at this stage.

Finally, last but not least, additional investments to increase railway capacity are under discussion with the Italian Infrastructure Manager (RFI), which include technological improvements (ERTMS). Moreover, interventions to reduce the impact of border controls are on-going.

Regarding road/rail/sea terminal configuration inside the port, at present no critical bottlenecks may be identified. If traffic volumes significantly increased, possible lack of storage areas would arise, but they could be compensated by specific solutions in terms of dry-port operations. Access to all existing terminals is available both for road and rail traffic. The only constraint is related to train length inside some of the terminals (Piers V and VI), that are less than 350m. Longer trains must then be split into two 275-meter-long sections long, each of them using one track.

No significant bottlenecks may be identified in the seaport infrastructure, neither in current situation nor in the planned port developments (Picture 11).

Picture 11 – Master plan

As far as transport infrastructure is concerned, the main bottleneck may be referred to lack of capacity in the main railway line.

Main line capacity estimation

Once the main infrastructure bottleneck has been identified, a more detailed analysis has been performed by using a micro-simulation tool, in order to dynamically represent railway traffic in different possible scenarios with increasing freight train volumes over the network. The aim is to simulate train movements on the railway network, and then, through the analysis of results, to determine the relationship between capacity and reliability.

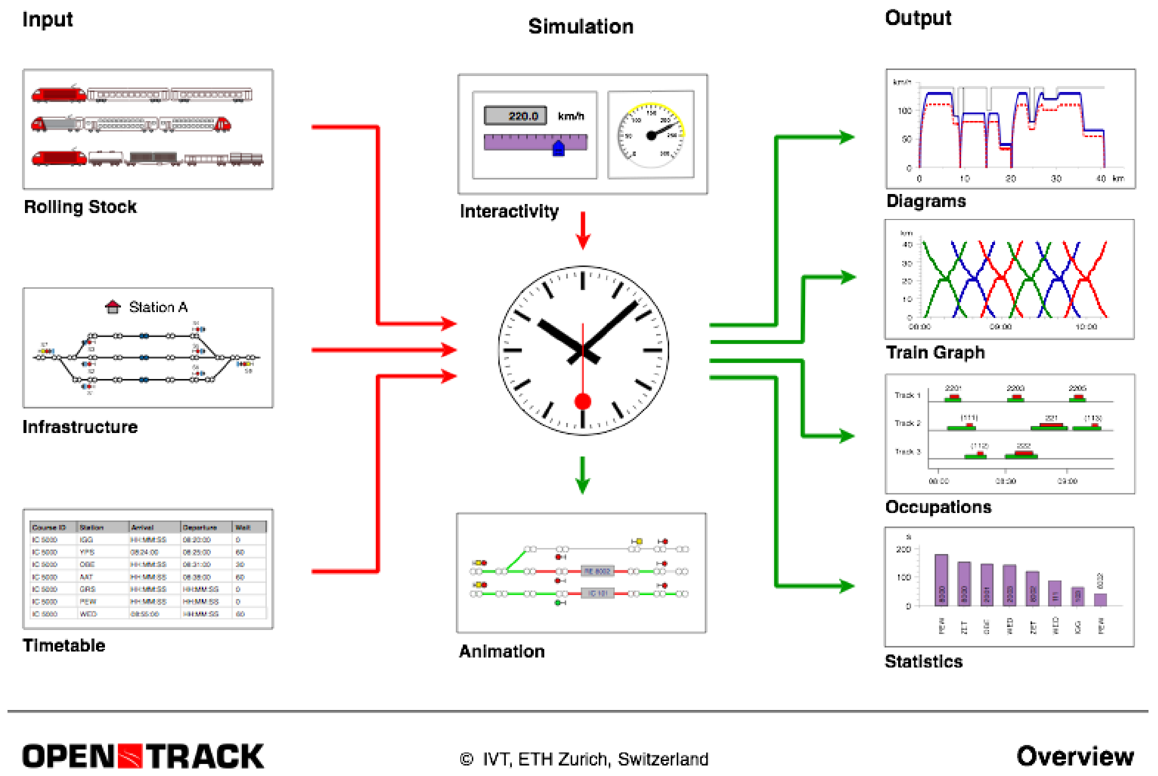
In particular, the tool OpenTrack has been chosen and used. OpenTrack began in the mid-1990s as a research project at the Swiss Federal Institute of Technology. The aim of the project, Object-Oriented Modeling in Railways, was to develop a user-friendly tool to answer questions about railway operations by simulation. Today, the railway simulation tool OpenTrack is used by railways, the railway supply industry, consultancies and universities in different countries. OpenTrack supports the following kinds of tasks:

- Determining the requirements for a railway network's infrastructure
- Analyzing the capacity of lines and stations

- Rolling stock studies (for example, future requirements)
- Timetable construction; analyzing the robustness of timetables (single or multiple simulation runs, Monte-Carlo simulation)
- Analyzing various signalling systems, such as discrete block systems, short blocks, LZB, ETCS Level 1, ETCS Level 2, ETCS Level 3 (moving block) or ERTMS
- Analyzing the effects of system failures (such as infrastructure or train failures) and delays
- Calculation of power and energy consumption of train services
- Simulation of Tram/Streetcar systems
- Simulation of Metro/Subway/Underground systems
- Simulation of Maglev systems (such as Transrapid)

Picture 12 shows how the simulation tool works.

