# Study on international rail passenger traffic development: Possibilities in the context of development of cities in the Baltic Sea Region

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## Final Report

**2008**

The study has been prepared within the framework of the INTERREG IIIB project “East - West Window” on behalf of the Ministry of Regional Development and Local Government of the Republic of Latvia.

The project “East - West Window” aims at the promotion of the territorial integration of North-West Russia and Kaliningrad into the Baltic Sea Region through joint spatial planning and development actions.



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# 1. Background of the study

## 1.1. The scope of the project "East-West Window"

The overriding aim of the East West Window project is to stimulate the development of the Baltic Sea Region (BSR) by improving railway services within the Region. The project is supported by the European Union BSR INTERREG III Neighbourhood programme – TACIS strand.

The project targets to promote the territorial integration of North West Russia and Kaliningrad into the Baltic Sea Region through joint spatial planning and the development of activities in priority fields such as business development, transport, and ICT development; to this can be added the planned development of how to use the sea and Integrated Coastal Zone Management. The project attempts to improve the level of awareness within the region regarding the existing development potential, its synergies and complementarities, and on methods regarding how this potential can be effectively implemented. . Finally, the project should serve the VASAB (Vision and Strategies around the Baltic Sea) as a useful tool for its main goal – to prepare a long term perspective for spatial development of the BSR until 2030 according to the outline set by the Council of the Baltic Sea States.

VASAB represents the co-operation of 11 ministers responsible for spatial planning and development in the countries of the Baltic Sea Region (BSR). German and Russian Regional authorities are participating in the VASAB co-operation.

Project partners are: Latvian Ministry of Regional Development and Local Government ( responsible partner for the project); German Federal Ministry of Transport, Building and Housing; Swedish Ministry of Enterprise, Energy and Communications; Polish Ministry of Regional Development; Danish Forest and Nature Agency; Swedish research institute Nordregio; Polish Maritime Institute; St. Petersburg's Administration; Kaliningrad State University; and the Russian Economic Developers Association (ASSET).

This study refers to Working Package II. Within the package, three types of activities are carried out:

1) A study of the present situation, development trends, and political objectives, and their consequences for transport and business development. .
2) A formulation of recommendations concerning improvement of the situation from an economical standpoint and the territorial integration of the BSR.
3) A specification of further activities and the implementation of particular measures. .

## 1.2. Objectives

The objective of this study is to analyse international passenger railway services in the Baltic Sea Region, and to assess their potential and impact on the development of cities in the region. A particular focus is placed on cities with populations above 25,000. The aim of the analysis is to propose new international rail connections between the cities in the BSR, considering medium-term demographic and economic development trends. If relevant, costs for the development of new connections will be estimated.

## 1.3. Methodology and Data

Data on existing international railway connections was collected and analysed within the scope of this study.

Furthermore, the following data on existing international railway services was collected: route frequency, travel time, distance, and travel time by alternative means of transport (i.e., airline, in some cases ferries). This data was analysed according to gauge type, average service speed, travel time and other variables.

In order to estimate the medium term population development for cities located in the Baltic Sea Region, population data for 2007 and 2000 was collected. In order to show availability of railway services and access to international railway passenger traffic, the existing transport and education infrastructure was studied as a compliment, the availability of airports and ferry ports as well as the accessibility of university education was included.

The information thus obtained was used in the description and analysis of this study. It was also applied in an analysis model of international passenger railway services in the region. This model follows the so-called gravity model. The gravity model uses a modified law of gravitation applied to social sciences. It takes into account the populations of two areas and the distance between them. Since larger cities attract people, ideas and commodities more than smaller cities, while areas close to each other show greater attraction, the gravity model incorporates these two features.

In order to analyse existing international passenger rail services in the Baltic Sea Region and to propose new connections, a modified gravity model was applied. The model was extended by adding variables that allow one to consider several aspects of international railway passenger flows. First, the different cities' index was introduced and applied in the model. The cities' index combines population growth ratio with the availability of transport and education infrastructure. During preliminary data analysis, a significant correlation was found between population growth and availability of railway infrastructure and university education possibilities. Further, in order to substitute missing data regarding passenger and cargo flows on existing international railway services in the Baltic Sea Region, GDP growth rate and the index of GDP per capita PPP of the respective country[1] was applied. The idea is that higher income generates higher mobility and higher consumption, thus stimulating growth of passenger and cargo. Included in the model was also the number of crossing countries: a growing number of countries implies an increased administrative burden when trying to establish well functioning services. On the other hand, difference in language and culture, partly also the labour markets hinder a free flow of passengers. This applies also to cargo flows. Existing immigration routines and customs control reduces the attractiveness of international connections. Finally, taken into account in the model was also the average speed of passenger trains on routes as a substitute for the quality of the technical infrastructure. In summary, the model results in a potential index for passenger output. If applied on existing international passenger railway services, it gives the passenger potential for a single train route:

## 1.4. Definitions and application in this study

| | |
|---|---|
| BSR countries – | Belarus, Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Norway, Poland, Russia (North-West), Sweden; |
| Baltic Sea Region – | The region covers Belorussia, Denmark, Estonia, Finland, Federal States of Brandenburg, Mecklenburg – Vorpommern, Schleswig – Holstein, Berlin and |

[1] In majority cases there was no comprehensive and up-to date information available in lower level than national GDP. Therefore, regional disparities within the country are not considered by the model.

| | |
|---|---|
| | Hamburg in Germany, Latvia, Lithuania, Norway, Poland, Oblastj Pskov, Oblastj Leningrad, Respublika Karelia in Russia, Sweden. |
| Major development centres – | Cities or city agglomerations with population exceeding 100,000 serving as transport hubs. Exceptions were made; Lahti (Finland) and Liepaja (Latvia) - were added. |
| Average speed – | The average speed of the train service between the starting and destination stations; measured by dividing the total route length in km by the total travel time (from departure to arrival). However, in some parts of this study the average service speed was measured on a base of distance between major stops (cities with population above 25 000[2]) on the international passenger railway route |

[2] The exception was made for Poland, where the cities with population above 50 000 were considered.

