
GRAVITATIONAL ZONES OF THE PORT OF RIJEKA

Martina Furdić^a, Nikolina Brnjac^a, Jasmina Pašagić Škrinjar^{a*}, Borna Abramović^a

^a University of Zagreb, Faculty of Transport and Traffic Sciences, Zagreb

Abstract: *Port of Rijeka is classified as the only TEN-T basic Croatian sea port. Apart from the maritime traffic, it has an excellent connection to road traffic, it is located near the airport, the oil pipeline system connects the Port of Rijeka with several states inside and outside the European Union, and rail traffic is growing despite the poor infrastructure. In this paper, gravitational zones of the Port of Rijeka will be defined along with their spatial and economic characteristics. The location and traffic connections of the Port of Rijeka will be more detailed and described, whereupon the gravitational zones of aforementioned terminal will be described. The most important elements of the analysis of the relevant resources and the economic development of the potential micro-location and the gravitational zone of the Port of Rijeka will be given. The purpose of this paper is to describe the location and geotrafic position of the port of Rijeka and to show the criteria that define the gravitational zones of Rijeka.*

Keywords: *Gravitational Zones, Port of Rijeka, Multi-modality.*

1. INTRODUCTION

A gravitational zone of a terminal is defined as the area where the transport flows of goods and people are initiated, so one stage of their movement includes passing through the terminal. The port of Rijeka has been named as one of the fundamental ports in the TEN-T map. It is Croatia's largest port, whose advantage lies in the water depth of the natural channel in the Adriatic. According to the statistics provided by the port of Rijeka authority, the largest amount of traffic is the transit-cargo traffic, the highest traffic is the transit cargo, with lines connecting it to the hinterland of Central Europe. To expand the gravitational zones of the port, it will be necessary to ensure the port's interoperability and accessibility and complete the development strategy of the port with the essential development of the road and railway infrastructure, as well as logistical areas. The purpose of this paper is to describe the location and geotrafic position of the port of Rijeka and to show the criteria that define the gravitational zones of Rijeka.

2. THE LOCATION OF THE PORT AND ITS GEOTRAFFIC POSITION

The city of Rijeka lies in western Croatia, 131 kilometres south-west from the capital Zagreb, on the northern coast of the Bay of Rijeka, which is a part of the Kvarner Gulf, in the Adriatic Sea. The port of Rijeka, the largest and most important seaport in Croatia, is located in Croatia's third biggest city, which is the administrative centre of Primorje-Gorski Kotar county (INSTITUT IGH,

* jpasagic@fpz.hr

2011). The geographical and traffic position of the port of Rijeka, as well as its traffic network, was described in more detail by Furdić (2015) in "Gravitational zones of intermodal terminals".

Table 1 lists the port of Rijeka's road and rail distances to some European cities. It is evident that the road distances are lower compared to rail. However, considering the harmfulness of roadway transportation, as well as the fact that a train composition can transport several dozens of containers, whereas a road cargo vehicle can fit only a single container, the railway transport is much more profitable.

Table 1. The distances between the port of Rijeka and European capitals towards which it gravitates (www.lukarijeka.hr)

CITY	ROAD DISTANCE (km)	RAIL DISTANCE (km)
Zagreb	145	228
Budapest	504	592
Bratislava	550	686
Vienna	490	572
Prague	810	844
Belgrade	569	669
Sarajevo	456	490

The advantage of north Adriatic ports over the ports in the North Sea or the Baltic results from the shortest maritime link between Europe and the Near, the Middle, and the Far East. Figure 1 illustrates the relationship between the distances (in nautical miles) between the north Adriatic and the North Sea ports from the five main world ports. The northern Adriatic is 2270 Nm closer to Far East seaports than the North Sea is, which amounts to approximately six additional days of navigation (Marković et al., 2003).