Picture 12 – OpenTrack architecture

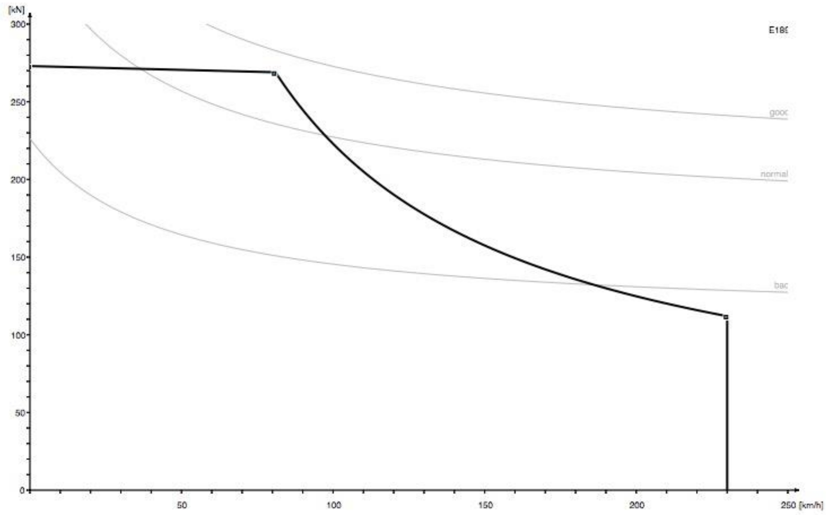


Predefined trains run on a railway network according to the timetable. During the simulation, OpenTrack calculates train movements under the constraints of the timetable and the signalling system. After a simulation run, OpenTrack can analyze and display the resulting data in the form of diagrams, train graphs, occupation diagrams and statistics.

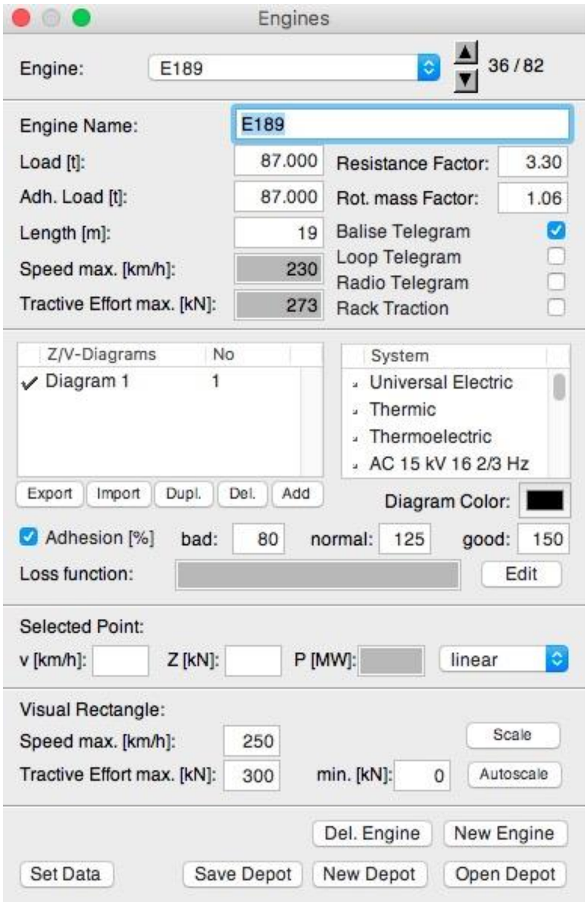
Three kinds of input data are needed: rolling stock, infrastructure and planned timetable.

Regarding rolling stock data, OpenTrack stores each locomotive’s technical characteristics, including tractive effort/speed diagrams, load, length, and adhesion factor. A database organizes locomotives into groups called depots. Picture 13 shows an example of the tractive effort/speed diagram, while in Picture 14 it is possible to see other kinds of information regarding locomotives, which are considered within the model.

