MODAL DISTRIBUTION ANALYSIS OF FREIGHT TRANSPORT IN REPUBLIC OF CROATIA

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Abstract: *Intensive modernization of traffic is the main objective of economic development. For this reason, statistical analysis is needed so that transport market could be seen in full and to implement some of the strategies to improve performance of the transport network, which is the main task of transport planning. Therefore, it is necessary to define some key indicators, which primarily show the volume of freight transport. One of the most relevant indicators is the modal distribution or modal split indicator. Therefore, statistical analysis was conducted for the transportation of goods by road, rail, air, pipeline and maritime transport and inland waterways in tons and ton-kilometers. Modal distribution provides the data that enables more efficient and proper utilization of transport network, determination of the dominant mode of goods transport between start and end points, better modal planning and other. Other indicators which are used in this analysis are division on national and international freight transport in tons.*

Keywords: *freight transport, modal distribution, statistical analysis, indicators, efficient and utilization.*

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1. INTRODUCTION

Transportation is an essential part of human activity, and in many ways the basis of all socio-economic interactions. Indeed, no two locations which can interact effectively without a viable means of movement. Thus, a good transport system is essential to support economic growth and development. That is, the ability to transport goods safely, quickly, and cost-effective which is important for national and international market, distribution and economic development of the country. For that reason it is necessary to develop modern technologies in the transport of goods in order to align the quality of service in national and international transport. In order to determine the transport system of some country a statistical analysis with necessary indicators is required. The main indicator which will be used in this statistical analysis of the freight transport in tons and ton-kilometers is the modal distribution or modal split indicator, while the other indicators which are used in this analysis are division on national and international freight transport in tons. Modal distribution is the share of different modes in freight transport from place A to place B. Modal distribution provides the data that enables more efficient and proper utilization of transport network, determination of the dominant mode of freight transport between start and end points, better modal planning and other. Therefore, statistical analysis was conducted for the transportation of goods by road, rail, air, pipeline, maritime transport and inland waterways. Each mode of transport has geographical, technological and economic advantages in certain situations that can be linked to an appropriate model.

The analysis was conducted by annual rate and average annual rate, using the data of freight transport volume during the period from 2006 to 2012, which are taken from the Croatian Bureau of Statistics. Statistical forms are divided into 14 categories, depending on the thematic group, and for this paper are important statistical reports of Transport and Communications. Statistical report refers to a data on development and state of transport in the Republic of Croatia, and is divided into sections depending on the mode of transport.

2. ANALYSIS OF MODAL SPLIT IN FREIGHT TRANSPORT

In order to see the transport market in full statistical analysis is required. The basic analysis is

divided into freight and passenger transport, but for the purposes of this study only freight transport will be analyzed. Furthermore, freight transport can be divided into national and international transport and by mode of transportation, as it is divided in this paper, on the rail, road, air, maritime, inland waterways, and pipelines. During analysis of fright transport, calculation of the annual rate and the average annual rate will be presented. The annual rate of change is relative change of figure value in current period compared to the previous period. It is calculated by the following formula:

$$i_{god} = \left(\frac{promet_{n+1}}{promet_n} - 1 \right) \cdot 100[\%] \quad (1)$$

where is:
i_{god} – *annual rate*
$promet_{n+1}$ – *transport in the (n+1) year*
$promet_n$ – *transport in the n-th year*

The average annual rate of change is relative average change of figure value in the observed period. It is calculated by the following formula:

$$i = \left(\sqrt[n]{\frac{promet_n}{promet_0}} - 1 \right) \cdot 100[\%] \quad (2)$$

where is:
i – *average annual rate*
$promet_n$ – *transport in the n-th year*
$promet_0$ – *transport in the 0-year*

2.1 Analysis of the total volume of freight transport in tons

According to Table 1 there is constant decline in the total volume of freight transport during the period from 2007 to 2012, while the increase was only between 2006 and 2007. The decrease in the total volume of goods was affected by the world economic crisis, which was manifested in Croatia in the late 2008 by stopping the growth, followed by a significant reduction in production and consumption, and GDP reduction by more than 6% annually. During that period, the decline in overall demand was primarily affected by reduction in gross fixed capital, which was in the 2011 32.3% less than in the 2008. This unfavourable trend in overall demand led to a reduction in the production of goods and services, which led to a negative trend in industrial production in Croatia in the last four years (2009-2012). The constant reduction of total volume of goods can be seen by reduction index for observed period, which were 0.99 for 2008/2007, 0.88 for 2009/2008, 0.92 for 2010/2009, 0.96 for 2011/2010 and 0.87 for 2012/2011, and by reduction of 33.8% of the total volume of goods transported in the 2012 compared to the 2007, which is followed by a constant decline.