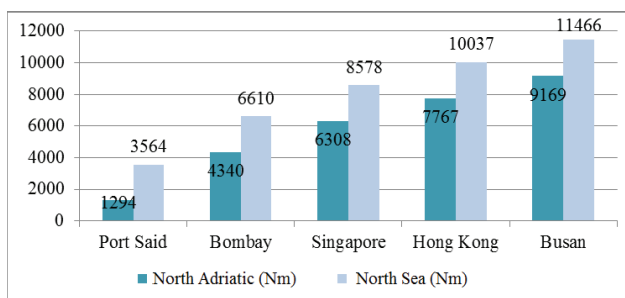


Figure 1. The distances between seaports in northern Adriatic and northern Europe, and some seaports in the world (Marković et al., 2003)

3. GRAVITATIONAL ZONES OF THE PORT OF RIJEKA

The port of Rijeka is situated in the Kvarner Gulf, a protected natural heritage, and through Kupa Valley there is a great connection potential to Zagreb and Pannonian basin, and consequently, to the Danube region and Central Europe (Marković et al., 2003). The port of Rijeka's favourable position places it within the gravitational area of Central European countries (Croatia, Hungary, Slovakia, Czechia, Austria, Slovenia, Southern Poland and Southern Germany), as well as Eastern Europe (Bosnia and Herzegovina, Serbia, Montenegro, Bulgaria, Romania and Western Ukraine). Figure 2 shows the gravitational tendencies of the port of Rijeka.

The main advantage of the port of Rijeka, apart from its excellent location, is its intermodality. Directly and indirectly, it is a junction of five traffic branches (road, railway, air, maritime and

pipeline traffic). The current investments in the expansion and modernisation of the port will have great impact on the increase of the size of the maritime traffic. However, if the Republic of Croatia wishes to realize the full potential of the port, it will have to commence with the development and restoration of the railway traffic and infrastructure, connecting the port to its gravitational hinterland as soon as possible.



Figure 2. Gravitational zones of the port of Rijeka (www.lukarijeka.hr)

During the twentieth century, the port of Rijeka used to be the tenth largest European seaport with a strong gravitational area of the Austro-Hungarian Monarchy. It was connected by a railway track in both directions to Vienna and Budapest, providing the cities with a direct access to the sea. The accession of Slovenia, Hungary, Czechia, Slovakia and Poland to the European Union in 2004 enabled that the port of Koper have the traditional and most important markets, which stayed beyond the border reach for the port of Rijeka. As Croatia entered the EU, the port of Rijeka gained the same starting position and opportunity for a fair competition against the neighbouring ports, with which it shares the same gravitational hinterland.

The geotrafic position and gravitational area are determined by various criteria, so the next part will analyse some of them, in order to define the gravitational zones of the port of Rijeka.

3.1 The Existing Domestic and International Traffic Flows and Transit

Most of the port traffic of Croatian seaports takes place in the port of Rijeka, which normally generates over 50 per cent of seaport traffic in the entire country.

The traffic capacity of every seaport is different, amounting to 23,100.000 tones annually in total. Together with the capacity of the Adriatic Oil Pipeline in Omišalj, Krk, 20,000.000 tons, the total capacity of the main seaports in the Republic of Croatia exceeds 43,000.000 tons of cargo per annum.

The analysis of the maritime and coastal traffic in the Republic of Croatia and the data obtained from the Croatian Bureau of Statistics on the traffic of goods in seaports shows that the most of the traffic in Croatian seaports is transit and international traffic. Figure 3 illustrates the relationship between the international and domestic traffic and transit in the period 2009-2015. During this time, transit traffic decreased by 32 per cent, the unloading in domestic traffic by 12, while the loading in domestic traffic dropped by 24 per cent. The unloading in international traffic in 2014 suffered the greatest drop, compared to 2009, by 5 per cent, while the growth in 2014-15 reached 13 per cent. In the seven years, the lowest loading was in 2012, and after the increase by 26 per cent in 2014, the following two years in international traffic the loading was in a decline.

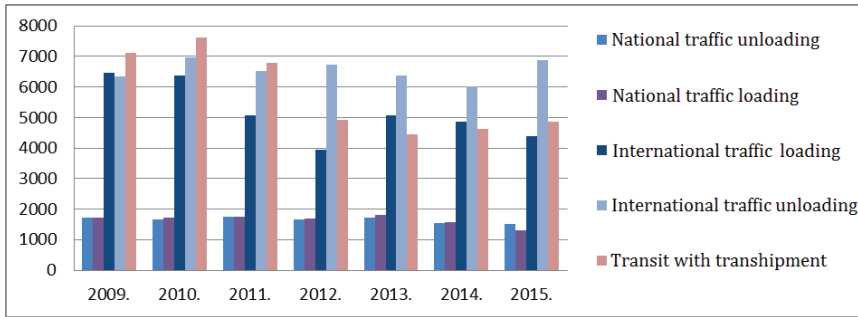


Figure 3. The relationship between the domestic and international traffic of goods in seaports in the Republic of Croatia [10^3 t] (Croatian Bureau of Statistics, 2015)

Figure 4 illustrates the comparisons of container traffic in Croatian seaports in the period 2012-15, comparing the traffic in the port of Rijeka to the total traffic in all other Croatian ports. It is clear that around 86 per cent of the containers in Croatian ports comes through the port of Rijeka. Between 2012-15, there was an increase in traffic by 21 per cent, and in 2014-15 the growth rose to 30. On a state level, the increase was even higher – 33 per cent in 2015 compared to the previous year.

