Introduction

Ferry shipping renders two main types of transportation services by using the horizontal system of transhipment of rolling stock (ro-ro), namely: passenger-cargo transport and cargo transport. In the first instance transportation may be performed by (conventional) universal ferries (passenger-cargo), where cargo transportation complements transportation of passengers or by, increasing in importance, cargo-passenger ferries, where in this instance transportation of passengers complements transportation of rolling stock units, such as lorries, semitrailers/trailers, swap bodies and other cargo rolling units. In practice, the car-passenger ferries are used to be named as ro-pax ships (ferries). In the ferry shipping there are ro-ro ships employed that are used entirely for the carriage of rolling stock (unaccompanied) in the forms of semitrailers/trailers, swap bodies, containers on chassis and other cargo units and there are rail or car-rail ferries transporting rail wagons and lorries. The most important parameter that characterises the potential of ro-pax and ro-ro ships is the length of their loading lines (in running meters) that can be used for transportation of cargo units.

The aim of this article is to determine forecasted changes in the size and structure of the tonnage employed in the carriage of rolling stock units on shipping lines in the Sweden-continent relations. The development of ro-pax and ro-ro connections, the analysis of the size and structure of the ro-pax and ro-ro employed fleet, the tendencies in changes of the size and structure of the ro-ro and ro-pax tonnage constitute the background for the predicted changes. The tonnage development trends have been subjected to verification with the observation of: sizes of vessels currently operated on connections in The Baltic Sea, new vessels introduced into service by ferry operators, reallocation of vessels from The North Sea basin to service ferry connections in The Baltic Sea. The maximum size of ro-ro and ro-pax vessels which will appear on the Sweden-continent connections in the future has been determined. The ports in Trelleborg and in Świnoujście adjust their berths to service ro-ro and ro-pax vessels with the maximum length of 240 meters.

Ro-pax and ro-ro lines network in the Baltic sea

In 2013, on The Baltic Sea there were 23 universal/ro-pax/rail-car ferry operators and 5 ones operating ro-ro vessels only. The biggest operator in The Baltic, by the number of units in the fleet, is Finnlines. The majority of operators in The Baltic have both ferry fleets as well as ro-ro vessels. On the market there are also shipowners who engage only in ferry (Viking Line, Color Line, TT-Line, Unity Line) or cargo ro-ro shipping (Transfenica, Mann Lines). The leading Baltic ferry and ro-ro operators are presented in the table 1.

<table>
<thead>
<tr>
<th>Operator</th>
<th>Number of vessels</th>
<th>Universal and ro-pax ferries</th>
<th>Ro-ro vessels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tallink/Silja</td>
<td>15</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Viking Line</td>
<td>7</td>
<td>7</td>
<td>–</td>
</tr>
<tr>
<td>Finnlines</td>
<td>24</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>DFDS</td>
<td>14</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Stena Line</td>
<td>18</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>Color Line</td>
<td>6</td>
<td>6</td>
<td>–</td>
</tr>
<tr>
<td>TT-Line</td>
<td>6</td>
<td>6</td>
<td>–</td>
</tr>
<tr>
<td>Mann Lines</td>
<td>6</td>
<td>–</td>
<td>6</td>
</tr>
<tr>
<td>Transfenica</td>
<td>12</td>
<td>–</td>
<td>12</td>
</tr>
<tr>
<td>Unity Line</td>
<td>7</td>
<td>7</td>
<td>–</td>
</tr>
</tbody>
</table>

Source: I. Urbanyi, Bałtycka żegluga, Namiary na Morze i Handel 2013, nr 21, s.11.

The main ro-pax ferry lines are presented in figures 1–6.
On the Świnoujście-Trelleborg line, Unity Line operates three vessels, namely: car ferry Galileusz, car ferry Gryf and passenger-rail-car ferry Wolin. The same operator employs four vessels on the Świnoujście-Ystad line. Those vessels are: passenger-rail-car ferry Polonia, passenger-car ferry Skania, rail-car ferry Jan Sniadecki and passenger-rail-car ferry Kopernik.

