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Traffic Infrastructure

Review

Accepted: July 23, 2009

Approved: July 5, 2010

RAIL TRANSPORT - AN IMPORTANT FACTOR IN THE PORT OF RIJEKA DEVELOPMENT

ABSTRACT

The economic situation and comparative advantages of the Port of Rijeka are no more than important preconditions of its development and competitive ability. No adequate connection of the Port of Rijeka to its catchment area is possible without a modern rail and road traffic. The researches and analyses of the port hinterland connection current state, the results of which are provided in these documents, clearly indicate the need to upgrade the existing railway tracks and build a new level Rijeka – Zagreb railway line. This line is a vital condition for ensuring both, a strong growth of the port performances and its competitive ability vis-a-vis other neighbouring ports. The level railway line Rijeka – Zagreb with Rijeka railway junction adequately upgraded, should be therefore regarded as strategic traffic project and conditio sine qua non for the future development of the Port of Rijeka. However, no solution of the Rijeka railway junction problem will be possible without finding the right way for better connection of some of the port terminals. When considering the integral solution of the rail traffic in the greater Rijeka Basin, it is important to know that the access to individual port terminals, the connection with the railway in Istria through the Učka Tunnel and connection with the port terminals on the Island of Krk are of great importance for the Port of Rijeka future development. The efforts to recognize the problems in the port environment and define priorities that make the rail transport a key factor of the Port of Rijeka's future growth, are the main contributions of this study.

KEY WORDS

Port of Rijeka, traffic connections, rail traffic, Rijeka railway junction, development guidelines

1. INTRODUCTION

The geographical position of the Adriatic Sea, which cuts deeply into Central Europe, with the Rijeka Port basin deep enough to accommodate the biggest vessels, offers considerable possibilities and creates outstanding preconditions for traffic-economic assessment of a wider significance.

It is its importance and the role in the traffic system of the Republic of Croatia that make the Rijeka traffic route worthy of continual attention, research works and analyses so that all necessary measures in terms of its adjustment to the new circumstances in its either closer or wider environment, can be undertaken on time.

However, the competitive ability of a seaport depends not only on its geographical position but primarily on the cargo handling rate inside a port system, where the promptness and capacity of shipments are particularly important. That is why the issues of modern solutions and construction of all the elements of the Rijeka road network are crucial for linking the port terminals to the main rail and road routes towards Central Europe and the Danube region. In this connection, there is no doubt that, when the good access of the port on the landside is in question, the rail traffic is irreplaceable and of top-priority.

The Port of Rijeka is connected to its hinterland by two railway lines constructed in the 19th century, in accordance with the then prevailing possibilities and standards. These are obviously not able to meet the actual traffic requirements. Moreover, as the existing rail infrastructure stands in the way of the port's devel-

opment, it is necessary to take all the corresponding measures for its upgrading.

Because of the expected increase in the rail traffic on this corridor, the direction towards Zagreb, that is, Central and Eastern Europe, poses itself as priority, with the construction of the level railway line being unquestionable. As to the improvement of the existing infrastructure, it should serve as an interim solution until the level railway line is put into exploitation.

Taking a long-term view, there is a need for the Port of Rijeka to establish connections with other North-Adriatic ports but it will depend on various political and economic factors. However, irrespective of the prospects of the Adriatic-Ionian railway, it is absolutely necessary to establish a direct connection between Rijeka and the rail network in Istria. It is also important to build a railway to the Island of Krk, thus creating a unique technical and technological system with all port basins linked together.

In view of the above said, the ultimate objective of this document is to make research and analysis of the most important factors that not only have a substantial impact on the present situation but also define the rail traffic development as an important factor of the Port of Rijeka development.

2. PORT OF RIJEKA – A FACTOR IN THE TRAFFIC AND ECONOMIC DEVELOPMENT OF THE REPUBLIC OF CROATIA

It is the seaports that ensure easier access to the world market. The seaports are absolutely vital for trade and business development as the most important international traffic corridors and commodity flows pass through them dictating global trend of economic development. Today, the biggest seaports have therefore become the regulators of the international trade, determining its trend and structure [1]. Their role in the international trade and economy is particularly important, since about three quarters of the international commodity exchange (speaking in terms of quantity) run by sea as the most suitable and in many cases the only possible transport route.

The ports as part of the national transportation system do not belong to any particular branch of traffic but are rather collection points of goods transported by various traffic routes and means of transportation. The role of modern seaports is particularly important for the general economic prosperity of a certain region. Namely, by stimulating economic growth and transport activities, the ports are a vital factor in defining the entire traffic network in the port's hinterland area and its catchment zone.

By recognizing such role of the ports, the legislative regulation of the Republic of Croatia has also recognized the importance of the Port of Rijeka as our

biggest port, which is defined as a port of special economic interest for the country. On the other hand, its traffic significance is beyond dispute because the Port of Rijeka is the central point of all transportation and cargo handling activities, not only for the north-west part of Croatia but the whole region. Rijeka is also the shortest and most economic route connecting Central Europe to the Mediterranean and other world regions.

