

## ROAD AND RAIL FREIGHT TRANSPORT

Dušan STAMENKOVIĆ<sup>1</sup>  
Ljubislav VASIN<sup>2</sup>  
Miloš MILOŠEVIĆ<sup>1</sup>

<sup>1)</sup> Faculty of Mechanical Engineering Niš

<sup>2)</sup> High Railway School of Professional Studies, Belgrade

### Abstract

Road and rail transport are the most important types of inland freight transport. Road transport has a significant advantage considering the possibility of transport of goods from door to door and it is much more suitable for the transport of smaller quantities and various goods. Rail transport is convenient to transport large amounts of goods but it isn't suitable for goods transportation from door to door. Statistical data in the EU countries show a different distribution of the modes of transport which points to the existence of many factors that influence the level of development and volume of transport. The paper analyzes the modal split of road and rail freight transport in Serbia and their competitive advantages and disadvantages. The paper also discusses the measures to be taken considering the commitment of the EU in the context of sustainable development strategy of transport due to the energy efficiency and ecology.

**Key words:** freight transport, road, rail, statistics, sustainable development.

### 1 INTRODUCTION

Transport of goods is an important segment of the modern economy and according that it is an object of constant investigation. Industry is very interested in the improvement of transport and new transport technologies application.

Transport is an economic, service industry, which has the purpose to satisfy customer needs. Customers of the transport service system, basically, are not interested in transport technology, but in the quality of service [1].

The choice of transport mode from the customers is based on the evaluation of the competitive advantages. The competitiveness of each transport mode depends on its technical and economic-exploitation characteristics, such as: reliability, safety (quantity of the lost, damaged or destroyed cargo pieces), security, transportation time, door-

to-door delivery system's applicability, adaptability, stability (considering technical and organizational possibilities of transportation), energy consumption, transportation prices, eco-friendly etc. [2, 3].

Most frequently mentioned factors are: access, design, environment, maintenance, mobility, safety, and transparency (communications/planning) [4]. Mobility was a top-of-mind category in the discussion of future transportation related needs. Participants expect increase of travel speed and less congestion.

The share of rail freight in intra-EU transport has been constantly decreasing over recent decades. Conversely, the share of road freight has been increasing. This general trend has held during both periods when the volume of goods transported has increased and periods of decline in transport activity. It has also continued through periods of strong economic growth as well as during economic recession [5]. Multimodal transport refers to the use of two or more carriers of different modes during the movement of a shipment from one country to another. The basic reasons for using multimodal transport are the characteristics of each single transport mode. Considering to the development of advanced transport technologies such as: palletisation, containerisation, RO-RO, LO-LO, RO-LO, Huckepack and Bimodal transport technologies, multimodal transport has gained increasingly in significance in order to the increase efficiency and effectiveness of the transport, with minimum negative effects for the environment [6].

This paper describes the basic characteristics of the road and the rail freight transport and indicates their advantages. Also, the main trends in road and rail freight transport volumes are analysed.

### 2 COMPETITIVE ADVANTAGE OF RAIL AND ROAD TRANSPORT

Comparative overview of main advantages of rail and road freight transport is given in Table 1.

**Table 1** Main advantages of rail and road transport

Railway transport	Road transport
<ul style="list-style-type: none"> <li>• Large transport capacity</li> <li>• Suitable for transport of large amounts of goods</li> <li>• Low cost of transport</li> <li>• Low total transport cost for the medium and long distances</li> <li>• High degree of safety</li> <li>• Reliable and accurate service</li> <li>• High energy efficiency</li> <li>• Environmentally friendly</li> <li>• Greater speed</li> <li>• Suitable for automation and computerization</li> <li>• Continuous technological progress and development</li> </ul>	<ul style="list-style-type: none"> <li>• Mutual independence movement of transport units</li> <li>• Small elastic transport unit</li> <li>• High density of transport networks</li> <li>• Transport "door to door"</li> <li>• High elasticity (flexibility) <ul style="list-style-type: none"> <li>• Simpler transport organization</li> </ul> </li> <li>• Large frequency in transport</li> <li>• Low terminal cost</li> <li>• Suitable for the transport of small quantities of goods over short and medium distances</li> <li>• Lower overall transport cost for short distances</li> <li>• Less total time of transport for short distances</li> </ul>

