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The Competitiveness of Feeder Shipping Compared to Road Transport

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ABSTRACT

Feeder shipping, as a segment of short sea shipping, plays an important role in the transport of containerized cargo between the European ports. Its competitiveness compared to the direct road transport depends primarily the cost and time of the whole land-sea transport chain. The article presents the comparative analysis of cost in transport including feeder shipping and pre-haulage and costs generated in direct road transport. On the basis of the analysis, the influence of localization of feeder and hub ports on competitiveness of feeder shipping was evaluated.

1. Introduction

In European transport system feeder shipping appears to be a segment of short sea shipping, which should be primarily understood as carriage of cargo between European countries. Short sea shipping, according to the EKMT definition, "covers coast side operations between ports of one country, international shipment between European ports and the European section of the ocean freight" [Short Sea Shipping, 1999]. Development of feeder shipping is strongly connected with the development of the container shipping. Since the introduction of containerization and mega-size vessels, the liner shipping companies have been benefiting from the economies of scale. Constantly growing size of deep sea going vessels started to require much larger ports with better technical parameters, which was the reason why they could not be operated everywhere. Moreover, the time and cost pressure caused carriers to start limiting the number of ports for vessels to call at, while reducing the frequency, so as to increase the utilization of ships and shorten the time of the journey [Imai et al., 2009]. Between hubs and other ports a small ship began to operate feeder lines.[Lee and Jin, 2013; Salomon, 2010] This transport system was named hub-and-spoke, while creation of hub and feeder port - ports polarization [Lieb and Gerundt, 1988; Szwankowski, 1994; Misztal and Szwankowski, 1999; Rydzkowski and Wojewódzka-Król, 2005].

Hub ports function as gates through which cargo of intercontinental maritime trade are passed The ports can receive post-panamax types of vessels, possessing from a few to over a dozen container terminals, annually operating even tens of millions TEU [Dong and Song, 2009; Imai et al., 2009]. In Europe only few ports function as hub-ports. The North Sea ports, that is, Rotterdam, Hamburg, Antwerp and Bremerhaven, service the regions of the northern and central parts of Europe including the Baltic Sea area. The ports of the Mediterranean Sea such as Gioia Tauro or Taranto have reached the status of hub ports in the region of Southern Europe.

Transportation of cargo from the hub can be realized in three ways:

- directly by road
- rail or inland waterway transport to intermodal terminals located deeply inside the mainland
- inland feeder, and then by rail or road transport directly to consignees [Author].

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2. The Main Competitiveness Factors of Short Sea Shipping

Maritime transportation has several advantages over other modes of transport, especially for the transportation of large quantity of goods. The first advantage of maritime transportation is its relatively low cost [Gelareh et al., 2013], which is due to, among others, bigger load capacity of ships when compared to the means of other modes of transport [Paixão Casaca and Marlow, 2002].

In practice, among factors determining the way of transport there are such as time, flexibility, accessibility or the quality of transport. For many, these are the reasons that speak for the use of road transport [Jacobs, 1993]. An important factor weakening the competitive position of feeder shipping when compared to road transport is the lack of door-to-door delivery to be realized by one means of transport. Door-to-door requires a change in the means of transport, which in turn prolongs and increases the cost of transportation process, and requires close coordination between the shippers, ports and land carriers [Pérez-Mesa et al., 2012].

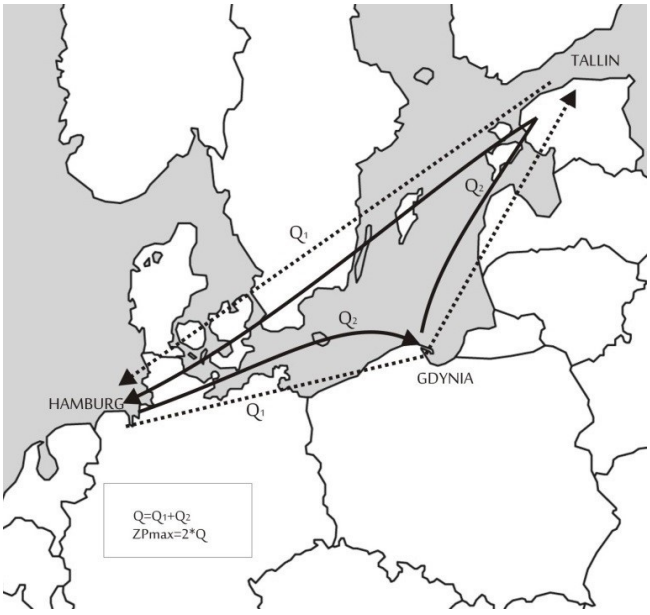
Another factor weakening the competitive position of feeder shipping is the aspect of timing. Feeder shipping, as a link of intercontinental transport chains, depends on the timetables and timeliness of the calls of ocean container services at hubs. Any delay in ocean-going vessels results in delayed feeder vessels operation and consequently delayed deliveries. As a result, feeder lines timetables are frequently updated, any delays disorganize the work of container terminals and further undermine cargo gestors confidence.

