

ALEN JUGOVIĆ, Ph.D.

E-mail: [ajugovic@pfri.hr](mailto:ajugovic@pfri.hr)

SVJETLANA HESS, Ph.D.

E-mail: [shess@pfri.hr](mailto:shess@pfri.hr)

TANJA POLETAN JUGOVIĆ, Ph.D.

E-mail: [poletan@pfri.hr](mailto:poletan@pfri.hr)

University of Rijeka, Faculty of Maritime Studies Rijeka

Studentska 2, HR-51000 Rijeka, Croatia

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## TRAFFIC DEMAND FORECASTING FOR PORT SERVICES

### ABSTRACT

*Successful management of any sea port depends primarily on the harmonisation of transport supply and demand, whereas their incompatibility leads to a number of problems. The port, i.e. its management, through its operation and part of port policy may affect the planning of the construction or modernization of its port facilities. In doing so, the specified planning requires forecasting and quantification of the needs for infrastructural services of specified port, i.e. assessment of traffic demand. Accordingly, the basic problem of research in this paper is forecasting of traffic demand for the port services by applying the appropriate forecasting methods. In order to find ways of solving concrete problems in the port operations the methods for traffic demand forecasting are set by applying the methodology and the presentation of the application of economic forecasting methods. The selected methods of demand forecasting for port services in demand are illustrated and tested on the example of the Croatian largest cargo port, the Port of Rijeka.*

### KEY WORDS

*planning, forecasting, traffic demand, commodity flows, port capacity*

### 1. INTRODUCTION

One of the best ways for successful management of certain transport companies is traffic demand planning. Demand is one of the most important aspects of business economics. Mismatch between supply and demand leads to a number of problems. Therefore, in case of port operations, higher supply than demand leads to the failure in the utilization of port infrastructure and suprastructure, and to the lack of cost-effectiveness. When the demand for port services exceeds the supply, there comes to congestion of port facilities, an increase in costs of ships and losses of time due to waiting. Since the traffic capacity is not flexible and its construction and development require substantial financial resources in order to be payable, supply must be designed in accordance with the anticipated

demand in the future. Therefore, in order to avoid the consequences of non-compliance of port supply and demand, and to create a basis for sizing supply, there is a need for demand forecasting of port services.

For future demand forecasting, the primary precondition is the construction and/or modernization of the future port infrastructure and superstructure. Since the port service cannot be stored, the port offer needs to be in line with the current demand. In previous studies several forecasts of the Croatian port traffic have been made, and they were created by the local and foreign authors. The projected values of traffic forecasting of the Port of Rijeka and other Croatian ports created ten years ago, deviate significantly from the actual current and future real value, since the disintegration of former Yugoslavia, and the new political and economic order in Croatia, but also in Europe influenced the change of the catchment area borders of the Port of Rijeka and its port area, and also had influence on the narrowing of the former market of port services which resulted in the change of the cargo structure, reducing the market and resulting in significant traffic decline. Also, the traffic and routing decline of goods were result of the decline in the economy or GDP, which reflected a decrease in production, import, export and transit. The analysis of relevant materials regarding traffic forecasting of demand for port services, particularly the demand for port services of the Port of Rijeka, has been indicated by a small number of scientific papers. One of the important papers dealing with these problems is the "Study of a long-term development of the maritime traffic in the Socialist Republic of Croatia" of the Croatian Economic Institute of the Socialist Republic of Croatia, and the Institute of Transport Sciences in Zagreb, made in 1983, that for the purposes of this study developed traffic forecasts of the Croatian ports in several variants using the average annual growth rate. The authors of the study from the year 1990 "Scientific basis of long-term development of Croatian Maritime Affairs until year of 2010" emphasize that the above mentioned results cannot be taken

as the basis for long-term planning by the year 2010, due to being significantly above the real value [16]. In this study, B. Kesić indicates that the most realistic value of the future port traffic is obtained by extrapolation of the linear trend. The same author in the paper "Development of the port system in the atmosphere of the new legal environment" (1998) takes into account the existing situation, the movement of goods on the European transport market, and comparing the activity of ports to a competitive port; the projection of future Rijeka port traffic is based on a linear trend [7].

Besides these scientific papers it is necessary to excerpt the professional papers: according to the study "Port of Rijeka and Ploče – Economic and Technical Study" (1996) for the forecast of the total trade of the Port of Rijeka, the authors used the barometric method of forecasting [20]. The forecast has been made based on the estimated annual growth rate of the turnover by types of cargo (general, dry bulk and timber) and by the direction of movement (local traffic, transit) based on the anticipated rate of gross domestic product (GDP), foreign exchange rates and other economic indicators for Croatia and other countries that gravitate to the Port of Rijeka. The study "Ten-year development plan of the Port of Rijeka" of the Institute of Transport and Communications, Zagreb (1998) predicted the traffic of the Port of Rijeka by the year 2015, on the basis of the estimated growth rates in certain periods, using the barometric method of forecasting [17]. The trading company "Luka Rijeka d.d." has made in 1999 "the forecast movement plan of traffic of the Port of Rijeka until the year 2012" as part of defining the development plans in the league getting the concession for the performance of port activities. The forecast is based on the forecasts for the economic growth trends.

