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FREIGHT TRANSPORT PERFORMANCE NDICATORS, EXAMPLE FROM BOSNIA AND HERZEGOVINA[1]

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Abstract

Efficiency of freight transport system is vital to the economy of each country. It is often said that freight transport is life-blood of the economic organism of the country. However, in contrast to the importance of freight transport, this sector of transport is less investigated and its performance is at least known among decision makers and even among professionals. Issues related to how much cargo is transported, where the cargo is being shipped, by which mode the freight is transported, what is the efficiency of the transport process, very often remain without precise answer. Without clear answers to these and other similar questions we cannot know the real state of the transport system. In fact, we only feel the consequences of inadequate functioning of the system. For creating transport policies and making strategic business and economic decisions at all levels, it is necessary to have information on the freight transport system and its performance. The term performance in this case means a parameter or group of parameters which are interdependent and which are the main indicators of efficiency of the freight transport system. In this paper we consider the following five performance criteria: freight transport intensity, freight transport productivity, truck fleet utilization, costs of trucking operations, and service quality. Consideration of these criteria is supported by an empirical example which is based on available data on freight transport in Bosnia and Herzegovina.

[1] Original scientific paper

Key words – Measuring; Freight; Transport; Performance; Bosnia and Herzegovina

INTRODUCTION

Transportation problems have become quite pronounced and widespread in developed and in developing countries. Economic growth has generated traffic demand exceeding the capacity of a large part of the transportation infrastructure. Years of under-investment in certain traffic branches in certain regions resulted in low traffic offering, so that the transportation system is often perceived collapse, even under conditions when the traffic demand was slightly higher than the average. Efficiency of freight transport system is vital to the economy of each country. It is often said that freight transport is life-blood of the economic organism of the country. However, in contrast to the importance of freight transport, this sector of transport is less investigated and its performance is at least known among decision makers and even among professionals. Issues related to how much cargo is transported, where the cargo is being shipped, by which mode the freight is transported, what is the efficiency of the transport process, very often remain without precise answer.

Without clear answers to these and other similar questions we cannot know the real state of the transport system. In fact, we only feel the consequences of inadequate functioning of the system. For creating transport policies and making strategic business and economic decisions at all levels, it is necessary to have information on the freight transport system and its performance. The term performance in this case means a parameter or group of parameters which are interdependent and which are the main indicators of efficiency of the freight transport system. The freight transportation is usually measured and described by quantity of commodity moved, expressed in tons or by quantity of commodity moved multiplied by distance, expressed in ton-kilometres. Also the freight transportation can be measured by vehicle movements expressed by number and types of freight vehicles. The freight demand, which is highly qualitative and differentiated, is derived from the socioeconomic system. The transportation of different kind of goods such as raw materials between specific locations in defined times, satisfies the people needs and influences economic and social development.

The term “performance” in this case means a parameter or group of parameters, which are interdependent and which are the main indicators of efficiency of the freight transport system. In this paper we consider the following five performance criteria: freight transport intensity, freight

transport productivity, truck fleet utilization, costs of trucking operations, and service quality.

FREIGHT TRANSPORT INTENSITY

Freight Transport Intensity (FTI) may be defined as the ratio of ton-kilometres (t-km) to an economic output measure such as Gross Domestic Product (GDP). There are very wide variations of FTI, because of the differences in economic structure, activities and average value of freight in different countries. The production and export in developing countries are characterized by low value of primary product that have moved in large quantities. Figure 1 shows amount of GDP generated per ton-km (which represents FTI) for some European countries. The FTI in Bosnia and Herzegovina is declining in recent years as a result of the economic crisis and the overall political situation in the country (Figure 2.)

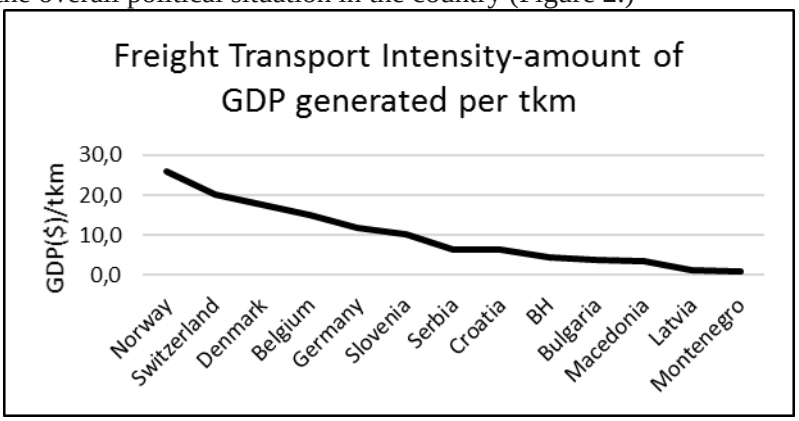

Fig.1. Freight transport intensity
(Source: [1], [4], [5] and author's calculation)

