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Forecast for Lorry Traffic – Example of State Road D – 404 in Rijeka City

Summary

The study presents an analysis of the impact produced by the construction and modernization of road connections on the improvement and development of the port of Rijeka container terminal and on the growth of its competitiveness on the northern Adriatic traffic route.
The paper focuses on the smoothing technique implementation as a quantitative prognostic method for road traffic. Considering the importance of container traffic within the total freight traffic in the port of Rijeka, prognostics is presented for lorry traffic on State road D – 404, which connects the container terminal of Brajdica to the expressway network to the hinterland. Thereby, the potential substratum gravitating to the container terminal and to the pertaining traffic route has been evaluated. Following description of the geographical, traffic-related and logistic situation of the port of Rijeka, the paper continues with technical and technological features of the container terminal of Brajdica and, in addition, with the significance of State road D – 404 for development of the container terminal of Brajdica and an analysis of lorry traffic trends on State road D – 404.
Whereas there are confirmed assertions that there are significant differences found quite often between projected values and those ones actually obtained, the expected traffic trend values obtained by applying the smoothing technique using the moving averages method for 2017 have been assessed as satisfactory.

Key words: forecast for lorry traffic, quantitative prognostic method, smoothing prognostic technique

1. Introduction

The basic prerequisite for efficient operation of any traffic system, inclusive of road and port traffic systems, is the traffic supply and demand in harmony. Their disharmony leads to a variety of difficulties. In case of the demand for traffic services exceeding the supply, the result is congestion of traffic capacities on roads or port terminals which consequently causes traffic jams, increased external costs, etc. On the other hand, the

supply exceeding the demand causes underutilization of traffic infrastructure and superstructure and thereby their unprofitability.

Considering that traffic infrastructure is inflexible and its construction and development require considerable financial investments, in order to be profitable it must be dimensioned in compliance with the expected future demand. The meaning is that, in order to avoid consequences of the traffic supply and demand in disharmony, there is the need for the demand for traffic services to be forecasted. Making of traffic forecasts or traffic demand projections for the future as precise as possible represents the main stage in the traffic infrastructure planning and design process.

The traffic infrastructure and superstructure coverage and development have an extremely important meaning for the development and operation of a particular port. The road transport is particularly important for the speed, flexibility and efficiency it provides but also for the possibility of 'door to door' delivery which has been reaching an increasingly growing trend in modern business conduct. The port of Rijeka is located at the very heart of the city and this fact poses a problem both for the port itself and for the city in general. On one hand the city prevents further extension of port capacities due to shortage of space, while on the other, the port located at the heart of the city prevents further expansion and development of the city itself.

For freight traffic prognostic purposes there are methods to be used which are divided in two groups: qualitative and quantitative ones. Qualitative prognostic methods include: reporting techniques, interviews, consulting teams, and Delphi method. Quantitative prognostic methods are the following: time sequence analysis, smoothing techniques, barometric methods, and econometric models. Quantitative prognostic methods are more precise where short-term forecasting is concerned and their implementation is more time-consuming. Quantitative methods are used to present quantitative results of a study carried out or to forecast trends that will follow the present data in the future period. Detaljnija objašnjenja o uporabi navedenih metoda mogu se naći u literaturi: [11], [14] and [15].

The study has the aim to present the implementation of quantitative methods in forecasting freight traffic trends on State road D – 404 or freight traffic flows from/to the port of Rijeka container terminal. The method applied in the study was the smoothing technique using the moving averages method and the exponential smoothing technique.

2. Container terminal 'Brajdica'

Owing to its exceptionally favourable geographical situation, the port of Rijeka is connected with Zagreb via the Kupa river basin, and further on with the Pannonia Plain or the Danube river basin and central Europe, representing for all those regions an exceptionally significant trading port. With two pan-European corridors (V. X.) passing through the country, the port of Rijeka is an integral part of Europe. [13]

Picture 1. Gravitational zone of the port of Rijeka
Source: http://logsys.hr/pictures/rijeka_distance.jpg (25.06.2017.)

Picture 1. shows the gravitational zone of the port of Rijeka that is elaborated in the next chapter.