Picture 13 - Example of the tractive effort/speed diagram

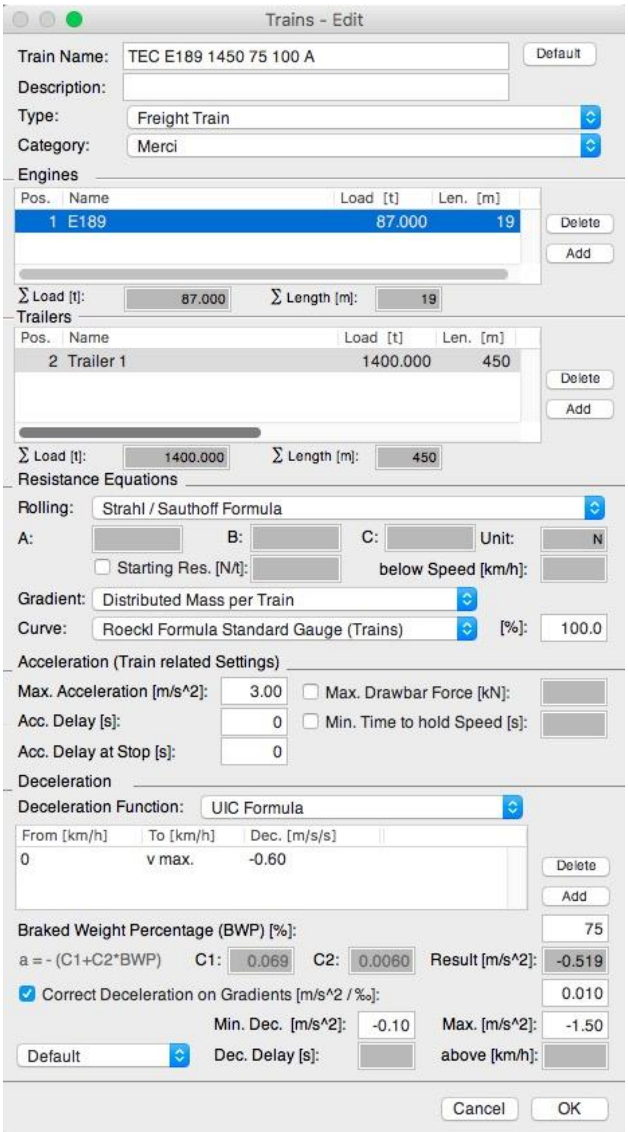


Picture 14 - Required data for locomotives



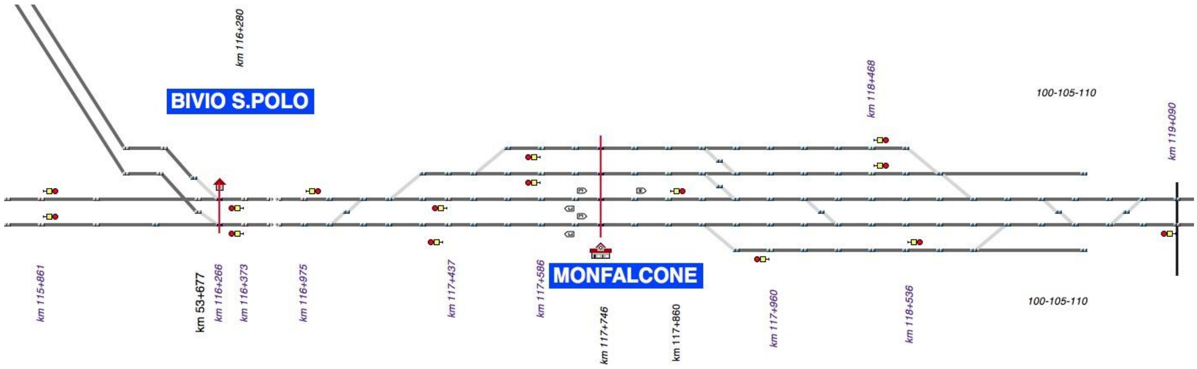
A simulated train consists of one or more locomotives from a depot together with a number of passenger or freight cars (carriages or wagons). Each train is characterised by additional information (see Picture 15), such as the suitable resistance equation, the maximum acceleration, the deceleration function, the Braked Weight Percentage and so on. Another database can store the simulated train.

Picture 15 - Required data for trains



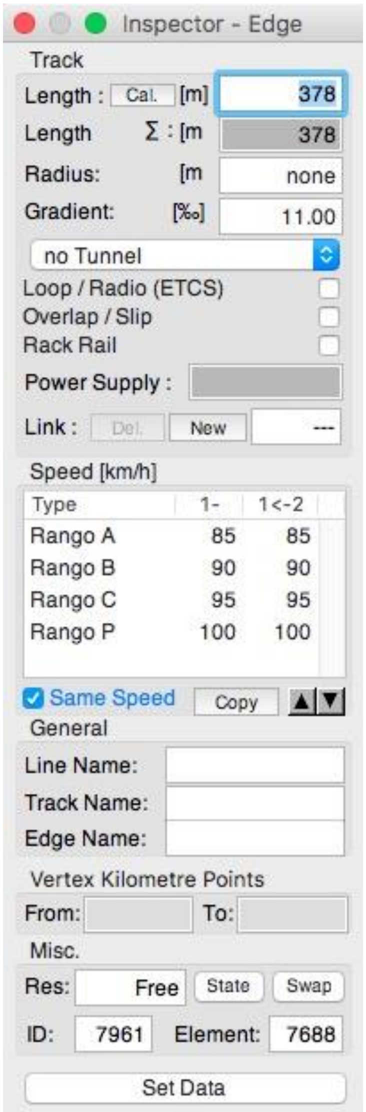
OpenTrack describes a railway network in special graphs called double vertex graphs. A user can edit the network's topology graphically. Picture 16 shows an example of graph referred to the Monfalcone station.

Picture 16 - Layout of a station.



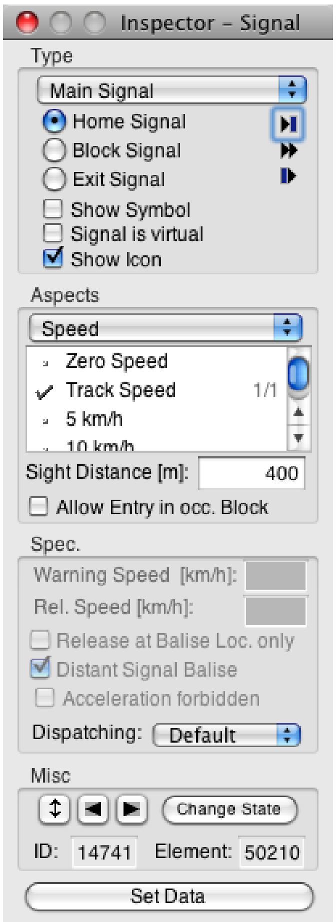
Each element of the graph holds various attributes. An edge, for example, holds a track section's length, gradient, maximum speed for different train categories and much more, as can be observed in Picture 17.

Picture 17 - Required data for edges



A user can create and manage objects for edges and vertices, and also signals, switches, stations and routes. Picture 18 shows an example for signals. Of course, different kinds of signals may be considered and, for each signal. Proper features should be included within the model according to the real-life train behaviour.

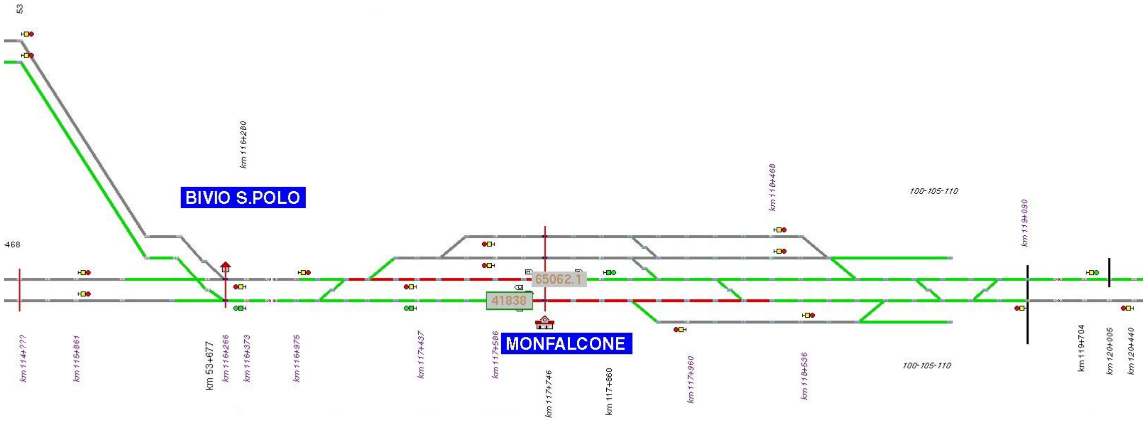
Picture 18- Required data for signals



The timetable database stores information for each train at each station, including arrival and departure times, minimal stop time, and connections to other trains.