# 2. General development trends in the Baltic Sea Region

## 2.1. Population

The overall population in the BSR has decreased by 0,6% on average between 2000 and 2007. Different trends can be observed in individual countries.

During the last seven years, populations in Scandinavia have increased by 3% on average, unlike the Baltic States where populations have decreased by 3%. Negative changes in population are also observed in North-West Russia and in Belarus, or -3%. Northern Poland shows a smaller population drop, or – 1%. In Germany, on the other hand, population has remained stable: according to Eurostat, during the period of 2000-2007, population has increased by 0,2% on average.

Negative population growth in combination with negative net migration (emigrants exceed immigrants) can be mentioned as the underlying reason for population decreases in the Baltic States. These two factors influencing population changes are positive for Denmark, Finland, Sweden, and Norway; birth-rates exceed the death-rates, and the number of immigrants exceeds the number of emigrating inhabitants. In Germany, Russia and Belarus, however, population net growths are negative while net migrations are positive. Poland's negative changes during the last years have been mainly influenced by negative net migration, as births exceeded deaths both in 2006 and 2007.

Germany is the most densely inhabited country in the BSR, with 230 inhabitants per 1 square kilometre. Next come Denmark, with 129 inhabitants per square kilometre, and Poland with 122 inhabitants per square kilometre. In Russia, Norway, and Finland, the corresponding figures are 9, 12 and 16. .

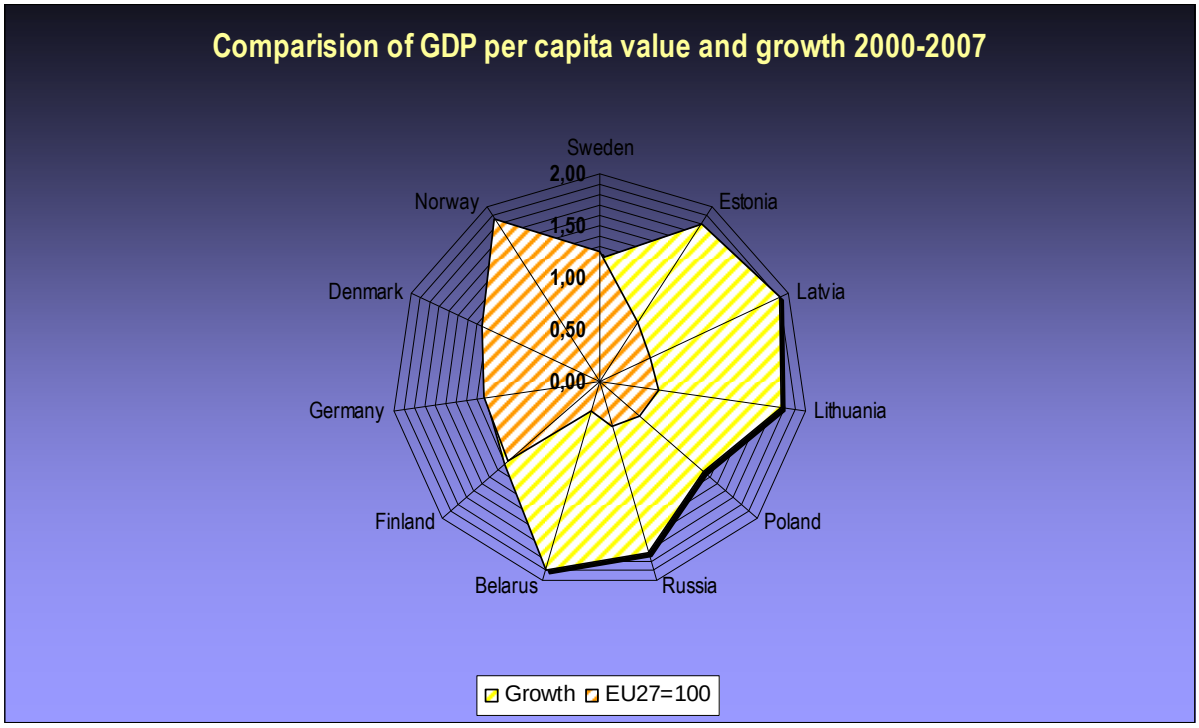
## 2.2. Economic development

With respect to the economic development, GDP was selected as indicator. If compared from data for 2007 and 2000, the fastest growth was observed in the Eastern part of the Baltic Sea Region. The Latvian, Belorussian and Estonian economies showed rapid GDP growth per capita during the last seven years, almost doubling the values. However, if compared to the EU27 average GDP per capita PPP values, the countries are among the least developed in the region. The Western part of the region shows GDP per capita PPP values that exceed the average EU27; growth rates during the last seven years fell between 10% (Denmark) and 21% (Finland).

The charts below summarise the disparities in the region – while the West is comparatively more developed and shows low growth rates, the opposite happens in the East – the East shows higher growth rates, while development still falls under the EU27 average.