As to the integration of the Croatian internal traffic system and its becoming part of the international traffic network, with linking the Panonian and the Adriatic regions, i.e. the Danube Basin and the Adriatic Sea, the role of the the Port of Rijeka is particularly important (via Karlovac to Zagreb, namely from Zagreb to Budapest across the Croatian Danube Basin) [2].

The modern economic and logistics strategies and conceptions cannot function without fully developed seaports, adequately equipped with modern installations and port facilities. Such ports represent strong logistic points as well as logistic platforms which put traffic routes on the map and foster commodity flows through certain ports.

Modernization of port terminals in Rijeka, a modern railway junction, a modernized railway and modern roads will enable the transformation of the Port of Rijeka into a modern transport and logistical point in this part of Europe.

3. GEOGRAPHICAL AND TRAFFIC CHARACTERISTICS OF THE PORT OF RIJEKA

Regarding its geographical position, the Republic of Croatia is located at the crossroads of two important trans-European routes, the first connecting Western and Central Europe with Middle East and the other going from the Baltic via Danube Basin to the Adriatic Sea. Before Croatia became independent, the traffic flows were taking place, for the most part, between the North-West and South-East Europe via so-called Sava-valley corridor, connecting longitudinally West and East Europe to South-East Europe and the Middle East, in which process the countries of what was then the Eastern Europe were not substantially involved. The disintegration of the Eastern Block in 1991, when the former East-European countries became part of Central Europe, paved the way in Croatia for the development of the, up to then, neglected transversal traffic route connecting Central Europe to the Adriatic [3].

The connection of the Danube Basin with the Adriatic region is more than mere link between the two Croatian regions – the Panonian and the Adriatic. In fact, this route is a bridge between the Mediterranean and Central – Southeast Europe, which creates the conditions for Croatia to assume a mediating role with-

in the European limits, connecting the greater Panonian region with the Mediterranean.

The development of every port depends to a large extent on the advantages of its geographical and traffic position. As to Rijeka, its port has many advantages, from the sea depth, good shelter from the adverse weather conditions to the fact that it was developed in the area where the Adriatic Sea cuts deeply into the European continent bringing Central Europe down to the sea, meaning a considerably shorter and faster land transport route to the markets of the highly developed countries. An additional good point is a very narrow (40-50 km) and relatively low "mountain" sill on the port landside. It is its geographical position that makes the Port of Rijeka a part of the North Adriatic port system with a large and important catchment area comprising central European countries. The narrower and the wider catchment area of the Port of Rijeka clearly shows the potential of its development with the use and recognition of all significant elements of the traffic routes.

It is, however, common knowledge that the geographical and traffic advantages are not guarantee for themselves for the prosperity and development. With the present-day technical and technological achievements and modern work organization, any natural and geographical conditions necessary for harbour development can be substituted and made up for with technical solutions and interventions. Besides, a number of the port's logistics factors as for example the quality of its equipment, good hinterland connections or table of rates can supersede or put on an even footing many different physical distances and some other natural aspects [4]. It was precisely the poor hinterland connection of the Croatian ports in the past that was a limiting factor preventing them from developing and undergoing modernization more rapidly. More precisely, their unmistakably favourable geographical position near the important traffic corridors was degraded by the poor quality of traffic routes, their inadequate capacity and functional obsolescence of the port equipment and facilities. All this resulted in a considerable decrease of transit traffic. It happened, thus, that Rijeka, once a prosperous and leading North Adriatic port started to stagnate, losing its previous market position. Its market share, namely, in the top quality commodity segments started to decline to the benefit

of its competitors, i.e. the better equipped neighbouring ports.

However, the creation of the Port of Rijeka Authority was followed by a number of important activities which resulted in the improvement and reconstruction of the port infrastructure capital facilities, purchase of adequate and modern container and cargo handling equipments, establishment of the Feeder Service and developing into a hub port. All these measures and other supporting activities have given rise to a considerable increase of cargo traffic at all terminals with the container throughput undergoing the biggest growth rate (Table 1). There was also an upturn of other port activities. Taking into consideration such positive trends, additional efforts need to be made in the incoming period to not only maintain the results already achieved, but seize the chance offered by the latest political and economic developments in the hinterland, such as:

- traffic overload in West Europe,
- enlargement of the European Union,
- defining the regional transport network of South East Europe.

The evaluation of the Port of Rijeka's geographical and traffic position is of interest to the entire country, national economy and transport sector in particular. In this connection, it is imperative to recognize the significance of the railroad infrastructure as the port performance relies very much on that of the rail transport which is also an important factor in ensuring high environmental protection and security standards.

Once Croatia becomes the member of the European Union and other Euro-Atlantic integrations, its geographical and traffic position vis-a-vis Central Europe and other European or overseas countries, will inevitably win additional stimulus and recognition.

