RO-RO SHIPPING NETWORKS IN THE BLACK SEA REGION AND PORTS CONNECTIVITY: COMPARATIVE ASSESSMENT

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Abstract: *The present article presents in detail the concept of ports connectivity of the ro-ro shipping networks in the Black Sea region. The existing ro-ro services in the region are studied in terms of transportation availability, frequency and capacity. A set of port connectivity indices is applied for measuring the interconnections between the ports in the region via ro-ro services. The results demonstrate that the ro-ro shipping network in the region has a potential for development and despite the low cargo volumes, low level of capacity utilization and lack of efficient hinterland connections of ports.*

Keywords: RO-RO SHIPPING, PORTS CONNECTIVITY, SHORT SEA SHIPPING, MARITIME PORTS

1. Introduction

Short sea shipping in the European Union has been a focus of extensive studies during the last three decades. The quality of European shipping network is being measured by specific indicators. There are several main measures describing transportation networks, mainly its connectivity and network's port accessibility. It is assumed that networks connectivity shows whether all nodes are reachable from a certain port. The connectivity studies of ro-ro shipping in Europe has not drawn much attention. Connectivity of ports in ro-ro shipping networks is highly relevant as a lot of ports set forth objectives for expansion against the underdeveloped road infrastructure in the hinterland. Due to this reason, Black Sea ports operators strive to increase the volumes of ro-ro shipments as a tool for expanding their market coverage. In order to achieve a larger market share of ro-ro shipments more efficient connectivity between ports is needed. The latter is feasible in case the connections with the hinterland are developed. In view of the latter, the development and application of port connectivity indicators within the European ro-ro shipping network allows for evaluation of the ro-ro network quality.

The present study presents in detail the concept of ports connectivity in ro-ro shipping networks. The applied indicators measure the port performance and the links between the ports in the region. The ports connectivity indicators within the ro-ro shipping network is evaluated and presented on a comparative basis for each country in the region. The results show that the application of such measurement tools help to outline the strengths and weaknesses of the ro-ro shipping networks within the region.

2. Ro-ro shipping in the Black Sea region – issues and challenges

Being part of the European short sea shipping network, ro-ro transportation has attracted considerable attention for the last several decades. The network design is affected by the port operators' strategies, demand for ro-ro transportation and availability of ro-ro vessels. Due to this each port location is determined by the intensity of cargo flows between the ports in the region. The structure of the ro-ro shipping network, the number of service providers and the service frequency are dependent on the status of ports' development and respective cargo volumes. These factors will affect the carrying capacity of the ships employed, number of ports in the service and the schedule. On the other hand, restructuring of ports to specialize in ro-ro shipments will depend on the hinterland access to/from the ports, available port superstructure and infrastructure and the geographical position of the port. Policy issues concern mainly the issues related to cabotage transportation in the form of restrictions (for example, cabotage transportation can be carried out by vessel flying the national flag only), customs formalities for exports and imports of cargo, policies for development of European transport corridors and the existing form of cooperation between the ports. Last but not least, hinterland connections also matter as these ensure for sustainable and reliable hinterland transport. Higher density of ro-ro shipping networks ensures for minimum transshipments and higher capacity utilization. The service quality is backed up by increased number of sailings, higher turnaround time at ports and higher reliability of services.

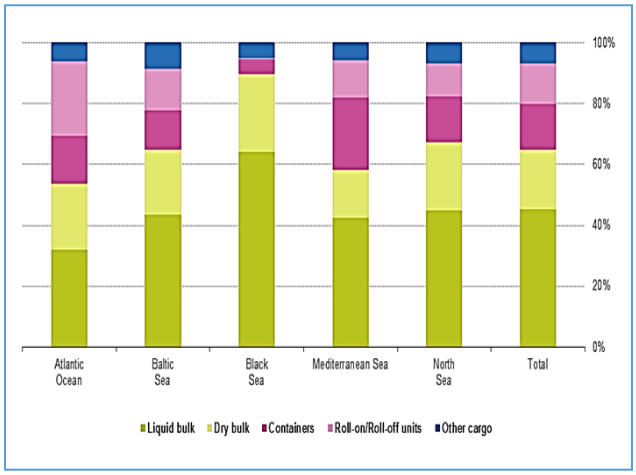

Figure 1. Short Sea Sipping in EU in 2016 [11]

Figure 1 present the volumes of different types of cargoes carried during 2016 via short sea shipping in the EU. Short sea shipping of liquid bulk cargoes prevailed for all the regions during the period - over 64 % of total short sea shipping of goods in the Black Sea [11]. Containerized cargoes accounted for only 5 % of the short sea shipping in the Black Sea, likewise cargoes transported in ro-ro shipments accounted for less than 2% in the Black Sea region.

