EVALUATION AND FORECAST OF THE FUNCTIONAL REGION OF THE NORTHERN ADRIATIC AIR TRAFFIC

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Abstract

The aim of this paper is to evaluate demand for air passenger traffic of the functional region of the Northern Adriatic and to define future measures (infrastructure, work and organization) in the air traffic sector of the functional region. The purpose of the paper is to prove the hypothesis that air traffic of the functional region of the Northern Adriatic is dependent on tourism, that existing airports meet the needs of the functional region and that it's not necessary to plan and build new airports. Research results rest on secondary information sources and scientific methods of descriptive and inferential statistics. The key finding of this paper indicates the growth of demand for air traffic, necessity of technical, technological and safety improvements and the need for expanding and upgrading new areas so that air traffic of the functional region of the Northern Adriatic may function more efficiently.

Key words: functional region of the Northern Adriatic, air traffic, demand, infrastructure, tourism

1. INTRODUCTION

Functional regions are areas with high-frequent intraregional interaction. The concept of functional regions is applied worldwide with the aim of understanding and defining functionally connected areas for the purpose of managing traffic system across administrative boundaries, however they cannot be considered constant in terms of space, so they have to be followed and adjusted continually. The most

common approach to defining functional regions is based on analysis of information on population commuting to work and school as daily migrations may serve as a quality basis for identifying the degree of other interaction forms. The functional region of the Northern Adriatic as one of six Croatian functional regions covers the area of the Istria county, Primorje and Gorski Kotar county and Lika and Senj county.

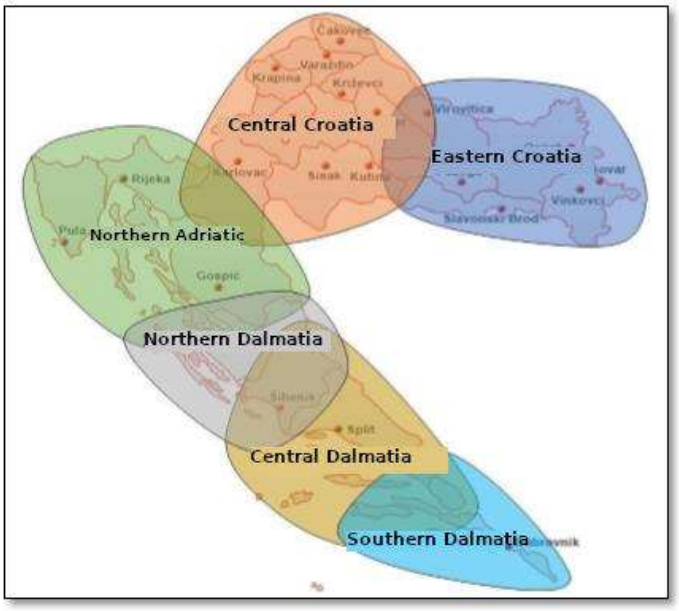
Air traffic and air traffic infrastructure represent a major factor of economy development and particularly of tourism in the area of the functional region of the Northern Adriatic. Consequently, this paper researches the correlation between the number of tourist arrivals and air traffic demand of the functional region of the Northern Adriatic in order to get an answer whether the existing air traffic infrastructure can meet current and future needs of the functional region and whether it is necessary to invest in building the new air traffic infrastructure. In order to find answers to these questions i.e. to prove the constructed hypothesis that existing airports meet the needs of the functional region – current and future demand for air passenger traffic and that no planning and building of new airports is required, in various combinations numerous scientific methods have been employed from which the methods of descriptive and inferential statistics stand out.

