

# D.3.2.4 Analysis of the physical and non-physical bottlenecks in Italy and Croatia

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## Document Control Sheet

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# INTRODUCTION

This document is part of WP3 \_” Elimination or reduction of Bottlenecks through the Harmonization of Data” of the project CHARGE (Capitalization and Harmonization of the Adriatic Region Gate of Europe) which capitalizes the collected results of IPA CBC Programme 2007-2013 CARICA project and other projects like ADRIATICMOS, INTERMODADRIA and EASYCONNECTING from IPA and ADB Multiplatform from South-East Europe having the objective the development of freight transports in the Adriatic area and connectivity to the other EU member states. .

The main objectives of WP3 are the identification of new physical and non-physical bottlenecks in the Adriatic area as an improvement, and pursuance of the CARICA activity by updating of CARICA reports on bottlenecks and traffic flows.

This document will follow given methodology for bottleneck collection. The main goal of the document is to give insight in state of the are in the Port of Split and show any possible flaws in traffic flows that occur. PP5 will provide all necessary information asked in methodology such as data of traffic flows and cargo turnover in the Port of Split, as well as analysed data collected form field research.

## ABSTRACT

The Analysis of the physical and non-physical bottlenecks for project partner SPA covers defining and characterising the Port of Split as the area of study, lists of all the bottlenecks and undesirable effects present in the area, analyses of those bottlenecks and proposes solutions for resolving the bottlenecks.

## EXECUTIVE SUMMARY

This report defines the Port of Split as the area under study. The report lists the following bottlenecks as being the most crucial: The connection between the terminal and highway network is not at satisfactory safety level; Main infrastructural bottlenecks are found in flow capacity of the roads; Railway bottlenecks; Terminal bottlenecks; Supply chain bottlenecks. The proposed solution for dealing with the infrastructural bottlenecks is investments into new infrastructure in the City Port and in the North Port.

## DEFINING THE SCOPE OF STUDY

The purpose of this document is to analyse bottlenecks in the Port of Split. As a part of the activity 3.2. “Identification of main physical and non-physical bottlenecks in the Adriatic area, within WP3, PP5 will do Analysis of the physical and non-physical bottlenecks in the port of Split.

This analysis is done as a part of the CHARGE project, and data about bottlenecks were collected through 2 months’ period of time. Data concerning freight flows and cargo turnover are collected for the years 2000 to 2017. This large period of time should show how port evolved in that time and what potential port has, if bottlenecks are reduced and solutions are found. Data were collected from own sources, port operators, custom administration, concessionaires, marine police, local and national public authorities. Data collected are mainly statistical data that show turnover of cargo. There are also data about terminals and their capacity, other infrastructure and road and railway connections, as well as marine links. These collected data will be compared with data of other big European ports in near vicinity. Data will be compared in absolute numbers and in percentage to show the development trend of the Port of Split.

# DEFINING THE AREA UNDER STUDY AND CHARACTERIZING RESPECTIVE AREA

The port of Split is situated in the central part of the eastern coast in the Adriatic basin. As for its strategic position it has become one of the most important passenger ports in the Mediterranean, often called as the gateway to the islands. The port is ranked first among Adriatic ports by the number of passengers and vehicles and third among Croatian ports regarding the transport of cargo behind port of Rijeka and port of Ploče. Also, the port of Split is largest port in central Dalmatian region, comprising both passenger and cargo transport as the main port business orientation. According to its purpose, the Port of Split is classified as a port open for international public traffic, while due to its size and importance, it was nominated a port of special (international) economic interest for the Republic of Croatia. The Port of Split has been also classified as a Trans-European Transport Network (TEN-T) comprehensive port for Croatia. Except the passenger transport, the port accommodates freight transport mainly to the destinations in the external environment of the port situated in the hinterland creating its gravitational area.



Source: Luka d.d. Split, 2017.

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The port is connected by the International E-road network routes E65 and E71 with link to the Croatian A1 motorway (Zagreb – Split) and the D1 state road. The existing road connection to port area is passing throughout city centre which usually cause stoppage on the city roads, regularly during summer season. The port is also connected with Zagreb by an electrified single track railway, which runs through Knin and Karlovac. Airport of Split is located 20km from port of Split and is able to receive any kind of planes, including planes for carrying cargo.

