OPPORTUNITIES FOR IMPROVEMENTS OF THE INTERMODAL TRANSPORTATION CHAIN: A CASE STUDY OF INTERMODAL FREIGHT OPERATION BETWEEN TURKEY AND SERBIA

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Abstract: In order to reduce the external costs of transportation, parties of logistics and transportation such as international organizations, governments, local authorities, transporters and users have been promoting the solutions which will be created more efficient results. Within this framework, opportunities related to rail transportation and reducing the rate of use of road freight transportation are very important factors in a green environment. This paper focus on the economic and environmental impacts of intermodal freight operations, rail transportation and intermodal freight terminals. On the other hand, results which will be obtained by using the intermodal freight terminals and rail transportation have been evaluated comparatively. In this context, several scenarios have been determined and they have been analyzed. In recent years, some concepts such as effectiveness, logistics costs and quick response had become more important with the globalization. These concepts were a result of competition, which have developed quickly. At the same time, not only competition occurs between companies, but also it was seen between global actors. Although these concepts have remained their importance, different subjects have begun to gain an importance, such as environment, human health and external costs of transportation. In order to reduce the environmental effects of the transportation, considering planning the differential and beneficial approaches has become imperative. One of the best ways is intermodality for solving the transportation problems. In this study, transportation alternatives and their effects were analyzed and new transportation alternatives between Turkey and Serbia have been recommended. Intermodal freight terminals which will be established in both of İstanbul and Belgrade city can be creating an effective solution for reducing the economic and external costs. On the other hand, it can provide sustainable and effective transportation system between two countries.

Keywords: intermodal freight transportation, terminals, intermodal rail transportation

1. Introduction

With the globalization, competition has become a most important concept and it has gained global characteristics. İn this process, some concepts such as logistics service level and logistics costs have become more important. Actually, there is an inverse ratio between these concepts. Companies are looking for ways of the reducing the logistics costs as well as providing the logistics service at a high level. In order to achieve both of these objectives and to gain a competitive edge with the best conditions, most important factors is speed. If companies can increase their speed, they can also increase their competitive advantage. As a result, increasing the speed can provide sustainability, reliability and customer satisfaction. Competition and concepts as mentioned above have remained their importance, different subjects have begun to gain an importance, such as environment, human health and external costs of transportation. In order to reduce the environmental effects of the transportation, considering planning the differential and beneficial approaches has become imperative. One of the best ways is intermodality for solving the transportation problems. Although road vehicles are new and their emissions are low compared to the past, when considering the number of road vehicles which passing from this route, external costs of road transport such as environmental pollution and risks have become serious and they cannot be ignored. On the other hand intermodality has become more important for European policy makers. Intermodal transport in Europe has registered a high rate of growth for many years since the beginning of its services. This growth is partly due to systematic promotion and subsidies received in various EU countries (Ballis and Golias, 2002). The development of intermodal freight is regarded as a key way in which rail can achieve a greater share of the freight transport market, but the limitations of official datasets make it difficult to develop a strong appreciation of the characteristics of existing intermodal flows (Woodburn, 2012). The promotion of environmentally friendly transport modes requires the enhancement of the economic, managerial and technical efficiency of the Intermodal transport terminals as well as of the whole Intermodal transport chain (Abacoumkin and Ballis, 2002). Serbia is an important country for global and regional logistics activities. It is located on the most preferred international road and rail routes between European and Middle East countries. In this study, benefits of intermodal freight transportation and intermodal train operations were analyzed between Serbia and Turkey.

2. The Current Situation and Logistics Opportunities in Serbia

Serbia has a great importance according to logistics and transportation actors. It is located in the center of the Balkan Peninsula, which gives it a strategic importance in the field of logistics, transportation and communications in the region. Two important international transport corridors pass through Serbia. First corridor is Pan-European transport corridor X which links nine countries from Germany to Greece and Turkey. In this corridor, road and rail transportation can be operated and its total length is around 2,360 km, of which 874 km is through Serbia. Another important transportation corridor which passes through Serbia is 7th Pan-European transport corridor (Danube waterway) which

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links ten states, from Germany to Ukraine and has 44 international ports. In this way, it represents an intersection between the south and the north, the west and the east of the Europe. These corridors intersect in Beograd city.