All these papers and studies have given a contribution to the development of methods for forecasting the traffic demand for port services, although none of them incorporate many different methods of forecasting for port services, and comparative analyses, comparing the results. Accordingly, the basic intention of this research is to contribute to the traffic demand forecast for port services using various methods of traffic demand forecasting on the concrete example of the Port of Rijeka as the results obtained by comparing each prediction.

## 2. FUNDAMENTAL PRINCIPLES OF TRAFFIC DEMAND FORECASTING

There are three different relationships between the supply of transport capacity that provide services and transport demands, namely [2]: shortage in supply of transport capacity in relation to the transport demand, excess of supply relative to demand, and

coordinated relationship between supply and demand. The task of the port traffic forecasting is to determine the quantity, type and structure of the cargo that will be moved through the port in the next period of time.

While forecasting the port traffic, planners have to deal with predictions that may affect the sizing of traffic, such as, for example, predictions regarding changes on the market to the state in which the composition of the port is located and transit countries, economic changes in the hinterland of the port, changes in the movement of goods, changes in technology and transportation of certain goods.

Likewise, it is necessary to ensure the system of observation in order to spot when the observed traffic starts to deviate from the predictions.

The methodology for forecasting of traffic demand should include the following steps:

- determination of appropriate methods for assessing and forecasting demand,
- model specification based on the preferences of economic theory for the studied phenomenon,
- parameters evaluation for the specified model,
- reliability testing of the model, and
- application of the model in the perspective of the observed phenomena.

The forecast of the port traffic is necessary in order to analyze the domestic transport market and foreign trade, and there is a need to thoroughly consider the transit market and the volume and structure of traffic from the countries in the hinterland catchment region of the port for which the forecast is made. The basis of each prediction is real understanding of the current situation and reasons that caused some movement of the reserves on the existing markets that can be activated. By the analysis of the commodity flows, the economic strength of the hinterland that gravitates to the determined port and associated land direction to/from the airport can set guidelines for the development and determine the size and significance of a particular port.

The progress in the application of quantitative methods was created as a result of the rapid development of computers and software that enables analysis of large amounts of data, and compares different versions and then provides the optimal solution.

## 3. ANALYSIS AND EVALUATION OF TRANSPORT ACTIVITIES OF THE PORT OF RIJEKA

To select the appropriate forecasting methods and to set precise relations, the first focus should be on analyzing the current state of the Port of Rijeka. Long-term plan and the development of each port are based on forecasts of future trends of its traffic.

Table 1 - Transport in the Port of Rijeka by the structure of cargo from 1998 to 2008 (in millions tons)

CARGO	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
General cargo	0.62	0.73	0.795	0.832	0.791	1.062	1.392	1.435	1.573	2.164	2.372
Bulk cargo	2.50	1.70	1.603	1.926	1.733	2.327	3.081	3.186	3.200	3.141	3.372
Liquid cargo	5.59	5.24	4.285	4.993	5.244	6.259	6.917	7.023	5.878	7.593	6.370
Wood	0.14	0.14	0.165	0.151	0.202	0.168	0.182	0.220	0.236	0.331	0.273
Total	8.85	7.81	6.848	7.902	7.970	9.816	11.572	11.864	10.887	13.229	12.387

Source: [http://www.portauthority.hr/rijeka/info\\_statistika.shtml](http://www.portauthority.hr/rijeka/info_statistika.shtml) (06.09.2009.); Master plan update – Port of Rijeka, Rotterdam Maritime Group, March, 2008, p. 28.

Therefore, in any future development planning and dimensioning the capacity of individual ports, the analysis of the current flow of traffic and its forecasts for the future have great importance. The forecasts of the future traffic movements should be developed separately according to the directions of movement (export, import, transit and internal transport) and the structure of cargo. The forecast is generally a very complex task usually with an uncertain outcome. For example, the current forecasts for the Port of Rijeka project an unrealistic traffic for the future period, partly due to unforeseen circumstances that have occurred (due to war in the past twenty years, there has been a diversion of cargo flows, falling traffic and reducing economic activity in general), and partly due to the use of extrapolation of a trend that is the forecast based on the movement phenomena in the past. Further in the text, the section analyzes the state of traffic in the port due to: the intensity, structure and dynamics of transport and transport due to the competing Ports of Koper and Trieste.

### 3.1 Analysis of traffic of the Port of Rijeka by the structure of cargo

Table 1 shows the intensity and dynamics of the freight traffic of the Port of Rijeka in the period from 1998 to 2008.

