THE SIGNIFICANCE OF THE INTERMODAL TRANSPORT ROUTE THROUGH THE PORT OF RIJEKA FOR SUSTAINABLE TRANSPORT

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Abstract

The road transport generates benefits to the economic development of each country, but it also produces the largest contribution to greenhouse gas emissions. The purpose of this paper is to examine the impact of road transport on the environment and to emphasize the requirement for its substitution by environmentally-friendly transport branches. An intermodal overseas transport route between the Southeast Europe countries and the North Adriatic Italian ports through the Port of Rijeka (Bakar Ro-ro terminal) as a junction point is analysed. The scope of this paper is to highlight the significance of the introduction of new seaborne truck traffic services from the Southeast Europe countries to the North Adriatic Italian port terminals for the reduction of vehicles gas emissions and sustainable development. The main research findings of the article are: the introduction of the new intermodal transport route from the Port of Rijeka to the North Adriatic Italian ports will decrease the gas emission from heavy vehicles operating on the North Adriatic transport route and thus contribute to sustainable transport. The methodology used in this paper consists of the analysis of the impact of road transport to the environment as well as the analysis of the implementation of the Bakar Ro-ro terminal and its influence to the road infrastructure in the Rijeka traffic junction. Further research regarding the possibility of reducing heavy vehicle road traffic through the North Adriatic should be deal with introducing an intermodal railway transport.

Key words: Port of Rijeka, Bakar Ro-ro terminal, road transport, intermodal transport, sustainable transport

1. INTRODUCTION

The development of transport was always closely linked to the economic, social and political growth of a country. The degree of transport system development is correlated to the level of economic development and the quality of life and, consequently, the overall economy of the country, region or area is also dependant on it. Therefore, enhancing the quality of the transport system is of vital interest to any community. Since the basic aim of the transport system is connecting business entities and people regardless of distance, purpose or mode of transportation, transport also has an international dimension. However, in addition to the positive socio-economic influence, transport also has a negative side. Its expansion has caused a series of negative factors which continuously jeopardize the quality of life and a country's economy. In that respect, particular emphasis must be given to environmental pollution (of air and water) caused by increased greenhouse gas emissions, noise and vibrations, occupation of public areas and spaces, as well as extraordinary events (traffic accidents) (Maglić et al., 2013, p. 38).

It is hardest to curb the increase of greenhouse gas emissions in transport since the necessary measures are slowly implemented and they are predominantly relative to the advances of the technical properties of motor vehicles. One of the basic goals of the European sustainable transport policy is meeting the environmental criteria which include a series of measures, among them: technical improvements of vehicles, alternative energy sources, tax policies, subsidies, defining environmental standards, etc. The countries of the North Adriatic transport route, Croatia, Italia and Slovenia, as countries on EU route accession, must also follow the trend of reducing transport sector emissions and must adopt the proposed taxation and tax relief measures in order to make the vehicles in use environmentally friendly.

When introducing a new intermodal traffic route, all the relevant port traffic and road transport interface parameters should be investigated. In order for the balancing of capacity to be successful, it should not be studied within only one traffic branch but within a traffic route as a whole. It is precisely the balancing of various traffic branches that creates a more realistic picture of an integrated traffic route’s capacity, i.e. the time parameter within which a specified cargo volume or a number of transport units can pass along a particular route. This also extends to transport costs, as well as safety sustainable development in relation to a particular itinerary.

2. ENVIRONMENTAL IMPACT OF ROAD TRANSPORT

There are approximately 500 million registered road vehicles in the world, 85-90% of which are cars and 8-12% lorries. According to OECD (Organization for Economic Co-operation and Development) data, the number of vehicles is expected to double by 2030. Due to increasingly rapid economic growth and development,

European road transport grows very quickly, and that reflects upon the increased usurpation of space, the increase in noise and vibrations, irrational energy consumption, water and soil pollution, and an overall negative effect on the environment as a whole. The world CO_2 emissions from road transport are projected to grow between 140% and 350% to 2050, depending by the changes in freight intensity and the share of rail in delivering future freight in land transport.[1]