2. CURRENT AIR TRAFFIC SITUATION OF THE FUNCTIONAL REGION OF THE NORTHERN ADRIATIC

Development of traffic system in the Republic of Croatia is considered highly important for both economic and social growth as well as international connectivity. Traffic system that consists of traffic infrastructure and its organization/management is an instrument of local development that fosters exchange of goods and better accessibility to all economic, health, tourist and other occurrences. Consequently, the Traffic Development Strategy of the Republic of Croatia for the period from the year 2017 to the year 2030 was drawn up, adopted and passed by the government of the Republic of Croatia in the session held on 24th August 2017 (National Gazette 84/17). The aforementioned strategy divided Croatia into six functional regions characterized by high level of traffic interaction within their respective areas as follows: 1) central Croatia, 2) eastern Croatia, 3) northern Adriatic, 4) northern Dalmatia, 5) central Dalmatia and 6) southern Dalmatia (Figure1).

In the area of the functional region of the Northern Adriatic there are three internationally certified airports that were awarded certificates in accordance with: 1) European Commission Regulation (EU) no. 139/2014: a) Pula Airport – permanently; b) Rijeka Airport – permanently. 2) Air Traffic Act (National Gazette no. 69/09, 84/11, 54/13, 127/13 and 92/14), Article 75, Mali Lošinj Airport – permanently.

Figure 1. Zones for functional and regional analysis



Source: Traffic Development Strategy of the Republic of Croatia for the period from the year 2017 to the year 2030

Pula, Rijeka and Mali Lošinj Airports serve regular international and domestic air traffic (network, charter and low-budget airlines) as well as irregular air traffic particularly in the tourist season (summer, a part of spring and autumn). There are regular flights to bigger neighbouring airports and international hubs such as Paris, Frankfurt, Vienna, Munich and London. Pula and Rijeka Airports are dominantly ports of international and Mali Lošinj of local character. Pula Airport has direct flights to 17, and Rijeka Airport to 10 European countries. These flights, besides Croatia Airlines, are maintained by several international airlines a part of which are low-budget such as Eurowings, Ryanair, easyJet and other.

Pula Airport has a capacity of 1.000.000 passengers per year and 1.200 tonnes of goods per year and due to favourable meteorological, technical and technological conditions it is able to ground handle also bigger aircrafts whereby it represents a possible alternative port for the area of Croatia as well as for airports of countries closer to Croatia. Today Rijeka Airport has a capacity of a passenger building and an apron at the current traffic level. Passenger building capacity is only 100.000 – 150.000 passengers per year for aircrafts that are 120- up to 140-seats big, which with regard to the ground handling of bigger planes with 200 and more seats in international traffic, doesn't qualify in terms of quality when it comes to ground handling. Mali Lošinj Airport in terms of capacity mostly meets the requirements of the current traffic level which represents app. ten thousand passengers per year, however the issue here is about increased safety since the existing USS is non-instrumental and the airport area is unenclosed.

Apart from these, there are airports that have approvals for use in accordance with Article 74 of the Air Traffic Act and particularly:

1) County of Istria: a) Vrsar Airport; b) Campanož Airport – Medulin; c) Pula Airport – on water within the port open for public traffic.

2) County of Primorje and Gorski Kotar: a) Grobnik Airport; b) Rijeka Airport -Port Rijeka (on water); c) Mali Lošinj Airport (on water); d) Rab Airport (on water);
3) County of Lika and Senj: a) Otočac Airport

Overview of airport and operator features is shown in the following Table.

Table 1. Overview of airport and operator features of the functional region of the Northern Adriatic

ICAO Code	*Airport Name*	*Airport Operator*	*ARP Coordinates*
LDPL	Pula Airport	Zračna luka Pula d.o.o.	445336.72N 0135519.89E
LDRI	Rijeka Airport	Zračna luka Rijeka d.o.o.	451.300.80N 0143412.96E
LDLO	Mali Lošinj Airport	Zračno pristanište Mali Lošinj d.o.o.	44357.26N 0142335.48E
LDRO	Otočac	Aeroklub Krila Gacke	445049.40N 0151713.56E
LDRG	Grobničko polje	Zrakoplovno društvo Krila Kvarnera	452246.41N 0143012.58E
LDRR	Rab (airport on water)	Europski obalni avioprijevoznik d.o.o.	444405.69N 0144551.74E
LDPP	Pula (airport on water)	Europski obalni avioprijevoznik d.o.o.	445257.27N 0135025.07E
LDLM	Mali Lošinj (airport on water)	Europski obalni avioprijevoznik d.o.o.	443315.34N 0142625.18E

Source: Prepared by the authors according to Croatian Civil Aviation Agency

In the future the local network of air lines will not change more significantly particularly when it comes to domestic needs, however the air lines network can be changed if capacity or other factors require to do so especially at the regional level.