Unlike the generally adopted perception, short sea shipping has certain disadvantages as compared with road transportation. It is necessary that the efficiency and service quality of short sea shipping is improved as well as the port infrastructure. The latter objectives should include: integration into multimodal transport chains or networks, stimulation of new maritime transport technologies, removal of administrative barriers, creation of reliable market data on existing land transportation that could be used for decision making, integration of border crossing systems, automation of customs and immigration security systems [8]. The advantages of short sea shipping as compared with land transport are:

- higher energy efficiency and environmental performance;

- favorable geographical location of the ports in the region;

- enhanced regional development for some of the countries;

- benefits for the ports development and expansion;

- carrying capacity increase for vessels flying the national flag (cabotage shipping).

As concerns ro-ro transportation in the region there several fallbacks. The frequency and scheduling of services depends mainly on the available for transportation cargo volumes and thus there are imbalances between front hauls and back hauls within the network. There is also the problem with inefficient integration with other modes of transport mainly due to the underdeveloped road structure. The latter impedes the integration of ro-ro shipping into the intermodal supply chains. It should also be noted that ro-ro vessels employed in the region are not of high service speed that leads to longer voyage duration and schedule irregularities. As concerns the marketing of this type of shipments, it should be noted that it is difficult to compete with containerized cargoes freight levels. Figure 2 presents the presently available ro-ro lines in the region, serviced by several operators.

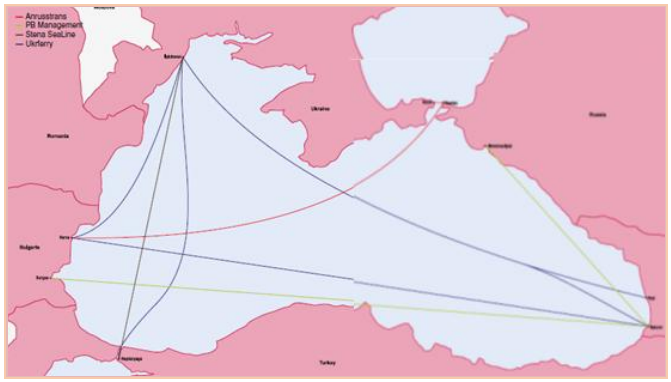

Figure 2. Ro-ro shipping network in the Black Sea region in 2016 [6]

As explained above there are frequency imbalances and variability of market shares among the main ro-ro operators and routes. In addition, shipping companies are faced with the issue of capacity underutilization and therefore general approaches are to be applied for each route/destination. Higher frequency can increase the income and decrease the unit costs by allocating fixed costs to a greater number of departures [7]. Most of the ro-ro operators maintain weekly departures from starting port and only a few maintain departures twice of thrice weekly. One of the methods to increase frequency of service is to include more vessel but the latter would involve considerable investments in assets which could not be paid-off given the low cargo volumes. Presently for all routes low frequency and low extent of capacity utilization are present. We should also consider the seasonal fluctuations in demand whereas cargo volumes will be imbalanced during winter and late autumn periods also due to unfavorable weather conditions. The optimal level of capacity utilization is directly related with the price levels whereas the pressure to reduce the prices for transportation would potentially increase the capacity utilization. Given the high level of competition between ro-ro companies, it is highly unrealistic that potential clients will be able to differentiate between companies on the basis of price other than the routes directions. Another issue is the routes' diversification which is unattainable for most of the companies due to lack of sufficient cargo volumes and lower frequencies of service. There is also the problem of insufficient statistics to evaluate both the market shares and levels of capacity utilization of the ro-ro operators in the region. Table 1 presents the currently operating ro-ro companies in the Black sea region providing regular ro-ro services for trucks, rail wagons and passengers.

Another issue is related with the national jurisdictions as the companies are based in countries with different national legislation.