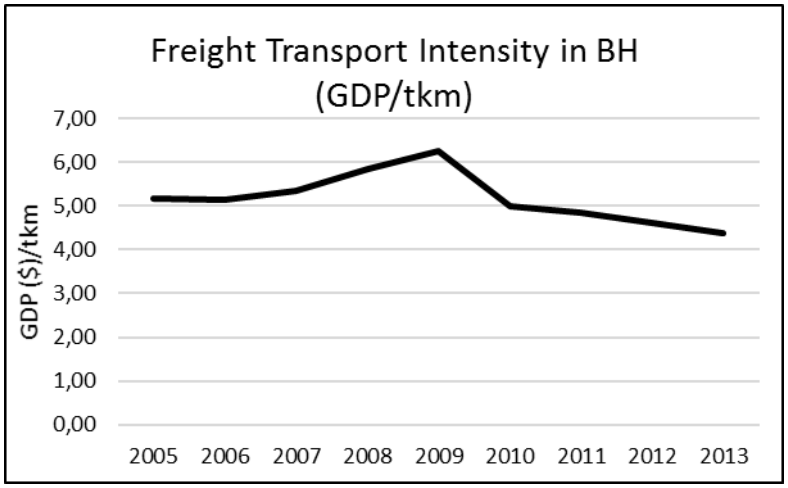

Fig. 2. Freight transport intensity in Bosnia and Herzegovina
(Source: [4], [5] and author's calculation)

FREIGHT TRANSPORT PRODUCTIVITY

The term "productivity" is usually defined as the ratio of outputs such as ton-kilometres or vehicle-kilometres, to inputs such as fuel, vehicles or labour. In other words, productivity is the ratio of results to resources. However, in our case, we will transform productivity into measure of efficiency by converting resource into activities. Therefore, the term "Freight Transport Productivity" means the amount of transported cargo in tons, or transport operation performed in ton-kilometre per unit of time. Productivity, which refers to the total (calendar) time for the truck fleet is called the full productivity and it is obtained when the recorded volume of transported tons or ton-kilometres is divided by the total calendar time. Productivity related to working time vehicles is called working productivity and it is obtained when the amount of transported cargo in tons or realized transport operation in ton-kilometres in a period of time is divided by number of hours the truck fleet works during this time period. Full productivity at the same denoted symbols WU and WQ, while working productivity denoted symbols WU` and WQ`. According to the definitions given full and working productivity will be:

Full productivity: $W_U = \frac{U}{24VD_a}\left[{}^{tkm}/_{h_a}\right]$ and $W_Q = \frac{Q}{24VD_a}\left[{}^{t}/_{h_a}\right]$

Working productivity: $\dot{W_U} = \frac{U}{24VD_w}\left[{}^{tkm}/_{h_w}\right]$ and $\dot{W_Q} = \frac{Q}{24VD_w}\left[{}^{t}/_{h_w}\right]$

Where:

W_U, W_Q -Full productivity expressed in ton-kilometer or ton per available hour

$\hat{W_U}, \hat{W_Q}$ -Working productivity expressed in ton-kilometre or ton per working hour

VD_a -Vehicle-days available per year

VD_w - Working vehicle-days per year

h_a - Available hours per year

h_w - Working hours per year

The full and working productivity of truck fleet in Bosnia and Herzegovina are depicted in Figure 5 and Figure 6.