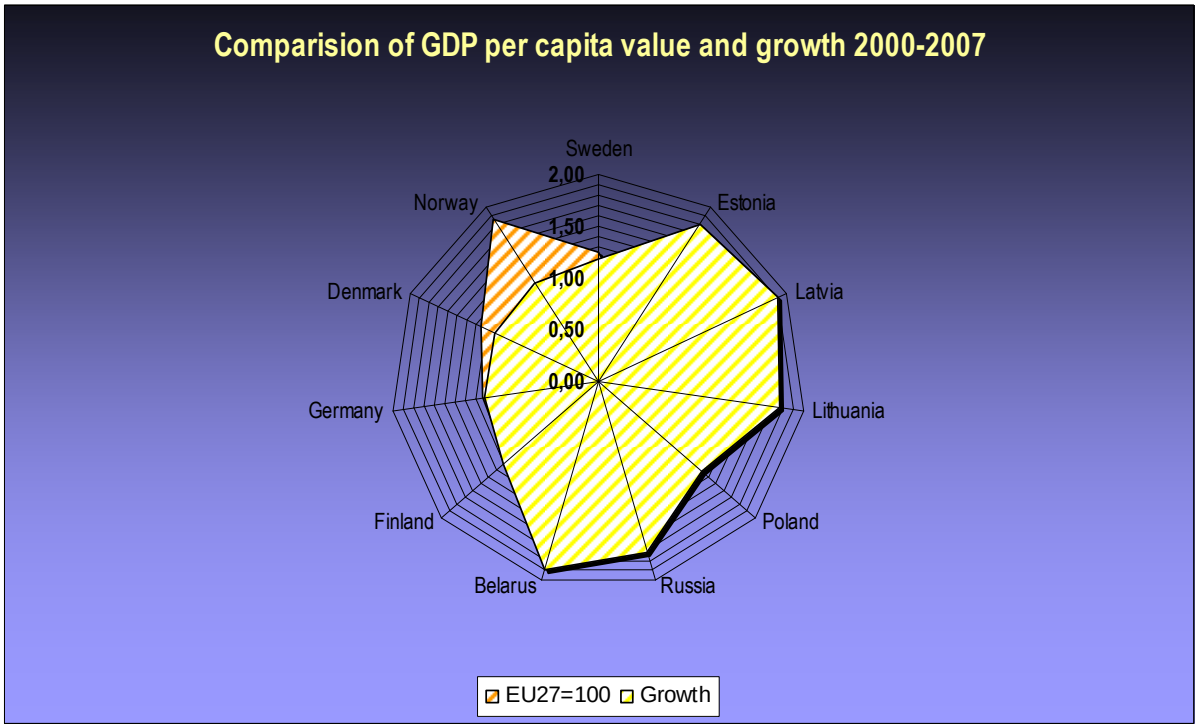
The fastest growing economies in the region are Latvia, Belarus and Estonia; the most developed economies are in Norway, Denmark and Sweden.

**Chart 1. Comparison of GDP per capita value PPP 2000-2007.**




Source: Eurostat, World Bank, IMF. Data for Russia 2006, Belarus 2005.

**Chart 2. Comparison of GDP per capita value PPP 2000-2007.**




Source: Eurostat, World Bank, IMF. Data for Russia 2006, Belarus 2005.

## 2.3. Railway infrastructure, cargo and passenger traffic development

When aggregating information regarding railway infrastructures, we came across missing or incomplete data in national statistical databases. Therefore, data from Eurostat was used in order to provide a comprehensive overview of the main indicators of development regarding railway infrastructures. Substantial differences for some indicators were encountered between Eurostat and the national statistical databases.

In general, we conclude that the length of railway tracks in all countries of the BSR has been shortened, except for Finland and Norway. In some countries like Poland, the overall length of track shortening had had a negative effect on passenger and cargo traffic.

During the period of 2000-2006, the number of passengers travelling on the regional railways in the BSR has increased by 30% on average. In some countries it has dropped by approximately 30%, for example, in Lithuania, Estonia and Poland. According to Eurostat, Sweden shows an increase of 226% in passenger traffic; this must be a mistake, though, as different indicators in the Swedish database show an increase of only 22% (2000 to 2006).
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Passenger traffic has dropped on average by 40% in Latvia, Lithuania, Germany, and Poland. In Scandinavia, on the other hand, there has been a positive increase in international passenger traffic, the importance of which has substantially increased.

Germany, Lithuania, and Norway are the leaders regarding the transport of cargo. In Poland, on the other hand, cargo has dropped by 82% according to Eurostat. Cargo transport by rail has also decreased in Estonia.

**Table 1. Overview of railway development in the Baltic Sea Region countries**

| | Change of total length of railway lines, % | Railway density per thous. km², 2003 | Change in number of rail passengers, % | Change in number of international rail passengers, % | Change in goods transport, % | Change in goods transport, tonne-km, % |
|---|---|---|---|---|---|---|
| **Latvia** | -6 | 35,13 | 54 | -47 | 8 | 2 |
| **Lithuania** | -11 | 27,17 | -31 | -75 | 23 | 25 |
| **Estonia** | -6 | 21,20 | -28 | 1 | -7 | 8 |
| **Finland** | 0 | 17,30 | 16 | 64 | 0 | 10 |
| **Sweden** | -10 | 21,96 | 226 | 153 | 12 | 10 |
| **Norway** | 1 | 10,59 | n.a. | n.a. | 19 | 32 |
| **Denmark** | -3 | 52,75 | 3 | 168 | -3 | -5 |
| **Germany** | -14 | 100,99 | 30 | -6 | 22 | 46 |
| **Poland** | -17 | 63,64 | -29 | -39 | -82 | -95 |
| **Russia** | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| **Belarus** | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |

# 3. The Cities in the Baltic Sea Region

## 3.1. Overview of cities in the Baltic Sea region

### Latvia

There was noticeable population decrease in cities in Latvia with more than 25,000 inhabitants during the period of 2000-2007. The exception is Jelgava, which lies relatively close to the capital; there population has increased by 4%. Altogether one can assume that the Latvian population during the last 7 years has decreased by 4%. However, in important regional centres it fell by 6%.

Railway traffic is available in the nine largest cities having population over 25,000. This means that approximately 1,2 million citizens, or more than a half of the total population in Latvia, have possibility to travel by train. International railway traffic operates through four cities with approximately 840 thousand inhabitants or 39% of the total.

Taking into consideration airport, harbour, and education infrastructures in the largest cities, the average index of city infrastructure is 2,9, and the average development index is 2,2 (including entrepreneurship, inhabitants, cargo and passenger traffic).