The data of the Port of Rijeka traffic in the previous table indicate that after ten years the Rijeka Port recorded in 2007 a record turnover of 13.229 million tons, of which 5.636 million tonnes of traffic was related to general and bulk cargo and timber traffic, which was implemented in the business activities of the *Luka Rijeka d.d.*, while the rest of the traffic of 7.593 million tons refers to the current traffic load, that was achieved at an oil terminal in the port based in Omišalj. Such load of Rijeka traffic was routed round before the war, but in 1990s the traffic fell sharply. Further information about the movement of traffic of the Port of Rijeka indicates that the Port of Rijeka recorded in 2008 a turnover of around 12.4 million tonnes, of which around 6 million tonnes of traffic was related to general and bulk cargo and timber traffic, which was implemented as part of the business activities of *Luka*

*Rijeka d.d.* Also, Table 1 shows that the Port of Rijeka in the period from 2001 to 2007 realized a total increase in traffic of about 67% or about 5.3 million tons. In the same period, general cargo traffic increased by 160%, bulk increased by about 65% and the real wood traffic. In 2007 all kinds of cargo recorded an increase of traffic, except for bulk cargo. General cargo (it includes the transport of containers) in 2007 compared to last year recorded an increase of 37%, 29% of liquid cargo and 38% of timber. The growth of certain types of goods was reflected in the share of total traffic, and in 2006 retained the same goods relationship of certain types of cargo in total. There is no doubt that in the sixth consecutive year the Port of Rijeka increased the total traffic. According to some estimates, in the year 2007 in the realized traffic of the Port of Rijeka there was 12% more cargo flows in the Rijeka traffic route. In the structure of dry cargo in 2008 bulk share was about 56%, while general cargo accounted for about 39%, and timber about 4.5%. The best business results in the Port of Rijeka, particularly in the period from 2002 to 2008, have been achieved by container terminal, where, after the technological modernization at the end of 2002 the turnover increased more than ten times. Regarding the dynamics and intensity of growth of container flows it is important to emphasize that the Port of Rijeka in 2004 compared to the year 2002 reported an increase of container traffic of about 400%.

In 2005 the container terminal of the Port of Rijeka realized a turnover of 76,258 TEU units, which, compared to the year 2004, is an increase of 25%. Expressed in TEU units in 2005, 15,394 TEU units and more were transferred, with the average transshipment amounting to 6,355 TEU units in a single month.

The next year 94,390 TEU units were reloaded, which is an increase of 24% compared to the year 2005. The container traffic of the Port of Rijeka has been recording new records. This has been confirmed by the data according to which, in the year 2008 a turnover of 168,761 TEUs was recorded, which is an increase of as much as 16% compared to the previous year.

The increase in the number of TEUs involves the development of the front of ports so that ships that sail into the Port of Rijeka have the capacity of 7,000 TEU

Table 2 - Container traffic in the Port of Rijeka

YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
TEU	6,866	8,925	12,711	15,215	28,205	60,864	76,258	94,390	145,040	168,761
Tons	-	64,388	106,982	130,460	246,966	500,635	581,888	719,738	1,196,914	1,423,284

Source: <http://www.lukarijeka.hr> (04.09.2009.); container terminal "Brajdica", Rijeka, October, 2009

units, and full regular service takes place over large shippers.

Parallel with the growth of traffic, TEU unit is growing, along with the amount of cargo that is being transported by containers. This is the reason for increase in the number of TEU units, also as the trend of transportation of "new" goods which have not yet been transported by containers, such as timber transport. In relation to the total reloaded 581,888 tons of cargo in the year 2005, in 2008 there was substantial growth in traffic considering that the container transshipment reloaded 1,423,284 tons of goods.

Enlargement of the port traffic is the basis for entering a new investment cycle in which the port is modernizing the existing port facilities and building new modern terminals. Regarding this, it is important to emphasize the construction of an appropriate terminal in the Port of Rijeka as a function of transshipment of containers, which will significantly affect the attraction of container cargo flows, increased traffic of the Port of Rijeka and the related Rijeka Gateway (Corridor V<sub>B</sub>).

### 3.2 Analysis of the Port of Rijeka traffic, according to the directions of movement

Considering the structure of goods given the focus, compared with local traffic and land-land transit (not including port transshipment), the transit traffic of the Port of Rijeka (with a share around 75%) in 2007 is the most important segment of the total traffic. According to the statistics service of the Port of Rijeka, the structure of the transit countries traditionally led the way and special partners of transit of the Port of Rijeka are especially mentioned: Austria, the Czech Republic, Slovakia, Hungary and Italy, while turnover with other countries leads within a specific group (other countries). However, it should be pointed out that recently some new transit markets have appeared, and these

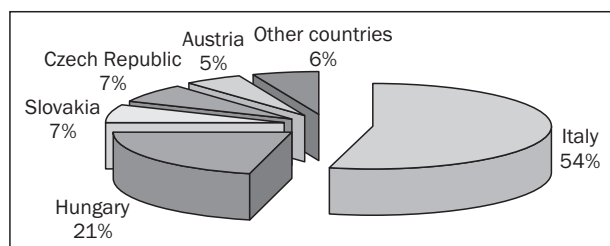


Figure 1 - Transit traffic structure of the Port of Rijeka in 2007

Source: Port of Rijeka, 2008 (03.09.2009)

are the markets of Serbia, Bosnia and Herzegovina and to a lesser extent Montenegro, which includes the restoration of lost cargo in the previous period.