Recognizing the global economic trends in the world, Europe and the neighbouring countries which gravitate toward the Rijeka traffic route, a Master-Plan has been made regarding the development of the Port of Rijeka according to the methods provided by the consultants of the Rotterdam Maritime Group. The plan was updated in 2008 in accordance with the tendency of increase, especially of container turnover during the previous years (Table 2).

Table 1 - Turnover through the Port of Rijeka (in millions of tonnes)

| Type of Cargo | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2005 | 2006 | 2007 | 2008 |
|----------------|------|------|-------|------|------|------|-------|-------|-------|-------|-------|-------|
| Liquid Cargo | 4.67 | 5.36 | 5.59 | 5.24 | 4.28 | 4.99 | 5.24 | 6.26 | 7.02 | 5.88 | 7.59 | 6.36 |
| General Cargo | 0.68 | 0.70 | 0.62 | 0.73 | 0.80 | 0.83 | 0.80 | 1.10 | 1.44 | 1.57 | 2.16 | 2.37 |
| Bulk Cargo | 1.50 | 1.70 | 2..50 | 1.70 | 1.70 | 1.90 | 1.70 | 2..30 | 3.19 | 3.20 | 3.14 | 3.38 |
| Wood | 0.14 | 0.14 | 0.14 | 0.14 | 0.17 | 0.15 | 0.2 | 0.17 | 0.22 | 0.24 | 0.33 | 0.28 |
| Total Turnover | 6.99 | 7.9 | 8.85 | 7.81 | 6.95 | 7.87 | 7..94 | 9.83 | 11.87 | 10.89 | 13.21 | 12.39 |

Source: Adapted from: http://www.portauthority.hr/rijeka/info_statistika.

Table 2 - Forecast turnover in the Port of Rijeka

| Type of cargo | 2016 | 2026 | 2036 |
|--------------------------|------|-------|-------|
| Liquid cargo (mil. tons) | 6.5 | 7.2 | 7.7 |
| Dry cargo (mil.tons) | 7 | 8,1 | 10 |
| Containers (000 TEU) | 428 | 1,300 | 2,700 |

Source: Prepared by the authors according to the Master Plan update – Port of Rijeka; Final Report; Rotterdam Maritime Group, 2008

4. RAIL TRANSPORT AND ITS ROLE IN THE SEAPORT DEVELOPMENT

Today, the development of the European seaports, the Adriatic ports included, is taking place under severe market conditions and strong competition. The competition among ports is particularly noticeable in the regions where distances play no important role and where some other issues are in the forefront. In such cases, the ports tend to make profit primarily by focusing on the quality of services, competitive prices and good hinterland connections.

There is a cause-effect relation between the seaports, i.e. their economic potential, on the one hand, and functioning of the traffic system, i.e. quality of traffic infrastructure on the other hand. This means that no investing into port facilities and port expansion ability can yield profit unless accompanied by an adequate activity in the field of traffic infrastructure construction and modernization.

As a complex transport and economic system a seaport is made of three basic and mutually connected and interactive segments:

- natural or built-up and protected sea basin (harbour) suitable for cargo handling and other port operations,
- port hinterland connections with its catchment area, and
- port maritime connections with overseas destinations.

It can be said that every port has two sides, the one facing the land and the other facing the sea. Consequently, hinterland and maritime foreland are equally important for the operation of seaports. This further means that, in terms of traffic and business operations, no port can function without adequate traffic connections, either by sea or land. However, with no intention to undervalue the maritime foreland of a port, it must be said that good hinterland connections were and still are essential precondition of its development. This factor is particularly relevant under the present-day market-oriented traffic policy, because no optimal results can be achieved in the seaborne transport without an adequate land infrastructure, modern railways and roads [5].

When the carriage of bulky and heavy goods, i.e. long distance transportation of large quantities, under

adverse weather conditions, at relatively low transport costs and with no excessive environmental pollution is at stake, it is the railway that should be given preference over road traffic, hence the importance of a modern railway for the development of the Port of Rijeka. In other words, it is not a wise solution to have the development of a seaport based exclusively upon modern road infrastructures. It must be, namely, remembered that, in the mountain-studded region such as Rijeka hinterland, particularly when dealing with large quantities of bulk cargo, containers and trucks destined for rail transport, the role of the railway can hardly be substituted by road transport.

In the frame of the new European traffic policy and with regard of Croatia approaching the EU membership, the links of the Danube Basin countries and the northern parts of Croatia to the Adriatic Sea are very much dependent on the achieved level of the traffic infrastructure, with the railway transport playing a crucial role. However, as resulting from the recently made analysis of the national railroad network, in the forthcoming years the Croatian Railroad will not be capable of meeting the traffic requirements, either in terms of its volume or quality. It is, therefore, necessary to proceed with the railway development strategy planning, i.e. with the implementation of the plans and projects already developed, to speed up the modernization and reconstruction of the main railroad arteries. The fact that Croatia has been assigned a transit role can be and has to be spotlighted by the development strategy of the Adriatic – Central Europe rail traffic routes, which allows for an adequate connection of the seaports as commodity trade generators.