**Table 2. Overview of cities 25,000+ in Latvia**

| | Number of population, 2007 | Population change 2000-2007, in % | Accessibility of rail services, in % of population | Accessibility of international rail services, in % of population | Average cities development index |
|---|---|---|---|---|---|
| **Cities above 25 000** | 1,197,780 | -2,9 | 52,5 | 39,2 | 2,2 |
| **… out of them cities above 25 000 and below 100 000** | 367,204 | -2,1 | 16,1 | 2,8 | 2,3 |
| **… out of them cities above 100 000 (important regional centres)** | 830,576 | -6,1 | 36,4 | 36,4 | 2,0 |
| **… out of them MEGAs** | 722,485 | -5,7 | 31,7 | 31,7 | 3,0 |
| **Country average** | **2, 281,305** | **-4,2%** | **n.a.** | **n.a.** | **2,4** |

### Lithuania

The population in Lithuania has gradually decreased during the last seven years by 3,6%. A considerable drop occurred in Kauna, by 6%; low increase can be observed in the capital Vilnius. Comparing these two cities one can assume that important regional centres have faced comparatively more negative changes.

Analysing the transport infrastructures of the largest cities in Lithuania with populations of over 25,000 one can conclude that railway services are available to approximately 1,5 million inhabitants, or 46% of the total population. International railway services, however, are accessible to only 1 million inhabitants, or 28% of the total.

**Table 3. Overview of cities 25 000+ in Lithuania**

| | Number of population, 2007 | Population change 2000-2007, in % | Accessibility of rail services, in % of population | Accessibility of international rail services, in % of population | Average cities development index |
|---|---|---|---|---|---|
| **Cities above 25 000** | 1 704 392 | -4,0 | 45,7 | 28,3 | |
| **… out of them cities above 25 000 and below 100 000** | 367 704 | -3,9 | 6,2 | 1,4 | -0,3 |
| **… out of them cities above 100 000 (important regional centres)** | 1 336 688 | -4,2 | 39,5 | 26,9 | 2,4 |
| **… out of them MEGAs** | 555 733 | 0,3 | 16,4 | 16,4 | 4,0 |
| **Country average** | 3 384 879 | -3,6 | n.a. | n.a. | **0,6** |

## Estonia

Population in Estonia in 2007 has decreased by 2,2% compared to 2000, which is less than in the other two Baltic States. In cities having populations between 25,000 and 100,000, the decrease is higher, or 3,6%; in Kohtla-Järva, for example, a city without airport, harbour, or railway, and which does not provide any university level education possibilities, the number of inhabitants decreased by 5% during the last seven years.

Railway services are available in cities with more than 25,000 inhabitants, or 45% of the total population. In cities with populations between 25,000 and 100,000, access to railway services is provided to approximately 100 thousand inhabitants, or 8% of the total. International railway services, however, are available to approximately 66,500 inhabitants or only 5% of the total.

Taking into consideration the transport infrastructures of the five largest cities and university level education possibilities, the city development index for Estonia is 1,8.

**Table 4. Overview of cities 25 000+ in Estonia**

| | Number of population, 2007 | Population change 2000-2007, in % | Accessibility of rail services, in % of population | Accessibility of international rail services, in % of population | Average cities development index |
|---|---|---|---|---|---|
| **Cities above 25 000** | 655 575 | -2,0 | 45,5 | 34,6 | |
| **… out of them cities above 25 000 and below 100 000** | 155 544 | -3,6 | 8,2 | 4,9 | 0,3 |
| **… out of them cities above 100 000 (important regional centres)** | 500 031 | 0,3 | 37,2 | 29,6 | 4,0 |
| **… out of them MEGAs** | 397 617 | -0,5 | 29,6 | 29,6 | 5,0 |
| **Country average** | 1 342 409 | -2,2 | n.a. | n.a. | **1,8** |

## Finland

During 2000-2007, the Finnish population increased by 2%. A comparatively higher proportion of growth can be observed in the largest cities having populations above 100,000. During this 7 year period, population growth In Espoo and Vantaa, which are situated close to the capital, reached 12% and 8% respectively, while the increase in the capital was only 2%.

Airports have relatively high importance in the Finnish transport infrastructure; air services are available to approximately 2,5 million inhabitants, or 44% of the total. Railway services operate in almost all large cities covering 51% of the total population. International railway services are comparatively poorly developed: they are available to only 700 thousand inhabitants living in cities with populations over 25,000. Taking into consideration university level education facilities in the cities included in the study, the average city development index for Finland is 3,5.

**Table 5. Overview of cities 25 000+ in Finland**

| | Number of population, 2007 | Population change 2000-2007, in % | Accessibility of rail services, in % of population | Accessibility of international rail services, in % of population | Average cities development index |
|---|---|---|---|---|---|
| **Cities above 25 000** | 2 773424 | 4,2 | 50,7 | 13,2 | |
| **… out of them cities above** | 1 259 587 | 3,7 | 22,0 | 2,5 | 3,2 |

| | Number of population, 2007 | Population change 2000-2007, in % | Accessibility of rail services, in % of population | Accessibility of international rail services, in % of population | Average cities development index |
|---|---|---|---|---|---|
| **25 000 and below 100 000** | | | | | |
| **… out of them cities above 100 000 (important regional centres)** | 1 513 837 | 6,5 | 28,7 | 10,8 | 5,1 |
| **… out of them MEGAs** | 1 174 386 | 5,9 | 22,3 | 10,8 | 5,0 |
| **Country average** | 5 276 955 | 2,0 | n.a. | n.a. | **3,5** |

### Sweden

During the last seven years the Swedish population has increased by almost 3%; in important regional centres and MEGAs it reached, on average, nearly 3,5%.

There are airports in 30 cities out of 44 with populations over 25,000. Railway services, however, do not operate in three cities having populations between 25,000 and 100,000. In general, railway services are available to 45% of all Swedish inhabitants, the highest proportion living in important regional centres. International railway traffic is accessible to approximately 30% of all Swedish inhabitants. The total city development index for Sweden is 3,3.