### *Infrastructure*

The port is divided into seven docking areas as follows: City port basin (passenger, ferry and cruise port), Vranjic - Solin basin (cargo port), Kaštela basin A, Kaštela basin B, Kaštela basin C, Kaštela basin D - Resnik and Komiža basin for fishing needs. The total surface of docking areas is amounted to 81.679051 km<sup>2</sup>, of which 0.672263 km<sup>2</sup> is related to land surface and 81.006788 km<sup>2</sup> of surface of the sea, while the total length of operational docks amounts to 6,239 km. The whole port area of the port of Split is under jurisdiction of the Port Authority Split, a non-profit legal person established according to Decree of the Government of the Republic of Croatia on the establishment of Port Authority Split („Official Gazette“ number 45/97, 155/98 and 72/11, 114/14) for the purpose of managing, building and using the Port of Split.

**City port basin** – is situated in the city central zone. It comprises area from the west breakwater to the junction of Obala Lazareta and Obala hrvatskog narodnog preporoda, primarily offering the transport of passengers and vehicles (private cars, trucks, buses) in national and international traffic. The City port basin is equipped with 3,643 km length of operational docks, four piers (Sveti Nikola, Sveti Petar, Sveti Duje and Lukobran), three quays and 27 berths being able to provide mooring to vessels having maximum length of 320 meters on berth. The cruise terminal situated in the city port basin is along ferry (RO-RO passenger

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and vehicle), passenger and catamaran vessels essential part of the port business, representing the strategic orientation of the port development indicated in the National Transport Development Strategy of the Republic of Croatia (2017 - 2030). The city port is a main connection to the central and south Dalmatian islands and destinations along the coast of central Dalmatia while also maintaining the weekly and daily traffic flows with Italy, where the frequency depends on the period of the tourism season. Considering that port is situated in the city central zone, all forms of the transport system, road, railway and maritime transport are integrated in the port area, enabling the use of intermodal services but also creating difficulties especially in the summer periods. The road infrastructure in the City port basin has limited throughput.

**Vranjic-Solin basin** - traditionally nominated as the “North port”, is the cargo port. The port possesses 1,854 km of operational docks, eight berths with maximum draft of 10.3 meters. The berths from 1 to 5 are intended for vessel transshipment operations of all types of cargo in accordance with legal provisions. The berth number 5 is equipped with RO-RO ramp with a maximum draft of 7.2 meters. The berth number 6 is intended for loading and unloading of grain commodity. Berths number 7 and 8 are located on the Obala Vranjic, intended for berthing vessels by the decision of the Split Port Authority. Shore to ship bunkering operations, referring to fuel transfer, are made on berths number 1,2,3,4 and 5. Ship to ship bunkering operation is possible only on berths number 1 and 2. The main activities of the cargo port are transport and transshipment of diverse commodities, of which the most common dry bulk products are iron ore, coal, cement and grain for key regular clients in the direct hinterland, with various seasonal commodities like sugar, salt, fertilizer and others depending on the demand. Also, there is a high demand in quartzite and slag for industries in Bosnia and Herzegovina. The key general cargo commodities are metal products and wood. Transport of yachts and small vessels especially in the summer periods and special cargo like

wind turbines intended for projects in the port hinterland should also be emphasized. The cargo port is also a center for import and distribution of petroleum products for INA concessionaire in Kaštela Basin C intended to supply the regional economy with oil derivatives. The container terminal is located in the Vranjica-Solin Basin, and is operated by the “Port of Split Ltd.” Company. It consists of one berth dedicated for container transshipment, with depth of 10,5 meters which allow berthing of larger container ships. The container terminal is connected with Zagreb by a highway, and is thus linked with European traffic corridors. Other connections include the road to larger cities of the Republic of Bosnia and Hercegovina, and Adriatic highway toward Rijeka and Dubrovnik., and the railway which connects the Port of Split with the Croatian market (rail of Lika) and with the market of the Bosnia and Hercegovina (rail of Una).

Transport of containers recorded a continuous increase in recent years as well as the truck cargo transport to destinations on Croatian islands.

**Kaštela basin A** - The operational dock is 0.08 km long, equipped with one berth having length of 80 m, maximum depth of 8.5 m being able to accommodate a vessel with maximum length on berth of 100 m. The berth is intended for berthing of vessels at the discretion of Port Authority Split with the consent of Harbor master's office.