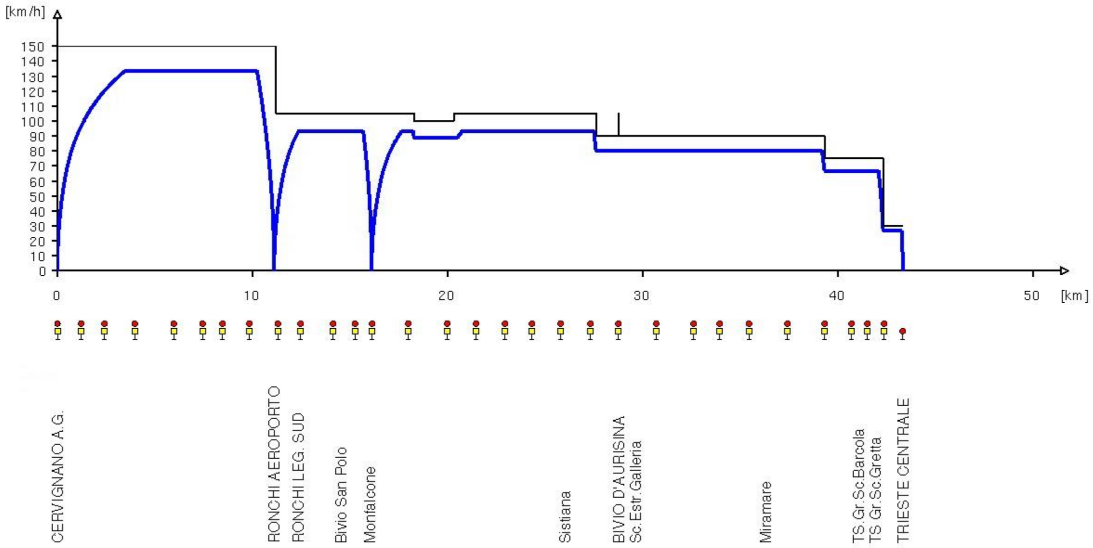
During a simulation, trains try to obey the given timetable. The differential equations for speed and distance are the basis for calculating a train's movement. The signalling system of the railway network poses constraints. Occupied tracks and restrictive signal aspects may impede a train's progress. The user can watch the simulation in an animation mode, which shows the trains running (grey boxes with train number inside) and lets the user analyze occupied tracks (red edges), reserved tracks (green edges) and signal aspects (see Picture 19).

Picture 19 - Animation of the simulation



During the simulation, every train continuously stores its speed, acceleration, position, power consumption and other data. These data can be evaluated after the simulation. Evaluations of a train, line or station are possible. For trains, OpenTrack offers diagrams such as acceleration vs. distance and speed vs. distance. For lines, there are evaluations in the form of diagrams of train movements, track occupation and line profiles. Every station produces output about all the trains that used it, including arrival, stopping and departure times. In particular, Picture 20 shows an example of speed-distance diagram for a passenger train from Cervignano to Trieste.

Picture 20 - Speed-distance diagram



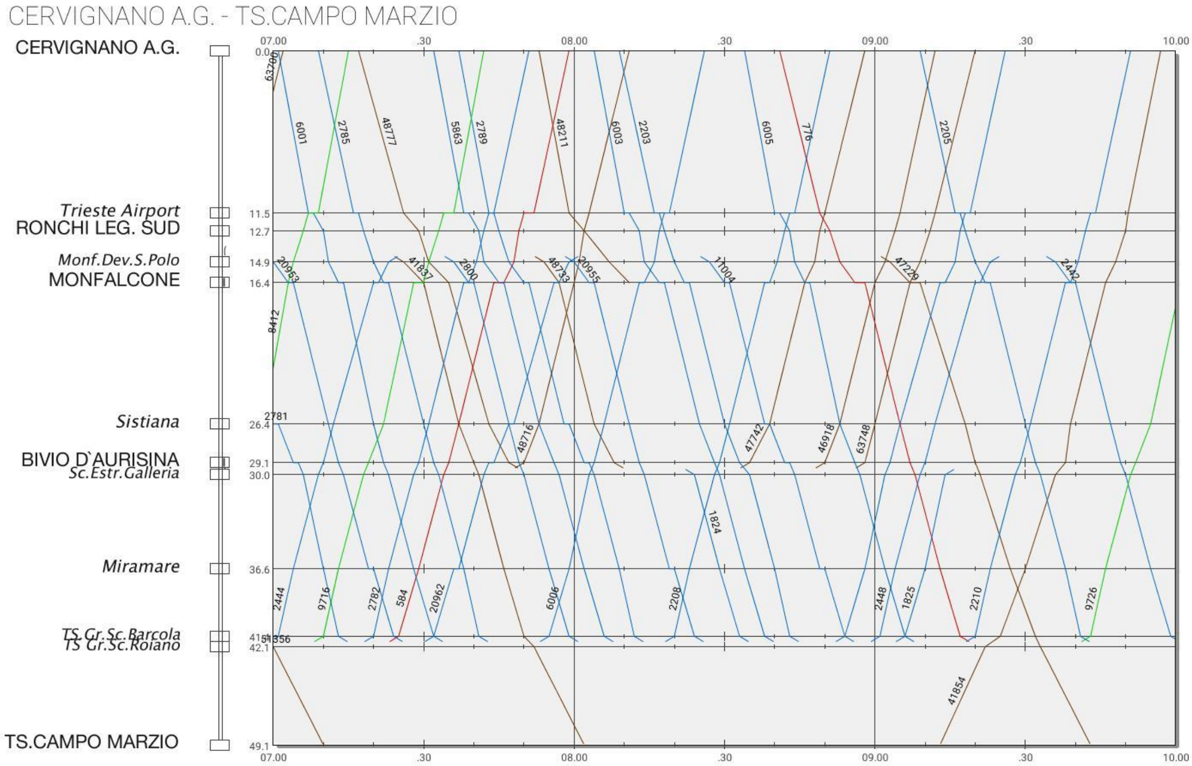
At the end of this brief description of the micro-simulation tool, it is important to remember that each scenario is then defined in terms of rolling stock, infrastructure and timetable. If differences occur at least in one of these elements, a new scenario should be defined.