Cargo-passenger (ro-pax) service is supplied by the German operator TT-Line on the two basic ferry lines from Trelleborg to Travemünde and to Rostock. The cargo ro-ro transport is realized on the Helsingborg-Travemünde link. Since the beginning of 2014, with its passenger-car ferry Nils Dacke, the operator commenced regular cargo-passenger service on the Trelleborg-Świnoujście line.
Polish Baltic Shipping had been employing one passenger-car ferry Wawel on the Swinoujście-Ystad line, till the end of 2012. In January 2013, its passenger-car ferry Baltivia was moved from the Gdańsk-Nynashamn line to the Świnoujście-Ystad one.
Presently, the ro-pax ferry lines from Trelleborg to Sassnitz and to Rostock are serviced by Stena Line. Scandlines has concentrated its operations on the short sea shipping transport from Germany (Rostock, Puttgarden) to Denmark (Gedser, Roedby) and from Sweden (Helsingborg) to Denmark (Helsingor).

Among many shipping connections by Finnlines, in the South-Western Baltic area, there are regular ro-pax services maintained from Malmoe to Rostock and to Travemunde. Since October 2012, the Helsinki-Gdynia line is serviced by one ro-ro vessel of the Hansa class. That is the vessel with the loading line of 3200 meters.
Since 2011, Stena Line operates two twin passenger-car vessels Stena Vision and Stena Spirit on the Gdynia-Karlskrona line. In the mid 2013 the shipowner strengthened the connection with the third ro-pax type vessels Stena Baltica. The biggest development that had happened on the Baltic shipping market was the expansion of Stena Line who in October 2012 took over from Scandlines five ferry lines in The Baltic, including the two ones connecting Germany with Sweden, namely: Sassnitz-Trelleborg and Rostock-Trelleborg. Analyzing the development of regular cargo and cargo-passenger transportation in The Baltic, one needs to observe that in the following years there will arise a competition between the ro-ro services and the shipping lines operating ro-pax vessels. The competition will cover the areas traditionally serviced by ferry operators, including the connections with Southern Sweden.

**Cargo-passengers ferries (ro-pax) and ro-ro vessels employed on the lines between Sweden and the Continent**

From the list of 28 ro-pax and ro-ro vessels employed in servicing rolling stock units on Sweden-continent lines emerges the following:

1. The biggest ones of the vessels so far employed on the Sweden-continent direction are the two car-rail-passenger ferries, i.e. Mecklenburg-Vorpommern and Skane, employed by Stena Line (Scandlines) on the Trelleborg-Rostock line. The technical-operational parameters of the vessels are the following: length/width/draft respectively 220/29/6 m, GT 36 200–29 000 GT, loading line of 3200–3295 m, rail line 945–1100 m, on a single voyage the ferries can carry from 90 to 440 passenger cars and from 745 to 600 passengers, their maximum speed is 22,5–21 knots and a single voyage lasts about 5,8–7,5 hours.

2. The second group of the biggest ro-pax ferries is formed by the vessels operated by TT-Line on the Trelleborg-Travemunde connection. The two twin vessels Nils Holgersson and Peter Pan are car-passengers units built in 2001 with the following technical-operational parameters: length/width/draft respectively 183/29/7 m, GT 32 500, loading line of 2640 m, on a single voyage the ferries can carry 744 passengers each, their maximum speed is 22 knots and a one way voyage lasts about 7–8 hours.

3. Big ferries are being operated by Finnlines on the connection from Malmo to Travemunde. The vessels Finnpartner and Finntrader have the following operational characteristics: length/width/draft respectively 183/29/7 m, GT 32 500, loading line of 3050 m, up to 272 passengers on a single voyage, the maximum speed of 21,3 knots and a single voyage passage lasting 9 hours. The built in 1999 ro-pax ferry Finneagle is a smaller unit. Its technical-operational parameters are: length/width/draft 188/29/7 m, GT 29 800, loading line of 2200 m, number of passengers is up to 440, their maximum speed is 21,3 knots.