**Table 6. Overview of cities 25 000+ in Sweden**

| | Number of population, 2007 | Population change 2000-2007, in % | Accessibility of rail services, in % of population | Accessibility of international rail services, in % of population | Average cities development index |
|---|---|---|---|---|---|
| **Cities above 25 000** | 4 148 660 | 2,7 | 44,6 | 30,1 | |
| **… out of them cities above 25 000 and below 100 000** | 1 892 715 | 2,6 | 19,8 | 6,5 | 3,0 |
| **… out of them cities above 100 000 (important regional centres)** | 2 255 945 | 3,6 | 24,8 | 23,6 | 5,2 |
| **… out of them MEGAs** | 2 020 531 | 3,4 | 22,2 | 22,2 | 6,0 |
| **Country average** | 9 113 257 | 2,8 | n.a. | n.a. | **3,3** |

### Norway

During the last seven years the Norwegian population has increased by 4,5%. However, in cities with populations over 25,000 the increase is almost double. On average, inhabitants in these cities have increased by 8%.

Railway services are not available in three of 16 cities having populations over 25,000. Services are available to almost 1,5 million inhabitants, 23% of them living in important regional centres. International railway services are available to only 17% of the total Norwegian population, 2% of them living in cities having populations between 25,000 and 100,000. There are airports in seven cities, harbours in 12. The total city development index for Norway is 4,9.

**Table 7. Overview of cities 25 000+ in Norway**

| | Number of population, 2007 | Population change 2000-2007, in % | Accessibility of rail services, in % of population | Accessibility of international rail services, in % of population | Average cities development index |
|---|---|---|---|---|---|
| **Cities above 25 000** | 1 599 508 | 7,3 | 31,5 | 17,0 | |
| **… out of them cities above 25 000 and below 100 000** | 545 262 | 7,0 | 9,0 | 2,0 | 4,3 |
| **… out of them cities above 100 000 (important regional centres)** | 1 054 246 | 8,2 | 22,5 | 15,0 | 6,5 |
| **… out of them MEGAs** | 783 679 | 7,9 | 16,7 | 11,7 | 6,5 |
| **Country average** | 4 681 134 | 4,5 | n.a. | n.a. | **4,9** |

### Denmark

During the last seven years, the Danish population increased on average by 2%. While there has been a population decrease by 2% in important regional centres, in cities with populations between 25,000 and 100,000 it increased by 3,5 % This fact could be related to the migration of citizens to smaller towns situated close to the larger cities. Population in MEGAs has increased by 3,6%.

There are airports in 14 cities out of 25. Railway services are available in all 25 cities holding almost 2 million inhabitant, or 34% of the total population. International railway traffic is available to approximately 1,2 million inhabitants; 4%, or 215 thousand , live in cities with populations between 25,000 and 100,000. Taking into consideration the availability of university level education, the total city development index for Denmark is 3,6%.

**Table 8. Overview of cities 25 000+ in Denmark**

| | Number of population, 2007 | Population change 2000-2007, in % | Accessibility of rail services, in % of population | Accessibility of international rail services, in % of population | Average cities development index |
|---|---|---|---|---|---|
| **Cities above 25 000** | 1 841 237 | 2,6 | 33,8 | 22,3 | |
| **… out of them cities above 25 000 and below 100 000** | 844 069 | 3,8 | 15,5 | 4,0 | 3,1 |
| **… out of them cities above 100 000 (important regional centres)** | 997 168 | -2,1 | 18,3 | 18,3 | 4,3 |
| **… out of them MEGAs** | 737 984 | 3,6 | 13,6 | 13,6 | 5,5 |
| **Country average** | 5 444 242 | 2,1 | n.a. | n.a. | **3,3** |

### Germany

During the last seven years, population in Germany has not substantially changed. A rapid population decrease can be seen in Brandenburg and Mecklenburg-Vorpommern, which is related to the reunification of the country that led to the migration of inhabitants to West Germany. There is higher population decrease in cities having populations between 25,000 and 100,000.

Railway services operate in 39 cities having populations over 25,000, providing services to 61% (7,5 million inhabitants) in the five Bundesländer surveyed. International railway services are available to 46% of the population, 2% living in cities having populations between 25,000 and 100,000.

The total development index for five federal states in Germany is 1,7.

**Table 9. Overview of cities 25 000+ in Germany**

| | Number of population, 2007 | Population change 2000-2007, in % | Accessibility of rail services, in % of population | Accessibility of international rail services, in % of population | Average cities development index |
|---|---|---|---|---|---|
| **Cities above 25 000** | 7 453 055 | -2,0 | 60,9 | 45,9 | |
| **… out of them cities above 25 000 and below 100 000** | 1 299 459 | -2,4 | 10,6 | 2,0 | 1,3 |

| | Number of population, 2007 | Population change 2000-2007, in % | Accessibility of rail services, in % of population | Accessibility of international rail services, in % of population | Average cities development index |
|---|---|---|---|---|---|
| **… out of them cities above 100 000 (important regional centres)** | 6 153 596 | -0,3 | 50,3 | 43,9 | 3,3 |
| **… out of them MEGAs** | 5 158 219 | 1,0 | 42,1 | 42,1 | 4,5 |
| **Country average*** | 12 244 644 | n.a. | n.a. | n.a. | **1,7** |

*Region included: Schleswig-Holstein, Hamburg, Berlin, Brandenburg, Mecklenburg-Vorpommern. Data on population by end 2001 and beginning of 2007..

### Poland

During the period of 2000-2007 there was a population decrease in Poland by 1,4%. The same population changes apply to important regional centres and MEGAs. Railway infrastructure was studied in North Poland (9 regions) with populations, in 2007, of 20,7 million. Out of them railway services are available to 37%, while international services are only available to 23%. International railway services are available only to 2% of citizens living in cities having populations between 25,000 and 100,000.

The total development index for the 9 Polish regions is 1,8; however, in the MEGAs it is – 4,3.