The competitiveness of some freight transport mode is predominantly determined by technical and economic-exploitation characteristics, such as:

- Capacity (the maximum amount of the goods that can be transported in a given time);
- Reliability of transport (the probability that the transport carried out according to plan and timetable regardless of the conditions (weather, infrastructure, etc.);
- Speed of transport;
- Economy (price of transport, transport costs);
- The elasticity or flexibility in adapting to the transport needs;
- Safety (general safety during transport from goods damage);
- The impact on the environment and others.

## 2.1 Technical and operational characteristics of the road freight transport

With a small transport units and high density of network, road transport can provide transport of different types of goods on a large number of destinations, and transport "door to door" at all distances.

In road transport each individual vehicle, in it's motion, is independent of the other vehicle. This is opposite to the rail traffic, in which the wagons are connected in the train. Because of the independence of vehicle units, road transport is very flexible and adaptable to all transport requirements. Road transport can accept any quantity of goods to be transported. Road transport is characterized by high flexibility due to transport time, because its transport units are technologically independent and do not require special procedures in the organization of the transport.

The total cost of road transport is higher than in rail traffic, due to higher movement resistance and the mutual independence of transport units. However, the transport of small quantities of goods on short distances, the road transport costs may be lower than the costs of rail transport, because they don't include the high initial/closing costs. This means that the cost competitiveness of road transport is dominant in transport on short and medium distances, but for transport on long distances road transport is unfavorable in relation to the railways. Road transport of new automobiles is shown in Figure 1.



Fig. 1 Road transport of new automobiles

The key advantage of road transportation is a relatively small investment in the purchase of transport units, which are available for small businesses, so many companies may have its own car park.

Road freight transport is performed, as a rule, without timetable. Rail transport can be only performed according to the established timetable, which must include each passenger or freight, ordinary or extraordinary train.

High movement resistance, in addition to the higher cost, causes also the less speed of road vehicles relative to the rail vehicles. However, considering the small time loss in operations such as waiting for the completion of the wagons, shunting of trains, fitting into the timetable, road vehicles can achieve a shorter total time of transport especially for short distances.

A road infrastructure requires a large space. In addition to movement areas, a road must provide a large areas for overtaking, passing, stopping and other needs.

Road traffic safety is objectively lower than safety of any other mode of traffic. Movement of a large number of transport units, with different capabilities, with different needs in the same traffic area, is objective cause of traffic accidents.

On the basis of the above, road transport has a distinct competitive advantage in the transport of small quantities of goods on the short and medium distances in relation to the rail.

## 2.2 Technical and operational characteristics of the rail freight transport

Rail transport is a type of inland transport which has the highest transport capacity and which has the lowest transportation costs. In accordance with that rail transport should have the priority at the transport of the large amount (mass) of goods. But transport time increases because of wagons manipulation in process of train formation in marshaling yards. The most effective rail freight transport is using the direct trains which are formed in the starting station and travel up to the final destination without processing in marshaling yards along the way. Marshaling yard in Belgrade is presented in Figure 2.



Fig. 2 Belgrade Marshaling yard

Rail transport is less sensitive to the influence of weather conditions (frost, snow, wind, etc.), and because of that it is reliable and punctual transport. Reliability of railway transport, however, can be reduced because of the strong connection of the rolling stock with the railway truck, and

malfunction of a single wagon can stop the whole train running, until the single car failure elimination.

Considering the small rolling friction resistance, railway can achieve the largest transport speed in inland traffic. In addition, rail transport is characterized by energy efficiency particularly in the transport of large quantities of goods at the middle and long distances. In general, the competitiveness of railways is particularly expressed in transport over medium and long distances (over 300 km).