Not without impact on competitiveness, including both factors the time of transport and transport capacity, is the way of organizing the shipping lines. Feeder vessels make the so-called round trips, calling at up to several ports, and the total turnover of containers takes place in the hub ports, while at feeder ports it is only partial. As a result, during a round trip a feeder vessel can carry twice as many containers than she is due to her cargo capacity ($2 \cdot Q$, regardless of the number of ports she calls at (fig. 1). The total cost is distributed to a number of containers, regardless of the distance of the feeder port from the hub port.

Due to such calculation, the costs of shipment by feeder vessels to the ports, which are closer to hub ports, do not have to be lower than to the more distant ones. Since in container shipping the arrangement of the transport chain is dealt with by deep sea operators, freights are calculated for the whole sea shipment (and quite frequently for the hinterland transport too). Fig.2. illustrates sample freight rates for the shipment of containers from Ningbo, a Chinese port to the hub port of Hamburg and feeder ports of Gdynia and Szczecin. In case of the freight from Ningbo to the ports of Gdynia and Szczecin, the price covers the sea transport to the port of Hamburg, cargo handling in the hub port and its shipment by feeder vessels to the local ports. The figure shows that in spite of a shorter sea distance from Hamburg to the port of Szczecin than to the other Polish sea ports, the rate of one container freight is higher.

To illustrate the competitive position of feeder shipping in relation to road transport and the impact of the location of a hub and feeder ports in relation to each other on the competitiveness of land-sea transport chains, there have been developed models of costs incurred in direct road transport and land-sea transport chain, whose participants are feeder shipping and road transport, as a link of pre-haulage transport. To take into account the effect of time on the competitive position of transport, to the model there has been introduced ”cost of time” designated by costs of tied up capital, which is a container with cargo transported in it.

Figure 1: Cargo capacity of a vessel operating in feeder shipping



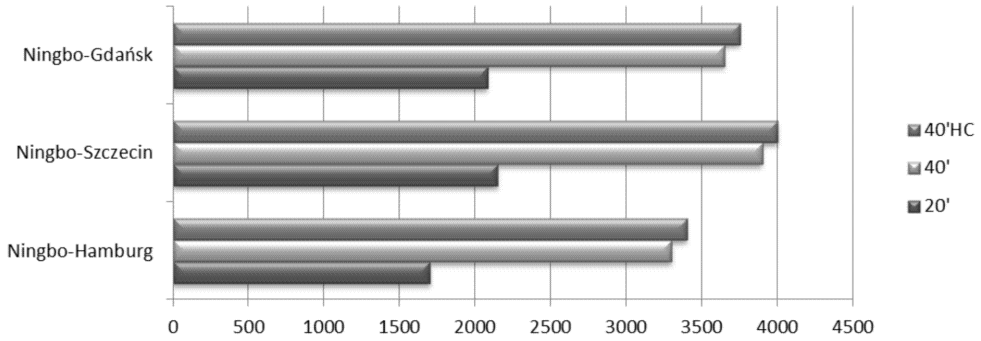
Source: Author
Q_1, Q_2 – amount of containers delivered between hub and feeder ports (v.v.)
ZP_{max}– total cargo capacity in the round trip

The economic costs in land - sea transport chain are affected by the cost of: carriage of a container to the port, its handling in the ports and maritime transport costs. At the same time, as it has already been mentioned, the cost of transport by a feeder ship from hub to feeder port does not depend on the distance, but the total cost of a ship's operation in her round trip, which consists of the following costs: capital, crew, insurance, maintenance and repairs, inventory, administration, etc., and on the variable costs arising during the round trip, mainly fuel costs. The port costs include costs incurred by the ship when in port, including the ship's fixed costs, the cost of fuel (MGO) and the costs of operating the ships in the harbor, as well as costs incurred by the cargo (storage and handling).