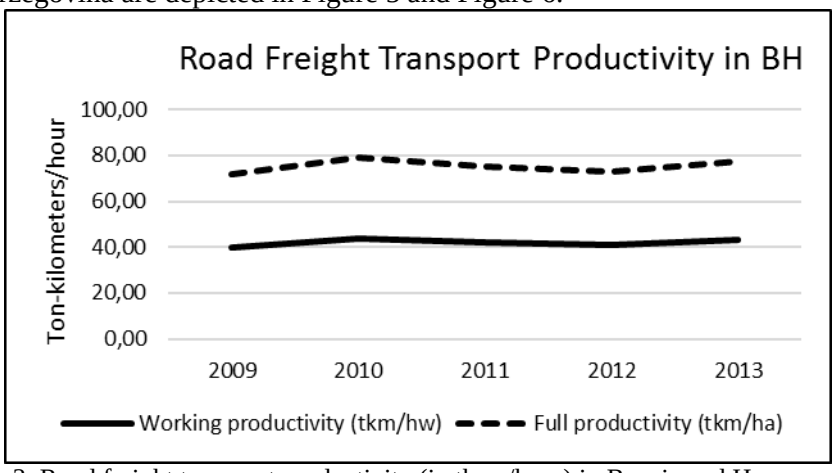

Fig. 3. Road freight transport productivity (in tkms/hour) in Bosnia and Herzegovina (Source: [4], [5] and author's calculation)

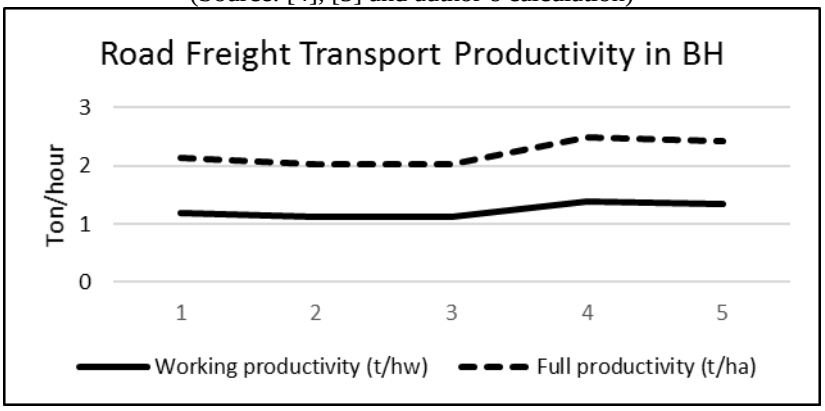

Fig. 4. Road freight transport productivity (in tons/hour) in Bosnia and Herzegovina (Source: [4], [5] and author's calculation)

TRUCK FLEET UTILIZATION

Truck fleet utilization may be considered through several parameters related to utilization of time, vehicle capacity, path (distance), etc. Let's put that factor value X represents the influence of elements which are related to the average carrying capacity of truck fleet and utilization of that capacity. [3] The value Y is in direct relation to the truck fleet utilization (proportion of time when it is available for work rather than under repair) and utilization of available time (proportion of time in operation during 24 hours). This factor directly reflects the quality of the company's management activities. The value Z represents the influence of elements related to path (route) utilization (proportion of loaded and unloaded distance travelled) and average speed. Thus, this factor expresses the influence of back-haul possibilities, demand patterns, availability of freight forwarding, road, traffic, and vehicle conditions. The value F represents the influence of lost time and distance of transport with load. Therefore we can write: [2]

$$X = \frac{1}{\varepsilon q};\ Y = \frac{1}{\alpha\rho};\ Z = \frac{1}{\beta S};\ F = \frac{T_t}{L_t}$$

Where:

ε- Coefficient of vehicle capacity utilization

q- Vehicle capacity

α- Coefficient of vehicle fleet utilization (proportion of days when vehicle is available for work and total available days in a certain period of time)

ρ- Coefficient of time utilization (proportion of hours of operation and 24 hours)

β- Coefficient of path utilization (proportion of kilometers empty running and the total kilometers)

S- Average speed

T_t- Lost time

L_t- Distance of transport (average length of loaded truck run)

The average values of operational parameters for truck fleet sample which consists of 7472 trucks and its corresponding value factors are presented in Table 1.

Table 1. Average values of truck fleet operational parameters and its corresponding value factors

Operational parameter	Value	Value factor			
		X	Y	Z	F
Coefficient of vehicle fleet	0.61		$1/_{0.24}$		

utilization (α)					
Coefficient of time utilization (ρ)	0.56				
Coefficient of vehicle capacity utilization (ε)	0.68	$^1/_{6.47}$			
Average vehicle capacity (q)-*ton*	14.0				
Coefficient of path utilization (β)	0.72			$^1/_{25.20}$	
Average speed (S) $-$ km/h	35.0				
Average lost time (T_t) $-$ $hour$	6.0				$^1/_{23.33}$
Average distance of transport (L_t) $-$ km	140.0				

(Source: [3])