In order to be integrated into the traffic trends and avoid isolation, based on the European traffic policy guidelines, Croatia should stimulate construction of the new railroads with modernization of the existing ones, focusing on the international transport corridors.

5. PORT OF RIJEKA – RAILWAY HINTERLAND CONNECTIONS

The development of seaports is defined by and dependent on the catchment hinterland area, its size and development level, which means that the overland transport capacities in the port's hinterland area should be concerned with the quantity and structure of the commodity being transported through the port.

If it is a question of the hinterland railway connection of the Port of Rijeka, there is a cause-effect relation between the railway track, railway junction in Rijeka and its hinterland and the port facilities. Therefore, any change of some of these elements will inevitably affect their mutual relation. It is therefore necessary to have this casuality in mind when making development plans for each of the abovementioned segment. Also,

it is not only the conception that needs to be harmonized, but also the timing of its realization [6].

In order to achieve a better connection of the Port of Rijeka with the hinterland, it is particularly essential to define and promote the elements of the railway system, such as:

- rail connections with the hinterland,
- upgrading of Rijeka - Zagreb railway,
- connection of port and railway terminals,
- level railway line,
- integrating of dislocated port terminals of the Rijeka Basin into a rail system,
- upgrading of the rolling stock,
- automation of traffic control,
- upgrading the existing railway information system and its connection to the port information system.

5.1 The status quo and problems

For a better understanding of the existing railway network connecting Rijeka to its hinterland, it is necessary to consider its historic dimension as well as political, economic and traffic circumstances at the time of its construction. In a period of only four months in 1873, towards Rijeka as many as two railway lines were constructed and put into operation.

- "Šenpeter railway line" - Sveti Petar (Pivka) - Rijeka,
- "Karlovac - Rijeka railway" - Karlovac - Rijeka.

Rijeka became, thus one of the rare cities with two railways. This fact had direct impact on the increase of the port performance and traffic volume. In only ten years' time, the Port of Rijeka was able to compete with Trieste. On the eve of the First World War Rijeka was among the ten leading European seaports.

It can be often heard that the capacity of the port in Rijeka is limited by that of the rail, which, at first impression, does not seem right. Both railways (towards Zagreb and Pivka) have a capacity of about 10 mil. tons per year, while the port operational needs to be serviced by the rail have never, not even in the best years, exceeded the annual amount of 7 mil. tons. However, the above thesis can be confirmed by a detailed analysis and unprejudiced approach. Namely, as the existing railway to Zagreb is in very bad condition, the traffic of such intensity would be carried out at inappropriately high costs while at the same time the effective exploitation of this railway would become disputable given its condition and poor quality of the equipment. The engines too, being in short supply and old, constitute major problems. As to the railway leading to Pivka, its exploitation at full capacity can hardly be expected, as the Slovenian Railways are not interested either in its upgrading or its more active exploitation.

Regardless of the fact that the above said railways, especially the Rijeka-Zagreb railway line, have been

modernized and upgraded (the trains are electrified and fitted with modern safety and telecommunication equipment), there is no ignoring that these have been in operation for more than 135 years. In spite of relatively good quality level of their technical equipment, the basic parameters of the railroad route which were to meet the steam-powered engines, with relatively small quantity of the facilities built along the route, have not changed so far.

5.2 Rijeka-Zagreb railway line

The Rijeka-Zagreb railway line is a single-track railway line, 228.7 km long. In near vicinity of Rijeka it additionally forks into several legs extending to the port facilities in Bakar and Rijeka Brajdica, by means of the branch line Škrlevo-Bakar (12 km) and Sušak Pećine-Rijeka Brajdica (2.9 km). The railway was constructed 135 years ago, in accordance with the technical possibilities of that time, designed to meet the then prevailing industrial and trade requirements. It is characterized by a rather elongated and unfavorable route with hard ascends and sharp curves. This rail is therefore completely contrary to the modern traffic requirements and needs, not to speak of the traffic standards in the future. This railway has always been reputed as a difficult. This is especially applicable to its Rijeka-Moravice section which is one of the most demanding mountain standard gauge railway tracks in Europe. However, not all of the railroad sections have the same features (Table 3).

In addition to the unfavorable track gradients, the railway also has a great number of small radius curves. Thus, its Karlovac-Rijeka section has as much as 70% of its length in curves, out of which even 40% with curves having a radius below 300 metres. The route of such characteristics (climbs, descents, curves) is vitally limited in terms of reaching the maximum permitted speed and this has serious repercussions on the maximum railway capacity, its operating performance and costs.

When considering the exploitation of this railway, the account should be taken of the lack of uniformity of the transportation needs which are not the same in both directions. There are more loaded trains going towards the interior, conditionally speaking a less favourable direction concerning the railroad characteristics. In the previous periods, the ratio of the Rijeka-Zagreb and Zagreb-Rijeka transportation expressed in tons was about 2:1, even up to 3:1.