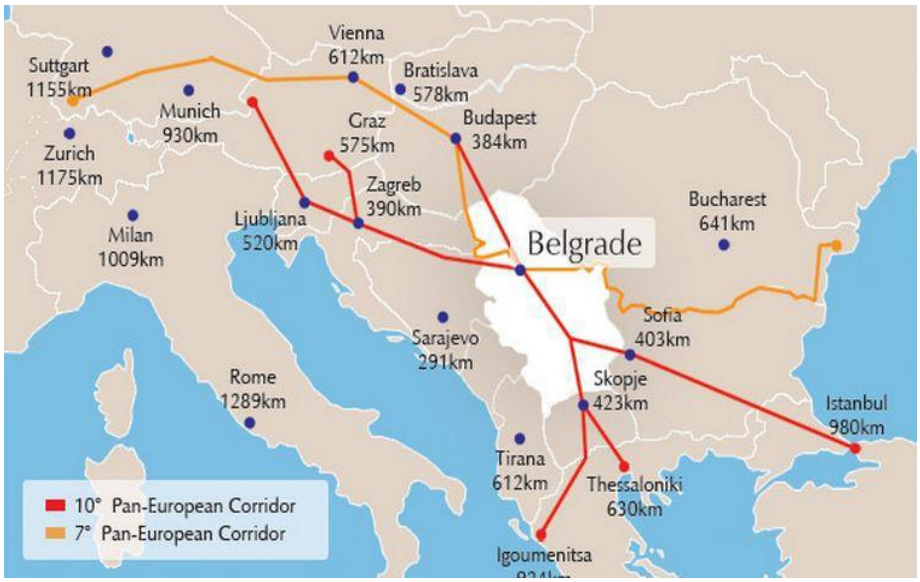

Fig. 1.
Pan European Corridors in Serbia

Because it is located in the important point which intersect mostly preferred two Pan European transport corridors, this city can be defined as logistics hubs for European and Middle East countries. In contrast, the logistics potential of Serbia cannot be used at adequate levels. Road transportation is mostly preferred transportation mode for both of domestic and international freight transportation. On the other hand, road freight transportation has a very high share, compared to other transportation modes. Road freight transport is a dominant mode of transport in Serbia (Medar and Manojlović, 2011).

According to the 2006 report from the Statistical Office of the Republic of Serbia, the international transport of goods by road (transit excluded) was twice as large as transport by railway and inland waterways measured in transported tones (Statistic Office of the Serbia). This situation is caused by an imbalance in the transportation sector. Unfortunately, railway and intermodal transportation is weak or it is not at the required level. Finally, economic and external cost of road freight transportation have been seen dramatically such as road congestion, accidents, loss of life and economic assets, environmental pollution and noise.

Nowadays, traffic congestion is very high when considering the road freight transport volume. Only number of road freight vehicles from turkey is reached to approximately 400.000 annually. With the traffic flow on the network ranging from less than 2,000 veh/day, to more than 100,000 veh/day. Also, 63% of the Core Road Network had traffic with more than 5000 veh/day in 2010, and a very small (< 10%) of network segments with very low traffic flows, less than 2000 veh/day (Manić, 2012).

According to Turkish authorities, transportation has been done 4884 times by road vehicles from Turkey to Serbia directly. On the other hand, 55.000 Turkish transit road vehicles passed from Serbia in 2013. At the same time, while 3274 times direct expedition have been done by road vehicles from Serbia in Turkey, in total 17.000 road vehicles entered into Turkey through Serbia. However, approximately 85.000 road vehicles of both countries were passed through this route in both of two directions.

When considering the total load between Turkey and European countries, in both of two directions a very busy road traffic which causes from road freight transportation is noticeable. According to statistics that issued by the International Transporters Association (UND), 499,437 road freight vehicles were passed from Turkey's border gate. 265,169 road freight vehicles were existing from turkey, 234,268 vehicles were entered into Turkey for import.