The costs of road transport, both pre-haulage to a feeder port, as well as direct transport to a hub port, are affected by variable costs, depending on the distance of transport, including, among others, fuel costs and infrastructure charges and fixed costs such as personnel costs, vehicle depreciation, administration [Author].

As a result, land and maritime transport chain model of economic costs (C_{LS}) takes the form:

Figure 2: Sample FCL rates in relation China-Poland (USD)



Source: Author

$$C_{LS} = \frac{CM + FC}{2 \cdot \lambda \cdot Q \cdot 24} \cdot (T_{RTf} - m \cdot TT_{pf}) + \frac{m}{2 \cdot \lambda \cdot Q} \left(\frac{T_{Pf} \cdot (CM + MGO)}{24} + PCH \right) + THC + c_B \cdot l_{PH} + c_S \frac{\ell_{PH}}{v_{RT}}$$

while the cost of the time $(C(t)_f)$ can be presented by the formula:

$$C(t)_f = V_c \cdot I_r \frac{T_{LS}}{8760}$$

In direct road transport the model of economic costs (C_{RT}) takes the form of:

$$C_{RT} = c_B \cdot \ell_T + c_s \cdot \frac{\ell_T}{v_{RT}}$$

and the cost of time:

$$C(t)_{CA} = V_c \cdot I_r \cdot \frac{T_{RT}}{8760}$$

where:

C_B cost of fuel, fluids and highway tolls (EUR / km);

ℓ_{PH} pre-haulage distance (km)

v_{RT} average transport speed

c_s fixed costs: depreciation, insurance, vehicle maintenance, personnel costs etc. (km/h)

CM costs of ship maintenance: capital, crew, insurance, living, provisions, administration etc. (EUR/24 h)

λ - the use of the vessels cargo capacity (%)

Q load capacity of a ship (load units)

T_{RTf} time of a round trip (h)

ℓ_T distance of direct road transport to the hub port (km)

m - number of ports in a round trip

T_{pf} time in the port (h)

V_c value of the cargo and a load unit (EUR)

I_r annual interest rate (%)

MGO diurnal cost of fuel in the port (EUR/24 h)

FC diurnal cost of fuel during a voyage (EUR/24 h)

PCH costs of servicing a ship in the port (EUR)

TCH costs of cargo handling in the port (EUR)

T_{LS} time of cargo shipment in the land-sea transport chain (h)

3. Data Collecting

The application of the model required a number of data. Most of the source data were the information obtained directly from the sea and road shippers, materials published by the European Commission, port tariffs, official reports on freight rates, fuel prices, etc. A load unit adopted in the analysis is a 40'container. The analysis assumes the costs for a container ship with a capacity of 1,500 TEU, which during a 7 day round trip calls at 3 feeder ports. The average speed of the vessel is 19 knots, and the average lay time in each port is 18 hours. The fixed costs of the ship have been based on the studies of COMPASS [1]. The average cost of operating ships in the harbor has been estimated on the basis of port tariffs of the ports of Szczecin, Świnoujscie, Gdynia and Gdańsk [Port tariff of Szczecin-Świnoujscie Port Authority, 2010; Port tariff of Gdańsk Port Authority. 2011; Port tariff of Gdynia Port Authority. 2007]. The average time adopted in the analysis of the awaiting loading units to be loaded on a ship and taken from the storage area is 7 days.

4. Results

Figure 3 illustrates the costs for land and maritime transport chain, depending on the pre-haulage distance to a port. For the

analysis, there have been adopted three distances to the port: 50km, 250km and 400km. For the presentation of the relationship between the location of the feeder port with respect to the hub port, and its competitiveness against road transport, in the figure were plotted lines corresponding to transport distances between the hub ports (Hamburg and Rotterdam) and feeder ports (Szczecin and Gdynia). Since the road costs, apart from costs dependent on the distance of transport, also cover costs associated with freight time, in the figure is visible an increase in the cost of road transport at the distance of 1200 km, which is the result of the vehicle standstill resulting from the mandatory daily rest periods for drivers.