Under the existing operating technology, due to the above mentioned problems, the heavy freight trains have to be "pulled out" to the station in Lokve, where they are coupled together to continue the journey as one train. The 52 km long Rijeka-Lokve section is the most difficult part of the entire railway line and has

Table 3 - Features of Zagreb-Rijeka railway line

| | | Features of individual sections | | |
|--------------------------|-----------------|---------------------------------|-----------|-----------|
| | | Zg - Ka | Ka - Mor. | Mor. - Ri |
| Incline (‰) | Direction A - B | 8 | 8 | 18 |
| | Direction B - A | 7 | 5 | 26 |
| Total resistance (daN/t) | Direction A - B | 8 | 10 | 22 |
| | Direction B - A | 8 | 7 | 29 |
| Max. train length (m) | Direction A - B | 502 | 472 | 365 |
| | Direction B - A | 484 | 488 | 362 |
| Electification | | 25 kV | 25 kV | 3 kV |
| Traffic control | | ABH | ABH | SD |

Note: SD - station distance, ABH - automatic block headway

all the features of a hard mountain railway. For these reasons the Lokve station has been later on provided with a pull-out equipment. As the existing engines being used on this section have to handle trains of about 500t, the traction is usually effected by two engines. Such lack of uniformity is solved, more or less successfully by organisational measures, but the whole situation, with making this route available for the engine returning operations, can result in further reduction of the railway capacity.

With regard to the above said, taking into consideration that the railway facilities and equipment are more than 50 years old, operated by single-phase, 3 kV DC electrically driven traction system that was implemented between 1953 - 1960, which is still in operation, it is evident that the actual performance of the Rijeka-Zagreb railway line can in no way meet the existing transport needs and demands.

5.3 Rijeka-Šapjane railway line

The other hinterland link of the port is Rijeka - Šapjane - state border - Pivka railway line. This is also a single-track 30.9km long mountain railway line with the highest climb of 25‰, and the minimal curve radius 250-300m, hence the biggest design resistance of 27 daN/t.

As to the quality and level of the railway technical equipment, it is poor and outdated. The same goes for the station facilities, too. These are of mechanical type (fitted in the 1930s) with a minimum of modernization and upgrading made so far. The inter-station sections traffic is regulated by phone with no interdependence units. The traffic safety is therefore unsatisfactory and so are the railway capacity and the operating ability.

The capacity of the Rijeka-Šapjane railway line, with the existing inter-station spacing, is 53 trains/day, i.e. about 3.8 mil. net tons per year. After the traction system is modified as foreseen, the railway capacity is expected to reach 57 trains/day which would provide reaching a turnover of about 4.3 mil. net tons of the goods transported per year [7]

It is in the mentioned characteristics of the railway lines that one should look for the reasons of the stagnation in the growth of railway traffic in spite of a large increase in cargo traffic passing through the Port of Rijeka (Table 4). Apart from the limited capacities, the existing railway lines cannot meet the demands of modern traffic and logistics regarding speed, reliability, regularity, flexibility and adaptability of the transport service.

Table 4 - Realized operation of the Croatian Railways with the Port of Rijeka (in 000 tons)

| | Station | | | Total |
|------|----------------------------|-------|----------|-------|
| | Rijeka (main and Brajdica) | Bakar | Škrljevo | |
| 2002 | 916 | 402 | 0 | 1,318 |
| 2003 | 961 | 593 | 6 | 1,560 |
| 2004 | 1,127 | 498 | 1 | 1,626 |
| 2005 | 1,315 | 521 | 4 | 1,840 |
| 2006 | 1,286 | 550 | 8 | 1,844 |
| 2007 | 1,530 | 874 | 15 | 2,419 |
| 2008 | 1,388 | 747 | 22 | 2,157 |

Source: HŽ - cargo d.o.o.

6. GUIDELINES ON THE RAIL INFRASTRUCTURE DEVELOPMENT FROM THE PORT OF RIJEKA VIEWPOINT

As visible from the analysis made, the capacities of the railways connecting the port to its hinterland area are very limited and will inevitably have a negative impact on the port's growth in the future. There is therefore the need of elaborating such rail traffic development strategy which should be compatible with the Port of Rijeka development strategy, thus stimulating the economic growth in the wider community.

Although the existing capacity of the railway lines connecting the port to its hinterland, in spite of their inadequate technical conditions, can meet the port

present needs, it cannot meet the port long-term strategic objectives in terms of the planned traffic volume growth. Therefore the construction of a level railway line, with the existing railways undergoing necessary upgrading and improvements, would be a good solution.

6.1 Rijeka-Zagreb railway line modernization programme

The vision of the Rijeka-Zagreb railway modernization and exploitation in the future is determined to a large degree by its location in the B-branch of the V Paneuropean traffic corridor. The importance that this traffic corridor, with the Port of Rijeka and other Adriatic ports, has for the new market, political and economic integration processes in Europe, give us every reason to expect a huge increase of both, cargo and passenger transport volume in the corridor, the part of which is the Rijeka-Zagreb railway line.