The main disadvantage of rail transport is the inability to travel “from door to door” because of the low density of railway network. The railway lines are mostly established in the transport direction with large mass of goods. The big users of the rail transport (mines, factories, warehouses, etc.) are directly connected with the railway network, allowing the loading (unloading) on the initial (final) point of the road.

The significant disadvantage of rail transport is large investments in the construction of railways and so high cost of operation and maintenance of infrastructure. Because of that rail transport requires high capacity utilization and high productivity.

Railway’s impact on the environment is more friendly than other transport modes. The relatively small area occupation by the railways infrastructure is advantage of railway relative to the road transport. The mostly application of electric traction in rail traffic causes the absence of harmful emissions in the environment and less noise.

Railway transport is very suitable for automation and computerization, that allows a constant increase in the quality of transport services and application of technical innovation. For freight transport it means an increase in line capacity, which can be implemented in two ways: modernization, introduction of computer systems for the management and regulation of traffic, and the technical innovations in the vehicle construction by increasing the driving force and by increasing the weight and length of trains.

### 3 MODAL SPLIT OF FREIGHT TRANSPORT

The analysis of the relative importance of the different inland transport modes (road, rail, inland waterways) in the European Union is made in article [6]. Among the three inland transport modes, road transport has a largest share of EU freight transport. Based on performed tonne-kilometres in EU freight transport road transport shares about 75%.

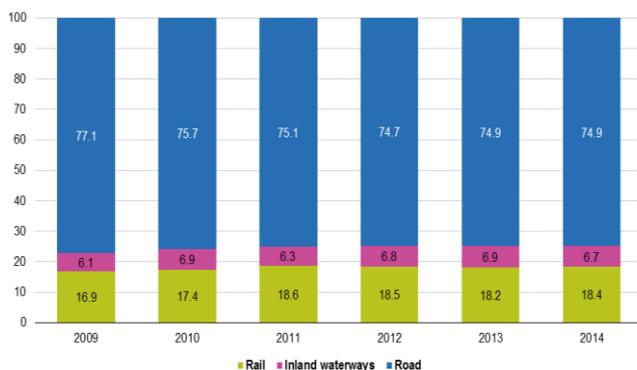


Fig. 3 Modal split of inland freight transport in EU 28 (Source Eurostat 2014)

Modal split of inland freight transport in EU 28 in period 2009-2014 is presented in Figure 3.

There are significant differences between EU countries in volume of railway freight transport. The volume of freight railway transport in 2014 (tkm) is shown in Fig. 4, and national, international and transit transport are indicated. Volume of national transport depends on development of domestic industry. Volume of transit transport mostly depends on geographical position of country.

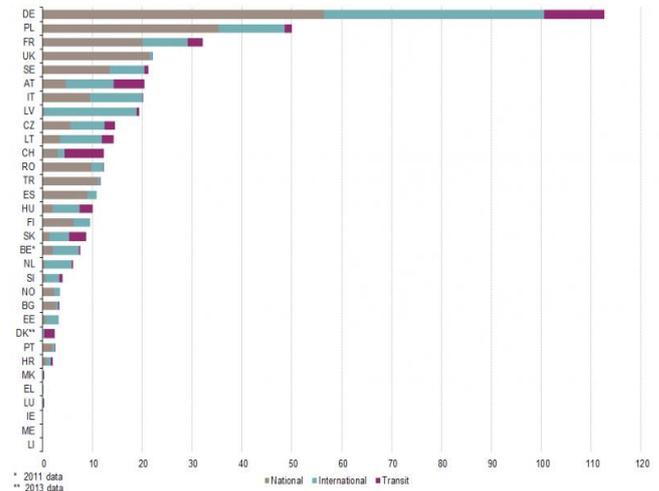


Fig. 4 Volumes (tkm) of railway freight transport in EU (Source Eurostat 2014) [7]

Modal split of inland freight transport in EU countries are different. According the data for 2014, the largest national share of road transport is in France (86.4%), Portugal (87.2%) and United Kingdom (87%), Denmark (88.8%), Spain (93.9%), Italy (86.9%) and the largest national share of rail transport is in Latvia (81.2%), Lithuania (68.1%), Estonia (55.2%), Slovakia 38.9%, Austria (33.3%) [7].