2.1. Geographical, traffic-related and logistic situation of the port of Rijeka

This situation of the port of Rijeka has enabled its location within the catchment area of numerous central and Eastern-European countries such as: Hungary, Slovakia, Slovenia, southern Poland, Austria, southern Germany, Bosnia and Herzegovina, Serbia, Bulgaria, Romania and many others. The significance of the northern Adriatic traffic route within the global trade is reflected in its role of the shortest and most cost-effective traffic route connecting Europe with the Mediterranean, and further on via the Suez Canal with many Asian countries where most of the present-day production is concentrated. Apart from Asian countries, the Suez Canal is the link to African countries and Australia. This route connects the part of the world distinguished of its highly developed industry to countries presently going through their developing stage.

There are some important traffic connections running from Central-European landlocked countries to the Adriatic Sea ports to cross within national territories of

Croatia, Slovenia and Italy with other important traffic flows running from Western and Central Europe to South-Eastern Europe and the Near East. [2]

Transport connection of the Danube and the Adriatic geographical area represents the connection of national areas with the Mediterranean area and its hinterland, which connects the continental countries of Central Europe with the Mediterranean.

Table 1 presents distances between three competitive ports (Rijeka, Koper, Trieste) and main economic centres in their respective hinterlands.

Table 1 - Distances between the ports of Rijeka, Koper, and Trieste and important European economic destinations

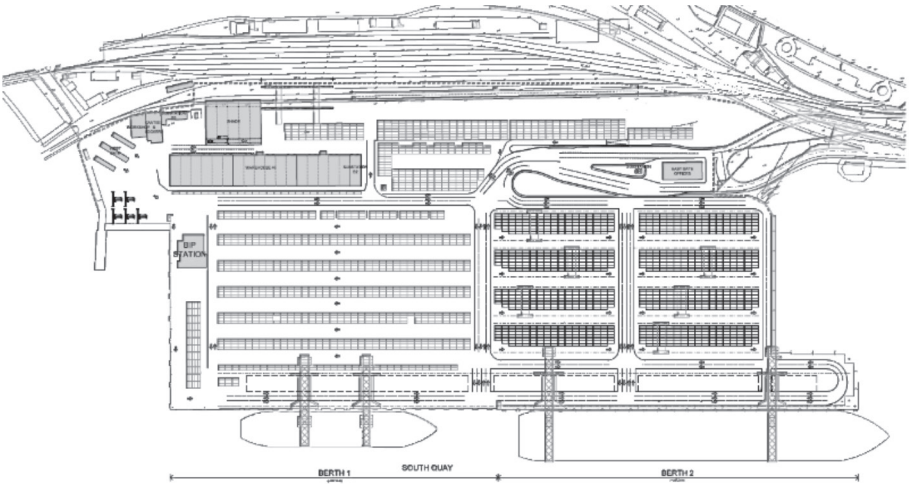
Road (distance in km)	Rijeka	Koper	Trieste
Budapest	509	567	556
Munich	515	506	494
Vienna	520	489	477
Belgrade	557	631	619
Bratislava	562	555	543
Prague	820	809	798

Source: the authors.

As for Central-European destinations, land transport distances are measurably shorter than from Northern-European ports, as presented in Table 1. The difference in the distance between the selected competitive ports in Northern Adriatic and European capitals is quite small and even insignificant where port of call is to be selected.

2.2. Features of container terminal Brajdica

Container terminal Brajdica is located in the eastern part of the port of Rijeka, at the eastern mouth of river Rječina, covering approximately 168.000 m^2 out of which an approximate area of 15.000 m^2 accommodates warehousing spaces for loading and unloading containerised cargo (container freight-station - CFS) and for container cleaning and repair purposes. The terminal quay is 514 m long, with berthing depth of 12 m, thus enabling accommodation of ships of up to 35.000 DWT. The terminal is provided with two functional berths for ships. The one most recently built is 14.5 m deep and provides safe mooring for larger container parent ships which makes the port of Rijeka not only feeder ship port but also a port capable of accommodating larger and/or parent ships as well.