**Kaštela basin B** - On the 0,532 km of operational docks, divided on Sv. Juraj I and Sv. Juraj II shores, five (5) berths are located. Berths are used for manipulation of liquefied gas cargo for industry purposes, for berthing of vessels while performing loading processes of cement and cement products and slag unloading for complementary industry located on the shore, for vessels performing unloading operations of coal, for vessels loading and unloading of fuel and gas trucks for the purpose of supply of islands with fossil fuels, and also for shore to ship bunkering operations.

**Kaštela basin C** - has 0,311 km<sup>2</sup> of sea surface. It has eight berths divided into three areas, quay of Sv. Kajo, INA tanker terminal and Brižine coast. Berth no. 1 on the quay of Sv. Kajo is used for vessels in domestic and international transport performing loading operations of cement and cement products and unloading of slag. Berths no. 1 and 2 on the quay INA are intended for loading and unloading operations of oil and petroleum products. Berth no. 3 is used for berthing of smaller tanker vessels. There are four berths on the Brižine coast. Berth no.1 is temporary used for berthing ships in lay-up (out of service), ships carrying out deratization and other needs at the Port Authority Split decision with the approval of the Harbor master's office. Berth no. 2 and no.3 on the Brižine coast are used for berthing of fishing vessels and other vessels at the Port Authority Split decision with the approval of the Harbor master's office. Berth no. 4 also on the Brižine coast is intended exclusively for unloading fish and loading of fishing gear and supplies for fishing purposes. The maximum vessels length of stay is limited to two hours.

**Kaštela basin D** - consists of 0,040 km of operational docks equipped with one 45 meter long berth being able to accommodate vessels with maximum draft of four (4) meters. The primarily function of Kaštela basin D – Resnik is in integrating the air and maritime transport modes creating an intermodal node, providing the direct passenger transport services from Split airport to destinations along the coast and islands with tourist or fast boats, evading the use of often congested road towards maritime passenger terminal in the city port basin.

**Komiža basin** - basin is dislocated basin on the island of Vis with 0,001086 km<sup>2</sup> of land area and 0,062538 km<sup>2</sup> of sea surface, having the main purpose of provision of fishing services.

### *Services*

Maritime links from port of Split includes.

- International ferry (RO-RO passenger) line to Ancona, Italy
- Several local passenger and ferry and HSC lines to neighbouring islands (Brač, Šolta, Hvar, Vis,..)

The ferry line from Split to Ancona is operated by several Ro\_Ro passenger vessels. Currently the service is maintained by two ferry operators. Local lines are operated by ferries, passenger high speed crafts and classical passenger vessels.

Ferry lines to Ancona are primarily oriented to transport of cargo on trucks and trailers during winter time and to transport of passenger (tourists) during summer season.

There are five state ferry lines operating from and to the port of Split towards islands of Vis, Lastovo, Korčula, Hvar, Brač and Šolta on an all year turnaround trip. There is also one state passenger line connecting the port with island of Čiovo and city of Trogir. The Port of Split has

five state high speed craft (HSC) (catamaran) line connections with central and southern Dalmatian islands, increasing the quality of additional services to passengers while reducing the time of the voyage. All the above mentioned state ferry, passenger and catamaran lines have public service obligations. There are seven catamaran lines without public service obligations, connecting Split with various destinations on islands and destinations on the coast

The port also has a one direct turnaround international passenger line with Italy enabling the efficient transport of passengers, vehicles (busses, trucks etc.) in the international trade. Two companies Jadrolinija and SNAV are operating on the route Split – Ancona, of which Jadrolinija

operates all year on turnaround voyage, calling the port of Stari Grad on Hvar Island in the high season, while SNAV operates only during the high season period.

Port of Split is increasingly recognized as a cruise destination, evident in the yearly increase of number of port of calls and passengers, where the port is usually a transit port on the scheduled itineraries and connected with other Mediterranean cruise destinations.

The northern part of the port is dedicated to the transport of cargo, equipped with cargo terminals being able to accommodate all types of vessels, depending on the typology of freight, typically including dry bulk products such as iron ore, coal, cement and grain as well as liquid products. Imported cargo is primarily intended for local markets of various industries in port hinterland, but also by supplying the steel industry in Bosnia and Herzegovina. In addition, various goods are exported to the Middle East, including wooden products. General cargo terminals are used to provide trade services to worldwide destinations depending on the demand for commodities, while the container terminal is connected with Mediterranean hub ports predominantly in the Adriatic. The port is directly connected with Freeport container terminal in Malta on the Adriatic X-PRESS 1 (ADX 1) service route jointly operated by CMA-CGM and Maersk on a weekly basis. The potential of the Port of Split for the development in the freight segment was confirmed with the adoption of the Transport Development Strategy of the Republic of Croatia (2017 – 2030) in 2017, indicating the appropriate specialization and proper development of the railway freight infrastructure as the development measures.