4. Presently, on the Swedish connections there remain 8 car-rail ferries, out of which 5 units are used for transportation of rail wagons. The two biggest car-rail ferries are employed on the Trelleborg-Rostock connection and they are the vessels Mecklenburg-Vorpommern and Skane. They are equipped with deck rails of 945 m and 1110 m in length, respectively. Rail wagons are also transported on the Trelleborg-Sassnitz line. It is serviced by two car-rail ferries Sassnitz and Trelleborg of 171 (170)/24/6 m in length/width/draft, with the length of deck rails of respectively 711 m and 755 m. On the Świnoujście-Ystad line, the transport of rail wagons is performed by one rail-car ferry Jan Śniadecki of 155/22/5 m in length/width/draft. The vessel is equipped with deck rails of 590 meters. The remaining ferries, namely Kopernik (166/22/6 m, deck rails of 650 m), Polonia (170/28/6 m, deck rails 604 m) and Wolin (189/23/6 m, deck rails 650 m), do not carry rail wagons at present.

The maximum technical-operational parameters of a vessel used to carry rolling stock units on the lines to Sweden are the following: length/width/draft 200/30/8 m (the draft for the ro-ro vessel Baltica on the Karshamn-Kiel line), tonnage of 36 500 GT, with the maximum loading line length amounting 3295 m (Skane), with maximum deck rail length amounting 1100 m (Skane), single voyage carriage capacity of up to 830 passenger cars (Skania) and up to 1800 passengers. The maximum speed of the presently operated vessels is 27 knots. The average age of the analyzed vessels is 19,3 years.

The analysis of the size and structure of the ro-pax and ro-ro fleet operated in The North and Baltic seas is shown in figures 7 and 8.

The average loading line on ro-pax vessels in operation in 2010 was 1863 meters. The share of the biggest ro-pax vessels with their loading line exceeding 3200 meters was 10% of the total operated fleet. The average age of ro-pax vessels was 16,7 years. Ro-pax vessels will, on shipping markets, replace worn-out conventional ferries of which average age is currently 21,8 years.

The average loading line on ro-ro vessels in operation in 2010 was 1986 meters. The share of the biggest ro-ro vessels with loading line exceeding 3200 meters was 26% of the total operated fleet. The average age of ro-ro vessels operated in 2010 was 19,8 years. During the next five years one should expect replacement of tonnage and in most cases there will be new vessels with the loading line of over 3200 meters.

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The additional factor influencing changes in the size and structure of the ro-pax and ro-ro tonnage is the new EU Directive coming into force in 2015 and requesting ship operators in the SECA area to reduce the content of sulphur in ship fuels down to 0.1%. This will have a great impact on ferry operators in The North Sea, English Channel and The Baltic Sea.

Forecasted development of ro-pax and ro-ro fleets on Sweden-Continent lines

The trends in development of sizes of ro-ro vessels and ro-pax ferries in The North Sea and The Baltic Sea are shown in figures 9 and 10.
In case of ro-ro vessels the increase of their size was forecasted to exceed 4500 m of loading line, respectively for ro-pax vessels the forecast was of close to 3000 m of loading line. The prognosis was based on the development trends of transportation of rolling stock units during the time period preceding the 2008–2009 crisis. In the face of crisis occurrences on shipping markets, most of new building orders were cancelled by shipowners. The tonnage developments have thus been verified with the consideration of the following:

- maximum size of vessel operated on The Baltic Sea connections
- new vessels being introduced into service by ferry shipping operators
- relocation by shipowners of vessels from The North Sea region to services in The Baltic Sea.

In The Baltic Sea, on the connections from Finland (Helsinki) to Germany (Travemünde/Rostock), the shipowner Finnlines operates five STAR class ro-pax vessels (Finnmaid, Finnlady, Finnstar, Europalink, Nordlink) the oldest of which was built in 2006. Those are modern and the biggest ro-pax vessels operated in The Baltic. Their size and carriage capacities had been adapted to the service conditions in the Baltic ports and to the expected development of cargo flows. The tonnage of the STAR class vessels is 42 923 GT, the overall length is 218,8 m, the breadth 30,2 m, draft 7 m and maximum speed 25 knots. Those vessels can carry 500 passengers, can take on board 500 passenger cars in one voyage and have loading line of 4216 m each. The vessels are fitted to carry freight units such as lorries, semitrailers and trailers with containers. By re-counting, they can carry 220 lorries in one voyage.