Transport is widely considered to be one of the causes of health problems linked with toxic air pollutants that endanger the ecosystem and human health. Other problems, including noise and space usurpation, also have a substantial impact on the ecosystem. A minimum of 25000 m^2 of space is required to construct one kilometre of motorway with three traffic lanes in each direction. That is the equivalent of constructing approximately 60 residential buildings. Of all the sources of municipal noise in cities, nearly 80% is due to traffic noise - an extremely problematic piece of information since traffic noise has a negative effect on the human organism.[2] In addition to the aforementioned negative effects on people and the environment, transport is also marked by numerous positive effects like the development of tourism, economic growth, employment, rise in competitiveness and accumulation of profit. It is therefore necessary to establish a balance, i.e. to support a development concept for sustainable transport in order to intensify its positive effects and eliminate the noxious ones. Transport, especially road transport, is responsible for 25% of the global carbon (IV) oxide emissions because of the use of fossil fuels. The average car annually emits its weight in CO_2 emissions. For a one hour drive on the motorway at 130 km/h a car consumes the same amount of oxygen that a human being consumes breathing for ten days.

Regulation on the Monitoring of Greenhouse Gas Emissions, Policies and Mitigation Measures in the Republic of Croatia (Official Gazette No. 87/12) and Ordinance on Greenhouse Gas Emissions Monitoring in the republic of Croatia (Official Gazette No. 134/12) prescribe obligation and procedure for emissions monitoring, which comprise estimation and reporting of all anthropogenic emissions and removals. The monitoring comprises the main greenhouse gases which emissions are the result of anthropogenic activities: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), halogenated carbons (HFC_s, PFC_s) and sulphur hexafluoride (SF_6), as well as the indirect greenhouse gases: carbon monoxide (CO), oxides of nitrogen (NO_x), non-methane volatile organic compounds ($NMVOC_s$) and sulphur dioxide (SO_2).

Greenhouse gas emission sources and sinks are divided into six main sectors: Energy, Industrial Processes, Solvent and Other Product Use, Agriculture, Land Use, Land-Use Change and Forestry and Waste. The largest contributor to the total greenhouse gas emissions in 2012 in the Republic of Croatia was the Energy sector with 71.5%. It was followed by the Agriculture sector with 12.8%, Industrial Processes 10.8%, Waste 4.3%, and use of Solvents and Other Products with 0.45%.[3]

[1] ITF Transport Outlook 2015 [available at: http://www.oecd.org. access May 19, 2015]
[2] http://www.bicikli.hr [access May 9, 2015]
[3] National Inventory Report 2014 (NIR 2014) – Croatian Greenhouse Gas Inventory for the Period 1990-2012, EKONERG – Energy and Environmental Protection Institute, Zagreb [available at: http://www.azo.hr, access May 20, 2015]

As the carbon dioxide emission from fuel combustion includes more than 88% of CO_2 emission it could be concluded that the Energy sector with its share of total greenhouse gas emissions presents the equivalent emission of CO_2.

The energy sector covers all activities that involve fuel consumption from stationary and mobile sources, and fugitive emission from fuels. Fugitive emission arises from production, transport, processing, storage and distribution of fossil fuels.

Transport sector is also one of more important CO_2 emission sources. This sector includes emission from road transport, civil aviation, railways and navigation. According to data from 2012, the share of greenhouse gas emissions caused by transport in the Energy sector was 21.33%. On the other hand, the CO_2 emission from Transport sector contributed with 29.3% to the national total CO_2 emission in the same year. The largest part of the CO_2 emission from Transport sector arises from road transport, i.e. 95%.[4]

3. EVALUATION OF THE CONDITION OF ROAD INFRASTRUCURE IN THE RIJEKA TRAFFIC JUNCTION

The geo-traffic position of the port of Rijeka is an important factor in its integration into the European Traffic System. In this respect, Bakar emerges as an important location, which, unfortunately, has not been sufficiently valorised and therefore holds much unused potential (particularly in the area of the former coke plant). The existing infrastructure, technical and traffic elements synthesize the aim for a well-balanced sea, road and/or railway traffic.