Picture 2. Topographic map of container terminal "Brajdica" of Rijeka
Source: http://www.ictsi.hr/index.php/hr/detalji-o-terminal (03.05.2017)

Picture 2. is a topographic map of the container terminal containing all relevant areas and facilities for complete handling of traffic services.

The construction and modernization of the terminal were completed in mid 2013. With the completion of phase II, the construction of 328 m of an additional new quay was completed of depth of 14.5 m, an entry-exit ramps at the connection to State road D-404, railway station, a platform intended for preparation of containers prior to their loading on/unloading from wagons to enable faster and more efficient container handling operations. Following the construction of an additional berthing area, the quay was equipped with two additional container cranes of features required for servicing of Post–Panamax container ships of capacity ranging from 8 000 to 10 000 TEUs. [16].

The latest ensemble comprised with the construction phase II includes a servicing garage for loading/unloading facilities, which is appropriately provided with all the necessary contents, warehouses, office premises and other spaces intended for servicing of loading/unloading facilities in compliance with Croatian ecological standards.

Apart from these berths, the container terminal also includes other spaces required for complete service supply such as: container stowage, repair, stuffing/unstuffing, space for accommodation of containers requiring maintenance of particular inner temperature, space for container forwarding to the hinterland by road, and railway tracks for wagons intended for container forwarding to the hinterland by rail.

„Jadranska vrata d.d." (Adriatic Gate), the company established in 2001 as a subsidiary of Luka Rijeka d.d. (Port of Rijeka) with a 10-year concession for commercial activity within the area of container terminal 'Brajdica'. In 2011, international port operators ICTSI (International Container Terminal Services) became strategic partners of container terminal 'Brajdica' through a 30-year partnership with Luka Rijeka d.d.

(Port of Rijeka) in the area of commercial activity, management and development. Today, Luka Rijeka d.d. (Port of Rijeka) owns 49% of shares in Jadranska vrata d.d. (Adriatic Gate), concession owners of container terminal 'Brajdica', while the ICTSI holds 51% of shares.

3. Significance of State Road D – 404 for development of container terminal 'Brajdica'

The port of Rijeka is connected to the hinterland with two expressways, i.e. the A6 expressway (Rijeka- Zagreb) and the A7 expressway (Rupa – Rijeka – Žuta Lokva). The A6 expressway links the Republic of Croatia capital Zagreb and the city of Rijeka, which accommodates the major national freight port, to the road network of Central and Western Europe. Near the hub of Bosiljevo, expressway A6 provides the diverging possibility to expressway A1 (Zagreb- Split) leading to Central and Southern Dalmatia. Expressway A7 (Rupa – Rijeka – Žuta Lokva) is only partly open for traffic, i.e. from the border crossing of Rupa to Križišće. Connections with these expressways satisfy the port of Rijeka requirements for smooth traffic flow without standstills and delays and for continual and free-flowing border crossing at the exit route from Croatia to neighbouring countries.

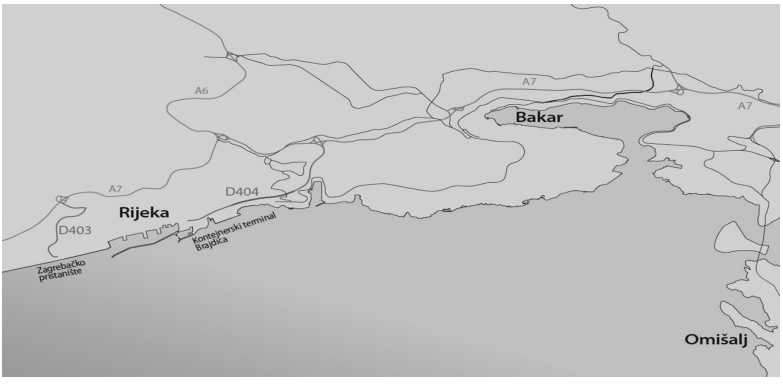
The development and extension of the city and the port of Rijeka cause traffic congestion both downtown and in the surrounding districts due to increased lorry traffic flowing to or from the port. The problem has been partly solved with the construction of the Rijeka ring-road stretching from the hub of Matulji to the hub of Orehovica along 11.89 km as a link to expressway A7. The Rijeka ring-road with its branches leading in the direction of Trieste, Ljubljana, Zagreb and Split represents the trunk road connection of a wider international significance as a branch of the trans-European road connection. [5]. With the view to relieving urban traffic and avoiding lorry/container traffic through the city, State road D-404 was open for traffic in 2008 thus providing a link between container terminal 'Brajdica' and the hub of Draga at the Rijeka ring-road and/or expressway A7.