As shown in Figure 3, the position of feeder shipping from Hamburg to the port of Szczecin is very weak (Fig. 3, A). The costs of both transport relations: direct road transport and with the participation of maritime transport are similar, only when the land-sea transport chain includes a short (up to 50km) pre-haulage road link. At a greater pre-haulage distance to the port of Szczecin direct road transport to the ports of Western Europe is more favorable. It is different in the case of carriage from the port of Rotterdam (Fig. 3, B). Cargo shipment by a feeder vessel with transshipment in the port of Szczecin generates lower costs, even if the pre-haulage distance is much greater (250km). Compared with Szczecin, the port of Gdynia has a much better competitive position. Freight comprising a feeder shipping route to Hamburg is more profitable in terms of costs even at a relatively large pre-haulage distance to the port (Fig. 3, C). It is at a pre-haulage distance of 400 km when costs in both transport chains are balanced. In case of pre-haulage from Gdynia to Rotterdam, land - sea transport chain generates lower costs, and therefore has a better competitive position than road transport in each analyzed pre - haulage scenario. The relationship shown in fig. 3 partly explains the depth of the hinterland of the both analyzed ports.

The research carried out in Polish container terminals indicated that the hinterland of the port of Gdynia actually reaches the whole territory of Poland. The share of close hinterland (up to 50km) is only 24%. More than half of all the containers are forwarded from a distance of over 250km, and 16% from over 400km. The average distance of the cargo carried by road transport is about 280 km. The ports also service the region traditionally treated as the captive hinterland of the port of Szczecin. About 15% of freight operated by road transport is forwarded to the Wielkopolskie and Lubuskie Provinces, and 3% to West Pomerania, though this phenomenon should rather be explained via a bigger number of shipping operators in Gdynia terminals than in the port of Szczecin.

Quite differently is shaped the hinterland of the port of Szczecin. The share of close hinterland (up to 50km) is 33%, whereas 85% of containers operated in the port are forwarded at a distance of less than 250km. Almost 50% of containers come from (or are destined to) the West Pomeranian Province, and over 40% of containers come from the Wielkopolskie and Lubuskie Province. The average distance of the cargo transported to/from the port of Szczecin is only 140 km. While the weaker competitive position of the port is affected by many factors, e.g. low admissible parameters of vessels, lack of storage areas in the immediate vicinity of the waterfront, low capacity of STS gantry cranes and long distance from the open sea [Author], but the location close to the largest hub port for the Baltic Sea area is most significant. The port of Szczecin is the closest feeder port to the west of Hamburg (German Baltic ports such as Lübeck, Rostock, Sassnitz do not support feeder services). Hence, a lot more containers coming (destined) from the port of Szczecin, traditionally referred to as the captive hinterland, are transported directly by road (rarely by rail) to the port of Hamburg.

5. Conclusions

Feeder shipping provides a significant market segment of short sea shipping, servicing the vast majority of containers transported between European ports. Because this type of shipping is an intercontinental link of transport chains, its functioning (timetables, freight) is closely related to deep sea shipping. During a round trip, whose time ranges usually from 1 to 2 weeks, ships can call at up to 7-8 ports. The main function, which is the forwarding of containers from / to the hub port, makes the ship's transport capacity during a round trip limited to a double load capacity. Its consequence is the height of freight rates independent of the distance between the hub and the feeder port. As a result, ports situated in a short distance from the container hub port often lose with direct land transport. The research carried out, based on the assumptions described in the article, has shown that the minimum shipping distance, for which the land-sea chain is more profitable than road transport is about 450-500km.