3. LITERATURE REVIEW

Croatia is small European country between the Mediterranean Sea and Central Europe. Potential traffic for domestic air transportation is limited because Croatia has a small number of population and modern highways constructed for all main directions. This study aims to find out the determining factors turning potential demand into air travel passengers. Population, gross domestic product per capita and distance are considered as the leading geo-economics dynamics behind air travel demand (Sivrikaya & Tunc, 2013) as depicted in Table 2.

Table 2. Commonality in Types of Variables

Variable's Name*	Number of Repeat	Reference Articles
Population	11	Abed, S.Y., Ba-Fail, A. O., Jasimuddin, S. M. (2001); Alam, J.B., Karim, D. M. (1998); Asri, D.U., Sugie, Y. (2003); Ba-Fail, A. O., Abed, S. Y. (2000); Bhadra, D. (2003); Grosche, T., Rothlauf, F, Heinzl, A. (2007); Ippolito, R. A.(1981); Kim, K.W., Seo, H. Y., Kim, Y. (2003); Kopsch, F (2012); Wirasinghe, S.C., Kumarage, S. (1998); Wu, C., Han, J., Hayashi, Y. (2011).
GDP	9	Abed, S.Y., Ba-Fail, A. O., Jasimuddin, S. M. (2001); Alam, J.B., Karim, D. M. (1998); Asri, D.U., Sugie, Y. (2003); Ba-Fail, A. O., Abed, S. Y. (2000); Grosche, T., Rothlauf, F, Heinzl, A. (2007); Ippolito, R. A.(1981); Kopsch, F (2012); Wei, W., Hansen, M. (2006).
Distance	5	Aderamo, A.J. (2010); Grosche, T., Rothlauf, F, Heinzl, A. (2007); Ippolito, R. A.(1981); Kopsch, F (2012); Wei, W., Hansen, M. (2006).
Travel Time	5	Abed, S.Y., Ba-Fail, A. O., Jasimuddin, S. M. (2001); Kim, K.W., Seo, H. Y., Kim, Y. (2003); Wirasinghe, S.C., Kumarage, S. (1998); Wu, C., Han, J., Hayashi, Y. (2011).
GDP per capita	4	Abed, S.Y., Ba-Fail, A. O., Jasimuddin, S. M. (2001); Ba-Fail, A. O. (2004); Ba-Fail, A. O., Abed, S. Y. (2000); Dargay, J., Hanly, M. (2001)
Price	5	Dargay, J., Hanly, M. (2001); Grosche, T., Rothlauf, F, Heinzl, A. (2007); Kopsch, F (2012); Wirasinghe, S.C., Kumarage, S. (1998); Wu, C., Han, J., Hayashi, Y. (2011).
Service Frequency	4	Alam, J.B., Karim, D. M. (1998); Asri, D.U., Sugie, Y. (2003); Ippolito, R. A.(1981); Wei, W., Hansen, M. (2006).
CPI	3	Abed, S.Y., Ba-Fail, A. O., Jasimuddin, S. M. (2001); Ba-Fail, A. O. (2004); Ba-Fail, A. O., Abed, S. Y. (2000).
Import Volume	3	Abed, S.Y., Ba-Fail, A. O., Jasimuddin, S. M. (2001); Ba-Fail, A. O. (2004); Ba-Fail, A. O., Abed, S. Y. (2000).
Employment	2	Alam, J.B., Karim, D. M. (1998); Carson, R. T., Cenesizolu, T., Parker, R. (2011).
Exchange Rate	2	Ba-Fail, A. O. (2004); Ba-Fail, A. O., Abed, S. Y. (2000).
Cost	2	Asri, D.U., Sugie, Y. (2003); Wirasinghe, S.C., Kumarage, S. (1998).