Table 1. Ro-ro operators in the Black Sea region in 2016 [6]

Ro-ro operator	Routes	Type of service
Akdeniz Ro-Ro (Turkey)	Eregli-Chernomorsk Samsun - Novorossiysk Samsun - Gelenzhik Samsun-Tuapse	ro-ro
Anrusstrans (Russia)	Kavkaz - Krym Kavkaz-Varna	ro-pax
PB Management (Bulgaria)	Bourgas - Batumi - Novorossiysk	ro-pax
Stena SeaLines (Turkey)	Chernomorsk - Haydarpasa	ro-pax
Ukrferry (Ukraine)	Chernomorks - Varna Chernomorks - Poti Chernomorsk - Batumi Varna - Batumi Chernomorsk - Haydarpasa	ro-pax

Other parameters are to be taken into consideration as well. These include the integration of ro-ro shipping into the existing intermodal chains (for example transport corridors IV and VII of the EU network), selection of optimal routes, the time needed for the trucks and rail wagons to reach the ports or the final destination from the port. As for the ports in the area there are certain problems that are to be overcome: inefficient port infrastructure; lack of efficient connections with the hinterland and the potential delays in ports due to that; considerable differences in port charges that result in different disbursement accounts for the ships, etc. Therefore, ro-ro operators must focus on the following strategic objectives – increase frequency and reliability of services, enhance service quality and achieve cost efficiency via increase of capacity utilization.

3. Measuring ports connectivity of ro-ro shipping networks in the Black Sea region

Ro-ro connectivity measures the extent of the ports in the network being connected to each other [2]. The data used for this study have been collected from the companies' websites as concerns routes, vessels and schedules and refer to year 2018 [9,10, 12,13,14]. It is assumed that the websites of the ro-ro operators present accurate data as concerns timetables, vessels' types and capacity and routes (Table 1). The study uses the following data, providing the variables needed: travel time, frequency of service, level of interconnectivity and the number of service operators. As concerns frequency of service this represents the number of sailings from the first port every week (officially published timetable of departures and arrival from/at each port).

In this part of the study we apply a method to measure the ports connectivity of the ports within the ro-ro shipping network. It is important, therefore, to establish the components of the connectivity indicators and how the indicator is calculated [4].

Unlike the feeder networks of containerized cargoes there is almost no transshipments in ro-ro shipping which is due to the shorter distances and the direct interrelation between transportation prices (freight) and time. Therefore, all connections between the ports in the ro-ro network are direct and are taken into account for the evaluation of the ro-ro network connectivity and calculation of connectivity indices.

For the evaluation of the connectivity of the ro-ro network in the Black Sea region we apply the beta index and gamma index measures developed by [1, 4, 5]. The first index evaluates the number of connections for each port being a quotient (Formula 1):

$$\beta = L / n \quad (1)$$

where

L = number of links for each port;

n = number of ports in the country, servicing ro-ro shipments.

Gamma index is an aggregate value showing the level of connectivity of the network being the ratio between the number of actual links and the maximum number of potential links [5]. Gamma index is expressed by Formula 2:

$$\gamma = L / [n*(n-1)] \quad (2)$$

In addition, on the basis of the data available, for each ro-ro operator in the region we have collected the following data presented in Table 2. The number of links presented for each country are based on one-way directions only.

Table 2. Number of nodes and links of the Black Sea region ro-ro shipping network [company web sites]

Country	Number of nodes per country *(n)*	Number of links *(L)*
Georgia	2	5
Bulgaria	2	5
Turkey	4	6
Ukraine	1	5
Russia	4	7

The applied indices can be used for measuring the connectivity of various types of transportation networks. For the calculation of the indices the following limitations have been applied [3]:

- ro-ro service is considered as regular transportation linking a certain set of ports in the region;

- ro-ro services considered have a minimum of weekly departure from the first port in the service;

- several of the ro-ro operators are servicing same ports and nevertheless these are considered as separate ro-ro services;

- intra-national services are considered only in cases where same is part of an international (regional) ro-ro service.

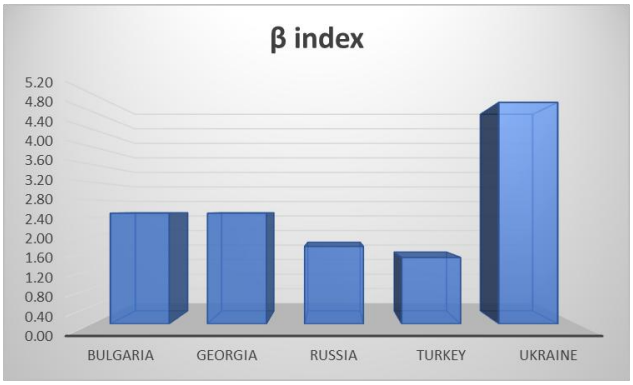

Figure 3. Beta index for each country in the region [own calculation]

As shown in Figure 3, Bulgaria and Georgia have an equal beta index at 2.5 having two ports each and 5 links respectively. As for Turkey, the beta index is at value 1.5 having four ports and six links within the network. Ukraine is present with only one port in the network (Chernomorsk) and five links thus having beta index equal to 5. Russia is relatively well presented with four ports and seven links leading to beta index of 1.75.