In the total HŽ cargo traffic, the traffic on corridor Vb which has its origin, i.e. destination in the Port of Rijeka, has a significant share. However, recognizing the great increase of the port turnover in the last years it is clear that there is still room enough for major increase in the railway transport operation. In estimation of the cargo quantities that gravitate towards the railway, the transit traffic is of extreme importance since it accounts for the largest share of the total turnover at the Port of Rijeka, and because of the distance in this segment the railway transport should be the priority choice. The major transit partners of the Port of Rijeka are Austria, the Czech Republic, Slovakia, Hungary and Italy. However, it should be emphasised that recently also new transit markets appear, and these are the markets of Bosnia and Herzegovina and Serbia, which means return of lost cargo in the past period. Relevant for the demand in railway traffic are the data about the high share of transit for Italy which operates to a great extent by sea. Therefore, the demand estimate can be based on an assumption that about 40% of domestic traffic will gravitate towards the railway, and 5% of the total transit transport will be distributed between rail and road traffic in ratio 4:1 (without container turnover). According to the mentioned, the demand for rail transport for the needs of the Port of Rijeka has been estimated to four million tons in 2020, i.e. five million tons in 2030.

The railway will certainly maintain a high share in the transport of bulk cargo; however, the share in the delivery of general cargo will get reduced. The most important reason for this estimate lies in the fact of reorientation of the Port of Rijeka towards the dominantly container port. And precisely due to the poor quality service in this segment of transport the railway has reduced its share to very moderate quantities (Table 5).

In any case, the container transport should be added to the mentioned quantities. Should the existing ratio of share of road and rail transport be maintained in the future, as well as the structure of transshipment in the port regarding the relation of empty and loaded, i.e. 20 and 40 feet containers, a demand for rail transport can be assumed in the amount of about 213,589 TEUs in 2020, that is 651,415 TEUs in 2030. Adding the demand of other economic entities in the environment which, along with the expected growth of GDP should reach 1 – 1.5 million tons, the overall demand for rail transport can be estimated at 7.3 million tons in million tons in 2020 i.e. 12.8 million tons in 2030.

Table 5 - Share of railways in container turnover to/from the Port of Rijeka (TEU)

| Year | Turnover of the Port of Rijeka | Transported by Rail | |
|------|--------------------------------|---------------------|-------|
| 1995 | 43,705 | 12,286 | 28.1% |
| 1996 | 29,492 | 7,836 | 26.6% |
| 1997 | 15,858 | 4,876 | 30.7% |
| 1998 | 12,182 | 4,360 | 35.8% |
| 1999 | 10,134 | 4,063 | 40.1% |
| 2000 | 14,500 | 4,358 | 30.1% |
| 2001 | 17,852 | 4,843 | 27.1% |
| 2002 | 18,078 | 5,135 | 28.4% |
| 2003 | 28,298 | 8,852 | 31.3% |
| 2004 | 60,864 | 15,414 | 25.3% |
| 2005 | 76,258 | 17,234 | 22.6% |
| 2006 | 94,390 | 21,811 | 23.1% |
| 2007 | 145,040 | 36,050 | 24.9% |
| 2008 | 168,761 | 42,485 | 25.2% |

The needs to create more efficient and better quality traffic connection of the port to its hinterland is nothing new. It is, namely, because Rijeka is the biggest Croatian port and was having the same status in the former Yugoslavia, many attempts were made in the past to increase the railway capacity and its performance, which for various reasons did not produce the expected results. The important investments required for its reconstruction, were no guarantee that the capacity and performance of the railway would be substantially improved. Everything pointed out to the need of constructing a new railway with completely new technical and operational standards. As the circumstances have not changed basically up to now, the same traffic problems still exist.

In order to improve the existing railway inland connections of the port, two solutions are under consideration. One is a short-term solution and can be suggested as a temporary measure. It comprises the increase of the existing railway capacity and performance primarily by completing the replacement of the old 3 kV

electric traction system by a new single-phase 25 kV, 50 Hz system that has been already installed along the entire Gyekenyes – Moravice railway section.

However, in addition to such re-electrification works, no significant improvement of the traffic capacity can be achieved without a number of other interventions such as fitting of APB on the remaining section from Moravice to Rijeka, purchase of more powerful engines, extension of some railway stations, if necessary, and so on.

The electrification of Rijeka railway line was carried out by a 3 kV 50 Hz DC system, making it the first electrically powered railway in the Republic of Croatia (from 1951 to 1956). Due to many reasons, the re-electrification started in the 1980s. The first phase comprising the replacement of the electrical traction units on 138.7 km long Zagreb-Moravice section, was completed on 25 May 1987. Although it had been planned that immediately after the completion of the first phase, the works would continue to change the outdated single-phase DC-3-kV system on the Moravice-Rijeka section, this failed to be realized, because of many circumstances involved, especially the outbreak of the War for Croatian independence. Also, as no APB was fitted in this section, it happened that the most demanding section of the Rijeka-Zagreb railway line was left with the lowest quality of equipment. It was 2006 when the preparatory works, aimed to continue the electrification, started as an investment project called "Change of electric traction system Moravice – Rijeka – Šapjane". Its realization is under way.