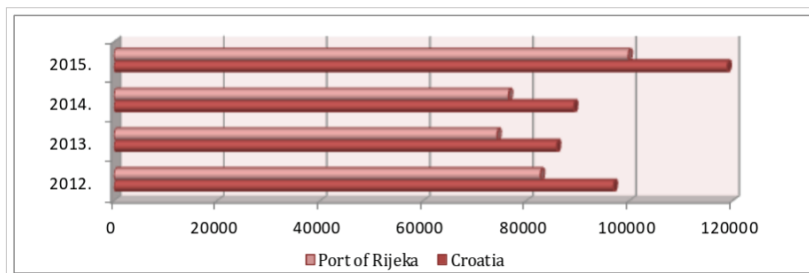


Figure 4. Container traffic comparisons in Croatia and in the port of Rijeka (Croatian Bureau of Statistics, 2015)

3.2 The Development of Traffic Network and Possibility of Connecting to Certain Roadways, the Depth of Aquatorium at Seaports, Connecting to at least two branches of traffic

The Mediterranean corridor of the Central Trans-European Traffic Network TEN-T is of crucial importance for the Republic of Croatia, because it passes through the countries stretching from Gibraltar to Ukraine. It goes from the south of the Iberian peninsula, over Spanish and French Mediterranean coastline, through the Alps on the north of Italy, entering Slovenia and continuing towards the Hungarian-Ukrainian border. This is a roadway and railway corridor, and its integral part is the route Rijeka-Zagreb-Budapest (railway and roadway link, which is here referred to as VB corridor) (www.mppi.hr). The port of Rijeka is the starting point of the Mediterranean corridor, which indicates its special importance for the European traffic network.

The port of Rijeka is the main and largest national port, and that is why it should have enough traffic capacity on the infrastructure available for all the goods arriving by sea to be delivered to their final destinations as quickly as possible, with no interruptions, congestions or bottlenecks. The port is the best case of multi-modal terminal in Croatia. Apart from the maritime transport, it is well-connected to the roadway infrastructure, and there is an airport nearby, as well. The oil pipeline system connects the port to several non-EU and EU states, and the railway transports

about 25 per cent of the goods that arrive in the port of Rijeka, while the rest of it is transported by road.

The traffic connection of the port to other traffic branches and important roadway links include:

- Motorway A6 (Mediterranean corridor) – Rijeka – Zagreb
- Motorway A8/A9 – Rijeka – The Istrian Y
- the Rijeka Bypass
- Railway (Mediterranean corridor). Šapjane – Rijeka – Zagreb – Koprivnica – Botovo
- Railway line M502: Rijeka – Pivka
- Rijeka Airport – Krk: 17 kilometres aerial distance, 25 kilometres road distance
- Oil pipeline system that connects the refineries in Croatia, Hungary, Austria, Bosnia and Herzegovina, Serbia, Czechia and Slovakia
- Connection to the Rhine – Danube corridor of the TEN-T Network and X corridor, passing through the Republic of Croatia
- The Baltic-Adriatic corridor – Venice – Trieste – Kopar – Ljubljana – Budapest: 115 km

The aquatorium depth is also one of the criteria that have impact on determining the gravitational zones of seaport terminals. The Rijeka bay is approximately 60 meters in depth, which is enough for even the greatest ships to dock, which is what made Rijeka an important seaport. However, the development of cargo ships demands greater draught (ship squat), and the port of Rijeka is inadequately equipped to dock newly-constructed ships.