Transit traffic structure of the Port of Rijeka in 2007 indicates that the largest share of transit traffic (54%) was realized with Italy (transport of coal destined for thermal power plants in northern Italy). Hungary, as a traditional partner of the Port of Rijeka in its proper background, participates with 21%, the Czech Republic and Slovakia with 7%, Austria 5%, and the remaining states with 6%. These central European countries also represent the strategic transport market of the Port of Rijeka, which were worthy for shaping the valuable transit cargo flows on Corridor V<sub>b</sub>. Although the structure of Serbia's share of transit traffic is not visible in Figure 1, it has already been calculated within the share that relates to other countries, and it is important to emphasize that the Serbian market is the most significant market for transit transport containers from the Port of Rijeka. Small share of Serbia is the result of statistical record-keeping because the transit and interests of individual countries in it are expressed in tons. A significant part of container traffic in the Port of Rijeka makes container transport to their destinations within the Croatian Republic, the so-called domestic traffic. Still, on the mainland shipping / delivery by rail traffic accounts for about 78% and on the road traffic 82% of the total container traffic. According to these data it can be seen that the most important export market for the container Port of Rijeka is the domestic market or the destinations within the Republic of Croatia.

Based on the analyzed data on the amount and structure of transit it is visible that the hinterland of Central Europe (Austria, the Czech Republic, Slovakia and Hungary), along with the markets of Serbia and Bosnia and Herzegovina, for the container traffic is an important strategic market segment of the transit Port of Rijeka and Corridor V<sub>b</sub>. However, the indicative data that suggests a risk of loss of the traditional markets of the transit Port of Rijeka, given the growing proportion of the Northern European routes and other Northern lines (from the ports of Koper and Trieste) in the overseas trade of these countries. Bearing in mind the fact that Hungary naturally gravitates towards the Rijeka traffic and the Port of Rijeka, and that Austria, although close to the other two North Adriatic ports (Koper and Trieste), has always been recording an important transit traffic from the Port of Rijeka, the question is what are the reasons for the tendency of

decreasing traffic of the Port of Rijeka to those countries. Transit traffic of Hungary, Austria and Northern European ports (Hamburg, Bremen, Polish Airports - Gdansk, Gdynia, Szczecin) recorded a slight growth, and this is one of the possible reasons. Likewise, we should take into account the orientation of the overseas trade of these countries in competitive North Adriatic ports of Koper and Trieste. Regardless of most reasons, the movement and decrease of the transit traffic to those states, it is necessary to take them seriously and to try to find a solution which contribute to the attempt of returning the cargo of these countries to the Rijeka traffic route.

### 3.3 Container traffic analysis of the Port of Rijeka in comparison with the traffic of competitive ports of Trieste and Koper

In a narrow catchment area of the port of Trieste, Koper and Rijeka act as mutual competitors. All three ports have the same natural catchment area, but there are some differences in serving the market. The ports of Koper and Rijeka are primarily focused on transit, which in both ports has a share of 65 to 75% of total turnover, while in the transit port of Trieste it is only about 20%. The container traffic in the ports of Trieste, Koper and Rijeka is shown in *Table 3*. The most important transit routes of the Ports of Rijeka and Koper are from Austria, Hungary, Czech Republic, Serbia and Slovakia. For the Port of Rijeka in the last two years an important transit partner and especially for container traffic is Serbia and Bosnia and Herzegovina. Therefore, the future expects an increase in transit traffic to these countries. The development plans of the Port of Trieste envisage an increase of transit traffic, especially for the Austrian, Hungarian, Czech and German cargo (Bavaria). Also, for all three ports interesting potential transit partners come from Western Ukraine and Southern Poland. In a wider catchment area there are several routes that are rapidly developing and in the last decade have become a dangerous competitor of northern direction.

This is primarily the transportation route through north-western Europe with the ports of Rotterdam, Hamburg and Bremen, and the East through the Black

Sea. These directions of commodity flows in the last few years have shown a significant increase in traffic especially in the proportion of Hungarian freight transport. Therefore, cooperation of the ports of Trieste, Koper and Rijeka are needed so that the ports, with concerted effort together can compete with the north-western European and Black Sea ports. Actual cooperation of Trieste, Koper and Rijeka ports consists of their joint promotion and promotion of the north Dalmatian gateway to international markets. However, there is need of strong joint marketing activities for all existing and potential markets.

## 4. TRAFFIC DEMAND ESTIMATION OF THE CONTAINER TRAFFIC IN THE PORT OF RIJEKA

The best business results for the last ten years in the Port of Rijeka are accounted for by the container terminal. Accordingly, within the growing importance of the container traffic in the world and the European freight flows, in this part of research, the traffic demand assessment was made exclusively for container traffic, using the following methods:

- 1) container traffic forecast of the Port of Rijeka, Trieste and Koper by time series analysis,
- 2) container traffic forecast of the Port of Rijeka by time series analysis,
- 3) container traffic forecast by the European Commission estimates,
- 4) forecast of container traffic in the Port of Rijeka regarding the movement of GDP, and
- 5) container traffic forecast using the regression analysis.