**Table 10. Overview of cities 25 000+ in Poland**

| | Number of population, 2007 | Population change 2000-2007, in % | Accessibility of rail services, in % of population | Accessibility of international rail services, in % of population | Average cities development index |
|---|---|---|---|---|---|
| **Cities above 25 000** | 7 772 839 | -0,9 | 37,5 | 22,8 | |
| **… out of them cities above 25 000 and below 100 000** | 1 547 306 | -0,7 | 7,5 | 2,1 | 1,2 |
| **… out of them cities above 100 000 (important regional centres)** | 6 225 533 | -1,3 | 30,1 | 20,7 | 2,4 |
| **… out of them MEGAs** | 3 132 816 | -1,3 | 15,1 | 15,1 | 4,3 |
| **Country average (9 regions)** | 20 710 710 | -1,4* | n.a. | n.a. | **1,8** |

* country average

### Russia

During the period of 2000-2007 there was a population decrease in the North-West Region of Russia by 3,7%. In the beginning of 2008 there were 13,5 million inhabitants. In cities with populations between 25,000 and 100,000 there was a comparatively larger decrease, or 5,9%. In Volhov and Kirovsk, population decreased by 18% and 10%; however, in Gatchina, which lies close to St. Petersburg, inhabitants have increased by 9% (interesting to notice is the fact that there is no international railway or airport in this city).

Railway services are available to 53% of inhabitants of North-West Region. The total city development index for this region is 0,5.

**Table 11. Overview of cities 25 000+ in Russia**

| | Number of population, 2007 | Population change 2000-2007, in % | Accessibility of rail services, in % of population | Accessibility of international rail services, in % of population | Average cities development index |
|---|---|---|---|---|---|
| **Cities above 25 000** | 7 324 100 | -5,4 | 52,9 | 40,2 | |
| **… out of them cities above 25 000 and below 100 000** | 1 216 500 | -5,9 | 7,7 | 1,0 | -0,1 |
| **… out of them cities above 100 000 (important regional centres)** | 6 107 600 | -3,4 | 45,2 | 39,3 | 2,9 |
| **… out of them MEGAs** | 4 580 600 | -1,7 | 33,9 | 33,9 | 5,0 |
| **Country average (Severo Zapodnij okrug)** | 13 501 100 | -3,7 | n.a. | n.a. | **0,5** |

### Belarus

According to available statistics, during the last seven years population in Belarus has decreased by 3%. Information regarding population change in particular cities is not available with the exception of the capital Minsk where population has increased by 3%; the average index for the whole country is lower than for the capital

Railway service is available to approximately 60% of the total population; international railway services, however, operate only through cities having populations over 100,000, or 31% of the total. University level education is available only in important regional centres.

The development index for MEGAs is 5,0. The average development index for Belarus, however, is 0,4.

**Table 12. Overview of cities 25 000+ in Belarus**

| | Number of population, 2007 | Population change 2000-2007, in % | Accessibility of rail services, in % of population | Accessibility of international rail services, in % of population | Average cities development index |
|---|---|---|---|---|---|
| **Cities above 25 000** | 5 712 800 | n.a. | | | |
| **... out of them cities above 25 000 and below 100 000** | 1 059 500 | n.a. | 10,6 | 0,0 | -1,0 |
| **... out of them cities above 100 000 (important regional centres)** | 4 653 300 | n.a. | 47,9 | 30,8 | 2,4 |
| **... out of them MEGAs** | 1 741 400 | 3,2 | 17,9 | 17,9 | 5,0 |
| **Country average** | 9 714 500 | -3,0 | n.a. | n.a. | **0,4** |

## 3.2. Overview of cities without railway services

Study of railway services was made for 293 cities in the Baltic Sea Region having populations over 25,000 (in Poland – over 50,000). Only 19 cities, with an average population of 40,000 (2007) do not have access to any service. Considering changes in population in these cities during the last seven years, one can recall some differences among the countries studied. For example, population in the three Baltic States has decreased by 3% on average. However, in Lithuanian and Estonian cities having no railway services population has dropped by 5% on average, for example, in Utena and Ukmerge in Lithuania, and in Kohtla-Järve in Estonia. Larger decreases can be observed in Russian cities without any access to railway services. While the total population decrease in the country was 4%, in cities of the North-West Region without railway services, such as Sosnovijbor, Segezha, Guseva and Severomorsk, the drop was even higher, or 6,5%.

During the last seven years, population in Scandinavia has increased by 3% on average. It can be noted that population has also increased in cities having no railway services at all. In Norway, for example, the population has increased by 4,5% on average during the last seven years. However, in cities without any services population has increased by 7%. The exceptions are Rauma (Finland) and Örnsköldsvik (Sweden), cities without any services; a small population drop of -2,5% and -0,5% respectively has been observed.

Considering the availability of services in cities of the Baltic Sea Region, population differences among the three countries must be noted. While in Latvian, Lithuanian, Estonian, German, Polish and Russian cities without international services the populations decrease, a contrary situation can be observed for Finnish, Swedish, Norwegian and Danish cities (having better developed economies), where populations increase.

It must be noted that such MEGAs in the Baltic Sea Region as Vantaa, Turku (Finland) and Bergen (Norway) do not have international railway services, while the populations in these cities have increased.

## 3.3. Overview of cities with railway services

Considering population changes and availability of railway services, development trends for cities in the Baltic Sea Region differ.

During the last seven years, populations in the largest Latvian cities with international services have decreased comparatively more than the total population of the country. While the total population decrease in Latvia was 4%, in cities with international railway services it was 6%. In Lithuanian and Estonian cities, however, the decrease was somewhat smaller than the average drops in the countries.

There are different indicators for Scandinavia as well. During the last seven years, populations in Danish cities with international railway services have tripled compared with country as a whole. In Norwegian cities, however, the growth was comparatively smaller than the country total. There are no substantial differences in population change in Sweden and Finland. It must be mentioned that in Scandinavia the growth was more rapid in cities with population between 25,000 and 100,000, having no railway services at all, but which are located close to important regional centres.

Smaller population decreases are observed in German, Polish and Russian cities with international railway services compared to cities without these services.