In the specific situation, an infrastructural model including the portion of the network from Trieste port to Villa Opicina, Gorizia and Cervignano has been created, thus considering the most critical section of Picture 10. The created model is reported in Picture 21.

Picture 21 – Infrastructure model

The starting point of the analysis is the existing timetable and train configuration (see Picture 22).

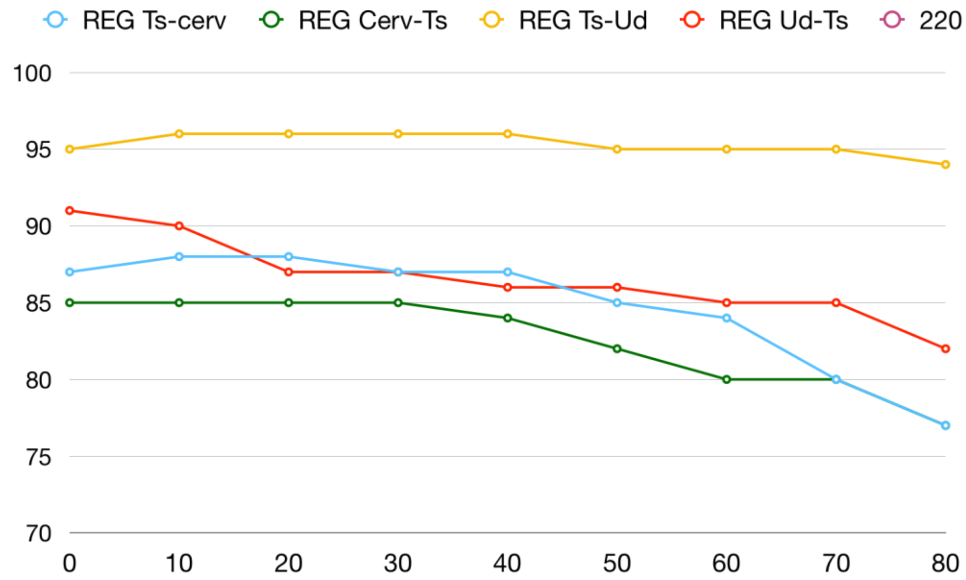
Picture 22 – Timetable



A step-by-step increase in freight trains leads to different simulation scenarios, whose results have been analyzed in terms of estimated delays and punctuality for passenger services. The maximum number of additional freight services may be then identified according to the acceptable worsening in the performances of passenger trains.

Picture 23 graphically shows the relationship between additional trains and the punctuality regional passenger trains.

Picture 23 – Punctuality vs. additional freight trains



As expected, the increase in freight trains causes an increase in the interactions among trains, which leads to a decrease of punctuality. This decrease shows some more relevant drops at around an increase of 20 trains/day (red line) and 50 trains/day (light blue and green line).

A.2. ROLLING STOCK / MACHINERY

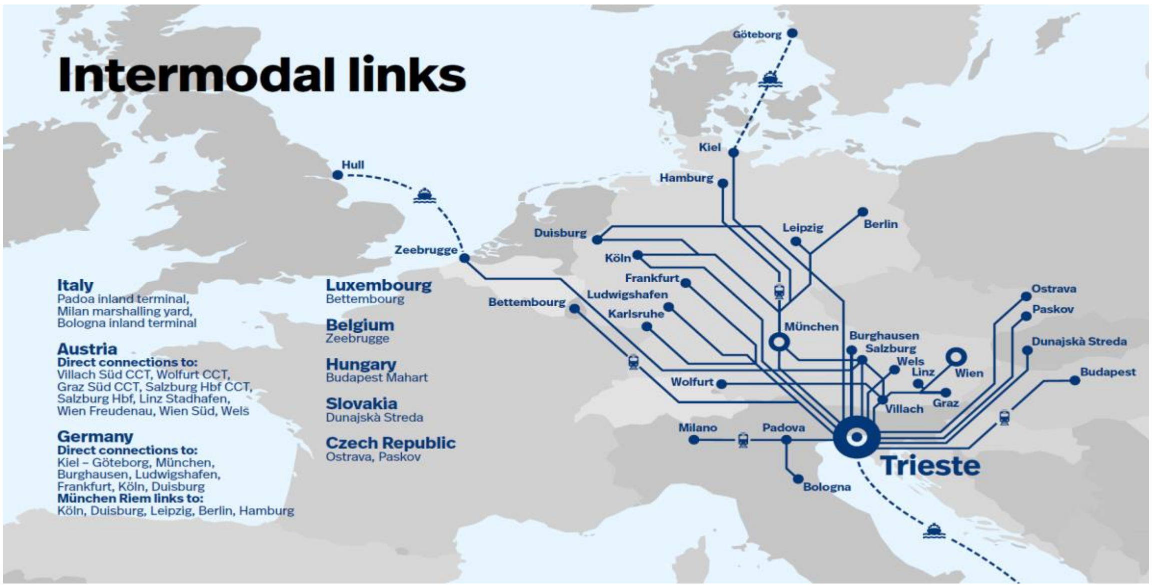
Reasons for bottlenecks at rolling stock and machinery may be related to:

- Rail transport
    - Lack of locomotives at rail carriers
    - Lack of freight wagons at rail carriers
    - Old rolling stock with often defects
    - Diesel traction, changes of locomotives
- Road transport
    - Old rolling stock with often defects
    - Limited transport volume per truck
- Cargo terminals (including ports):
    - Transhipment capacity machinery
    - Lack of gantry cranes, reach stackers, forks
    - Lack of trailers
    - Old transhipment machinery with often defects

The analysis may be divided into three sections:

- railway operations on the main network: at present, a number of Train Operating Companies operates in the port of Trieste, offering a wide range of long-distance services, as shown in Picture 24. No lack of freight wagons or electric locomotives is present and their performances are good with normal defects.