The European Union (EU) statistical directives relating to road freight make the collection of only one utilization metric mandatory for member states, the percentage of truck-kms run empty (the European Commission, 2012). As a result the EU's statistical agency, Eurostat, has by far the most comprehensive set of truck empty running statistics in the world, expressed in terms of distance travelled and trip numbers, and split by type of operator (own account and hire and reward) and between domestic and cross-border movements. This European data set reveals wide international variations in empty running ranging from 43% and 36% of truck-kms in Cyprus and Greece, respectively, to 7% and 12% in Luxemburg and Denmark, respectively (Figure 5). No attempts have so far been made to explain these variations or assess their sensitivity to differences in government freight transport policy. Empty running can be considered clear evidence of the underutilization of transport capacity, leaving carriers exposed to the criticism that they are not using their assets efficiently. This, however, would be a misinterpretation of much of the available empty running data. Several studies have shown that there are often good reasons for empty running, including geographical imbalances in freight traffic flows, short lengths of haul, tight delivery scheduling and vehicle compatibility issues. Trucks' empty running in Bosnia and Herzegovina was 32% (Figure 6.) which is significantly over the EU average (23%).

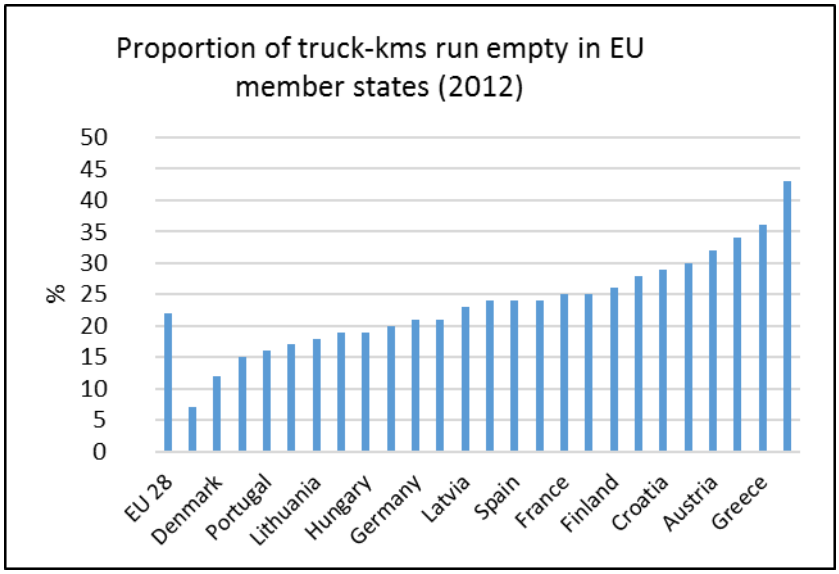

Fig. 5. Proportion of truck-kms run empty in the European Union (Source: [1])

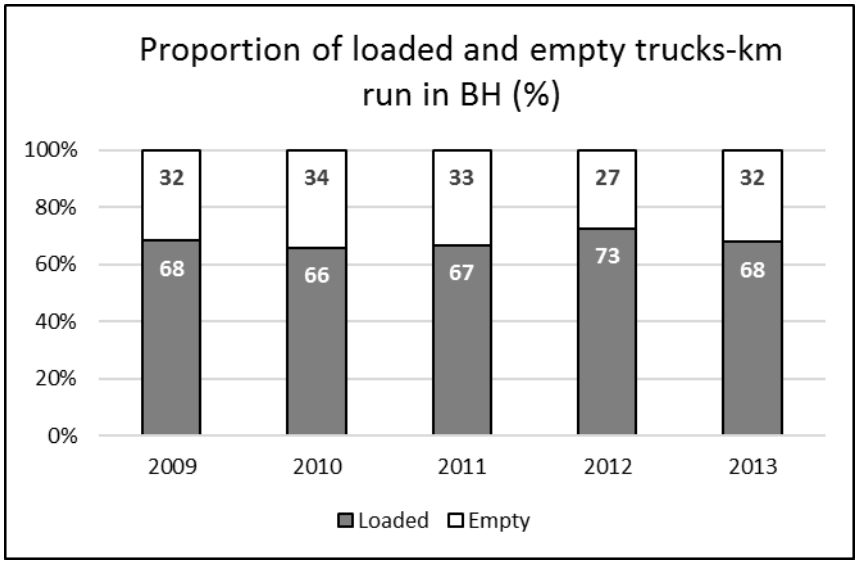

Fig. 6. Proportion of truck-kms run empty in Bosnia and Herzegovina (Source: [4], [5] and author's calculation)