The following table shows population change by country while considering cities with railway services.

**Table 13. Overview of cities with rail services 25 000+ Baltic Sea Region**

| | Population change 2000-2007, % Country average | Population change in cities with int. rail services | Availability of rail services, % of population | Availability of int. rail services, % of population | Average city development index |
|---|---|---|---|---|---|
| **Latvia** | -4,2 | -6,0 | 52,5 | 39,2 | 2,2 |
| **Lithuania** | -3,6 | -2,9 | 45,7 | 28,3 | 0,6 |
| **Estonia** | -2,2 | -1,8 | 45,5 | 34,6 | 1,8 |
| **Finland** | +2,0 | +0,9 | 50,7 | 13,2 | 3,5 |
| **Sweden** | +2,8 | +2,9 | 44,6 | 30,1 | 3,3 |
| **Norway** | +4,5 | +2,9 | 31,5 | 17,0 | 4,9 |
| **Denmark** | +2,1 | +7,6 | 33,8 | 22,3 | 3,3 |
| **Germany** | n.a. | -1,0 | 60,9 | 45,9 | 1,7 |
| **Poland** | -1,4 | -0,7 | 37,5 | 22,8 | 1,8 |
| **Russia** | -3,7 | -4,1 | 52,9 | 40,2 | 0,5 |
| **Belarus** | -3,0 | n.a. | 58,5 | 30,8 | 0,4 |

# 4. International passenger railway connections in the Baltic Sea Region

## 4.1. Overview of international passenger railway connections in the Baltic Sea Region

### General information

All together, 36 international railway connections link the cities in the Baltic Sea Region. Out of these, 20 connections are operated on a 1,435 mm gauge railways, 11 on 1,520/1,524 mm gauge railways. Five connections run both: 1,435 mm and 1,520/1,524 mm gauges.

The routes are crossing 2 to 4 countries. The majority of routes (28) connect only two countries. Only two routes connect more than 3 countries; the service between Berlin-St. Petersburg and Berlin-Moscow are the only routes crossing 4 countries.

The average route length in the region is approx. 620 km; the average speed on these routes is 62 kmph. It has to be noted that the average speed is 5% lower on routes having 1,520/1,524 mm gauge tracks. On routes where combined gauge tracks are used, the average speed is even lower (by approx. 9%), which indicates that the time consuming exchange of wheels is not even compensated by considerably larger route distance.

**Table 14. Average service speed of trains in international connections in the Baltic Sea Region**

| Gauge type | Average route length, km | Average service speed, kmph | Difference from average |
|---|---|---|---|
| 1,435mm | 388 | 64,3 | +3,8% |
| 1,520/1,524mm | 680 | 59,1 | -4,5% |
| 1,435mm and 1,520/1,524mm | 1,412 | 56,6 | -8,5% |
| **AVERAGE** | 620 | 61,9 | - |

### Analysis by route length

The routes of international passenger railway connections in the Baltic Sea Region range in length from 47 km to 2,019 km. These routes have been analysed with regard to six categories based on length of route (km): 0-200, 201-400, 401-600, 601-800, 801-1,000, above 1,000. It has been assumed that routes below 200 km have predominantly regional, or city-region but cross-border character. Routes between 201 and 800 km are considered as those where competition with alternative transport means, especially airline transport, is ongoing. Connections below 800 km connect only two countries, with the exception of the Berlin-Kaliningrad route. Connections above 800 km are routes that connect cities in the BSR of two to four countries.

The first group of connections are routes below 200 km in length. There are only three routes below 200 km, which are serving for international passenger traffic: Copenhagen-Malmo, Berlin-Szczecin and Vilnius-Minsk. Only the route Copenhagen-Malmo has very dense passenger train flow (approx. 60 trains run each day between two cities). There is no airline connection between the cities; in fact, the train serves as a link between the cities and the airports.

The second group of connections with route length between 201 km and 400 km is the major group in the region and accounts for 11 routes. The connections are operated mainly on the 1,435 mm gauge railways, except of two routes: Vilnius-Kaliningrad and Tallinn-St. Petersburg, with 1,520/1,524 mm gauge. There is an alternative for only four services – direct airline connection. The train speed is comparatively low; travel time by train exceeds the flight time by almost a double.

The third group consists of ten connections with route length between 401 km and 600 km. These connections are the fastest ones; the average speed of trains is approx. 66 kmph, which is approx. 7% above the average speed of international connections in the region. Only three routes are not serviced by direct airline connections (Berlin-Gdansk, Warszawa-Sestokai and Berlin-Arhus). Despite the fact that these are the "fastest" routes, trains cannot be considered competitive with alternative means of transport, airlines in particular. On average, travelling by train takes almost three times longer than by airplane. However, if two extremely slow routes, Berlin-Gdansk and Berlin Kaliningrad, would be excluded, airline services would be only 2,4 times faster. From this group only routes St. Petersburg- Helsinki and Warszawa-Minsk are partly / fully operated on 1,520/1,524 mm gauge railways.

The longest routes in the region, above 600 km, are mainly operated on 1,520/1,524 mm gauge. Only exception is route between Stockholm (Sweden) and Narvik (Norway). These routes connect the region with Moscow (6 routes out of 12 are connections with Moscow), which, in fact, is outside the Baltic Sea Region; at the same time they are important connections between cities in the Baltic Sea Region. The speed on these routes is below the average in the region, and there are alternative means of transport for these routes, especially operating airline services. No direct airline connection is available for routes between Minsk and St. Petersburg, Vilnius and St. Petersburg, Tallinn and Moscow, and Stockholm and Narvik. On average, journey by train lasts over five times longer than by airplane, therefore, these connections are not very competitive with airlines. However, night trains are often operated, attracting certain number of passengers from airlines. Further, this gives an indication that these routes are used for travelers with less income, since the speed of the connection is not a priority. It can be expected that these routes will become less advantageous with time, since the economic development shows rapid growth rates.