### 4.1 Container traffic forecasting of Port of Rijeka, Trieste and Koper by time series analysis

In the port traffic forecasts using time series analysis, it is assumed that the traffic will be carried out in the future in the same or similar dynamics as in the previous period. The result is a potential substrate for containerized cargo that will be attracted to the north-

*Table 3 - Container traffic of the ports of Rijeka, Trieste and Koper (in TEU)*

PORT	2000	2001	2002	2003	2004	2005	2006	2007	2008
Rijeka	8,925	12,711	15,215	28,205	60,864	76,258	94,390	145,040	168,761
Trieste	206,134	182,379	163,472	120,768	131,200	198,319	220,310	265,863	335,943
Koper	86,679	100,000	115,000	120,000	153,347	179,745	218,970	305,648	353,880
Total	301,738	295,090	293,687	268,973	345,411	454,322	533,670	718,578	860,611
Rijeka share (%)	3.0	4.3	5.2	10.5	17.6	16.8	17.7	20.2	19.6

Source: [http://www.porto.trieste.it/docs/statistiche\\_2008.pdf](http://www.porto.trieste.it/docs/statistiche_2008.pdf), (22.09.2009) - statistical data for Port of Rijeka, Koper, Trieste (2007 and 2008); <http://www.luka-kp.si/eng/terminals-and-cargo>, (22.09.2009) - statistical data for Port of Koper (2007 and 2008)

Table 4 - Container traffic forecast of northern port by parabolic trend and share of Rijeka

Year	Total (TEU)	Port of Rijeka: scenario in TEU		
	Trieste, Koper, Rijeka	Low	Medium	High
2008	786,000	168,000	168,000	168,000
2010	993,587	168,910	248,397	327,884
2015	1,807,102	307,207	451,776	596,344
2020	2,915,417	495,621	728,854	962,088
2025	4,318,532	734,150	1,079,633	1,425,116
2030	6,016,447	1,022,796	1,504,112	1,985,428
2035	8,009,162	1,361,558	2,002,291	2,643,023
2040	10,296,677	1,750,435	2,574,169	3,397,903

Table 5 - Traffic forecast by the parabolic trend (for the Port of Rijeka separately)

Year	2008	2010	2015	2020	2025	2030	2035	2040
Traffic (TEU)	168,761	215,584	499,420	903,342	1,427,348	2,071,440	2,835,616	3,719,878

ern transport route. For input data the amounts of container traffic ports were taken: Rijeka, Koper and Trieste in the period from 1995 to 2008.

In the first step, with the method time series analysis, linear, parabolic and exponential equations are obtained representing the trend for total container traffic of northern ports. Also, appropriate degrees of representativeness for each equation are obtained.

In the second step, the forecast of the future traffic trend continues with the selected parabolic equation because that equation had the highest level of representation (the actual data rate adaptation to the estimated equations). The results obtained are shown in Table 4.

In the third step, total container traffic forecast for the Ports of Rijeka, Koper and Trieste was used as the basis for obtaining forecasts of container traffic of the Port of Rijeka. Three scenarios have been set:

- low, where the share of the Port of Rijeka is assumed at 17% of the total container traffic observed in northern ports,
- medium, with the share of the Port of Rijeka of 25%, and
- high, with the share of the Port of Rijeka of 33%.

#### 4.2 Container traffic forecast of the Port of Rijeka by time series analysis

If the traffic of the Port of Rijeka, in the previous period from 1992 to 2008, was considered separately, without reference to the total turnover of the northern ports of Rijeka, Koper and Trieste, the analysis of time series indicates that observed traffic best adapts to the parabolic trend, which was taken as the basis for further prediction until the year 2030 (Table 5).

#### 4.3 Forecast of container traffic in the Port of Rijeka due to GDP movement

In order to calculate the container traffic forecast of the Port of Rijeka considering the movement of GDP, the following assumptions are defined:

- GDP growth rate in the initial year of forecast is 5%, and in the coming eight-year period shows a continuous slight decrease of about 2% of growth;
- after the eight-year period, from the year 2018 until the final forecast year 2030, the GDP growth rate is constant, and amounts to about 2% with negligible fluctuations around these values.

Table 6 - Container traffic forecast until 2040

Year	Rate - GDP	Traffic (TEU)
2008	-	168,761
2010	5.0000	107,500
2015	2.7500	138,867
2020	2.4721	161,252
2025	2.0473	176,241
2030	2.0892	185,233
2035	2.1769	189,426
2040	1.9496	189,835

#### 4.4 Forecast of container traffic by estimation of the European Commission

Based on the estimated average of annual growth, container traffic from the European Commission accounts for 11%, and the proposed part of the Port of Rijeka in total northern Ports of Rijeka, Koper and Trieste from 17% for the low scenario, 25% for the medium scenario and 33% for high scenario. The obtained data on the traffic forecasts is shown in Table 7.