It is important to emphasize that the re-electrification project does not concern the Rijeka-Zagreb railway line only. It also comprises all the connecting railway lines within the Rijeka railway network as well as the Rijeka-Šapjane section. Consequently, in addition to solving the problems related to the Port of Rijeka traffic requirements, this project is planned to have much larger implications, such as:

- considerable increase of the railway capacity,
- creation of a uniform electric traction system on the entire track network of the Croatian Railways,
- reduction of the maintenance costs for both stationary and mobile facilities,
- relatively small increase in investment, regarding the investment needed for the extensive repair and overhauling of the existing system,
- the service life of the electric 1061 series (3 kV) locomotives is nearing its expiration,
- there are valid economic reasons for the introduction of new technical solutions (the remote control device and automatic interference detecting device),
- lower electrical energy costs.

Generally speaking, the implementation of the re-electrification project is an imperative and cost-effective task which will have many positive impacts

on the railway itself. In terms of the Port of Rijeka development, the project will provide for a considerable increase of the overland transport capacities. As estimated, once the electric traction system of the Rijeka-Moravice section is upgraded, the railway carrying ability will be increased by 40-60%, i.e. from the existing 6.2 to future 9.9 mln. net tonnes per year, which is really useful, but still not a long-term solution.

6.2 Level railway line

A necessary additional increase of the railway carrying ability on corridor Vb, cannot be achieved without a completely new railway line to be constructed towards Zagreb, that is Budapest. Its construction represents a long term solution of the railway connection problems the port of Rijeka has been facing for many years. Such an important undertaking, with the transport conditions radically changed would produce far-reaching effects on the freight and passenger transport, not only in this part of Croatia but in the central Danube region as well. Apart from being considerably shorter, the new railway is planned to be constructed at a lower altitude, with less climbs and curves which would considerably increase the speed and quality of the rail transport and reduce the costs of its exploitation. In case the other important projects are also realized, particularly those involving the construction of the Danube-Sava Canal, with the Sava River made navigable up to Sisak (Zagreb), which are preconditions for intermodal transport, completely new traffic standards would be ensured in this part of Europe. The position of Rijeka would be additionally improved with the port obtaining the advantage over not only the North Adriatic but also the North Sea and the Baltic ports.

Several variants of the new railway routes were under consideration. The route called "Drežnička" was accepted as optimal solution in which process the criterion applied was based on the extent of its integration into the existing and future rail network (Figure 2). This is an important criterion bearing in mind that there are many cases of overlapping with other railway routes planned to be constructed in the future. Thus, on its Zagreb-Drežnica section, the route coincides with the Zagreb-Split route, and on the Rijeka-Drežnica route there is overlapping with the Adriatic railway. The entire route is in fact covered with two rail directions which is a guarantee that it will not be underused in the future.

From the aspect of the Port of Rijeka the planned railway line characteristics exceed the requirements since they primarily refer to the provision of high efficiency railway connection. Therefore the justification of the project of the new railway line regarding maximal speeds, minimal curve radii, length, etc. can and have

to be considered only in a significantly wider context. The decision about the time of starting the realisation of this project is also very complex even if wider connotations are excluded. It is, namely, difficult to give an answer from a purely traffic aspect, since the condition of the existing railway infrastructure makes the usual methodology impossible. The implementation of the criteria of capacity usage of the existing railway line is not adequate due to its obsolescence and incompetitiveness in relation to modern road infrastructure. The absence of growth in railway traffic, in spite of the increase in the volume of cargo flowing along this traffic corridor shows the failure in attracting even those cargoes that would actually have to be transported by rail. Thus, the capacities of the existing railway lines will not be used to the maximum which may lead to wrong thinking that there is no need for the construction of a new railway line. However, the construction of a level railway line is expected to bring a shift in the ratio of the share of road and rail traffic, i.e. substantial increase in the cargo volumes transported by rail. In such circumstances the forecast demand in rail traffic, respecting the structure and expected quantities of cargo in the Port of Rijeka and taking over of the main role in the container transport towards the hinterland, can be estimated at 12.8 mil. tons in 2020 i.e. 27.2 mil. tons in 2030.

It is true that the level railway line Rijeka-Zagreb is a very expensive project financially but, it is also true that the construction we are talking about is a generation project which can generate the development of the entire country in the following 30-50 years. As regards the port of Rijeka, this railroad, with the planned minimum capacity of 25 mil.tons per year is of great importance and significance for its development as the existing hinterland connection problems will cease to exist. As regards its function of enabling a better connection of Istria with Rijeka and other parts of Croatia, after a new railway line through Učka mountain is built, thus becoming a part of the alternative international railway connection Milano-Trieste-Rijeka-Zagreb, with legs towards Budapest, Vienna and Belgrade, Sophia and Istanbul, Thessaloniki and Athens respectively, or to become a part of the Adriatic railway along East Adriatic and Ionian coast, nothing has been decided yet, but there is such perspective.