Expenditures	2	Ba-Fail, A. O. (2004); Ba-Fail, A. O., Abed, S. Y. (2000).
Fuel Price	1	Carson, R. T., Cenesizolu, T., Parker, R. (2011).

*The most common variables are listed out of a sample of 15 different relevant articles

It is established that transport is closely related to the economic activity, (ECMT, 2001). Both passenger and freight transport follow generally the rate of economic development. Passenger transport is directly influenced by increased income and quality of life. One of key impacts on traffic demand is attributed to GDP, because it typically generates an increase in travel (Pupavac, 2009).

Croatian economy is peculiar because tourism is one of the most important economic sectors, so further on, the number of tourist arrivals will be considered as a potential variable of an econometric model. Before the 90s of the past century, 60-65% of air transport was contributed to tourist travel. The number of tourists using air transport before the 90s was at a steady 20% of the total number of tourists. The latest survey conducted by the Institute for Tourism provides the following indicators: 91% of tourists arriving to destinations in Croatia use road transport, air transport is used by 8%, maritime transport by 0,7% and rail transport by 0,3%. This indicates that tourists have preferences for road and air transport on arrival in Croatian tourist destinations, while the use of maritime and rail transport lags far behind. This means that air transport dominantly depends on the movement of tourist demand (Pupavac, et al, 2014). According to data obtained by the World Tourism Organization in 2010, 51% of international tourists used air travel for arrival to desired destinations (UNWTO, 2011).

4. DATA AND METHODOLOGY

Traffic demand represents the entirety of requirements for transport services or transfer of various entities (people, goods, packages, information) by different types of traffic with a defined price within a certain timeframe (Pupavac, 2017). The starting point of passenger traffic demand is found in advantages passengers want to gain at a certain destination (Čavrak, 1999). Physical indicators of passenger traffic demand are the number of transported passengers, passenger kilometres, number of vehicles and alike. In order to estimate traffic demand, the correlation between the growth of gross domestic product and passenger traffic is most often the subject of analyses in research (Pupavac, 2009). As the Republic of Croatia is an explicitly tourist country, which almost one fifth of its GDP earnes from tourism, it seems appropriate to research the role of tourism as a generator of demand for passenger air traffic. Accordingly, a model to estimate air passenger demand in the functional region of the Northern Adriatic can be written as a function:

$$PA = f(BDP, TA) \quad (1)$$

where: PA – air passenger demand, GDP – gross domestic product, TA – tourist arrivals. Variable PA is a dependent variable, while GDP and TA are independent or

explanatory variables. Supposing that the number of passengers in air transport depends on the GDP and the number of tourist arrivals, its linear form would be as following:

$$Y = b_0 + b_1BDP + b_2TA \quad (2)$$

Data required for analysis are shown in Table 3.

Table 3. Passenger traffic in airports of the functional region of the Northern Adriatic, tourist arrivals and GDP fluctuation

Year	Passengers_ Rijeka Airport	Passengers_ Pula Airport	GDP in 000 HRK	TA (000)
2000.	14230	66772	234589,7	7137
2001.	32799	102985	243586	7880
2002.	50366	140431	256841,8	8320
2003.	46587	136207	269575	8878
2004.	57024	155566	281031	9412
2005.	122493	209412	292859,8	9995
2006.	169250	295342	306739,8	10385
2007.	162740	384487	323522,8	11162
2008.	111863	397363	331155,4	11261
2009.	113563	318838	308305,7	10935
2010.	61883	332399	301214,7	10604
2011.	84713	355920	301214,7	11456
2012.	77082	367455	295190,4	12434
2013.	142975	351196	292238,5	13128
2014.	106235	382992	291946,2	12914
2015.	139718	359426	298661	14343
2016.	145297	436121	309114,1	15594
2017.	142111	595812	317769,3	17431
2018.	183606	718187	326031,3	18667

Source: Prepared by the authors according to: Statistics of Pula Airport and Rijeka Airport, Statistical Annual of the Republic of Croatia and Tourism in Numbers 2018

This study applied desk research scientific methods: methods of analysis and synthesis, comparative method, methods of descriptive and inferential statistics. Numeric calculations are performed using the MS-Excel.