The road cargo transport routes correspond to the distant traffic itineraries towards Bakar, i.e. the Rijeka Traffic Junction. These are the routes from the continental hinterland, i.e. Central and Eastern Europe, which primarily exist as two access routes from Zagreb and Ljubljana and, secondarily, from Dalmatia and Istria. The Rijeka Traffic Junction access roads, together with the motorway links, is integrated into the Rijeka By-pass Road. The basic concept of connecting the Bakar Basin with access trunk roads and county roads is based on the tangential access in relation to the Rijeka city centre. The reason for this was, until recently, the limited capacity of the D8 road and the old industrial road through the Kukuljanovo industrial zone. As a result, a substantial inflow of vehicles, especially heavy cargo traffic from the direction of Zagreb, was threatening all the advantages of a balanced crossroads and access roads capacity in the so-called eastern approach area. As to the road connection with the main road network, the eastern part of the Rijeka Traffic Junction has a relatively high degree network density. Assuming that the introduction of an intermodal service results in the traffic load of 2x150 vehicles per day, the future traffic load projection may be calculated in the following way:

Q = 11280 vehicles/day (current traffic flow)

[4] Guidebook on the cost-effectiveness of fuel consumption and CO_2 emissions (2015), Ministry of the Interior, Zagreb [available at: http://www.mup.hr, access May 19, 2015]

Δq = vehicles/day (increase in traffic) = 150x2 = 300x3 = 900 assumed vehicles

$p_{\%} = Q + \Delta q / Q = 11280 + 900 / 11280 = 1.08$

Comment: The increase in traffic flow of 8% in case of 150x2 daily truck arrivals at the Bakar Ro-ro terminal by the route D8 and the decrease in the service level.

The road traffic service quality of the subject junction will influence the implementation of the intermodal transport services from the countries in the Southeast of Europe to the North Adriatic Italian ports. The biggest changes concerning directing and intensifying the traffic flows to the eastern part of the Rijeka Traffic Junction will be caused by the introduction of a Ro-ro service from Bakar terminal to the North Italian ports, i.e. Chioggia or Venezia.

In consequence of the anticipated increase in traffic due to ever increasing inflow into the Bakar Ro-ro terminal, the situation could worsen during rush hours. The only way this problem could be solved is by implementing sophisticated methods of fleet management, i.e. distance management from a distribution centre within the Ro-Ro terminal itself.

4. ROLE OF THE TRUNK ROAD D40 & D8

The introduction of a new intermodal truck traffic route from the countries in the Southeast of Europe to the Bakar terminal including onward transport by sea creates a new challenge and a test for the existing land infrastructure and superstructure, and especially for the road network. In this context, the road network within the gravitational hinterland represents the infrastructure segment of the entire logistic system (Vilke & Baričević, 2009, p. 98).

The so-called contact area of the Ro-ro terminal parking lots and the trunk roads D8 and D40 should represent the connection between the outer-city and inner-city network.

At the immediate entrance to the Ro-ro terminal or within the terminal itself, there should be a parking lot for the accommodation of heavy vehicles, trucks, trailers, semi-trailers and trailer trucks. The parking lot should have sufficient capacity to accommodate all vehicles that might, in the worst case scenario, simultaneously be waiting to embark/disembark onto the Ro-ro vessels.

Regarding the priority role of the railway for low-tariff bulk cargoes from the Bakar basin, the possibility of large increase in truck traffic has not been examined while designing the junction. Otherwise, the consideration of introducing new seaborne itineraries would certainly affect the change of parameters relevant to the position, number and type of the terminal road links to the D8 road.

More exactly, the new leg of the road link in subject might have been built with a non-levelled crossroads. In this way the continuity of traffic flows for the benefit of both networks would have been realized which is the basic principle in the design of the outer-city and inner-city road network. The existing traffic solution is insufficient for outflow as the unnecessary resistance in the network when joining the road D8 is

created, caused by the road link's lower priority rank. However, taking into consideration the current traffic connections, the requirements of the new intermodal route from/to the Bakar terminal have been achieved as the road D40 contributed to the improvement in the quality of distant traffic. Only 7.5 km of the three-lane road rise from the port to the level of Čavle Road Traffic Junction and directly to the trunk road D3 towards Zagreb. Moreover, the Sv. Kuzam Road Traffic Junction plays as an important role by directing the cargo traffic from D8 to D40 (Kukuljanovo industrial zone) and vice versa.

Secondary route towards Split (the 'old' Adriatic trunk road) plays a complementary role in the service of the hinterland. Finishing the construction of the eastern leg of the Rijeka By-pass Road, i.e. the initial leg of the Adriatic motorway stretching over the coastal area Rupa-Rijeka-Žuta Lokva, a long-term perspective for a better service of the Bakar Ro-ro terminal is created.