# LISTING OF ALL BOTTLENECKS AND UNDESIRABLE EFFECTS

In the picture below are shown bottlenecks collected from the field research.

Bottleneck		Question	Answer	Relevance	
infrastructural bottlenecks	road	safety	Is the connection between the terminal and highway network at a satisfactory safety level?	NO	HIGH,YES
			Is there a regular maintenance of the terminal roads and connection between the terminal and highway network?	NO	HIGH,YES
			Are there clearly marked routes for accessing the terminal and leaving the terminal in order to reach the highway network?	NO	HIGH,YES
			Is there adequate (satisfactory) lighting on the terminal roads and connection between the terminal and highway network?	YES	HIGH,YES
		Are there clearly marked routes to get to the terminal and to the highway network?	NO	HIGH,YES	
	flow capacity		Is there a direct access to the highway network?	NO	HIGH,YES
			Is the current capacity of the road infrastructure sufficient?	NO	HIGH,YES
			Is there a sufficient number of lanes on terminal roads and connection between the terminal and highway network?	NO	HIGH,YES
			Is the width of the lanes on the terminal roads and connection between the terminal and highway network appropriate (satisfactory)?	NO	HIGH,YES
	rail	safety	Is the connection between the terminal and highway network passing through the urban and inhabited area?	NO	HIGH,YES
			Is there a road and pedestrian crossing on the railway?	YES	HIGH,YES
			Is the signalization on a satisfactory level?	NO	HIGH,YES
			Is there adequate (satisfactory) lighting on the terminal railway infrastructure?	NO	HIGH,YES
	inland waterways	safety	Is there a regular maintenance of infrastructures relevant for the satisfactory level of security?	YES	HIGH,YES
			Is there a road and pedestrian crossing on the railway?	YES	HIGH,YES
			Are the crossings satisfactory marked?	NO	HIGH,YES
			Is the current capacity of railway infrastructure satisfying?	NO	HIGH,YES
	terminal	flow capacity	Is it the connection of railway and road infrastructure at a satisfactory level?	NO	HIGH,YES
Is it possible to dispatch the maximum allowed quantities of the train at once?			NO	MEDIUM,NO	
		Is there a ramp for the loading/unloading of the trucks on the railway?	NO	MEDIUM,NO	
safety		Is the safety level of the port access satisfactory?	NO	HIGH,YES	
	Is the area of the port basin sufficient?	NO	HIGH,YES		
a supply chain bottlenecks	flow capacity	Is the capacity of the access to the terminal sufficient so the barges shouldn't be separated?	NO	MEDIUM,NO	
		Is there a RO-RO ramp on the terminal?	NO	HIGH,YES	
	capacity	Are the parking spaces adequately signposted for identification?	NO	HIGH,YES	
		Is the capacity of a parking lot sufficient?	NO	HIGH,YES	
		Is parking space able to accommodate all dimensions of the vehicles / units?	NO	HIGH,YES	
		Are the roads at the terminal separated from waiting areas for the loading / unloading cargo?	YES	MEDIUM,NO	
	safety	Is the number of berths for mooring ships sufficient?	NO	HIGH,YES	
		Are the lengths of berths sufficient for mooring the largest vessels?	YES	HIGH,YES	
		Are the sea depth/draft berths enough for the biggest ships?	YES	HIGH,YES	
		Is the sea depth in the driveway shore/terminal satisfactory for the biggest ships?	YES	HIGH,YES	
	weather	Is there a storage space near the berth?	NO	MEDIUM,NO	
		Does the space for storage of goods have sufficient capacity?	NO	MEDIUM,NO	
Does the terminal (individual bindings) have conditions of secure mooring?		YES	HIGH,YES		
Is the sea access to the terminal sufficient (maritime safety requirements)?		YES	HIGH,YES		
regulatory bottlenecks	work shifts	How much time a year is the terminal out of function for bad weather?	NO	MEDIUM,NO	
	information exchange	Is it guaranteed cargo handling 24 hours a day every day of the year?	YES	MEDIUM,NO	
		Is there a guaranteed flexibility in the composition of stevedoring crews and handling equipment to absorb demand peaks in loading / unloading services?	YES	MEDIUM,NO	
	time response	Is there a system which allows the electronic exchange of documents and communications between the driver unit and the terminal?	NO	MEDIUM,NO	
		PILOTS - Is it the time required from the request to reaction at a satisfactory level?	YES	HIGH,YES	
	cooperation	TUGS - Is it the time required from the request to reaction at a satisfactory level?	YES	HIGH,YES	
		Is the cooperation between the terminal and the agent at a satisfactory level?	YES	MEDIUM,NO	
	technology	Is the administrative co-operation of the terminal and Ship at a satisfactory level?	YES	MEDIUM,NO	
Is the cargo handling capacity of the terminal sufficient?		YES	MEDIUM,NO		
Does the shore cranes terminal have sufficient performance /capacity?		NO	MEDIUM,NO		
Does the mobile cranes terminal have sufficient performance /capacity?		NO	MEDIUM,NO		
customs inspections	Is there in the function the VTMS system?	YES	HIGH,YES		
	Is the cooperation between the Customs Authority and Ships at a satisfactory level?	YES	HIGH,YES		
	Is the time required for inspection (veterinary, phytosanitary, etc.) at a satisfactory level?	YES	HIGH,YES		
	Are there any cabotage restrictions?	NO	HIGH,YES		
cabotage restrictions	Is there an exemption obligations pilots for ships in service, which regularly touch the port?	NO	MEDIUM,NO		
	Is there an exemption obligations tugs for ships in service, which regularly touch the port?	NO	MEDIUM,NO		
other					