3.1. Construction of State Road D - 404

In the past two decades, due to increased international trade in containerised goods and to the introduction and growing rate in the number of container liner services at the port of Rijeka, growing trend has been also affecting traffic density on road connections. Growth in the road transport as a branch of transport enabling fast, efficient, and flexible transport of goods on a door-to-door or from-producer-to-consumer basis has caused congestion of urban and local roads within the city of Rijeka.

Within the road transport hub of Rijeka, major role is attached to two road connections (D-404 and D-403) which fall within the category of roads of national importance,

yet with a very significant role for the operation of the whole urban traffic system and for relieving city streets from freight transport and transit. [13]



Picture 3 - Cartographic display of the newly built road D-404 and the D-403 presently in the terminal-phase of construction
Source: http://www.portauthority.hr/docs/portauthorityHR/documents/13/1.0/Original.pdf (05.05.2017)

Picture 3. shows sections of roads D – 404 and D – 403. State road D – 403 is going to connect the new container terminal at the Zagreb Pier and its construction has not yet commenced. The D - 404 road route begins in the very centre of the city, i.e. from the Ivan Zajc Street over the districts of Delta and Brajdica where the container terminal itself is located, and through the recently built tunnel Pećine, to be connected above the district of Martinšćica to the road hub of Draga and/or to the eastern Rijeka ring-road and expressway A7. This section of the newly constructed road has provided direct connection between container terminal 'Brajdica' and the expressway. By having brought this project to life, the city and the port of Rijeka have enabled direct connection to four crucially important road connections: toward Slovenia and Italy, toward Slovenia and Austria, toward Hungary, and toward Serbia and other Eastern European regions.

Due to congested urban traffic before the construction of State road D – 404, both the urban traffic in Rijeka and the existing infrastructure were choking, requiring frequent reconstruction and renewal interventions which used to cause significant traffic limitations and redirecting within the area. The D – 404 road total length is 3.49 km, the major portion of which or 45% consists of tunnels and 15% of viaducts and a bridge. The investment in the construction amounts to HRK 640 mil. The D – 404 is a four-lane road of 3.50 m lane width and a 0.30 m marginal strip. At the above mentioned section between terminal 'Brajdica' and the road hub of Draga, there are 7 infrastructure facilities, a bridge, five viaducts and two tunnels enabling shorter and faster travelling along the distance. [7].The most important and most complex portion of the road construction was the Pećine tunnel which required overcoming of the 35 m height difference along 1,341 m.

Among the most important advantages achieved by the construction and exploitation of the D – 404 road there are the city centre and the surrounding area relief from freight transport in transit, reducing of pollution from harmful gas emissions, reducing of noise and vibrations, increasing safety of other participants in traffic, reducing commuter excess waiting time as a result of reduced congestion of city streets.

3.2. Analysis of lorry traffic trends on State road D – 404

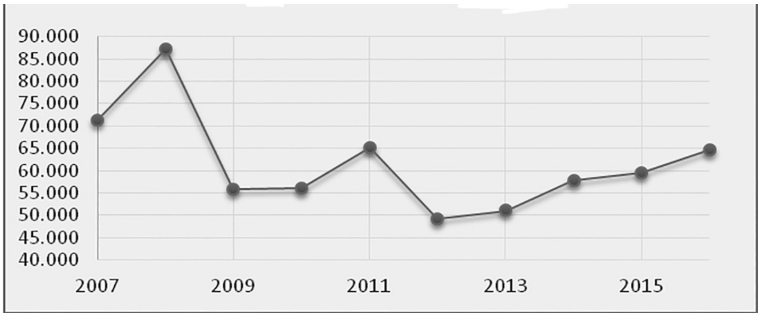
Table 3 shows data concerning lorry traffic trends on D – 404. Due to the missing traffic counter on the road, data collected in respect of lorry entry/exit from the terminal in the period 2007 – 2016 are the only equivalent to the data on lorry traffic count on the D-404 road referring exclusively to container terminal.