The average transport trend is different between Member States. In period 2000-2012 rail freight volumes had grown by more than 30% in Germany, the Netherlands and the Baltic Member States, but had declined in France, Bulgaria and Slovakia. National trends depend on a number of factors, including the extent of railway networks, the proportion of international traffic in total traffic and the extent of competition from other modes (e.g. inland waterways, maritime). The share of freight carried by road and rail varies greatly depending on the type of goods transported. Heavy transport (such as coal and building materials) is predominantly transported by rail, whereas goods that are lighter and/or more perishable (such as food and textile products) are transported by road.

The choice of transport mode (road or rail) is made by shippers. Decisions made by shippers are a function of the characteristics of past experience, the type of goods carried, the carriers’ attributes and distance/time requirements. Evidence about shippers’ preferences from national case studies points to the importance of cost considerations in some countries where rail freight is perceived to be too expensive (France, Italy). More broadly, the need for high-quality and better connected rail infrastructure is demonstrated by all case studies, with a focus on bottlenecks (Germany), capacity (Italy, France) and reliability (Spain, Poland) [5].

European transport strategy (Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system) sets the goals of increasing the quality of rail freight, as well its effectiveness and capacity in order to promote energy efficiency in EU transport. This transport strategy predicts significant reduction of Europe's dependence on imported oil and reduction of transport carbon emissions. Initiatives proposed have a goal to shift 30% of road freight over 300 km to other transport modes such as rail or inland waterways transport by 2030.

The modal split of freight transport in Serbia in 2015. is presented in Figure 5. The volumes of road and rail transport are similar and each of them amounts about 40% of total volume. Pipeline and waterway transport modes amount about 10%.

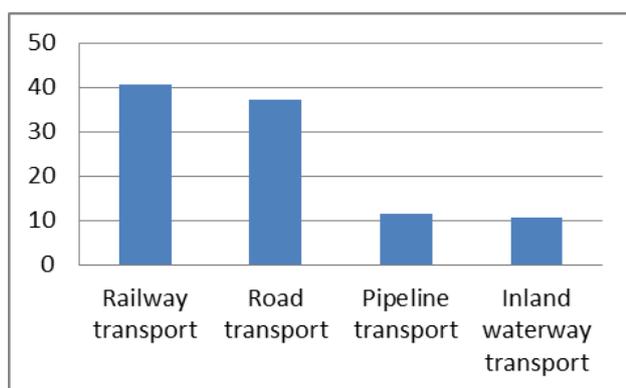


Fig. 5 Modal split (%) of freight transport in Serbia 2015

The volume of freight transport in Serbia, expressed in tkm, is increased in period 2011-2015. for 10 %. The basic indicators of freight transport in Serbia in period 2011-2015 according the data from Statistical yearbook of the Republic of Serbia [8] are presented in Table 2.

Table 2 Basic indicators of freight transport in Serbia (10<sup>6</sup> Ton-kilometers)

	2011	2012	2013	2014	2015
Railway transport	3611	2769	3022	2988	3249
Road transport	1907	2474	2824	2959	2974
Pipeline transport	1005	901	958	904	923
Inland waterway transport	726	605	701	759	859
Air transport	2.7	1.9	1.9	3.3	4.7

In Serbia there are 5227 km of state road I category, of which 741 km are the motorways. The length of state roads II category is 10935 km. Goods that are usually transported by road in Serbia are metal ores, products of agriculture, fish, food products, tobacco, rubber and plastic products, chemical products, metal products and equipment, and others.

Total length of the railway network is 3.808 km, from which 1.196 km are electrified railway lines. Volume of railway freight transport in period 2000-2015 is presented in Fig. 6. The volume of rail freight transport is the highest at Corridor X and it is smaller on regional and local railway lines. On the Serbian railway network in year 2015 was

loaded 5,521.000 t in 149.000 wagons, mostly building materials, metal products, coal, ores, oil and others.