In order to more short distance from other alternatives, transporters use to the 10th corridor which passing from Serbia mostly. In Serbia, routes divides two sections, while the first route continues to west direction, second route continues to north. In order to a portion of road freight vehicles which transported to northern countries such as Romania, Ukraine and etc. Existed from Bulgaria, vehicles which passed from Serbia are reduced to 420,847. In directions of the west, 352.000 road freight vehicles were run between Belgrade and Ljubljana. Routes is separated in different directions, the number of road freight vehicles which carried out on the different parts of the route is decreasing towards the west.

Table 1
Number of Road Freight Operations between Turkey and European Countries

Country	Turkish (Export)		Turkish (Import)		Foreign (Export)		Foreign (Import)	
	Border Gate		Border Gate		Border Gate		Border Gate	
	H.Beyli	K.Kule	H.Beyli	K.Kule	H.Beyli	K.Kule	H.Beyli	K.Kule
Albania	0	203		141		8		
Austria	334	4642	208	1104	312	4902	179	1948
Belgıum	1043	3062	323	1325	503	1876	212	632
Bosnıa	39	2900	4	1764	17	653		202
Bulgarıa	2584	9699	10042	35815	2350	4468	11858	24054
Croatıa	30	1561	17	777	4	344	1	194
Czech Rep.	1178	2240	863	3439	518	1193	961	2441
Denmark	329	1613	65	680	241	612	30	125
England	2538	7138	285	1140	1065	2255	43	359
France	1749	7796	1273	2427	1063	3169	573	878
Germany	7034	45265			8078	51101	2768	5820
Holland	1731	6732	728	793	335	2971	614	1009
Hungary	1015	2069	919	2723	967	3597	995	7229
Italy	127	2047	139	448	72	1726	708	837
Kosovo	0	45		100		2		5
Luxembourg	9	278	1	5	7	36	6	15
Macedonıa	7	870	14	614	1	89	27	124
Montenegro	0	193	2	175		3		17
Poland	3474	5286	3038	6228	4538	6515	2655	5947
Portugal	0	7	27	177	8	2	20	31
Romanıa	12888	13814	12027	3889	12853	8425	10505	4189
Serbıa	130	3471	26	3539	15	1097	34	2212
Slovakıa	861	1029	722	1741	1096	2283	593	3004
Slovenıa	30	1286	7	162	202	4342	159	1006
Spaın	40	436	591	1518	361	100	602	656
Swıtzerland	93	1988	26	165	113	1179	11	113

Source: Statistics of International Transporters Association (UND) www.und.org.tr

2.1. Impacts of Road Freight Transportation between Turkey and Serbia

Distance of route that is often preferred by road transport operators is 941 kilometers from Istanbul to Belgrade city. Annually, 420,847 heavy road vehicles operate on this route. Even if the average emission value of all of these vehicles is low, traffic intensity causes the serious and intolerable results. According to European Commission, acceptable emission value for per road vehicles is 176 g/km (EC 2007) Total emission value can be calculated as multiplying the route distance and emission factor per heavy road vehicles as seen below;

$$r_{em} = r_{tl} \, x \, r_d \, x \, rw_e \qquad (1)$$

While r_{em} is represents the total emission value, r_{tl} is the total distance of road, r_d is total heavy road vehicles which operate on this route, rw_e is an emission factor per vehicle. When 85.000 heavy road vehicles have been operated in both of two direction, annual emission value can be calculated as below;

r_{em} = 420,847 x 1882 x 176 = 139,398 ton

A calculated emission value that caused by heavy road vehicles is very high. According to an important scientific study realized by the Research Center of Marine and Climate at University of Hamburg, the marginal cost of emission is calculated as 104 dollars per ton. (Tol, 2003) When this value takes into consideration, annual marginal cost of emission can be calculated as 14,497,391 USD. On the other hand, in addition to environmental costs of road transportation, it can cause social and economic costs. There are very large numbers of cost items can be seen in total transportation costs such as energy, transit, driver, loss of value and maintenance costs, etc. In contrary, most important cost item causes from energy consumption of heavy road transportation as below;