Table 2 - Statistics on freight traffic on D-404 (in the number of lorries)

YEAR	FREIGHT TRAFFIC ON D-404
2007	71,420
2008	87,355
2009	55,814
2010	56,073
2011	65,279
2012	49,273
2013	51,099
2014	57,891
2015	59,581
2016	64,730

Source: Prepared and adjusted by the authors according to statistics by AGCT

Graph 1 - Lorry traffic on the D-404 road in the period 2007-2016



Source: Prepared by the authors according to data from Table 3. using MS Excel

According to the data displayed, it can be stated that there were no major cyclic traffic oscillations in the period observed. The only major change worth mentioning here was the traffic drop in 2009 as a result of the global economic crisis that had affected the market. The period between 2012 and 2016 recorded a traffic growth rate of approximately 7.14% on the average, which indicates a positive traffic trend that may be envisaged for the D-404 road in future as well. In 2016, the recorded traffic growth rate was 8.64 % as compared to the preceding year, which makes us conclude that, provided the continued positive traffic trend, the traffic forecast for 2017 may reach approximately 70,000 lorries depending significantly, however, on other factors as well. By observing traffic trends during a 10-year period, it may be noticed that the 2016 recorded a traffic drop rate of 9.36% as compared to 2007.

4. Prognostics for lorry traffic on State Road D-404

Making prognostics for future trends and determining values of variables in future periods are very complex and demanding tasks. Future trends can be considered and determined through forecasting using appropriate methods. Traffic forecasting consists of analysis of so-far traffic trends, determination of future development trends and estimates for a particular period and represents the key segment of the observed planning. [3].

Any forecasting should include an analysis of the present state and consequences of goods flow trends as well as an analysis of past trends. In analyzing the port of Rijeka traffic flows, it is necessary to evaluate its size and its significance in terms of traffic and economy. Such an evaluation is to be performed by analyzing the intensity of goods flows by land transport and the economic strength of the port hinterland as the goods' destination. Traffic prognostics may be performed by the major group of goods calling at the port or even by the direction of goods flow.

Prognostics are made using appropriate qualitative and quantitative methods in dependence on the given issue and many other factors affecting the selection of forecasting method. In forecasting freight traffic on the D-404 road, quantitative prognostic methods will be used. Quantitative methods require in the first place observation of traffic trends in the so-far period and then quantification of interdependence between the observed phenomena. It is important to note here that any method used in making prognostics for future trends include stability of the observed system as the prerequisite. Likewise, it should be pointed out that prognostics are not exact or that the results actually obtained in respect of the observed problem are different from the ones prognosticated. To this end, a certain space needs to be set aside for possible errors.

The method used in making the prognostics was the quantitative one using the smoothing technique. The data the prognostics are based on refer to container loading/unloading from lorries within the terminal „Brajdica" and on freight lorry flow on the D-404 road to/from the port which were analyzed in the preceding chapter.

4.1. Prognostics for freight traffic on the D – 404 road using smoothing techniques

Smoothing techniques belong to quantitative methods that are used, beside the time series analyses, in short-term prognostics. By these techniques, future values of an observed time series are forecasted on the basis of different average values from the past. The most significant and most frequently used smoothing techniques are moving averages and exponential smoothing. Smoothing techniques are most frequently used in short-term forecasting because they enable forecasting exclusively for one time period in advance (1 year, 1 quarter, 1 month, 1 day). The exponential smoothing technique is most frequently used in practice because it provides more acceptable results than the moving averages technique. This is because the exponential smoothing technique takes into account that the data referring to several recent time periods are more significant and provide much more precise and better results than the data from the beginning of the period.

4.2.1. Traffic forecast using the moving averages technique

The moving averages technique represents the simplest smoothing technique used in forecasting future trends. It is based on the fact that the forecasted value of a time interval in a time period equals the average value of intervals in several past time period. Tables 6, 7 and 8 show the forecast using the moving averages technique for two, three and five time periods. After the completed forecasting, it is necessary to decide which one of the moving averages indicates a more precise forecasted value that is more approximate to actual data or which forecasted values are more credible. Such a decision is to be made by taking into consideration the value of the root mean square error (RMSE). The moving average or the exponential smoothing ponder showing lower RMSE will be used in forecasting future period trends.