5. THE BENEFITS OF INTERMODAL TRANSPORT ROUTE THROUGH THE PORT OF RIJEKA

The introduction of the North Adriatic overseas itineraries, more exactly truck ro-ro transport between the Croatian and Italian North Adriatic coast was the consideration subject of many initiatives. An implementation attempt of a *joint venture* Ro-ro service between the port of Rijeka and the port of Chioggia was realized in the year 2004. Unfortunately the service was soon interrupted due to several reasons, primarily the non adequate selection of the location for loading/unloading heavy road trucks in the port of Rijeka – the city centre close to the bus station. The Bakar basin as a better quality solution could not be taken into consideration at that period due to the unprepared ground, the absence of customs, etc. (Vilke & Baričević, 2009, p. 100).

Concerning the future introduction of the intermodal route via the Bakar ro-ro terminal as the junction point, a more systematic approach is necessary in which all relevant factors, directly or indirectly providing for the success of the subject design during a long-term period will be included.

The main argument for the initiatives regarding the introduction of the new Ro-ro transport route is the deviation of truck traffic from the west Croatian, Slovenian and North Italian road network. In this way the road networks traffic density would be reduced, the waitings on customs transit as well as the procuring of expensive permissions for the road network utilization would be eliminated.

In the event of substantial increase of truck traffic between the Southeast European countries and the North Adriatic Italian ports, a possibility of introducing an intermodal railway transport should be considered. Even if the railway access track to the existing railway network is not constructed, new technologies are expected to enable the cargo in trailers and semi-trailers to be carried and delivered onto the ro-ro terminal. The same effect could be achieved by applying the „Piggyback"system (Huckepack system) „A" technique with minimal investment at the point within the existing railway network closest to the terminal.

The great improvement of the implementation of the new intermodal transport route through the Port of Rijeka as well as the introduction of the intermodal railway system would be the decrease of the greenhouse gas emissions from road transport, i.e. heavy road vehicles at the North Adriatic transport route. Since the largest part of the CO_2 transport emission arises from road transport, the new Ro-ro route through the Bakar Ro-ro terminal would create benefits regarding the diminishing of greenhouse gas emissions. Thus, the new intermodal and seaborne route will contribute to sustainable transport development.

6. CONCLUSION

Although distance, time and cost of transport are mutually intertwined components influencing extensive exploitation of the Bakar Ro-ro terminal, the fact is that each component has its own significance. Once a new traffic route has been introduced, a record should be kept of technological, transportation and exploitation indicators, and even partial studies should be carried out for particular segments of the whole system. The necessary tools for this approach should be the simulations which would enable testing of particular sub-systems, such as an interactive information support service, telematic fleet management, etc.

Due to changes in input regarding the increase/decrease in the number of freight vehicles and changes in transport locations in particular countries and in customs policy, as well as the other parameters with notable dynamic and stochastic features, there will be some necessary changes in the logistic model of the considered traffic route.

The set-up of the existing infrastructure and superstructure in Bakar, Rijeka, County of Rijeka and Croatia as a whole allows for an uninhibited start of an extremely positive initiative. However, an efficient intermodal route between the countries of Central and Eastern Europe, Bakar and the North Italian ports, i.e. Chioggia or Venezia, is possible only by way of an integrated logistic support.

The Energy sector, including Transport as a sub-sector, is the main source of the anthropogenic greenhouse gas emission with share of 71.5% in total emission. Carbon dioxide is the most significant anthropogenic greenhouse gas. The most significant anthropogenic sources of CO_2 emissions in the Republic of Croatia are the processes of fossil fuel combustion for electricity or/and heat production, industrial processes and transport. Road transport respectively vehicle fuel combustion generates great volumes of CO_2 emissions.

The introduction of the new intermodal transport route through the Port of Rijeka connecting the east European countries and the Italian north Adriatic ports will redirect the heavy vehicle road traffic from the North Adriatic transport route. Thereby, the west Croatian, Slovenian and North Italian road networks traffic density would be decreased. In addition, introducing intermodal railway transport would generate the diminishing of road transport gas emission and lead to sustainable transport development.

As the largest share of all transport emissions, more exactly about 95%, is originated from road transport, the implementation of the analysed transport route

would contribute to sustainable transport mission and goals. Moreover, the introduction of railway transport in the intermodal service will furthermore diminish the impact of road transport to environmental problems.

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