Picture 24 – Intermodal services



- shunting operations inside the port (and in the whole area depicted in Picture 27); all shunting movements are performed using diesel traction; a change of locomotives is then needed. On the other hand, a **Shunting Manager** (SM) has been identified and it carries out the Maneuvering Service as foreseen in the train schedule plan. The company performing shunting operations in the Port of Trieste is appointed for 5 years, unless expressed and motivated revocation. At present, the total number of employees is 92 and its locomotive fleet is composed by the following vehicles:

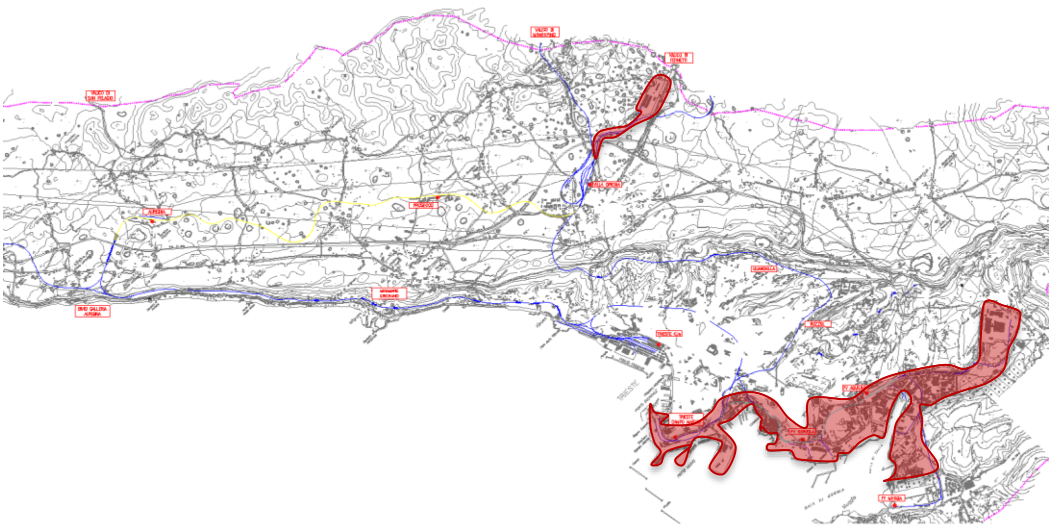
- - 5 locomotives Diesel Hesnchel mod. DGH 700;
- - 1 locomotive V100;
- - 2 locotractors Diesel Zephir;
- - 2 locomotives Siemens Vectron E191 – (rental);
- - 1 locomotive Diesel D100 – (rental).

Pictures 25 and 26 show some of these locomotives, while Picture 27 illustrates the shunting area.

Picture 25 – Examples of shunting locomotives used in the Port of Trieste

Picture 26 – Examples of shunting locomotives used in the Port of Trieste

Picture 27 – Shunting area



- terminal operations: terminal equipment and machineries are at present suitable for current traffic flows and development plans have been forecasted in order to be able to accommodate volume increases for the future, both in terms of space and equipment.

As far as rolling stock/machinery is concerned, the main bottleneck may be referred to the need of changing locomotives due to the presence of a Diesel traction system inside the port. Investments to extend electrified tracks are under discussion.

A.3. SERVICES ▫ OPERATIONS

Reasons for bottlenecks at services and operations may be related to:

- Services and operations comprises several components (Hardware, Software, Orgware, Lifeware, Netware and Dataware) that must all possess the same level of quality.
- Lack of Information communication technologies in transport is a bottleneck regarding
  - information flows or
  - data exchange between different transport stakeholders and end users.
- Market services:
  - Lack of offers - no providers for different services
  - Only one provider – market monopoly (high prices)
- Transport restrictions on roads
  - Limits for trucks during the weekends/holidays
  - Limits for trucks on road sections (bridges…)
- Working hours of terminals
  - No working hours at night/during holidays
- Language barriers for international transport
- Lack of the labour force for different types of professions (drivers, technicians…)
- Border crossing procedures for rail and road transport
  - Take a lot of time
  - Police and customs procedures
  - Mismatch organisation
  - EU member state – EU non-member state

As regard technological facilities, Trieste Port Authority has lately introduced an IT platform, named Sinfomar and developed by Info.era S.r.l., which constitutes the Port Community System (PCS) of the Port of Trieste. It supports the computerization of the running process of port system operations and publicly provides detailed and real-time information on the vessels which are moored at the various port terminals. Besides, thanks to the creation of a reserved access section specifically dedicated to trains, a twofold objective has been achieved. Indeed, on one hand, Sinfomar has enabled the management of incoming and outcoming railway traffic flows by recording both the expecting and the actual time of train movements. On the other hand, it has allowed the dematerialization of the document called CH30, facilitating the interoperability with the information platforms of railway and logistics third parties. CH30 is a customs document containing precise information concerning both freights and the mean of transport, in term of the physical composition of trains. As such, it attests the arrival and departure of goods to and from the Port of Trieste. This digital documentation evolves through different statuses along the arrival and departure processes of trains, tracking the development of the administrative activities performed on vehicles. For sure, the smoothness in freight data exchanges provided by the implementation of Sinfomar has beneficially impacted on railway port operations and it is meant to support intermodality even more through the integration with terminal operation systems and the information platform for the management of the railway national network.

In confirmation of this, ports are deemed to represent the leading area for shipping-related information technology, especially with reference to terminal operating systems and intra-port communications. As a matter of fact, together with the ability of such tools in handling a variety of data, their power and speed of information processing are considered the key features which contribute to reshape the shipping and port industry.

Thanks to this PCS, no bottlenecks have been identified in terms of IT systems or data exchange among stakeholders.

Regarding offered services, at present in the Port of Trieste there is no market monopoly as many train operating companies run trains and offer services from/to European markets.