5. RESEARCH RESULTS AND DISCUSSION

Based on the data from Table 4 it is evident that the functional region of the Northern Adriatic carries out slightly less than a half of the total tourist arrivals to the Republic of Croatia.

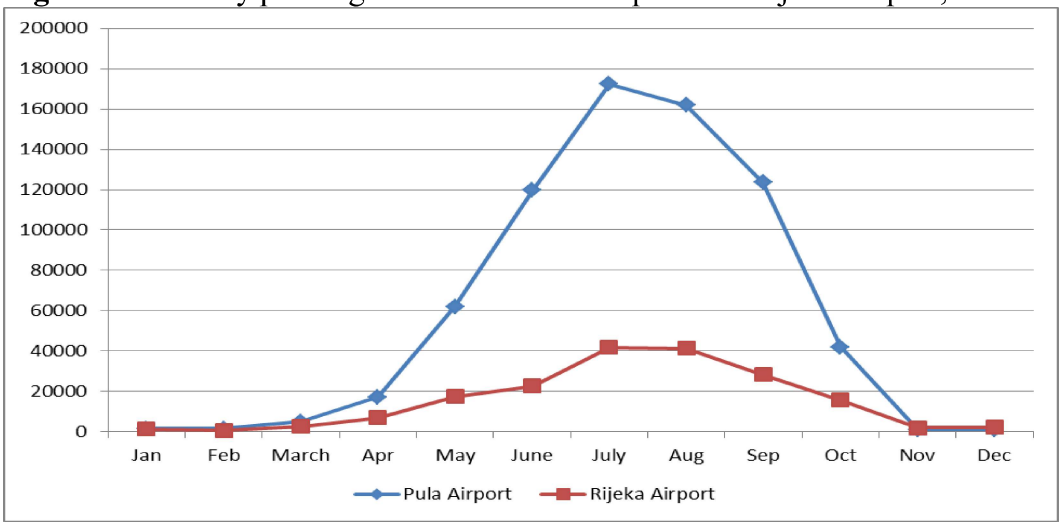
Table 4. Tourist arrivals to the Republic of Croatia and counties of the functional region of the Northern Adriatic (in 000)

County	2016	2017	Growth rate 2017/2016
Istria	3763	4104	9,06%
Primorje and Gorski Kotar	2598	2789	7,35%
Lika and Senj	621	736	18,51%
Total:	6982	7629	9,26%
Total Republic of Croatia	15594	17431	11,78%
% share of the Northern Adriatic region	44,77%	43,76%	

Source: Tourism in numbers 2017, p.31 and our own calculations

It's interesting that only 11% of tourists come to Croatia by air traffic. There are several reasons for this – vicinity to large emissive markets, good development of road traffic and weaker development of other traffic forms (Pupavac, 2018). Nevertheless, huge dependence of air traffic of the functional region of the Northern Adriatic on the number of tourist arrivals is evident. This is also confirmed by huge seasonality of air passenger traffic (cf. Figure 2).

Figure 2. Monthly passenger traffic in Pula Airport and Rijeka Airport, 2018



Source: Prepared by the authors according to statistical data of Pula Airport and Rijeka Airport

The seasonality issue i.e. dependence on the number of tourist arrivals is particularly emphasized at Pula Airport, which throughout summer months carries out traffic 154 times bigger than in off season. In order to get a deeper insight into passenger traffic in these two airports based on the data from Table 2, a short

descriptive analysis is made showing the number of transported passengers in Rijeka Airport and Pula Airport for the period from the year 2000 until the year 2018 (cf. Table 5).