$e_c = r_{tl} \, x \, u_{fc} \, x \, f_{uc}$ (2)

While e_c is represents the total energy cost, r_{tl} is the total distance of road, u_{fc} is unit energy consumption per road vehicle, f_{uc} is the monetary value per liter of fuel. If these factors are multiplied with each other, the total energy cost can be calculated per heavy road vehicle. As assumed that, unit fuel consumption is 30 liter per one hundred kilometers in optimum conditions. At the same time, unit fuel cost was taken into consideration as the unit sales price without taxes. When the total energy consumption cost calculated, it can be calculated as below;

e_c = 941 x 30% x 0,45 = 127.035 €/vehicle

Annual energy consumption cost can be calculated as multiplying the unit energy cost per vehicles with the number of heavy road vehicles which pass through this route.

$\sum e_c$ = 420,847 x 127.035 € = 53,462,299 USD

In total, annual external and economic costs of road transport can be reached at 67, 96 million euro on the route between Turkey and Serbia. The monetary value of the road transportation cost is very high and it cannot be bearable by Serbian and Turkish policy makers. They should be seeking new transportation alternatives and they should create a new perspective which related to available or new transportation opportunities. In this context, railway transportation may be one of the best ways for solving the transportation problems and it can provide a sustainable transportation system and infrastructure.

2.2. Intermodal Transportation Opportunities in Serbia

Intermodal transportation may be defined as the transportation of a person or a load from its origin to its destination by a sequence of at least two transportation modes, the transfer from one mode to the next being performed at an intermodal terminal. Transportation of containerized cargo by a combination of truck, rail, and ocean shipping, dedicated rail services to move massive quantities of containers and trailers over long distances, main transportation mode for the international movement of goods, central piece in defining transportation policy of the European Community, trips undertaken by a combination of private (e.g., car) and public (e.g., light rail) transport, and so on (Crainic and Kim, 2007). Intermodal terminals as Logistics Centers (LC) are complex facilities with multiple functions, including transshipment yards, warehouses, wholesale markets, information centers, exhibition halls and meeting rooms, etc. (Ilin and Simic, 2013). When the intermodal opportunities of Serbia are considered, this country has a great advantage for being an intermodal hub. In contrast, opportunities related to intermodality cannot be used at the required level. According to Freight Service Department, JSC of Serbian Railways, while the share of intermodal transportation is 11.62% the share of conventional transport such as road, rail, and maritime transportation is reached to 88.38% nowadays.