The basin depth in the area of the port authority are listed as follows: (www.portauthority.hr)

- Rijeka / Sušak basin – container terminal, passenger terminal, Ro-Ro terminal, conventional general cargo, grain, conditioned cargo, timber terminal
 - Water depth: 5 – 14 meters (container and Ro-Ro terminal (Brajdica) – 11–12 meters)
- Bakar port basin – bulk cargo, Ro-Ro terminal
 - Water depth: 18 meters
- Port basin Omišalj – oil, oil derivatives terminal
 - Water depth: 30 meters
- Raša port basin (Bršica) – general cargo, livestock, timber terminal
 - Water depth: 8 meters

3.3 Environmental Impact

In her work, Furdić (2015) describes the different ways of negative impacts of ports and ships on environment as a criteria for determining gravitational zones. The harmful gas emissions largely affect the environment of the port. The negative effects on the sea can also be expected due to the water pollution resulting from fuel, oil or other chemical leakage during loading and unloading, illegal release of waste water, perchlorination surface runoff on the parking spaces or due to the thermal pollution of water. Noise is another important ecological issue in ports.

As explained by European Union (2014) the operation of seaports can have a negative impact on the soil, mostly due to oil and chemical leakage. The sedimentation of the polluted sediments is the other potential impact connected to water pollution, resulting from the ship movement, and there is also the possibility of soil erosion. Seaports have significant negative results related to waste.

3.4 The Surface Size Intended for the Port of Rijeka

The port of Rijeka comprises several port terminals that represent separate unities which interact to form a unique port authority area. Within the port there are: bulk terminal, container terminal, Ro-Ro terminal, grain terminal, conventional cargo terminal, multi-purpose terminal Bršica. Every terminal handles a certain type of cargo and holds appropriate transport,

warehouse and transport equipment.

The total surface of the terminals in concession of the port of Rijeka is 1.176.043 m², which includes the closed warehouse spaces and furnished warehouse surfaces. The length of the operational coastline is 5.052 meters and it is intended to be used for docking ships of great and long coastal navigation.

The total surface of the Adriatic Gate Container Terminal (AGCT) is 16.8 ha, with the annual capacity of 250,000 TEU. Škrljevo terminal is a warehouse complex with the surface of 417.413 m², with a free zone status. It is 10 kilometres away from Rijeka, a 3 kilometres from Bakar.

4. CONCLUSION

The gravitational zone of the terminal is the starting point for merchandise traffic flows, which at one stage of their movement pass through the terminal. The zone is determined by the geographical location, domestic and international traffic flows, economic and political factors as well as the number, structure and locations of the users of the service provided by the intermodal terminal.

The port of Rijeka is Croatia's largest port and a starting point of the Mediterranean corridor. Besides the maritime traffic, it is ideally connected to road traffic, and the airport is also nearby. The oil pipeline system connects the port with several states within and outside the EU, and the railway traffic, despite its outdated infrastructure, is on the rise.

Due to its favourable position, the port of Rijeka belongs to the gravitational area of central European countries (Croatia, Hungary, Slovakia, Austria, Slovenia, southern Poland and southern Germany) as well as Eastern countries (Bosnia and Herzegovina, Serbia, Montenegro, Bulgaria, Romania and western Ukraine).

In order for the port to continue operating successfully, it is necessary to ensure its interoperability and accessibility through the absolutely essential development of the railway and road infrastructure, and logistical areas. Every investment in the port makes it more competitive with surrounding ports, which leads to a greater satisfaction among the existing users and attracting new ones, which will ultimately result in an increase of traffic, income and expansion of gravitational zones.

REFERENCES

- [1] Croatian Bureau of Statistics (in Croatian: Državni zavod za statistiku)
- [2] European Union, (2014). Strategic Assessment of Environmental Impacts. Strategy for Transport Development of the Republic of Croatia, Operational programme Transport 2007-2013.
- [3] Furdić, M., (2015). Function of the Gravitational Areas of Intermodal Terminals (in Croatian: Uloga gravitacijske zone intermodalnih terminala), Faculty of Transport and Traffic Sciences, Zagreb, Croatia.
- [4] Marković I., Muić M., Vučić D., (2003). Position and Development Prospects for the Port of Rijeka (in Croatian: Položaj i perspektive razvoja Luke Rijeka), Pomorski zbornik 41, 123-133.
- [5] Baričević, H., Poletan Jugović, T., Krpan, Lj., Šuperina, V., (2008). The Integral Study of Urban Traffic in the County of Primorsko-Goranska and Town of Rijeka, Automatizacija u prometu, 5-10.
- [6] www.lukarijeka.hr (March 2017)
- [7] www.mppi.hr (March 2017)
- [8] www.portauthority.hr (March 2017)