At present, no significant transport restrictions have been identified in terms of infrastructure or working hours limitations, especially on the railway side. The only limitation that exists in Italy is referred to freight road traffic on Sundays.

Language barriers have been managed and labour forces have been trained so that at present there is no lack of knowledge.

Finally, regarding border crossing procedures, it shall be noticed that the Port of Trieste is characterized by the Free Port regime, which entails that customers can benefit from special regulations with respect to customs procedures and the fiscal regime. This unconventional favourable legislation guarantees the exemption from duty payments for customers and regards import, export and transit operations. Proof of this, a wall marks such different legal framework, physically separating the Free Port zone from the other surrounding port areas. However, in face of the described commercial advantages, in practical terms this condition implies more complex administrative procedures for the functioning of the port system, because it requires the engagement of a larger group of stakeholders for the actual freight movement. This leads to longer stopping times, and it implicates that the involvement of customs is required to enter and exit the port and, of course, that transport is related both to EU and EU non-member countries.

A very detailed analysis of this kind of constraints has been performed, in order to be able to describe all processes that must take place in port and intermodal operations. These procedures are better described in the document related to the operations model inside the port.

As far as rolling service & operations is concerned, the main bottleneck may be referred to border crossing procedures related to the Free Port Regime. Additional IT improvements are planned to increase efficiency, together with a new free area definition aiming at reducing the impact of procedures on railway operations.

A.4. LEGISLATION ▫ ADMINISTRATION

Reasons for bottlenecks at legislation and administration may be related to:

- Legislated bottlenecks, which arise in circumstances when the existing legislation is not following work normative in actual technology and labour organization, therefore the world labour normative can't be accomplished.
- Administration bottlenecks, which evolve due to ancient or unsuitable documentation or information processes that precede and follow all technological processes in traffic.
- Non harmonized legislation for transport between different levels
    - Local
    - Regional
    - National
    - EU
- Environment restrictions:
    - Emission standards
    - Energy efficiency standards
    - Emission taxes
    - Sustainability transport
- Non harmonized fees
    - Railway transport
    - Road transport
    - Maritime transport
- Legislation for labour force
    - Social rights
    - Labour certifications
- Standards for transport infrastructure and operations
    - Safety standards in transport
    - Technical Specifications for Interoperability (TSI) in railway transport

As stated before, the Port developed a PCS, which is totally compliant with all regulations in terms of labour, environment and transport. Moreover, all infrastructure developments and operations have been completely designed in relation to safety standards and TSI. No bottlenecks may be related to this section.

CONCLUSIONS

This paragraph summarises the main findings of this analysis.

As far as transport infrastructure is concerned, the main bottleneck can be referred to lack of capacity in the main railway line. This may become an issue in the long-term horizon, if the total number of freight trains is assumed to increase up to additional 50 trains/day.

As far as rolling stock/machinery is concerned, the main bottleneck may be referred to the need of changing locomotives due to the presence of a Diesel traction system inside the port. Investments to extend electrified tracks are under discussion.

As far as rolling service & operations is concerned, the main bottleneck may be referred to border crossing procedures related to the Free Port Regime. Additional IT improvements are planned to increase efficiency, together with a new free area definition aiming at reducing the impact of procedures on railway operations.

No bottlenecks may be related to Legislation & Administration.

The attached table shows a schematic summary of the identified bottlenecks, while the forms which are included in the annexes contain a description of each bottleneck and the corresponding action to remove it.

Finally, there may be some bottlenecks related to a lack of flexibility in terms of different time horizons for long-term infrastructure planning (planning, design, tenders, construction, putting in operation) and short-term demand fluctuations and operations changes. This may lead to temporary inconsistencies between demand needs and supply capacity, that may be managed through a proper interaction among stakeholders.

A similar tool as the one used in this pilot action can be easily used also in other territories, and it can be considered as a backbone for the development of a railway “digital twin”, i.e. a virtual representation that serves as the real-time digital counterpart of the railway processes in the ports or RRTs, allowing for real-time monitoring and simulation of different scenarios, benefitting internal as well as external port stakeholders.

Such a tool proved to be powerful, the only prerequisite being that the concerned entity already has detailed information on the existing railway infrastructures, also in GIS format

		1/2	3	4	5	6	7	8	9	10
	Project partner ⇨	**TMIL/FHE**	STMK LR	PIL	PNAEAS	KIP	CETC-EGTC	ITL	LK	RER
	Type of the bottleneck ⇩	**Thuringia**	Austria	Slovenia	Italy	Croatia	Poland	Italy	Slovenia	Italy
1	**TRANSPORT INFRASTRUCTURE**									
1.1	*Lack of capacities port/terminals/railway lines*				✓					
1.2	*Speed restrictions on the transport infrastructure*				✗					
1.3	*Railway lines regarding technical parameters:*									
1.3.1	track gauges				✗					
1.3.2	traction systems				✗					
1.3.3	signal systems				✗					
1.3.4	axle load				✗					
1.3.5	train length				✗					
1.3.6	loading gauge				✗					
1.3.7	station sidings (along single line tracks)				✗					
1.3.8	loading ramps				✗					
1.3.9	missing links				✗					
1.4	*Cargo road/rail/sea/river terminals:*									
1.4.1	Lack of storage areas				✗					
1.4.2	Access to the terminals				✗					
1.4.3	Railway station sidings				✗					
1.4.4	Lack of storage capacities				✗					
1.4.5	Missing terminals				✗					
1.5	*Sea/river port infrastructure:*									
1.5.1	Lack of berths				✗					
1.5.2	Short length of the berths				✗					
1.5.3	Short draft at the berth				✗					
1.5.4	Lack of storage capacities				✗					
2	**ROLLING STOCK / MACHINERY**									
2.1	*Rail transport:*									
2.1.1	Lack of locomotives at rail carriers				✗					
2.1.2	Lack of freight wagons at rail carriers				✗					
2.1.3	Old rolling stock with often defects				✗					
2.1.4	Diesel traction, changes of locomotives				✓					
2.2	*Road transport:*									
2.2.1	New intermodal technologies (Modalohr)				✗					