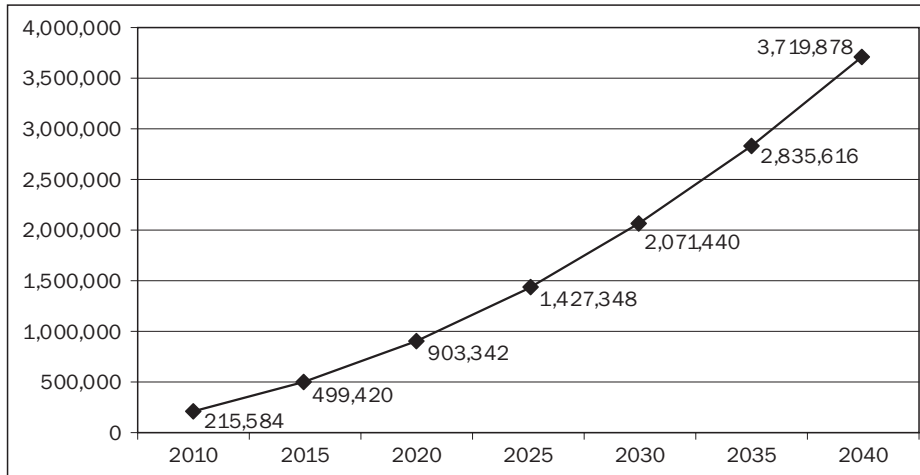


Figure 2 - Traffic forecast by the parabolic trend in TEU

Table 7 - Container traffic forecasts of the northern Adriatic ports and share of Port of Rijeka in the traffic forecasts by the plan of the European Commission and the growth of 11% (in TEU)

Year	Total Trieste, Koper, Rijeka	Port of Rijeka: scenario		
		Low	Medium	High
2010	872,460	148,318	218,115	287,912
2015	1,470,146	249,925	367,536	485,148
2020	2,477,281	421,138	619,320	817,503
2025	4,174,363	709,642	1,043,591	1,377,540
2030	7,034,044	1,195,788	1,758,511	2,321,235
2035	11,852,774	2,014,972	2,963,193	3,911,415
2040	19,972,613	3,395,344	4,993,153	6,590,962

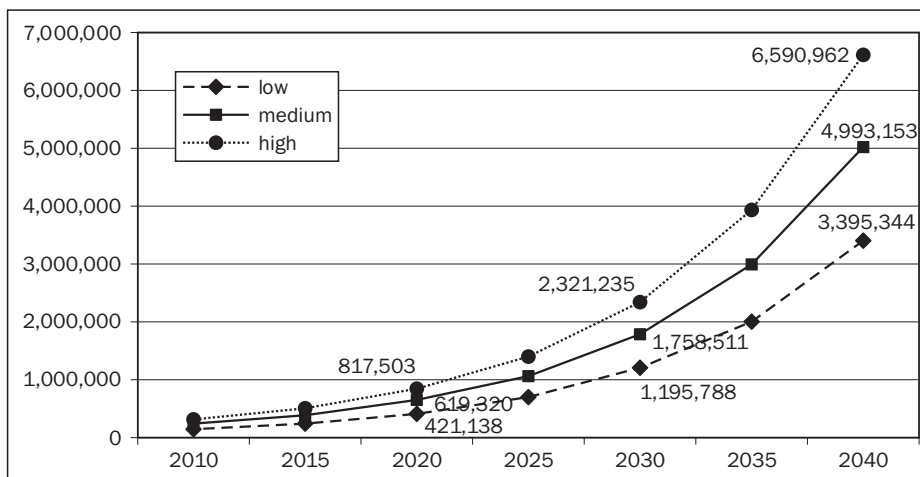


Figure 3 - Traffic forecast by the European Commission plan (in TEU)

#### 4.5 Container traffic forecast by regression analysis

The regression forecast model of container traffic of the Port of Rijeka takes into account, and puts into functional relationship general economic developments of home port countries and transit Central European countries with forecast traffic. For future traffic forecast, the foreign trade of the Croatian ports has

been taken into account, with the gravitational countries of the Port of Rijeka. For the overall operations of each port, the domestic traffic from the national foreign trade is of great importance, since it is a safe load that can always be counted on. However, domestic cargo is generally not sufficient to employ all the port facilities and to guarantee the development, and it becomes more necessary to promote international markets and to provide more goods from the countries

in the port hinterland. Transit traffic represents non-commodity export and generates foreign exchange revenues, and enables the attraction of major quantities of cargo. The regression model set for evaluating the demand for container traffic in the import / export in million USD explains the (independent) variable well enough to satisfy all the economic and statistical criteria, and therefore, it has been concluded that it can be used for further prediction.