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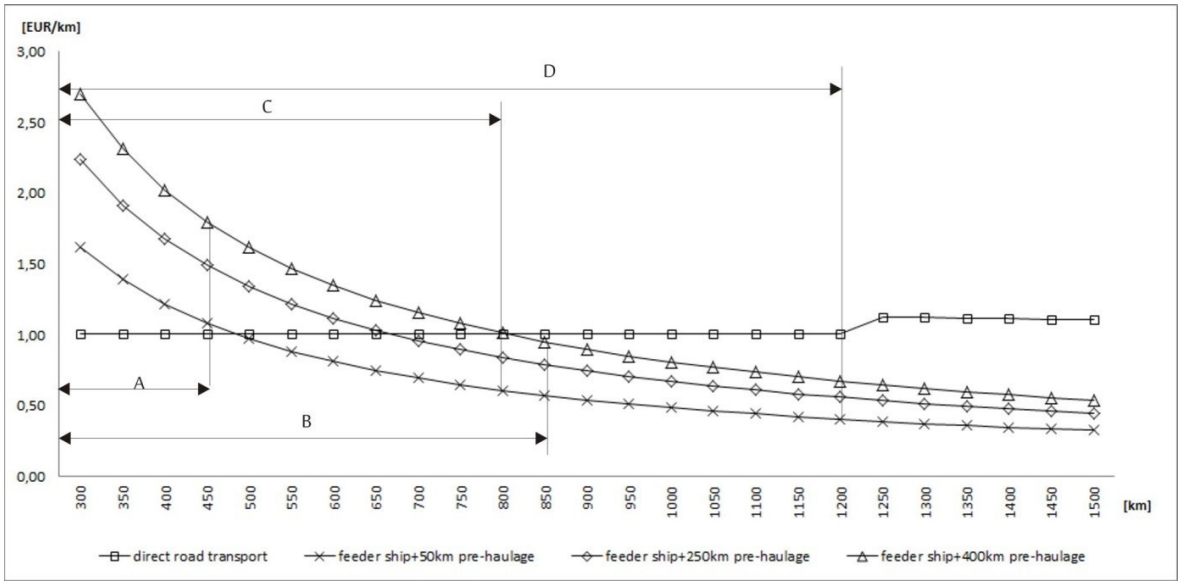
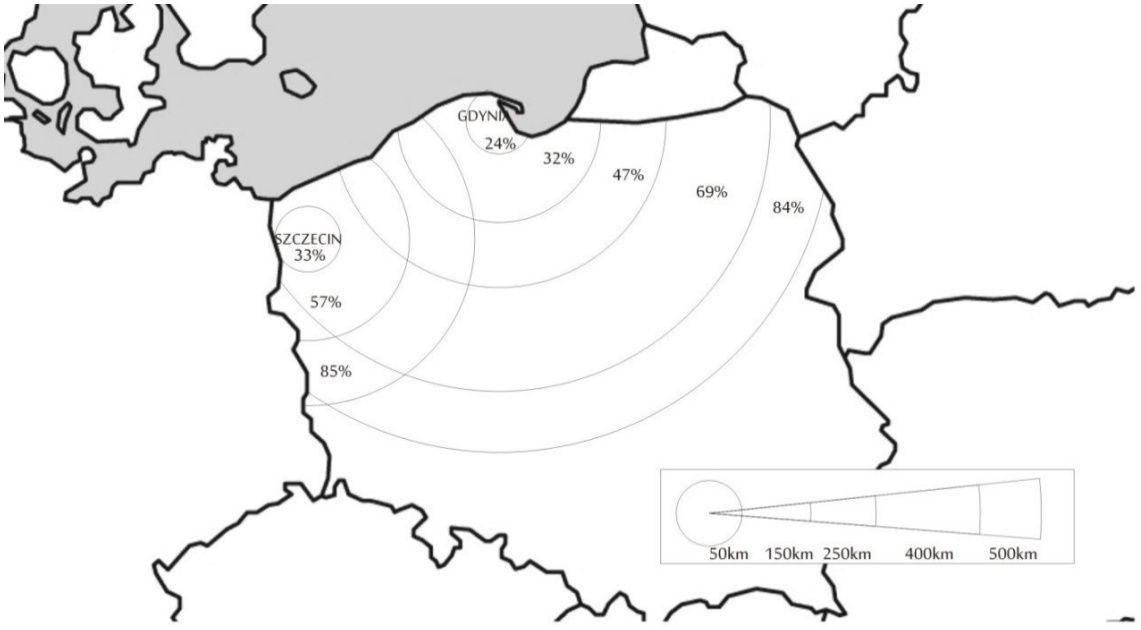
Figure 3: Unit costs in land-sea transport chain (with feeder shipping and road transport) as well as direct road transport [EUR/(40'container*km)].



Source: Author
A- distance from Hamburg to Szczecin
B- distance from Rotterdam to Szczecin
C- distance from Hamburg to Gdynia
D- distance from Rotterdam to Gdynia

Figure 4: Range of hinterland of Polish feeder ports serviced by road transport.



Source: Author

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