Table 3 – The two-year moving average

YEAR	LORRY TRAFFIC ON D-404 (in 000) (A)	2-year moving average (F)	A-F	$(A-F)^2$
2007	71.420	-	-	-
2008	87.355	-	-	-
2009	55.814	79.39	-23.57	555.710
2010	56.073	71.58	-15.51	240.607
2011	65.279	55.94	9.34	87.152
2012	49.273	60.68	-11.40	130.028
2013	51.099	57.28	-6.18	38.155
2014	57.891	50.19	7.71	59.367
2015	59.581	54.50	5.09	25.867
2016	64.730	58.74	5.99	35.928
2017		**6216**	∑	1172.814

Source: Prepared by the authors according to data from Table 2.

The forecasted values for a two-year period were obtained as the arithmetic mean for two past periods. The forecast for 2017 based on a two-year moving average results in 62,160 freight vehicles or 2,570 lorries less than in the preceding year. The RMSE for the two-year moving average results in 12.11.

Table 4 – The three-year moving average

YEAR	LORRY TRAFFIC ON D-404 (in 000) (A)	3-year moving average (F)	A-F	$(A-F)^2$
2007	71.420	-	-	-
2008	87.355	-	-	-
2009	55.814	-	-	-
2010	56.073	71.53	-15.46	238.909
2011	65.279	66.41	-1.14	1.288
2012	49.273	59.06	-9.78	95.694
2013	51.099	56.88	-5.78	33.362
2014	57.891	55.22	2.67	7.150
2015	59.581	52.75	6.83	46.603
2016	64.730	56.19	8.54	72.926
2017		**60.73**	∑	495.933

Source: Prepared by the authors according to data from Table 2.

The forecasted values for a three-year period were obtained as the arithmetic mean for three past periods.

The forecast for 2017 results in 60,730 freight vehicles or 4,000 lorries less than in 2016. The RMSE for the three-year moving average results in 8.42.

Table 5 – The five-year moving average

YEAR	LORRY TRAFFIC ON D-404 (in 000) (A)	5-year moving average (F)	A-F	$(A-F)^2$
2007	71.420	-	-	-
2008	87.355	-	-	-
2009	55.814	-	-	-
2010	56.073	-	-	-
2011	65.279	-	-	-
2012	49.273	67.19	-17.92	320.954
2013	51.099	62.76	-11.66	135.951
2014	57.891	55.51	2.38	5.681
2015	59.581	55.92	3.66	13.381
2016	64.730	56.62	8.11	65.698
2017		**56.51**	∑	541.664

Source: Prepared by the authors according to data from Table 2.

The forecasted values for a five-year period were obtained as the arithmetic mean for five past periods. The forecast value for 2017 based on the five-year moving average results in 56,510 lorries or almost 10,000 lorries less than resulting from the known value in 2017. The RMSE for the five-year moving average results in 10.41.

The forecast for 2017 obtained on the basis of the three-year moving average amounting to 60,730 is more reliable and provides more precise results than the one based on the two-year moving average resulting in 62,160 and the one based on the five-year moving average resulting in 56,510. In selecting the more representative forecasting results, it is important to follow the RMSE values. The lower the value of this parameter, the more precise the forecast, i.e. the closer the forecast to actual values.

4.2.2. Traffic forecast using the exponential smoothing technique

The exponential smoothing technique is more frequently used owing to its more precise results in comparison with the moving averages technique. The forecast for the period t+1 (F_{t+1}) using the exponential smoothing technique is obtained as a pondered average of the actual and forecasted values of the time series within the period t. When using the exponential smoothing technique, the actual value of the time series is attached the corresponding ponder ω which may acquire a value between 0 and 1. By selecting the ponder value of 1, the result will be the value equalling the actual value of the time series. This forecast is known as the naive forecast.