Table 8 - Traffic forecast by regression analysis (relating to import/export (in mil.USD))

Year	Forecast import/export (million USD)	Traffic (TEU)
2009	42,331	141,142
2010	47,751	161,919
2015	81,038	289,507
2020	124,632	456,604
2025	178,534	663,209
2030	242,743	909,323
2035	317,260	1,194,946
2040	402,084	1,520,077

#### 4.6 Final forecast

Previous methods of traffic demand forecasts indicate the expected value of different traffic. Therefore, it is one of the possible solutions of providing the average of all methods, and thus has the possibility of getting relevant results. The average values of forecasts show the final score given for medium

and high scenarios, and the results are shown in Table 9.

It can be concluded that different forecasting methods produce results that differ significantly. At this point the important role is played by the port managers who, depending on the directions of further development of port and market, need to choose the most realistic method that suits the current and future market situation.

#### 4.7 Measures and activities for predicting container traffic demand

In order to estimate the demand for container traffic flows as qualitatively and objectively, i.e. realistically as possible, given the contemporary market configuration and anticipated changes in the future predicted period, it is necessary to have verified and elaborate information on the existing volume of container traffic, predicted trends of growth i.e. predicted volume of container traffic in the Port of Rijeka and the wider competitive environment (northern Adriatic port and wider European environment).

However, the attempt to meet this primary condition of issuing an objective forecast which refers to gathering of the above mentioned initial input data on flow of goods, i.e. traffic of the Rijeka Port, has pinpointed some inconsistencies concerning the indicators of traffic volume, especially of the Rijeka Port container traffic. These inconsistencies depend upon the data sources which are various subjects in port processes with their own individual way of monitoring and recording the data. This mostly refers to different management and statistical analyses of the port turn-

Table 9 - Average method to forecast medium and high scenarios (in TEU)

Scenario	2010	2015	2020	2025	2030	2035	2040
Medium	190,303	349,421	573,874	878,004	1,285,724	1,837,094	2,599,422
High	220,160	401,857	660,158	1,013,891	1,494,532	2,154,885	3,083,731

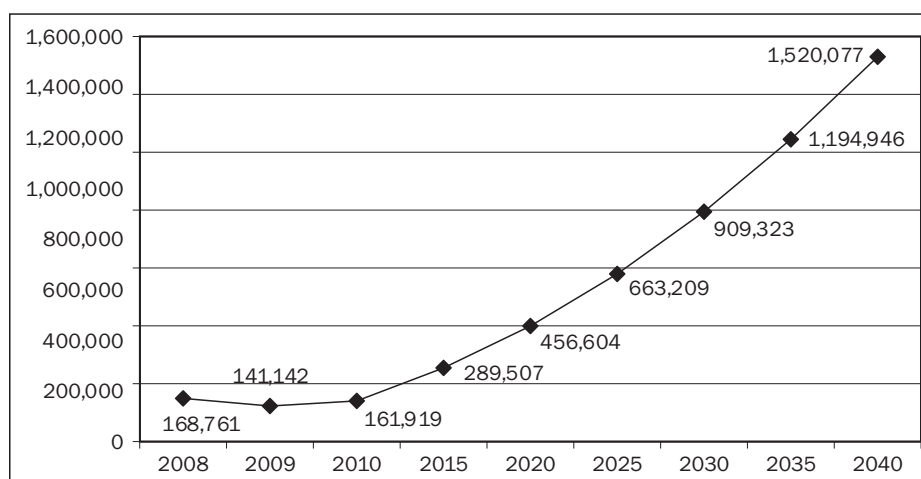


Figure 4 - Traffic forecast by regression analysis (in TEU)



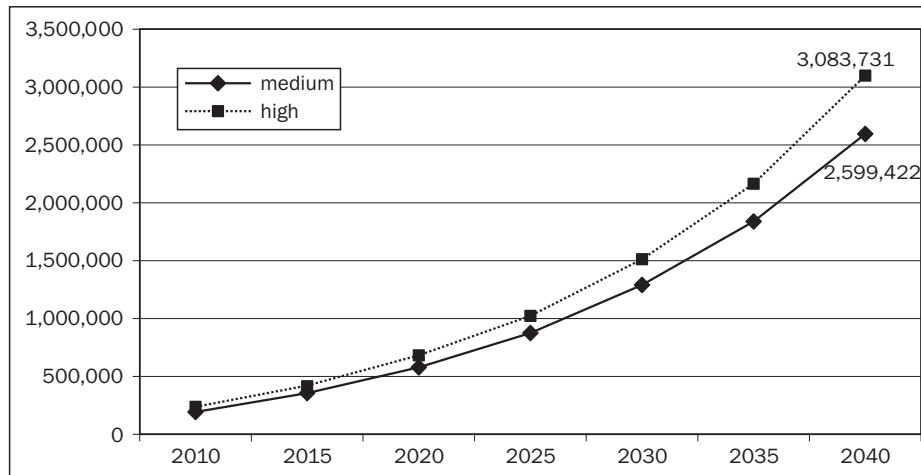


Figure 5 - Average forecasting method for container traffic (in TEU) for medium and high scenarios

over given by port authorities, port captaincies, companies as well as statistical annuals and publications. Therefore, it is almost impossible to obtain accurate and realistic data of the realised turnover in the Port of Rijeka. Therefore, the authors of this paper have made an attempt to overcome these circumstances, for research purposes and in order to be able to anticipate the turnover. Thus, the data on turnover used are result of the analysis that has been carried out taking into consideration various data sources. Here, the undisputable importance of uniform management of statistical data should be emphasised, thus ensuring greater objectivity and accuracy of observing and analysing the existing traffic and anticipating future turnover as well.