Freight transport in tons in the Republic of Croatia was decreased by 12.3% in the 2012 compared to the 2011. There are fluctuations from year to year in every mode of transport, within the observed period, as a result of reduced economic activity in Republic of Croatia.

The average annual rate of decline in rail transport within the observed period was -5.32%. HŽ Cargo (HŽ Cargo Limited Liability Company for Cargo Transport) in the 2012 reached transport of goods of 11,088 thousand tons, which makes reduction of transport by 5.9% compared to the 2011. The total decline in the freight transport by rail was affected by reduction of international (6.1%) and national transport (4.2%).

An average annual rate of decline in road transport is - 10.5% from 2007 to 2012, so in the 2012 there is 42.75% less transport of goods compared to the 2007. Road transport, which represents 60% of all freight transport, decreases much faster than the available transport capacity, which represents an increasing cost for carriers. Looking at the ratio only between rail and road transport in 2012 in land transport, it is seen that he increased in tons from 13.64% to 14.49% in favour of rail transport.

Maritime transport during the observed period has more or less the same amount of transported goods. Large decrease of 15.53% occurs in the 2012 compared to the 2011. The largest share in the total volume of freight transport has Port of Rijeka, which generates more than 50% of the total freight transport from all ports. The largest decrease is seen in the total transport of bulk cargo - iron ore, coal, stone aggregate, grains and oilseeds, and other bulk cargo (6% compared to 2011). The European transport market suffers from recession, reduced energy consumption industries, thermal power plants are closed or they are operating at reduced capacity, all of which affects the bulk cargo transport. Port of Rijeka, with the Port of Ploče, operate on a transit port services market, in other words transit represent two thirds of the total port transport, mostly goods for the members of European Union. Due to the negative impact of "Schengen regime" and competitiveness from northern ports, an increased decline was recorded. Access Republic of Croatia in European Union will make ports have increased operations, because of the equal market conditions.

In the 2012 only inland waterways and air transport have increased their freight transport compared with the 2011, 14.47% for the inland waterways and 33.33% for air freight transport. Despite their increasing it still does not have a significant impact on the total amount of transported

goods, because of their small share in the overall structure of freight transported. The big increase of the total volume of freight transport by inland waterways from 2007 to 2008 occured due to the inclusion of transit in the statistical analysis, which significantly increases the amount of transported cargo. Pipeline transport have constant decline since 2009, which is the most affected by the global crisis in the transport of goods, according to the average annual rate of decline of -9.24%.

Table 1. Volume of freight transport (in 1000 tons) [11, 12, 13]

Year	Total	Rail	Road	Maritime	Inland waterways	Air	Pipeline
2006	120.817	15.395	63.840	31.423	1.509	6	8.644
2007	173.661	15.764	114.315	32.420	1.468	6	9.688
2008	171.616	14.851	110.812	30.768	6.415	5	8.765
2009	150.455	11.651	92.847	31.371	5.381	4	9.201
2010	134.985	12.203	74.967	31.948	6.928	3	8.936
2011	129.746	11.794	74.645	30.348	5.184	3	7.772
2012	114.979	11.088	65.439	25.636	5.934	4	6.878

2.2 Analysis of the total volume of freight transport in ton-kilometers

A common measure for performance is the ton-kilometers, and it can be used in the analysis of freight transport. Tonne-kilometers is a unit of measure representing the transport of one tonne over a distance of one kilometer.

According to Table 2, in the period from 2006 to 2008 the total volume of goods measured in ton-kilometers has increased. Increase index was 1.01 for 2007/2006 and 1.03 for 2008/2007. After 2008 comes to an expected decline caused by the global crisis, according to the reduce index of 0.95 for 2009/2008, as well as for 2011/2010 and 0.82 for 2012/2011. In 2010 comes to the sudden increase in the total volume of freight transport in ton-kilometers, according to the increase index of 1.16. Growth was caused by the increase within the maritime transport and transport on inland waterways that year. This increase is explained by the increase between supply and demand in the international transport market, and since the Croatians ports are mostly focused on the transit of goods (mostly within the EU), that was reflected in the total amount of goods.