At the beginning of the procedure, it is necessary to add a value to the initial forecast. One possibility is for value F_t to take the mean value of the whole time series observed. Tables 9, 10 and 11 show the exponential smoothing forecasts based on ponders (ω) 0.1, 0.3, 0.5.

Table 6 – Exponential smoothing with ponder ω= 0.1

YEAR	LORRY TRAFFIC ON D-404 (in 000) (A)	FORECAST with w=0,1 (F)	A-F	(A-F)^2
2007	71.42	61.85	9.57	91.56
2008	87.355	62.81	24.55	602.54
2009	55.814	65.26	-9.45	89.28
2010	56.073	64.32	-8.25	67.98
2011	65.279	63.49	1.79	3.19
2012	49.273	63.67	-14.40	207.34
2013	51.099	62.23	-11.13	123.95
2014	57.891	61.12	-3.23	10.42
2015	59.581	60.80	-1.22	1.48
2016	64.73	60.67	4.06	16.45
			∑	1214.17
2017	-	**61.08**		

Source: Prepared by the authors according to data from Table 2.

According to the forecasting using ponder ω=0.1, the 2017 forecast results in 61,080 lorries. The RMSE value results in 11.02.

Table 7 – Exponential smoothing using ponder ω= 0.3

YEAR	LORRY TRAFFIC ON D-404 (in 000) (A)	FORECAST using **w=0.3 (F)	A-F	(A-F)^2
2007	71.42	61.85	9.57	91.56
2008	87.355	64.72	22.63	512.25
2009	55.814	71.51	-15.70	246.43
2010	56.073	66.80	-10.73	115.12
2011	65.279	63.58	1.70	2.87
2012	49.273	64.09	-14.82	219.61
2013	51.099	59.65	-8.55	73.06
2014	57.891	57.08	0.81	0.65
2015	59.581	57.32	2.26	5.09
2016	64.73	58.00	6.73	45.27
			∑	1311.91
2017	-	**60.02**		

Source: Prepared by the authors according to data from Table 2.

Using ponder ω=0.3, the obtained forecast value is obtained for 2017 of 60,020 as compared to the preceding one using ponder ω=0.1. The forecasted value obtained for 2017 is lower by 1.74% than the one obtained using ponder ω=0.1. The respective RMSE value is 11.45.

Table 8 - Exponential smoothing using ponder ω= 0.5

YEAR	LORRY TRAFFIC ON D-404 (in 000) (A)	FORECAST using **w=0.5 (F)	A-F	$(A-F)^2$
2007	71.42	61.85	9.57	91.56
2008	87.355	66.64	20.72	429.29
2009	55.814	77.00	-21.18	448.65
2010	56.073	66.40	-10.33	106.74
2011	65.279	61.24	4.04	16.32
2012	49.273	63.26	-13.99	195.61
2013	51.099	56.27	-5.17	26.70
2014	57.891	53.68	4.21	17.71
2015	59.581	55.79	3.79	14.40
2016	64.73	57.68	7.05	49.65
			∑	1396.62
2017	**-**	**61.21**		

Source: Prepared by the authors according to data from Table 2.

As resulting from the above table, the forecasted value for 2017 is 61,210 lorries. The RMSE value is 11.82.

The forecasting using three ponders was carried out in order to enable best choice among those offered, i.e. selection of the forecast providing the most accurate forecast data for 2017. Selection of the most accurate forecast is made on the basis of the lowest RMSE. Among the above presented forecasts the lowest RMSE results from the forecast using ponder ω=0.1, i.e. this forecast is closer to actual values. There follows the interpretation of the result obtained using the exponential smoothing method stating that the value obtained for 2017 using ponder ω=0.1 (61,080) provides more accurate and more reliable data than the forecasted value of 60,020 obtained using ponder ω=0.3 and the value obtained using ponder ω=0.5 (61,210).