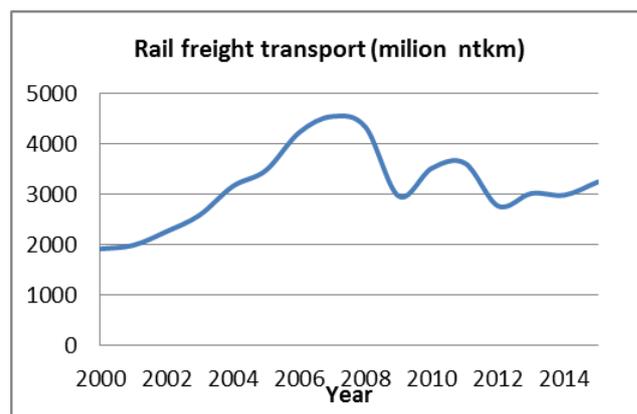


Fig. 6 Volume of rail freight transport in Serbia 2000-2015

The main reason for insufficient use of the railway transport capacities in Serbia are unsatisfactory quality of transportation services for customers, considered in terms of quality parameters, specified in the carriage of cargo (lack of reliability and punctuality of trains, too much handling of cargo during loading and unloading, the inability to transport "door to door", difficulty in planning and implementation of transport due to organizational changes in the structure of the railways, etc.).

## CONCLUSION

Considering the actual fact that world is faced with increasing of the energy consumption and environmental pollution predominantly caused by the rapidly enlarge of traffic, transport sector needs to be rationalised and transport development must be performed in harmonization of the social and economic requirements. One of the measures is to balance the transport modal split. The transport system rationalisation regarding transport distance can certainly be done by selection the more efficient transport mode and by combining road and rail transport mode using the advantages of each one of them.

Road transport, apart from its main negative characteristic reflected in the increased energy consumption and pollution emission, features a number of positive characteristics such as higher transport speed, greater mobility, and possibility of door to door transport. The road transport has a distinct competitive advantage in the transport of small quantities of goods on the short and medium distances in relation to the rail.

The advantages of rail transport are reflected primarily in the energy efficiency and in ecology, as well as in the safety. The rail transport has advantage in the transport of large quantities of goods on the medium and long distances in relation to the road transport mode.

Road is the dominant transport mode. Further development of road freight transport should be oriented towards reduction of the share of road transport by shifting a part of the transport to the railways and waterways. In order to provide the sustainable transport development, social community should stimulate the transport modes which reduce energy sources and environmental protection.

## REFERENCES

1. Božić V., 2011, *Traffic economics*, Faculty of Economics, University of Belgrade.
2. Adamović, M., 1999, *Introduction to traffic*, Faculty of transport and traffic engineering, University of Belgrade
3. Vasin Lj, Stamenković D, Mijajlović M, Milošević M., 2016, *Quality of transport service at serbian railways*, 17th International Scientific-Expert Conference on Railways - RAILCON 16, Niš, Serbia, pp. 89-92.
4. I. E. Schneider, T. Guo, S. Schroeder, 2013, *Quality of Life: Assessment for Transportation Performance Measures*, Minnesota Department of Transportation.
5. EUROPEAN PARLAMENT, Policy department, 2015, *Freight on road: Why EU shippers prefer truck to train*, Study.
6. Brabec D, Pilko H, Starčević M, 2011, *Environmental aspects of comparing rail and road transport*, 6th International Conference on Ports and Waterways – POWA 2011, Zagreb, Croatia.
7. [http://ec.europa.eu/eurostat/statistics-explained/index.php/Freight\\_transport\\_statistics\\_-\\_modal\\_split](http://ec.europa.eu/eurostat/statistics-explained/index.php/Freight_transport_statistics_-_modal_split)
8. Statistical Office of the Republic of Serbia, STATISTICAL YEARBOOK OF THE REPUBLIC OF SERBIA 2016.

Contact address:

**Dušan Stamenković,**

Mašinski fakultet u Nišu

18000 NIŠ

A. Medvedeva 14

E-mail: [dusan.stamenkovic@masfak.ni.ac.rs](mailto:dusan.stamenkovic@masfak.ni.ac.rs)