Table 5. Descriptive statistics of traffic in Rijeka Airport and Pula Airport

	Rijeka Airport	Pula Airport
Mean	103396,5789	321416,3684
Standard Error	11454,12602	37678,56941
Median	111863	351196
Standard Deviation	49927,37781	164237,0764
Sample Variance	2492743055	26973817262
Kurtosis	-1,114798034	0,729992297
Skewness	-0,16390497	0,568694333
Range	169376	651415
Minimum	14230	66772
Maximum	183606	718187
Sum	1964535	6106911
Count	19	19
Largest (1)	183606	718187
Smallest (1)	14230	66772
Confidence Level (95,0%)	24064,22577	79159,73679

In the observed period 1,96 million passengers passed through Rijeka Airport. The annual mean amounts to only 103 396 passengers (SD =49 927). The largest annual traffic volume of 183 606 passengers was realized in the year 2018. The smallest traffic volume of 14 230 passengers was realized in the year 2000. The median value amounts to 111 863 which means that in one half of the years of the observed period the bigger value of median is recorded. In the same period 6,1 million passengers passed through Pula Airport. The annual mean amounts to 321 416 passengers (SD =164 237). The largest annual traffic volume of 718 187 passengers was realized in the year 2018. The smallest traffic volume of 66 772 passengers was realized in the year u 2000. The median value amounts to 351 196 meaning that in 50% of the years in the observed period the bigger value of median is recorded.

Further on in this research, discussion based on the data from Table 2, interdependence among passenger traffic in airports of the functional region of the Northern Adriatic, the gross domestic product and the number of tourist arrivals is researched. (cf. Table 6).

Table 6. Correlation analysis of the number of transported passengers in Rijeka and Pula airports, GDP and the number of tourist arrivals

Correlations (ZLRKA) Marked correlations are significant at p < ,05000 N=19 (Casewise deletion of missing data)						
	Means	**Std.Dev.**	**PAP**	**PAR**	**GDP**	**TA**
PAP	321416,4	164237,1	1,000000	0,773153	0,829015	0,943313
PAR	103396,6	49927,4	0,773153	1,000000	0,818009	0,746820
GDP	293767,7	26656,3	0,829015	0,818009	1,000000	0,700400
TA	11680,8	3114,3	0,943313	0,746820	0,700400	1,000000

The carried-out correlation analysis confirmed the existence of strong and positive dependence of the number of transported passengers on the number of tourist arrivals and gross domestic product in both airports. With regard to Pula Airport (PAP) air traffic shows somewhat greater dependence on the number of tourist arrivals (r=0,94), whereas the traffic volume of Rijeka Airport (PAR) shows somewhat greater dependence on the fluctuation of gross domestic product (r=0,81). Consequently, a regression analysis was carried out (cf. Table 7 & Table 8) in order to form a separate model to estimate the number of transported passengers in Rijeka Airport and a separate model to estimate the number of transported passengers in Pula Airport.

Table 7. Results of regression analysis for Rijeka Airport (PAR)

Regression Summary for Dependent Variable: PAR R= ,85351674 R^2= ,72849082 Adjusted R^2= ,69455217 F(2,16)=21,465 p						
	b*	**Std.Err. - of b***	**b**	**Std.Err. - of b**	**t(16)**	**p-value**
Intercept			-279073	80529,45	-3,46547	0,003188
GDP	0,578941	0,182510	1	0,34	3,17211	0,005914
TA	0,341329	0,182510	5	2,93	1,87020	0,079865

Table 8. Results of regression analysis for Pula Airport (PAP)

Regression Summary for Dependent Variable: PAP R= ,97234350 R^2= ,94545188 Adjusted R^2= ,93863336 F(2,16)=138,66 p						
	b*	**Std.Err. - of b***	**b**	**Std.Err. - of b**	**t(16)**	**p-value**
Intercept			-715140	118736,7	-6,02291	0,000018
GDP	0,330399	0,081806	2	0,5	4,03882	0,000951
TA	0,711902	0,081806	38	4,3	8,70235	0,000000

Based on the conducted regression analysis (cf. Table 7 & Table 8) regression models can be recorded with the aim of estimating traffic volume in Rijeka Airport (PAR) and Pula Airport (PAP) until the year 2025.