## D.3.2.4 Analysis of the physical and non-physical bottlenecks in Italy and Croatia

Interreg Italy - Croatia CHARGE		Questionnaire for CHARGE project - collection of bottlenecks			
European Regional Development Fund		EUROPEAN UNION			
		Answer: simple yes/no answers			
		Relevance: How important is this part for your port and is this the reason for bottlenecks? Will reduction of this problem solve bottlenecks?			
Bottleneck		Question	Answer	Relevance	
infrastructural bottlenecks	road	safety	Is the connection between the terminal and highway network at a satisfactory safety level?	YES	
			Is there a regular maintenance of the terminal roads and connection between the terminal and highway network?	YES	
			Are there clearly marked routes for accessing the terminal and leaving the terminal in order to reach the highway network?	YES	
		flow capacity	Is there adequate (satisfactory) lighting on the terminal roads and connection between the terminal and highway network?	YES	
			Are there clearly marked routes to get to the terminal and to the highway network?	YES	
			Is there a direct access to the highway network?	NO	
	rail	safety	Is the current capacity of the road infrastructure sufficient?	YES	
			Is there a sufficient number of lanes on terminal roads and connection between the terminal and highway network?	YES	
			Is the width of the lanes on the terminal roads and connection between the terminal and highway network appropriate (satisfactory)?	YES	
		flow capacity	Is the connection between the terminal and highway network passing through the urban and inhabited area?	YES	
			Is there a road and pedestrian crossing on the railway?	YES	
			Is the signalization on a satisfactory level?	YES	
	terminal	safety	Is there adequate (satisfactory) lighting on the terminal railway infrastructure?	YES	
			Is there a regular maintenance of infrastructures relevant for the satisfactory level of security?	YES	
			Is there a road and pedestrian crossing on the railway?	YES	
		flow capacity	Are the crossings satisfactory marked?	YES	
			Is the current capacity of railway infrastructure satisfying?	YES	
			Is it the connection of railway and road infrastructure at a satisfactory level?	YES	
	inland waterways	safety	Is it possible to dispatch the maximum allowed quantities of the train at once?	YES	
			Is there a ramp for the loading/unloading of the trucks on the railway?	NO	
Is the safety level of the port access satisfactory?			YES		
flow capacity		Is the area of the port basin sufficient?	YES		
		Is the capacity of the access to the terminal sufficient so the barges shouldn't be separated?	YES		
		Is there a RO-RO ramp on the terminal?	YES		
a supply chain bottlenecks	capacity	Are the parking spaces adequately signposted for identification?	YES		
		Is the capacity of a parking lot sufficient?	YES		
		Is parking space able to accommodate all dimensions of the vehicles / units?	YES		
		Are the roads at the terminal separated from waiting areas for the loading / unloading cargo?	NO		
		Is the number of berths for mooring ships sufficient?	YES		
		Are the lengths of berths sufficient for mooring the largest vessels?	NO		
	safety	Are the sea depth/draft berths enough for the biggest ships?	NO		
		Is the sea depth in the driveway shore/terminal satisfactory for the biggest ships?	NO		
		Is there a storage space near the berth?	YES		
	weather	Does the space for storage of goods have sufficient capacity?	YES		
		Does the terminal (individual bindings) have conditions of secure mooring?	YES		
		Is the sea access to the terminal sufficient (maritime safety requirements)?	YES		
regulatory bottlenecks	work shifts	How much time a year is the terminal out of function for bad weather?	Never out of function		
		Is it guaranteed cargo handling 24 hours a day every day of the year?	YES		
		Is there a guaranteed flexibility in the composition of stevedoring crews and handling equipment to absorb demand peaks in loading / unloading services?	YES		
	information exchange	Is there a system which allows the electronic exchange of documents and communications between the driver unit and the terminal?	YES		
		PILOTS - Is it the time required from the request to reaction at a satisfactory level?	YES		
		TUGS - Is it the time required from the request to reaction at a satisfactory level?	YES		
cooperation	Is the cooperation between the terminal and the agent at a satisfactory level?	YES			
	Is the administrative co-operation of the terminal and Ship at a satisfactory level?	YES			
	Is the cargo handling capacity of the terminal sufficient?	YES			
technology	Does the shore cranes terminal have sufficient performance /capacity?	YES			
	Does the mobile cranes terminal have sufficient performance /capacity?	YES			
	Is there in the function the VTMS system?	YES			
other	customs	Is the cooperation between the Customs Authority and Ships at a satisfactory level?	YES		
		Is the time required for inspection (veterinary, phytosanitary, etc.) at a satisfactory level?	YES		
	inspections	Are there any cabotage restrictions?	NO		
		Is there an exemption obligations pilots for ships in service, which regularly touch the port?	NO		
cabotage restrictions	other	Is there an exemption obligations tugs for ships in service, which regularly touch the port?	NO		