Transport of goods in the Republic of Croatia in the 2012 was decreased by 18.6% in ton-kilometers compared to the 2011. HŽ Cargo in 2012 has achieved transport of 2,332 million ton-kilometers which makes transport reduction of 4.35% or 106 million ton-kilometers compared with 2011. The decrease was affected by the decline of international transport (2.1%) and national transport (9.2%). The average annual rate of decline within the observed period for rail transport was -8.19%. Looking at the ratio only between rail and road transport, there is increased utilization of road transport in the 2012 in land transport measured in ton-kilometers.

The reason for this is the reduction of economic activity in the building, chemical, manufacturing and automotive industry in Republic of Croatia, which are typical for rail transport. However, the biggest problem in railway transport is poor infrastructure, which especially now after joining the EU should adapt according to European conditions, and offer lower operating and administrative costs in order to gain a part of transport.

During the observed period road transport has an average annual rate of decline -5.42%, while the largest decrease was in 2009 of 17.5% compared to 2008. Road transport is characterized by the largest competition, lots of small, medium-sized and micro - individual carriers, bottlenecks on major road corridors, ecologically least acceptable, one of the most expensive forms of transport and the expansion of the transport infrastructure resulting in loss of habitat. However, despite these facts, notes the dominance of road freight transport in the European and Croatian transport market, which is the most chosen mode of transport.

Within the maritime transport there are some fluctuations from year to year. The biggest decrease was 19.4% in 2012. However, maritime transport has growth potential because of its low congestion, low utilization of Port of Rijeka and ability to reduce needed transport time from the Far East to the EU.

Inland waterways transport also captures fluctuations from year to year, but from 2008 there is big increase in total volume of freight transport, due to the inclusion of transit in the statistical analysis. As already mentioned, inland waterways

transport and air transport have increased their total volume of freight transport in tons, as well as in ton-kilometers in 2012. Air transport has increased by 50% compared with 2011, and inland waterways transport by 11.56% for the same period.

Table 2. Volume of freight transport (in 1000 tkm) [11, 12, 13]

Year	Total	Rail	Road	Maritime	Inland waterways	Air	Pipeline
2006	152.127	3.305	10.175	136.994	117	3	1.533
2007	154.370	3.574	11.429	137.474	109	3	1.781
2008	159.849	3.312	11.042	142.972	843	3	1.677
2009	151.942	2.641	9.429	137.345	727	3	1.797
2010	176.795	2.618	8.780	162.751	941	2	1.703
2011	168.972	2.438	8.926	155.437	692	2	1.477
2012	138.650	2.332	8.649	125.678	772	3	1.216

An average annual rate of decline for pipeline transport is -12.2% in the period from 2009 to 2012. Decrease in pipeline transport was caused by stagnation of pipelines capacity through Republic of Croatia.

2.3 Analysis of the total volume in national and international freight transport in tons

According to the territorial organization market is divided into national (NT) and international transport (IT), therefore statistical analysis will be conducted per this division.

The railway transport has fluctuations within the observed period in national and international transport. In 2012 the 18.48% of the total volume of freight transport is related to national transport and 81.52% to international transport. The average annual rate of change for national transport is approximately -6%, while for international is almost equal, with amount of -5.18%. The decrease in national transport in 2012 of 4.2% compared to the 2011 was affected by the reduction in transport of iron and steel, minerals (aggregates) and products of plant origin (corn). Only transport of minerals (oil and petroleum products) was increased. In international transport, there is a decrease of 6.1% compared to the 2011. The most significant decline in international transport is recorded in transportation of minerals (oil and oil products), wood and wood products, chemical products, semi-finished wood products, products made of stone, cement and products of plant origin (corn). The increases in transportation are visible in the transportation of minerals (ores) and non-precious metals (iron and steel).

Compared with other modes of transportation road transport only achieves increasing transport in national transport. One of the main reasons for this is the existence of many carriers in Republic of Croatia, but also a great demand for the transport of goods by road.