Since June 2009, three sister STAR class ro-pax vessels have been operated on the Travemünde/Rostock-Gdynia-Helsinki line. From the experience in the service of those vessels in the port of Gdynia, it can be derived that the handling time of a vessel in the port, after equipping the berth with storied ramp enabling simultaneous loading/discharging of cars on upper and lower decks, had been shortened from the initial four hours down to three hours.
In the beginning of 2014, the operator DFDS received the first of the two ordered rolling stock carriers. MS ARK Germania, is the universal ro-ro/ro-pax/con-ro vessel of 195 m LOA. The loading line of the vessel is 3000 m which allows the carriage of 185 trucks in one voyage. The vessel can also carry up to 342 chassis with containers.

In 2010, on the ferry line Hook of Holland-Harwich (The North Sea), Stena Line introduced two sister ferries Stena Hollandica and Stena Britannica with the following technical-operational characteristics: the tonnage of 62 000 GT, length/width/draft 240/32/6,4 m. The vessels can take on board 1500 passengers on a single voyage and they offer 5500 m of loading line. That started the set of the cascade transfers of big passenger-car ferries to The Baltic Sea by the operator. The shipowner transferred from The North Sea to the G Göteborg-Kiel Line the two big ferries, rebuilt during 2010–2011, Stena Germanica and Stena Scandinafrica which have the following technical-operational characteristics: tonnage 51837/57958 GT, length/width/draft 243–241/29/6,3–6,15 m, up to 1300 passengers in a single voyage, loading line of 4100–3907 m, maximum speed 21,5 knots. To the Gdynia-Karlskrona line, initially, there were transferred two passenger-car ferries with the following technical-operational characteristics: tonnage 38 772 GT, length/width/draft 176/29–31/6,7 m, up to 1300 passengers in a single voyage, loading line of 1900 m. And later there was one more ro-pax vessel transferred with the following technical-operational characteristics: tonnage 22308 GT, length/width/draft 167,8/26,8/6,20 m, up to 210 passengers in a single voyage, loading line of 2188 m.

By the end of 2017, the operator Unity Line expects to receive into management and operate two new ro-pax ferries which are to replace the ferries Wolin and Gryf on the Świnoujście-Trelleborg Line. The ferries (Patria and Piast) will be equipped with a dual propulsion system using interchangeably the low sulphur marine gas oil (MGO) and the liquefied natural gas (LNG) and will reach maximum speed of 22 knots. According to the initial construction assumptions, those will be 34211 GT ro-pax vessels of 207 m LOA, 27 m BEAM and 6,3 m draft. The ferries will have 3000 m loading lines which will enable transportation of up to 160 trucks in a single voyage. Each ferry will be able to take 344 passengers on board in a single voyage.

The STAR class ro-pax vessels ordered by DFDS set up the direction of changes in the rolling stock carrying tonnage employed in The Baltic Sea. The future ro-pax vessel will be equipped with the dual (LNG/MGO) propulsion system and will have the following linear parameters: length over all up to 240 m, width up to 32 m, draft up to 8 m. The length of the loading line will be in the range of 4200–4500 m. The vessels will be fitted to carry 240 trucks and semitrailers and containers (up to 350 TEU) in a roll on/off system. In a single voyage, they will be taking on board 350-500 passengers (mainly truck drivers).

The maximum in size passenger-car ferry will be characterized with the following technical-operational parameters: tonnage 60000 GT, length/width/draft 240–245/32/8 m, loading line length of 4500–5000 m, 1500 passengers on board, 250 trucks and semitrailers in a single voyage.

Investments adapting the ports in Trelleborg and Świnoujście to reception of big seaborne vessels

Trelleborg is the main port in the South of Sweden servicing the ferry traffic in Sweden-Continental Europe relations. In 2013, in the port of Trelleborg there were transhipped 10 mln tons (respectively 10,7 mln tons in 2012) of cargo, 618 000 trucks and swap bodies (691 000) with 9 mln tons of general cargo, 27 000 rail wagons (36 000) with 772 thou. tons (1 mln tons) of cargo and there were 1,6 mln passengers (+5,2%) serviced.

In 2010, the Trelleborg port received the permission to transfer its ferry operations from the vicinity of the centre of the town and to construct four new ferry berths. All the berths will be able to accommodate sea ferries of 240m in length. The construction of the first ferry berth was completed in September 2014.