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Bottleneck		Question	Answer	Relevance	
infrastructural bottlenecks	road	safety	Is the connection between the terminal and highway network at a satisfactory safety level?	NO	
			Is there a regular maintenance of the terminal roads and connection between the terminal and highway network?	YES	
			Are there clearly marked routes for accessing the terminal and leaving the terminal in order to reach the highway network?	YES	
		flow capacity	Is there adequate (satisfactory) lighting on the terminal roads and connection between the terminal and highway network?	YES	
			Are there clearly marked routes to get to the terminal and to the highway network?	YES	
			Is there a direct access to the highway network?	NO	
	rail	safety	Is the current capacity of the road infrastructure sufficient?	NO	
			Is there a sufficient number of lanes on terminal roads and connection between the terminal and highway network?	NO	
			Is the width of the lanes on the terminal roads and connection between the terminal and highway network appropriate (satisfactory)?	NO	
		flow capacity	Is the connection between the terminal and highway network passing through the urban and inhabited area?	YES	
			Is there a road and pedestrian crossing on the railway?	YES	
			Is the signalization on a satisfactory level?	YES	
	terminal	safety	Is there adequate (satisfactory) lighting on the terminal railway infrastructure?	YES	
			Is there a regular maintenance of infrastructures relevant for the satisfactory level of security?	YES	
			Is there a road and pedestrian crossing on the railway?	YES	
		flow capacity	Are the crossings satisfactory marked?	YES	
			Is the current capacity of railway infrastructure satisfying?	NO	
			Is it the connection of railway and road infrastructure at a satisfactory level?	NO	
inland waterways	safety	Is it possible to dispatch the maximum allowed quantities of the train at once?	N/A		
		Is there a ramp for the loading/unloading of the trucks on the railway?	N/A		
		Is the safety level of the port access satisfactory?	YES		
	flow capacity	Is the area of the port basin sufficient?	YES		
		Is the capacity of the access to the terminal sufficient so the barges shouldn't be separated?	N/A		
		Is there a RO-RO ramp on the terminal?	YES		
supply chain bottlenecks	capacity	Are the parking spaces adequately signposted for identification?	YES		
		Is the capacity of a parking lot sufficient?	NO		
		Is parking space able to accommodate all dimensions of the vehicles / units?	YES		
		Are the roads at the terminal separated from waiting areas for the loading / unloading cargo?	N/A		
		Is the number of berths for mooring ships sufficient?	YES		
		Are the lengths of berths sufficient for mooring the largest vessels?	YES		
	safety	Are the sea depth/draft berths enough for the biggest ships?	NO		
		Is the sea depth in the driveway shore/terminal satisfactory for the biggest ships?	NO		
		Is there a storage space near the berths?	NO		
		Does the space for storage of goods have sufficient capacity?	NO		
		Does the terminal (individual bindings) have conditions of secure mooring?	YES		
		Is the sea access to the terminal sufficient (maritime safety requirements)?	YES		
work shifts	How much time a year is the terminal out of function for bad weather?	N/A			
	Is it guaranteed cargo handling 24 hours a day every day of the year?	YES			
	Is there a guaranteed flexibility in the composition of stevedoring crews and handling equipment to absorb demand peaks in loading / unloading services?	YES			
	Is there a system which allows the electronic exchange of documents and communications between the driver unit and the terminal?	YES			
	PILOTS - Is it the time required from the request to reaction at a satisfactory level?	YES			
	TUGS - Is it the time required from the request to reaction at a satisfactory level?	YES			
information exchange	Is the cooperation between the terminal and the agent at a satisfactory level?	YES			
	Is the administrative co-operation of the terminal and Ship at a satisfactory level?	YES			
	Is the cargo handling capacity of the terminal sufficient?	NO			
	Does the shore cranes terminal have sufficient performance /capacity?	N/A			
	Does the mobile cranes terminal have sufficient performance /capacity?	NO			
	Is there in the function the VTMS system?	YES			
technology	Is the cooperation between the Customs Authority and Ships at a satisfactory level?	YES			
	Is the time required for inspection (veterinary, phytosanitary, etc.) at a satisfactory level?	YES			
	Are there any cabotage restrictions?	N/A			
	Is there an exemption obligations pilots for ships in service, which regularly touch the port?	N/A			
	Is there an exemption obligations tugs for ships in service, which regularly touch the port?	N/A			
	other				