2.3	*Cargo terminals (including ports):*									
2.3.1	Transhipment capacity machinery				✗					
2.3.2	Lack of gantry cranes, reach stackers, forks				✗					
2.3.3	Lack of trailers				✗					
2.3.4	Old transhipment machinery with often defects				✗					
3	**SERVICES & OPERATIONS**									
3.1	*Lack of ICT in transport:*									
3.1.1	information flows				✗					
3.1.2	data exchange				✗					
3.2	*Market services:*									
3.2.1	Lack of services				✗					
3.2.2	market monopoly (high prices)				✗					
3.3	*Transport restrictions:*									
3.3.1	Limits during the weekends/holidays				✗					
3.3.2	Limits on transport infrastrructure (bridges...)				✗					
3.4	*Working hours of terminals*									
3.4.1	No working hours at night/during holidays				✗					
3.5	*Language barriers for international transport*				✗					
3.6	*Lack of the labour force:*									
3.6.1	Lack of knowledge				✗					
3.7	*Border crossing procedures:*									
3.7.1	Long stopping times				✓					
3.7.2	Police and customs procedures				✓					
3.7.3	Mismatch organisation				✗					
3.7.4	EU member state – EU non-member state				✓					
4	**LEGISLATION & ADMINISTRATION**									
4.1	*Non harmonized legislation:*									
4.1.1	Local				✗					
4.1.2	Regional				✗					
4.1.3	National				✗					
4.2	*Fair / comparative environment restrictions:*									
4.2.1	Emission standards				✗					
4.2.2	Energy efficiency standards				✗					
4.2.3	Emission taxes				✗					
4.2.4	Sustainability transport				✗					
4.3	*Non harmonized fees:*									

4.3.1	Railway transport				✗					
4.3.2	Road transport				✗					
4.3.3	Maritime transport				✗					
4.4	*Legislation for labour force:*									
4.4.1	Social rights				✗					
4.4.2	Labour certifications				✗					
4.5	*Standards for transport:*									
4.5.1	Safety standards				✗					
4.5.2	Technical Specifications				✗					
5	**Additional Bottlenecks (TMIL/FHE)**									
5.1	lack of staff (train drivers and at (un)loading facilities)									
5.2	lack of flexibility (long planning horizons & contract durations for infrastructure and equipment)				✓					
5.3	lack of support to establish new / revive former company freight sidings (Gleisanschlüsse)									

Bottleneck 1

Part 1: Analysis of Bottlenecks

Problem Description

Lack of capacities port/terminals/railway lines. Some bottlenecks are present both in the port and on its railway lines. In particular, the residual capacity on the mainline is low and some constraints due to free port operations are present at the moment

Consequences	low	middle	high

verbal: These limitations do not affect operations at present, but they can limit traffic development in the future

Problem-Allocation

Infrastructure		Service	
Track	Terminal	Administr.	Engineering

Part 2: Deduced Action

Specification of the Solution

Problem-solving Approach	Investments to increase railway capacity are under discussion with the Italian Infrastructure Manager (RFI), which include technological improvements (ERTMS) and new infrastructures. Moreover interventions to reduce the impact of border controls are on-going			
Responsibility	Port Authority, Infrastructure Manager (RFI), Government			
Investment needs in T€	0	<100	100 ... 1.000	> 1.000
Organisational needs	none	low	middle	high
Time need	immediately	short-term	middle-term	long-term
Expected benefit	low	middle	high	vast

Best Practice examples known?

Bottleneck 2

Part 1: Analysis of Bottlenecks

Problem Description

Diesel traction, changes of locomotives: This happens for shunting operations from the main station to the terminals

Consequences	low	middle	high
verbal: Shunting operator is needed			

Problem-Allocation

Infrastructure		Service	
Track	Terminal	Administr.	Engineering

Part 2: Deduced Action

Specification of the Solution

Problem-solving Approach	Investments to extend electrified tracks are under discussion. Also IT improvements to increase efficiency of shuntings are on-going			
Responsibility	Port Authority, Infrastructure Manager (RFI), Government			
Investment needs in T€	0	<100	100 ... 1.000	> 1.000
Organisational needs	none	low	middle	high
Time need	immediately	short-term	middle-term	long-term
Expected benefit	low	middle	high	vast

Best Practice examples known?

Bottleneck 3

Part 1: Analysis of Bottlenecks

Problem Description

Border crossing procedures: Long stopping times - Police and customs procedures - EU member state – EU non-member state: Trieste is a Free Port in EU, therefore specific controls are required while entering/exiting from/to landside. Some controls and actions are needed on railway on border crossing in case of international services

Consequences	low	middle	high

verbal: Waiting times may affect capacity both in the port and in some portions of the network

Problem-Allocation

Infrastructure		Service	
Track	Terminal	Administr.	Engineering

Part 2: Deduced Action

Specification of the Solution

Problem-solving Approach	IT improvements to increase efficiency are on-going			
Responsibility	Port Authority, Infrastructure Manager (RFI), Government			
Investment needs in T€	0	<100	100 ... 1.000	> 1.000
Organisational needs	none	low	middle	high
Time need	immediately	short-term	middle-term	long-term
Expected benefit	low	middle	high	vast

Best Practice examples known?

Bottleneck 4

Part 1: **Analysis of Bottlenecks**

Problem Description

Lack of flexibility (long planning horizons & contract durations for infrastructure and equipment)

Consequences	low	middle	high
verbal: Long planning horizons make it difficult to follow traffic dynamics, that are quite more rapid			

Problem-Allocation

Infrastructure		Service	
Track	Terminal	Administr.	Engineering
X		X	X

Part 2: **Deduced Action**

Specification of the Solution

Problem-solving Approach	Increase the quality of planning scenarios			
Responsibility	Port Authority, Infrastructure Manager (RFI), Government			
Investment needs in T€	0	<100	100 ... 1.000	> 1.000
Organisational needs	none	low	middle	high
Time need	immediately	short-term	middle-term	long-term
Expected benefit	low	middle	high	vast

Best Practice examples known?