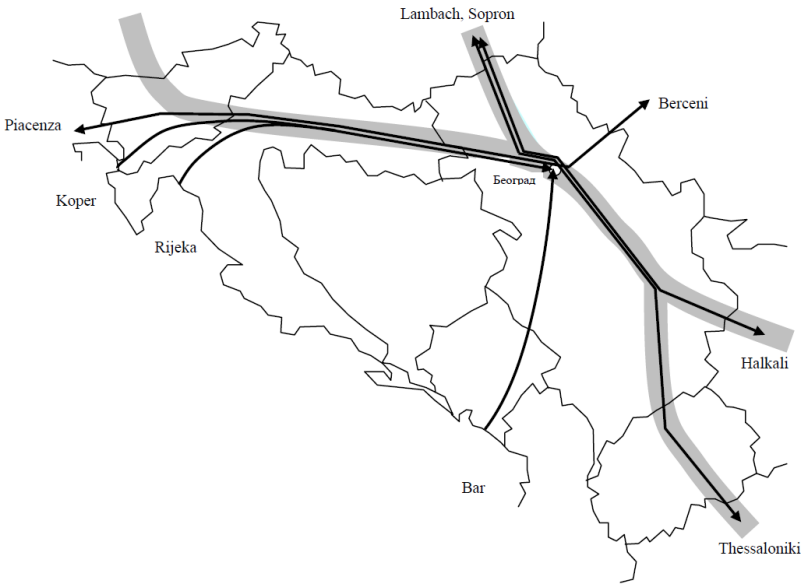

Fig. 2.
International Railway Network in Serbia

On the other hand, improvements are seen on intermodal transportation in Serbia, although road freight transportation is the dominant transportation mode. Although a large number of intermodal rail freight operations are carried out between European countries and Turkey and it was not continuously and systematically. These operations were carried out because of infrastructure projects such as gazelle project, block train project and etc. But they were not systematic and continuous rail operations. They were shown an individual characteristics and they were organized and planned when needed for such operations. Most important rail operations among them is block container train between Cologne/Germany and Köseköy/Turkey. These railway operations have been started in 2004 in order to create an effective solution for automotive logistics between automotive spare parts suppliers and automobile manufacturers. Nearly 12.000 swap bodies are transported on this route annually. Although, still Cologne – Köseköy line is important, it may not be effective and consistently at the required level. Another important experience related to railway operation between Turkey and European countries is block pipe train between Giengen/Czech Republic and Halkalı/Turkey. These operations were carried out from November 2010 to September 2011 for the gazelle pipeline project. The block train operation runs 130 times and 90.000 tones pipe were transported in the framework of this project.
Halkalı – Sopron rail line is used for container block train operations in the past. Miscellaneous goods have been transported by container train being operated reciprocally between Halkalı and Sopron 4 times in a week. At the same time other rail transportation experiences such as Halkalı – Wien/Austria container block train and Halkalı – Ljubljana/Slovenia were realized in previous time.
All of these projects were considered, Serbia is a transit country and it cannot be shown a dominant characteristic related to logistics flows, although it is an important country which located at the intersection point of rail and road transportation networks. In order to establish a more effective logistics system, Serbia should not be transit country, it should play a key role as the dominant actor related to logistics activities not only at regional but also at global level. Consequently, Serbia is defined as a logistics hub, regional logistics activities can be performed much better and mutual benefits can be gained by parties of logistics such as countries, transporters and users.

Fig. 2.
Freight transport on Serbian rail network
Source: Andrija Ristović, Leading organizer for intermodal transport Freight Service Department, JSC "Serbian Railways" 1st South East Environment Workshop.

Initially, logistics and freight terminal which can respond to regional logistics needs should be established in Belgrad city. This terminal has two functions such as collecting and distributing. Loads from different European and Middle East countries should be collected to this terminal and they should be consolidated and distributed in there. On the other hand, the high speed freight train may run on this line and it may provide better solution different from conventional trains. In this study proposed that, Belgrad intermodal freight terminal can be a central hub point for Europe and Middle East. When considering the total logistics flows between European countries, total logistics cost can be very high.

Reasons for this can be listed as using level of road transportation is very high, using of rail transportation at low level, because of the transportation operations has been run between two countries such as origin and destination countries, consolidation level and amount of cargo are insufficient according to efficiency, productivity and lower unit logistics costs. Logistics costs are the sum of the transportation costs between each point. In order to transportation operation can be realized with different capacity using level, productivity and unit logistics costs, total logistics cost can be variable and high. If load from different points can be consolidated in intermodal terminals, there may be saved in resources related to logistics activities such as transportation operations and using transportation vehicles and equipment.