By comparing the selected results obtained using the moving averages method ($F_{2017.}$=60,730) and by the exponential smoothing method ($F_{2017.}$=61,080) it is possible to state that the value obtained for 2017 obtained using the three-year moving average provides more reliable results than the value obtained using the exponential smoothing method based on ponder ω=0.1. The difference between the data displayed is that the forecasted value using the three-year moving average is lower by 0.57% than the forecast obtained using ponder ω=0.1. The presented departure is minimal and will not produce any significant effect upon the value to be actualized in 2017. It is interesting to observe that the values forecasted using smoothing techniques result in lower values than the values actually obtained in 2016, whereby the assumption and assertion is confirmed that a certain space needs to be set aside for possible errors in respect of forecasted data because forecasted values are often significantly different from those actually obtained.

Conclusion

State road D-404 is of vital importance for the road freight transport within the city of Rijeka since it represents the connection between container terminal 'Brajdica' and the eastern ring-road and expressway A7, and further connections to expressways to Zagreb and Ljubljana. Its construction and opening for traffic provided relieving of urban traffic and avoiding lorry/container traffic through the city and wider urban area of Rijeka.

Traffic projections for the future period are significant for planning and design purposes and can be made using appropriate forecasting methods.

Traffic forecasting is the key segment in the traffic planning process, which refers to analyses of traffic trends in the so-far period, determination of future traffic trends and estimates for a particular period. Traffic forecasting can be performed using appropriate qualitative and quantitative methods. Qualitative methods are more concerned with subjective approach and/or opinion of individuals. On the other hand, quantitative methods are used to present quantitative results of the study involved and therefor their implementation is more frequent in traffic forecasting. Quantitative forecasting methods require more time for implementation but are more precise for short-term projections. These methods are aimed at forecasting trends to follow the so-far traffic rate in a particular future period.

In forecasting freight traffic trends on the D-404 road, the quantitative forecasting method using the smoothing technique was implemented.

Having analyzed the prognostic results obtained by the moving average and exponential smoothing methods, we were lead to the conclusion that the most relevant projection of traffic forecast was the one obtained on the basis of the three-year moving average. The forecast for 2017 obtained on the basis of the three-year moving average amounts to 60,730 lorries which is 4,000 less than the amount reached in 2016.

Although the container terminal 'Brajdica' resulted in a turnover of 103,791 TEU in the first half of 2017, which exceeded by 16% the one of 2016, the amount obtained has been assessed as satisfactory taking into account the fact that this year has seen significant growth in container transport by rail as a result of market liberalization.[9].

However, better quality projections for future traffic values, in particular for several years in advance, would require implementation of additional forecasting methods with other factors to be taken into account beside traffic trends from the past period. The container port traffic as well as the road freight traffic being dependent on economic trends in general, changes on the market and other factors, it is recommended for a more complete forecasting in further research work to use other methods in addition to smoothing technique methods.

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Prognoza kamionskog prometa na Državnoj cesti D – 404

Sažetak

U radu je analizirano kako izgradnja ili modernizacija cestovnih prometnica utječe na unaprjeđenje i razvoj kontejnerskog terminala riječke luke te povećanje njene konkurentnosti na sjevernojadranskom prometnom pravcu.
Cilj ovoga rada je prikazati primjenu metode tehnike izglađivanja kao kvantitativne metode za prognoziranje cestovnog prometa. S obzirom na značaj kontejnerskog prometa u ukupnom teretnom prometu riječke luke prognoza je načinjena za kamionski promet na Državnoj cesti D – 404, prometnici koja povezuje kontejnerski terminal Brajdica sa autocestovnom mrežom prema zaleđu. Na taj način procijenjen je potencijalni supstrat koji gravitira kontejnerskom terminalu i pripadajućem prometnom pravcu. Nakon opisa geoprometnog i logističkog položaja riječke luke prikazana su tehničko-tehnološka obilježja kontejnerskog terminala Brajdica. Nadalje, prikazano je značenje Državne ceste D – 404 za razvoj kontejnerskog terminala Brajdica te je analizirano kretanje kamionskog prometa na Državnoj cesti D – 404.
Iako su potvrđene tvrdnje da se prognozirane vrijednosti često znatno razlikuju od stvarno ostvarenih, dobivene veličine očekivanog prometa pomoću tehnike izglađivanja metodom pomičnih prosjeka za 2017. godinu ocijenjene su kao zadovoljavajuće.

Ključne riječi: prognoza kamionskog prometa, kvantitativne metode prognoziranja, tehnika izglađivanja.