There is tremendous growth of 76.87% in national transport in the 2008 compared to 2007, which is followed by a constant decline at an average annual rate of change of -13.27%. International road transport has achieved more or less the same amount of cargo transported within the observed period, but in the 2012 comes to a decrease of 10.16%. After the accession Republic of Croatia in the EU carriers who conducted international freight transport must have license of the Community, in order to continue to conduct international freight transport. In the coming period, it may appear an additional decrease in the international freight transport, because of the embargo on cabotage (2+2 years) for Croatian carriers in the EU members.

Maritime transport has larger share of international transport, with the amount of 96.97% in 2012, while the national transport is 3.03% for the same period. This confirms that the Croatian ports are mostly oriented to transit of goods (two-thirds of total operations). Statistical data in the observed period clearly indicate the effects of the economic crisis that has a negative impact on maritime freight transport in general, especially on national transport. It shows within a decrease of 32.57% in 2009 compared with 2008.

In transport on inland waterways on national transport goes 89.96% of the total transport and 10.04% on international transport. Transport on inland waterways is one of the least used modes of transport, both in the national and international transport. The reason for this is poor infrastructure, poor navigability of river corridors, as well as more

frequent occurrence of droughts and floods. So, there is a decrease of 27.22% in national transport in 2011 due to the very low water levels of rivers that year. In 2012 comes to re-growth of 11.84% in comparison with the 2011. After 2008 there is a decrease in international transport, which is also caused by the global crisis. The average annual rate of change for that period was -5.23%. The biggest decrease was in 2010 of 71.87% in comparison with the 2006, when it was the highest growth.

International air transport was consistently decreasing in the observed period, except in the 2012 when was noted increase in freight transport. The average annual rate of change from 2006 to 2011 is -9.96%. Indicated increase in 2012 is 17.13% compared to the 2011. National air transport has increase by 11.35% in 2007, followed by a constant decline at an average annual rate of change of -14.38%. The highest decrease of 14.5% in national air transport was in 2011.

Table 3. The volume of freight transport in national and international transport (in 1000 tons) [11, 12, 13]

Year	Rail		Road		Maritime		Inland waterways		Air	
	NT	IT	NT	IT	NT	IT	NT	IT	NT	IT
2006	2.959	12.436	55.881	7.959	1.273	30.150	189	1.320	1.868	3.769
2007	2.586	13.178	57.926	8.888	1.300	31.120	163	1.305	2.076	3.572
2008	2.617	12.234	102.457	8.355	1.176	29.592	5.676	739	1.767	3.369
2009	2.406	9.245	85.358	7.489	793	30.578	4.975	406	1.286	2.542
2010	1.996	10.207	67.126	7.841	797	31.151	6.558	370	1.049	2.148
2011	2.167	9.627	66.332	8.313	777	29.571	4.773	411	1.117	2.230
2012	2.049	9.039	57.971	7.468	776	24.860	5.338	596	955	2.612

3. CONCLUSION

Analysis of freight transport in Republic of Croatia by different modes of transport shows that the current transport system in the Republic of Croatia is not optimal and efficient. It is noted that all benefits of all modes of transport are still poorly used, and the main mode of land transport is transport by road. Transport of goods by rail is not nearly as efficient as it should be, since there are no conditions to take advantage of freight transport by rail. Transport of goods by inland waterways is one of the oldest modes of transportation, and the Croatian inland waterways are also included in the European network of waterways, but they are not sufficiently used for transport of goods. Such state of inland waterways is due to the fact that there was less investment in infrastructure, and for this reason there is a stagnation of this mode of transport in Republic of Croatia. For that reason, river ports excluding cargo handling are transformed into logistics centers. Also there is a very small volume of freight transport in national transport, as opposed to the much larger volume of freight transport in international transport. All data and trends indicate an uneven distribution of transport and definitive dominance of road transport in freight transport at the expense of other modes of transport (maritime, rail, river) that, contrary to European standards and European policy of sustainable transportation system, belonged in category of more appropriate, desirable and sustainable in a mass cargo transport. Since there was an increase in the 2012 in the freight transport on inland waterways and air transport compared to other modes of transport, such data can be taken as a small but positive step in terms of turning all types of cargo from roads to other modes of transport. Given that this situation causes traffic congestion, especially on the major trans-European corridors and in urban areas, it is mandatory to deal with the problem according to the principle of regulating competition between the various modes of transport. Otherwise, road freight transport could achieve a monopoly on freight transport in the European Union, and this imbalance would enable growth and the development of intermodal transport, which is a priority of European transport policy.

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