In order to obtain a more objective forecast, this research and the anticipated results suppose the necessity of implementing particular projects and investments (increase of operative area, the acquisition of new cranes, construction of new terminals, access roads and railway infrastructure) as well as the need for scheduled deadlines for the realisation of these projects in order to ensure assumptions for realising additional volume of traffic.

In analogy to that, for the achievement of predicted container traffic in the Port of Rijeka, numerous conditions have to be met, and the most important ones are: privatisation of container terminal, construction of the new container terminal on the Zagreb coast, development of intermodal transportation, modernisation and construction of the railway, etc. It is therefore necessary to create a system that will take into consideration and work on the development of all port and traffic entities (physical planning section, local administration, creditors, and relevant government bodies). Such a system should, together with the Port management, aim at creating a "positive climate"; which is an important strategic element of the development of the port and traffic projects.

Only by taking into account the proposed measures, activities and recommendations can there be "talk" about a symbiosis of the scientific approach and professional background, that would result in a qualitative and objective anticipation of cargo turnover at the Port of Rijeka, i.e. a more objective and qualitative forecast of demand for container traffic, that is being analysed in this paper.

## 5. CONCLUSION

The task of port traffic forecasting is to determine the quantity, type and structure of the cargo that will be carried through the port in the next period. While forecasting, the port traffic planners have to deal with predictions that may affect the resizing of traffic, such as, for example, predictions regarding changes in the market to the state of which the port is part of, and transit countries, economic changes in the hinterland of the port, the change in movement of commodity flows, changes in technology, transport of certain goods. According to the fact that forecasting is generally a very complex job with an uncertain outcome, the results of this study indicate that by using different methods of forecasting traffic demand for port services and the results obtained by comparing each prediction, can affect the reduction of uncertain outcomes and a better forecast of the future demand for port services, which can result in many positive business activities (investments, modernization, conversion, or even reallocation). Since the port service cannot be stored, and since the port supply has to satisfy, and be consistent with the current demand, using this method of forecasting is reasonably and necessarily required, but it also requires a large amount of data, continuous monitoring of port traffic, capacity, foreign exchange, GDP values and other required indicators, which highly complicates and raises the price of the forecasting process. Given that forecast traffic demand obtained

in the work indicates the expected value of different traffic it was necessary to make the average of all methods, and thus get relevant results.

When the synthesis of the results obtained by different methods of forecasting is made, it can be concluded that the market demand for the services and transshipment of containers in the Port of Rijeka is far beyond the current capabilities of the existing terminal. The obtained values represent the average value of traffic demand forecasts of container traffic made by different prognostic models for a planned period of up to 2040, and on long-term basis indicates that the expected long-term traffic potential is beyond the existing development projects, "Brajdica 2" and "Zagreb coast", and in the future the construction of a new port terminal for servicing the traffic demand on the Rijeka traffic direction is expected.

Dr. sc. **ALEN JUGOVIĆ**

E-mail: [ajugovic@pfri.hr](mailto:ajugovic@pfri.hr)

Dr. sc. **SVJETLANA HESS**

E-mail: [shess@pfri.hr](mailto:shess@pfri.hr)

Dr. sc. **TANJA POLETAN JUGOVIĆ**

E-mail: [poletan@pfri.hr](mailto:poletan@pfri.hr)

Sveučilište u Rijeci, Pomorski fakultet  
Studentska 2, 51000 Rijeka, Hrvatska

## SAŽETAK

### PROGNOZIRANJE PROMETNE POTRAŽNJE ZA LUČKIM USLUGAMA

Uspješno poslovanje svake morske luke prvenstveno ovisi o usklađenosti prometne ponude i potražnje, dok njihova neusklađenost dovodi do niza problema. Luka, odnosno njen menadžment, svojom poslovnom i dijelom lučkom politikom mogu utjecati na planiranje izgradnje ili modernizacije svojih lučkih kapaciteta. Pritom, navedeno planiranje zahtjeva prognoziranje i kvantificiranje potreba za lučkim infrastrukturnim uslugama, odnosno procjenu prometne potražnje. Sukladno tome, osnovni problem istraživanja u ovom radu je prognoziranje prometne potražnje za lučkim uslugama primjenom odgovarajućih metoda prognoziranja. U svrhu pronalaženja načina rješavanja konkretnog problema u lučkom poslovanju, postavljanjem metodologije i prikazom primjene metoda ekonomskog prognoziranja, odabrane metode prognoziranja potražnje za lučkim uslugama potražnje ilustrirane su i testirane na primjeru najveće hrvatske teretne luke, luke Rijeka.

### KLJUČNE RIJEČI

planiranje, prognoza, prometna potražnja, robni tokovi, lučki kapaciteti

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