6.3 Adriatic-Ionian Railway

By its geographical position, the port of Rijeka belongs to the North Adriatic port basin which also includes the ports of Trieste and Koper. All these ports have similar geo-traffic advantages and are oriented to more or less overlapping hinterland countries and markets. However, taking a long-term view, in the integrated Europe, as part of global economy, with the

economic rationalization and business efficiency seen as primary objectives, all North Adriatic ports, from Venice via Trieste, Koper and Rijeka to Bakar and Krk will be regarded as an integrated port system.

Moreover, the port authorities of Rijeka and Trieste have already signed an agreement on the necessary coordination of their respective long-term development strategies. As it was established by their managements, the North Adriatic region would face a serious shortage of the port capacities and will not be able to cope with the expected increase of the traffic volume in the future. What chances will Croatia have for supporting and protecting its interests in these new circumstances, will depend on both, the present and the future development of the port of Rijeka and the construction of the road and rail traffic infrastructure.

With the rail-project Jurdani-Lupoglav completely realized and Buzet-Koper-Trieste connected by a new railway track as planned, the transport route connecting these ports would be shortened by about 40km, which would allow for their practical integration.

With the planned construction of the level railway track, this rail connection, as part of an alternative international railway route Milano-Trieste-Rijeka-Zagreb, with branch lines towards Budapest and Vienna, Belgrade, Sophia and Istanbul, respectively Thessaloniki and Athens, will gain a broader significance.

7. CONCLUSION

It is the existing inadequate rail infrastructure and its inadequate capacity that is preventing the Port of Rijeka to make the most of its very favourable traffic and geographical position. It is quite possible that the actual technical-technological stagnation and underdevelopment of the Croatian railways, in particular those being a part of the Euro-Croatian traffic corridor, give rise to the situation where the goods transport from Central and East Europe would be redirected to the traffic routes towards the North Sea and Baltic ports or the ports of Trieste and Koper.

The review of the present condition of the Croatian railway infrastructure and capacity, especially the Rijeka traffic route, reveals their inadequacy to meet the more demanding volume and quality that freight transport will impose in the future. The modernization of the Rijeka-Zagreb railway section is particularly important for the promotion of railway traffic on the Rijeka-Zagreb-Central Europe direction. In addition, it is important to make a better connection of rail and port system in the Rijeka traffic network and to find the best way of including the dislocated terminals in the rail system. All the above elements and solutions aim at providing better rail transport operations, for the benefit of the port of Rijeka. The modernization should particularly involve the constant renewal of the rolling

stock, automation of processes and the IT connection of the port and the railway systems.

However, only the construction of a level railway track Rijeka-Josipdol-Karlovac-Zagreb would create significant preconditions for the Port of Rijeka, to make significant improvements in the freight transport, by increasing its volume and safety and by reducing the operating time. To accommodate future growth of cargo volume, the port of Rijeka is expected to realize a cargo turnover of more than 30 mil. tons per year. It is precisely the construction of this railway, with the necessary modernization of railway stations and construction of a modern marshalling yard that will create the necessary preconditions for the port of Rijeka to finally realize its ambitious long-term development plans. Hence, the priority and importance of the level railway line as a chance for the Port of Rijeka to become an important port in the South Europe. Failing that, Rijeka could face a serious risk of losing part of its market which would have disastrous consequences for its operations.

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SAŽETAK

ŽELJEZNIČKI PROMET U FUNKCIJI RAZVOJA RIJEČKE LUKE

Gospodarski položaj i komparativne prednosti Luke Rijeka samo su značajne pretpostavke za njezin razvoj i konkurentnost. Adekvatna povezanost Luke Rijeka s gravitacijskim zaleđem nije moguća bez suvremenog željezničkog i cestovnog prometa. Istraživanja i analize postojećeg stanja povezanosti riječke luke u ovom radu, ukazuju na potrebu modernizacije postojećih željezničkih pruga ali i izgradnju nove ravničarske željezničke pruge na pravcu Rijeka – Za-

greb koja bi bila u funkciji snažnijeg razvoja Luke i osiguranja konkurentnosti u odnosu na ostale luke u okruženju. Nizinska pruga Rijeka – Zagreb, te rješavanje riječkog željezničkog čvora predstavljaju strateške prometne objekte u funkciji razvoja Luke Rijeka. U sklopu rješavanja željezničkog čvora u Rijeci, uspješno povezivanje pojedinih lučkih terminala ima posebno značenje. U sklopu potpunog rješenja željezničkog prometa u širem području riječkog lučkog bazena, prilazi pojedinim terminalima kao i povezivanje s istarskim prugama kroz tunel Učka te povezivanje lučkih terminala na otoku Krku ima veliku važnost za budući razvoj Luke. Glavni doprinos ovog rada upravo je analiza postojećeg stanja i definiranje elemenata i prioriteta koji afirmiraju željeznički promet kao glavni faktor u funkciji razvoja Luke Rijeka.

KLJUČNE RIJEČI

Luka Rijeka, prometna povezanost, željeznički promet, riječki željeznički čvor, smjernice razvoja

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