As

seen from tables above, different stakeholders give different answers. It can be concluded that main problems are:

The connection between the terminal and highway network is not at satisfactory safety level, since the City port is located in the city centre. Although there is regular maintenance of the terminal roads and connections within the port, done regularly by Port Authority, it would be more beneficial if port would have direct access to the highway network.

Main infrastructural bottlenecks are found in flow capacity of the roads. There is no direct access to the highway network and the current capacity of the road infrastructure is not sufficient. – the part of the port area, which is mainly intended for passenger traffic, City Port is located in the city centre. The road through the centre is not good, and the traffic flow of the vehicles which are coming to port is during the summer season and especially at weekends

#### D.3.2.4 Analysis of the physical and non-physical bottlenecks in Italy and Croatia

is large – the City Port handles up to 35.000 passenger per day and more than 100.000 passengers and around 16.000 vehicles at weekends. The average vehicle speed is 500 meters per hour at that time. Terminal is limited in space and have small number of lanes that is crossing through the terminal. Also, there isn't a sufficient number of lanes on roads which are heading to the port form highway network. The width of the lanes on the terminal roads and connection between the terminal and highway network are not at satisfactory level.

#### Railway bottlenecks:

Signalization is not at satisfactory level, as well as the crossings' marking – this can cause problems in safety operations at terminal.

Lighting is not adequate on the terminal railway infrastructure – this can also cause problems in safety operations at terminal.

The current capacity of railway infrastructure is not satisfying, as well as the connection of railway and road infrastructure. This is causing limiting flow capacity in the port, and limited ability to receive more cargo.

There is no ramp for the loading/unloading the trucks on the railway.

#### Terminal bottlenecks:

The capacity of a parking lot is not sufficient.

The parking space is not able to accommodate all dimensions of the vehicles/units.

The number of berths for mooring ships are not sufficient.

The lengths of berths are not sufficient for mooring the largest vessels.

The sea depth/draft berths is not enough for the biggest ships.

The sea depth in the driveway shore/terminal is not satisfactory for the biggest ships.

A supply chain bottlenecks:

The shore and mobile cranes terminal does not have sufficient performance /capacity.