PAR = -279073 + GDP + 5TA (3)

PAP=-715140+2,GDP+38TA (4)

Model (3) is not conclusive (cf. Table 7). The regression analysis without tourist arrivals as variable in model shows the better result (cf. Table 9).

Table 9. Results of regression analysis for Rijeka Airport (PAR)

Regression Summary for Dependent Variable: PAR R= ,81800869 R^2= ,66913821 Adjusted R^2= ,64967576 F(1,17)=34,381 p						
	b*	**Std.Err. - of b***	**b**	**Std.Err. - of b**	**t(17)**	**p-value**
Intercept			-346696	77060,14	-4,49903	0,000316
GDP	0,818009	0,139508	2	0,26	5,86353	0,000019

Because we want to keep importance of tourist arrivals as variable we made decision to use model (3) for estimating traffic volume in Rijeka Airport which is the main limitation of this research. The mean GDP growth rate of the Republic of Croatia standing at 3% per year and the mean annual growth rate of the number of tourist arrivals standing at 4% will be taken as starting assumptions for traffic predictions in two aforementioned airports until the year 2025. Validity of the aforementioned assumptions is based on the fact that the Tourism Strategy predicts the growth of the number of tourist arrivals at the mean rate of 4% until the year 2025 and that the Croatian economy will get out of crisis as well as on positive economic growth rates. If the aforementioned assumptions are realized, then the traffic volume through the airports of the functional region of the Northern Adriatic would look as shown in Table 10.

Table 10. Traffic volume prediction in airports of the functional region of the Northern Adriatic until the year 2025

Year	PAR	PAP
2020.	206477	746985
2021.	222148	798429
2022.	238333	851719
2023.	255051	906923
2024.	272317	964112
2025.	290151	1023357

Based on the made prediction it is evident that both Airports in the future will indicate a trend in increasing the number of passengers. In the year 2025 Pula Airport could qualify among Croatian airports that realize passenger traffic volume larger than a million of passengers (Zagreb, Dubrovnik, Split) and thus reach the full level of its capacity. Also, Rijeka Airport could reach the full level of its capacity until the year 2025.

6. CONCLUSION

One of the main aims of the Traffic Development Strategy of the Republic of Croatia and Master Plan of the Functional Region of the Northern Adriatic is to provide highest safety standards for air traffic on international, national and regional level in order to efficiently decrease dangers in air traffic, reduce accidents possibility and limit negative consequences of such accidents. Infrastructure of airports and aircrafts have to meet international safety standards. Pula Airport is important for accessibility of this region from distant locations. Traffic volume in the airport indicates a seasonality trend which might cause bottlenecks considering the limited infrastructure. It is necessary to observe two operative aspects that include: 1) service quality, primarily because of competitiveness with neighbouring international airports and 2) balance between safety and operative capacities. These aspects, inter alia, emphasize the need for increasing capacities of this airport by upgrading certain elements: access light signalling system, take-off and landing runways, aprons, terminals and accesses. The Master Plan of the airport defines validity of proposed measures and identifies priorities having in mind environmental requirements and real needs and capability according to expected demand. Rijeka Airport shows growth of passenger traffic and has additional capability to increase passenger traffic. The Master Plan of Rijeka Airport has to lay down scope and dynamics of activities in airport development by taking into account environmental requirements. Development of Mali Lošinj Airport is planned with the aim of better connectivity between Mali Lošinj and parts of the functional region in accordance with various safety requirements and traffic demand. Analyses show a prospective need for expanding the take-off and landing runway, apron and terminal. The Master Plan of Mali Lošinj Airport will lay down validity of these measures and order them by priorities having in mind environmental requirements and real needs and capability according to expected demand. Pula, Rijeka and Mali Lošinj Airports meet the needs of the functional region and neither planning nor building new airports is required but technical, technological and safety improvements, expansions and upgrading of new areas. The fact that the number of tourist arrivals depends mostly on the gross domestic product of emission countries is pointed out as the major deficiency of this paper and accordingly, future researches should include gross domestic product fluctuations in these countries as variables in the model for predicting the number of passengers in the airports of the functional region of the Northern Adriatic.

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