The Świnoujście Ferry Terminal constitutes the main ferry port of Poland-Sweden relations. In comparison with the total turnover of the Polish ferry terminals the terminal services 70% of trucks and 100% of rail wagons. In 2013, there were 313 953 trucks and swap bodies plus 10 392 rail wagons transhipped at the Świnoujście Ferry Terminal. The total cargo turnover of the terminal amounted 4 532 thou. tons of cargo.

In the light of the increasing cargo traffic and the forecasted increase of the ro-ro and ro-pax fleet, an investment undertaking, consisting in the construction of the new 242 m long ferry berth no. 1 with its technical/permissible draft of 12/13 m, had been commenced. The investment will be completed by the end of 2014 and it will result in creation of possibilities to accommodate 240 m long vessels.

In the Northern part of the Terminal it is planned to reconstruct the berths number 5 (167 m) and number 6 (130 m) by combining them into one 270 m long berth as well as by reconstructing the berths’ waterfront facilities, including the construction of a car flyover leading from the truck and swap body waiting area to the Northern ferry operation area, and adopting it to intermodal traffic.

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4 Riksintresseprecisering Trelleborgs hamn. Trafikverket region Syd, Malmö 2013.
5 Data of the Świnoujście Ferry Terminal.
Conclusions

1. The analysis of the development of the regular cargo traffic and passenger-cargo traffic in The Baltic Sea indicates that in the next coming years it will come to a competition between ro-ro type ferry services and the ro-pax ones. The competition will cover the areas traditionally serviced by ferry operators, including the connections with the Southern Sweden.

2. In the not far future, it will come to the increase of size of vessels employed in transportation of rolling stock units. The ro-ro vessel will be equipped with a dual LNG/MGO propulsion system and will be characterised with the following linear parameters: length over all up to 240 m, width 32 m, draft 8 m. The length of the loading line will be in the range of 4200–4500 m. The vessels will be fitted to carry 240 trucks or swap bodies and containers (up to 350 TEU) in a roll on/off system. They will be taking from 350 to 500 passengers (mainly truck drivers) in a single voyage.

3. The future car-passenger ferry on the lines to Sweden is a unit with the following technical-operational characteristics: tonnage 60 000 GT, length/width/draft 240–245/32/8 m, loading line length 4500–5000 m, up to 1500 passengers on board, single voyage carriage capacity of 250 trucks and swap bodies.

4. The wide investment programme is under realization in the port of Trelleborg with the aim to transfer ferry operations away from the town’s centre. It encompasses, among others, the targeted construction of four new ferry berths. All new berths will be able to accommodate big, 240 m long, sea vessels. The construction of the first ferry berth was completed in September 2014.

5. In the Southern part of the Świnoujście Ferry Terminal there is the new ferry berth number 1 constructed with the length of 242 m and technical/permisable draft of 12/13 m. The investment will be completed by the end of 2014. Furthermore, a new investment, encompassing the reconstruction of the berths number 5 and number 6 and combining them into one 270 m long ferry berth and the construction of a car flyover on the berths’ waterfront to enable the smooth movement of trucks and swap bodies to/from the Northern area of the Terminal, is planned. The new berth number 1 and the planned new ferry berth emerging out of the combination of the berths numbers 5 and 6 will be adjusted to service 240 meters long ro-ro and ro-pax vessels.

Abstract

The aim of the article is to determine the forecasted changes in the size and structure of the tonnage employed in the carriage of rolling stock units on the shipping lines in the Sweden-continent relation. The background for the forecasted changes is constituted by the development of ro-pax and ro-ro shipping lines in The Baltic Sea, the analysis of the size and structure of ro-pax and ro-ro fleet employed in maritime transport, the change tendencies in the ro-ro and ro-pax tonnage characteristics. The tonnage development trends have been subjected to verification with the observation of: the sizes of vessels currently employed in The Baltic, the new vessels being introduced into operation by ferry operators, reallocation of ferries from The North Sea to service ferry lines in The Baltic. The maximum sizes of ro-ro and ro-pax ferries which will appear on the Sweden-continent connections has been determined.

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2. Data of the Świnoujście Ferry Terminal.
4. Riksintresseprecisering Trelleborgs hamn, Trafikverket region Syd, Malmoe 2013.