# ANALYSING OF LISTED BOTTLENECKS AND THEIR CAUSATIVE RELATIONS

The Port of Split has mostly one type of bottlenecks: infrastructural bottlenecks, which occurs in road, rail and terminal infrastructure.

Main road infrastructural bottlenecks are referred to the safety and flow capacity. Connection between the terminal and highway network is not at a satisfactory level in both port areas – City Port and North/Cargo Port. Also, there is not direct access to the highway network, and the current capacity of the road infrastructure is not sufficient. If this bottleneck would be solved, it would have helped to solve problems with congestion when approaching the port and within the port, especially in summer season in City Port when traffic (both passenger, vehicle and cargo trucks) flow is very high and it has tendency to rise every year.

A rail infrastructural bottlenecks problem is mostly not sufficient current capacity of railway infrastructure and connection of railway and road infrastructure. These bottlenecks are referring mostly on North/Cargo Port, and if it would be solved, it would allow cargo traffic to increase, because more cargo would be sent away through railway and not by trucks.

As main terminal bottleneck is not enough sea depth/draft for the biggest ships, the biggest ships must be at the anchor, which causes problems with operationalization within the port system. This problem could be solved by transferring those ships in North Port.

# PROPOSING SOLUTIONS OF BOTTLENECKS AND ANALYSING HOW IT WILL AFFECT FUTURE FREIGHT FLOWS

With existing road, terminal and rail infrastructure insufficiencies and with number of passengers and vehicles on the increase in the Port of Split it will not be possible in the future to manage the flow of passengers and vehicles effectively. There is a berthing capacity deficit resulting in vehicle congestion, long time needed to embark and disembark, low energy efficiency etc. Also, there is not direct access to the highway network, and at the main terminal not enough sea depth/draft for the biggest ships, as well as not sufficient current capacity of railway infrastructure and connection of railway and road infrastructure

These infrastructural bottlenecks could be solved by investing into the new infrastructure in the City Port and in the North Port.

One solution is the modernization of infrastructure of the Berth of Sv. Petar in the City Port. It assumes the extension in a way that will create a new manipulative area for boarding passengers and vehicles together with new berthing capacities that will be able to accommodate larger vessels. The second solution is constructing new port infrastructure in the North Port- Vranjic-Solin Basin- Stinice area, by creating a new manipulative area for Ro-Ro ships to berth and thus relocate cargo trucks to the newly constructed infrastructure in order to disburden the traffic within the City Port Basin and the centre of the City of Split. This newly constructed infrastructure will be constructed in a way to be able to accommodate both cargo and passenger vessels in future.

Also, one of the solutions would be construction of New Passenger Terminal in the City Port Basin. The proposed construction would revitalise worn out former industrial facilities in the City Port through reconstruction, as well as former warehouses, workshops, and office space through demolishing and reconstruction. New terminal would accommodate maritime passenger transport related content, various commercial content as well as conference centre and parking building.

By investing into the new infrastructure, the Port of Split Authority would reduce the congestion within both the Port of Split and the centre of the City of Split. Realization of this planned investments will help to solve main bottlenecks in the City Port Basin, as well as in the North/Cargo Port. In this way entering the Port will be simplified, as well as cargo handling, and at the end congestion of vehicles in the old city centre, where the City Port Basin is located, will be partly avoided and passenger guidance and security increased.

## CONCLUSION

Port of Split as for its strategic position has become one of the most important passenger ports in the Mediterranean and it is part of the comprehensive TEN-T network. The port is ranked first among Adriatic ports by the number of passengers and vehicles and third among Croatian ports regarding the transport of cargo behind port of Rijeka and port of Ploče. Also, the port of Split is largest port in central Dalmatian region, comprising both passenger and cargo transport as the main port business orientation. After the economic crisis in 2006., Split Port has a constant growth of traffic both passenger, vehicle and cargo, and today more than 5 million passengers and 800.000 vehicles were transported through cruise and ferry transport, and 3 million tons of cargo were handled in Cargo port.

Besides the favorable location and acceptable connection with other transport modes, the state of access roads and rail infrastructure as one of the indicators of further port development is unsatisfactorily, having limited capacity and throughput, where the points of congestion mainly occur. Therefore, the investments in infrastructure are needed to maintain competitiveness in both passenger and cargo transport in Adriatic and Mediterranean. Investments in infrastructure would eliminate and reduce existing bottlenecks and due to the expected growth potentially new points of congestion in port area and accompanying traffic infrastructure.