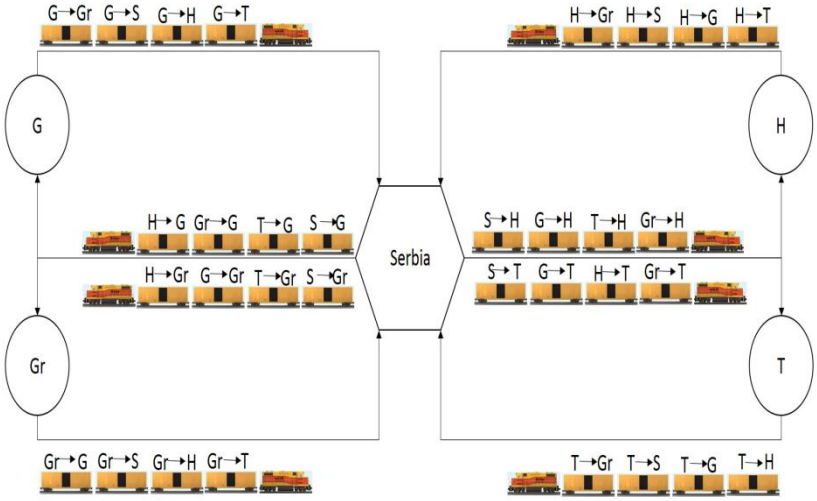

Fig. 3.
Terminal Based Models and Connections between Serbia and European Countries

3. Benefits of the Intermodal Transportation between Turkey and Serbia

When the total amount of cargo which transported between Turkey and European countries and averagely 22 ton cargo can be transported by per road freight vehicles, according to regulations, approximately 9, 3 million ton cargo have been transported in recent year. Daily, 25,366 ton cargo can be moved in both of two directions. Even if 30% of these cargoes can be transported by intermodal freight trains, total economic and environmental costs can be reduced significantly. According to transportation rules 26 ton cargo can be loaded to per 40 feet container and an intermodal freight train capacity is 32 containers. However 832 ton cargo can be transported in one expedition by this train. With the ten intermodal freight rail operations which will be run between Turkey and Serbia in a day, 8320 ton cargo can be transported and total economic benefits can be calculated as seen below;

$$r_{vn} = [C_c \; x \; t_c \; x \; n_{op}] \qquad (3)$$

$$d_{em} = ([r_{vn}] / rv_c) \; x \; r_d \; x \; r_{we} \qquad (4)$$

$$\sum m_{ec} = [(d_{em}) \; x \; e_{mc}] \; x \; n_{day} \qquad (5)$$

While r_{vn} is represents the total transported cargo per intermodal freight train, C_c is container capacity, t_c is number of containers which can be loading per train, n_{op} is number of transport operations in both of two directions in a day, d_{em} is amount of emission which can be reduced in a day, rv_c is capacity per road freight vehicles, r_d is distance of route, r_{we} is emission factor per vehicle, e_{mc} is marginal cost of emission per ton, n_{day} is number of day in a year, m_{ec} is total reduced marginal cost of road transportation annually. On the other hand, with the using of intermodal transport operations by trains, economic loses which causes from road freight transportation can be reduced. National and regional economy can be affected by using the fossil fuels as well as environment, social structure other assets. Road freight transportation is an unproductive and ineffective transportation type. Only, when considering the energy cost of road transportation, it can be seen that are at unsustainable levels. These negative effects cannot be eradicated completely, it may be reduced dramatically with the using of intermodal rail operations. If a portion of cargoes which transport by road vehicles can be shifted to rail transportation, energy cost may be reduced as seen below;

$$\sum re_c = ([r_{tl} \; x \; u_{fc} \; x \; f_{uc}] \; x \; r_{nv}) \; x \; n_{day} \qquad (6)$$

While re_c is represents the reduced energy cost in total, r_{tl} is the total distance of road, u_{fc} is unit energy consumption per road vehicle, f_{uc} is the monetary value per liter of fuel, r_{nv} is the number of vehicles that will be reduced with the using of intermodal freight trains, n_{day} is number of day in a year.

4. Conclusion

Economic and environmental impacts of road transportation is very high and it cannot be sustainable. With the using of intermodal freight rail operations, economic and environmental costs of road transport can be reduced dramatically. In this study, the effects of the intermodal freight rail operation and the key role of Belgrade as an intermodal freight terminal have been represented. If only 30% of cargo which transported by road vehicles can be shifted to railway, while environmental costs can be reduced as 4,03,657 dollars, saving on energy cost can be reached at 34,691,526 dollars. As a result, total saving can be reached at 39,395,183 dollars annually.

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