As explained above, gamma index represents the ratio between the number of actual inks and the maximum number of potential links [5]. Figure 4 present the gamma index for the ro-ro network in the Black Sea region evaluated on the basis of available data.

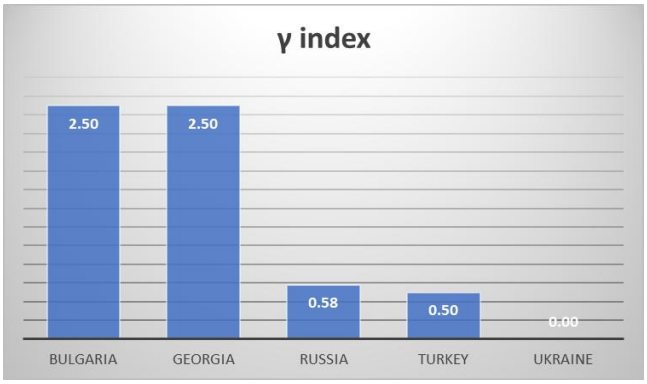

Figure 4. Gamma index for each country in the region [own calculation]

Gamma indices for Bulgaria and Georgia are at the same level for the described network, while for Russia and Turkey it is about five times lower mainly due to bigger number of ports and links. An interesting observation is the gamma index for Ukraine, presented in this network by only one port but with five links, which clearly denotes that there is a need for inclusion of other nodes in the network to improve the country's ro-ro connectivity.

Ports connectivity in the region can contribute to the increase of cargo flows and ports throughput. On the other hand, it is proved that higher connectivity leads to decreased costs of trade flows between the region and other regions in Asia and Europe. The higher the number of ro-ro connections, the higher the share of short sea transportation in intermodal chain. It should be also noted that the hinterland connections are a vital element of the network in terms of increasing the quality of port services.

Ports connectivity in the modern ro-ro network in the Black Sea region is also related to the overall performance of the regional ports. It promotes intermodal connectivity of the port being considered as a key element of supply chains. Ro-ro transport and increased ports connectivity should promote quality customs formalities to ensure for faster turnover of goods and transfers from and to the ports. On the other hand, higher levels of port connectivity will decrease road congestions due to modal shift to ro-ro shipments.

Ports connectivity of the ro-ro shipping network can be analyzed also on a comparative basis with adjacent regions (for example the EU Mediterranean region) or with a group of ports. As leading indicators, the average values of the indices should be taken into account to achieve realistic comparison of the ro-ro connectivity of several regions.

4. Conclusion

The present paper has presented a study on the applicability of port connectivity indices to Black Sea ro-ro shipping network. Port connectivity is a valuable tool for policy makers and ro-ro operators as it provides guidelines for the development of this network feature.

The applied indices are similar to the already developed by UNCTAD liner shipping connectivity index (LSCI) related to liner shipping (containerized cargoes). However, unlike container liner shipping, ro-ro shipping does not involve transshipments and ro-ro services are direct services [4]. The main reason behind this type of transportation via short sea routes is the carriage of goods that are of high value and are time-sensitive. Over 50% of the ro-ro operators in the Black Sea region offer service both for freight (trucks and rail wagons) and for passengers. The application of the beta and gamma indices to measure the port connectivity of the ro-ro transportation in the Black Sea region show that the port of Batumi, Georgia is the port with most connections in the region. The latter is due to its connections with ports in Bulgaria, Russia and Ukraine. We proved that the port of Chernomosk has the highest link quality which is

due to the high frequency of ro-ro services. The potential topics for further research should include: adding additional variables for development of more complicated indicators to measure ro-ro connectivity of ports based on frequencies and number of service providers, expanding the application of port connectivity indices to include the available links with dry ports in the hinterland and analysis on the issue whether ro-ro connectivity indices influence the trade volumes and trade flows.

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