COSTS OF TRUCKING OPERATIONS

The main factors that affect costs of trucking operations are [3]:

- Truck size and its utilization
- Back-hauls possibilities (demand pattern)
- Empty running
- Availability of freight forwarding and other services
- Road and traffic conditions
- Input of factor prices (labor, vehicle, spars and fuel)
- Quality of management

While cost is usually the single most important aspect of trucking services, customers also require fast, secure and reliable door-to-door delivery of goods. The vehicle utilization (vehicle-km per year) significantly affects the balance between fixed and variable costs. The typical proportion of transport costs for efficient trucking operations (in low and medium income countries and medium vehicle utilization) is given in Table 2. Higher than expected proportion of fixed costs could indicate vehicle utilization much less than 100 000 km per truck per year. The low truck fleet utilization is often caused by the following factors:

- Poor conditions of roads due to inadequate maintenance
- Poor conditions of vehicles due to absolute trucks, inadequate maintenance and poor driving habits
- Inadequate management and operational practices

Table 2. Typical proportion of truck transportation costs

Type of costs	**Costs Item**	**Proportion of operating costs [%]**
Variable Costs	Fuel Costs	20-30
	Lubrication Oil	1-5
	Tires	10-15
	Spare Part	15-20
Fixed Costs	Drivers	10-20
	Other Labor	5
	Depreciation and Interest	15-20
	Overhead and Other	10-15

(Source: [6])

Using the data for value factors (Table 1.) together with the estimated fixed transportation costs C_f = €1.5/hour and variable transportation costs C_v = €2.8/hour, we obtain the truck transportation costs:
$C_t = X[YC_f(Z+F) + ZC_v]$ =0.075 €/tkm.

SERVICE QUALITY

The service quality, generally, is a relative concept. Measuring the quality of freight transport services should be related to some kind of norms, or it must be compared with similar data for other countries with similar overall conditions. Supply-side metrics used to assess the quality of a country's freight transport system need to be accompanied by surveys of the perceptions from the companies using it. There are numerous examples of successful measurements of quality of service in freight transport at the company level. However, measuring the quality of logistics and transportation services at the national level is more difficult since there are no norms or criteria for such measurements. Also, the difficulty is the fact that the basic criteria are essentially the same at the micro and the macro level, consisting of the average transport time, the degree of reliability and condition of cargo on delivery. Quantifying these variables at the national level is very difficult. The World Bank (2014) effectively captures and synthesizes this in its bi-annual LPI survey. Freight transport variables, such as timeliness, track-and-trace and infrastructure feature very prominently in this survey as they clearly have a strong influence on managers' rating of a country's overall logistics capability. The trade flow data used, however, is monetary rather than weight-based or volume-based and the levels of trade are clearly influenced by many factors other than the quality of a country's transportation links. The quality of freight transport service at the national level can be expressed through parameters of performance measurement presented in this paper and its combination. Thus, for achieving satisfactory freight transport service quality, it is necessary to seek to achieve maximum value for FTI (Freight Transport Intensity) and FTP (Freight Transport Productivity), the optimum value of operational parameters for TFU (Truck Fleet Utilization) and minimum values for CTO (Cost of Trucking Operation).

DISCUSSION

Efficiency of freight transport system is vital to the economy of each country. However, in contrast to the importance of freight transport, this sector of transport is less investigated and its performance is at least known among decision makers and even among professionals. Transportation professionals must be able to communicate with diverse groups that are made up of other professionals, practitioners, elected officials, and the public. In this paper the following five important performance criteria or parameters are considered: freight transport intensity, freight transport productivity, truck fleet utilization, costs of trucking operations, and service

quality. There are very wide variations of freight transport intensity, because of the differences in economic structure, activities, and average value of freight in different countries. The freight transport intensity in Bosnia and Herzegovina is declining in recent years as a result of the economic crisis and the overall political situation in the country. The freight transport productivity means the amount of transported cargo in tons, or transport operation performed in ton-kilometre per unit of time. The value of this parameter in Bosnia and Herzegovina is between 40 and 45 tkm per working hour. Truck fleet utilization in this paper is considered through several parameters related to utilization of time, fleet, vehicle capacity and path, which have significant influence on transportation costs. The important conclusion of this paper is that considered parameters require additional investigations and should be checked with different types and sizes of truck fleet in different environment. The special attention should be given to the investigation of the service quality, which is generally a relative concept and whose quantification is very difficult.

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