The following table shows that if rail connections would be upgraded to the average speed of 100 kmph (which is the highest value in the region up to date) in distances between 200 and 400 km, it would eliminate any difference of travel time by train or airline. Therefore, the rail connection could become very competitive. The competiveness would increase considering that the train stations are situated in city centres but airports require additional travel time from / to the city centre.

Passenger rail services could also become very competitive with airline services in distances between 400 and 600 km, if high-speed train connections would be introduced. The table below shows that it would require doubling speed in connections where airline service is available.

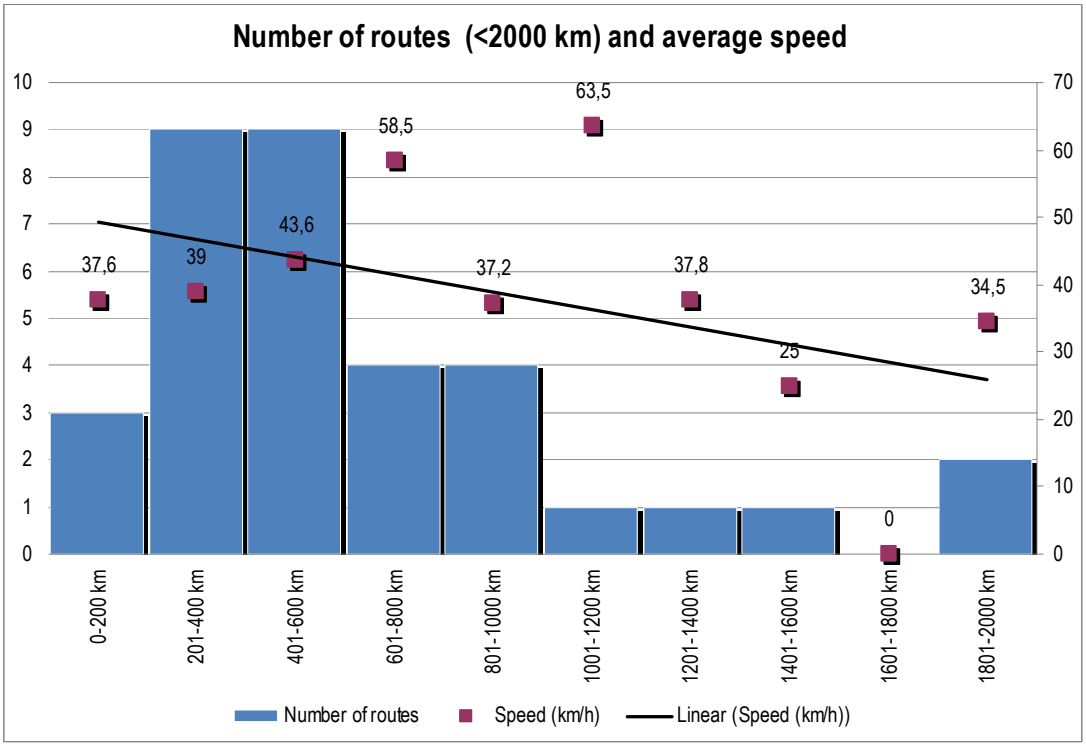
**Table 15. Comparison of international passenger rail connection in the BSR by route length**

| Route length, km | Number of connections | Average of weekly runs per route | Average travel time, decimal | Travel time by plane, decimal[3] | How many times travel with train exceeds flight time on average?[4] | Average service speed, kmph | No. of stops per 100km of the route |
|---|---|---|---|---|---|---|---|
| 0-200 | 3 | 153,67 | 2,24 | 0,00 | -[5] | 63,14 | 7,01 |
| 201-400 | 11 | 27,91 | 5,46 | 2,79 | 2,0 | 59,37 | 3,83 |
| 401-600 | 10 | 15,70 | 8,10 | 2,80 | 2,9 | 66,09 | 2,65 |
| 601-800 | 2 | 7,00 | 12,88 | 3,00 | 4,3 | 54,07 | 1,93 |
| 801-1,000 | 4 | 26,25 | 15,06 | 3,13 | 5,0 | 61,38 | 1,28 |
| above 1,000 | 6 | 7,50 | 25,03 | 4,37 | 5,7 | 60,76 | 0,99 |

### Analysis by average speed

In order to compare international passenger railway services in the BSR, we selected the following criteria – average train speed, considering the distances between main stops of the routes (cities with total populations above 25,000). Therefore, we tried to identify bottlenecks in existing railway infrastructures.

**Chart 3. Comparison of international passenger rail connections in the BSR by route length and average speed**




[3] In connections where airline service is available
[4] In connections where airline service is available
[5] No airline service.

The comparison table shows differences among services, including those where trains run at comparatively higher average speeds (approx. 100 km/h). The analysis by distance shows that these routes compared to airline connections are slow. It also indicates that existing services do not run along optimal tracks, or – meaning along the shortest distance between cities. We conclude that international services are not competitive compared to airline connections In addition, current railway services often do not link major cities in the BSR area, although they still have regional importance.

**Table 16. Comparison of international passenger services by average speed: top 5 fastest connections**

| Route | Average service speed, kmph | Average speed (distance on air), kmph |
|---|---|---|
| Berlin-Warszawa | 101 | 54 |
| Copenhagen-Stockholm | 100 | 66 |
| Helsinki-Moscow | 82 | 63 |
| Malmo-Copenhagen[6] | 81 | 31 |
| Copenhagen-Goteborg | 80 | 44 |

**Table 17. Comparison of international passenger services by average speed: 5 slowest connections**

| Route | Average speed, kmph | Average (distance on-air), kmph |
|---|---|---|
| Berlin-Kaliningrad | 33 | 25 |
| Kaliningrad-Gdansk/Gdynia | 35 | 20 |
| Berlin-Gdansk | 38 | 31 |
| Warszawa-St. Petersburg | 43 | 25 |
| Tallinn-St. Petersburg | 43 | 23 |

## 4.2. Gravity model application on existing international passenger railway services

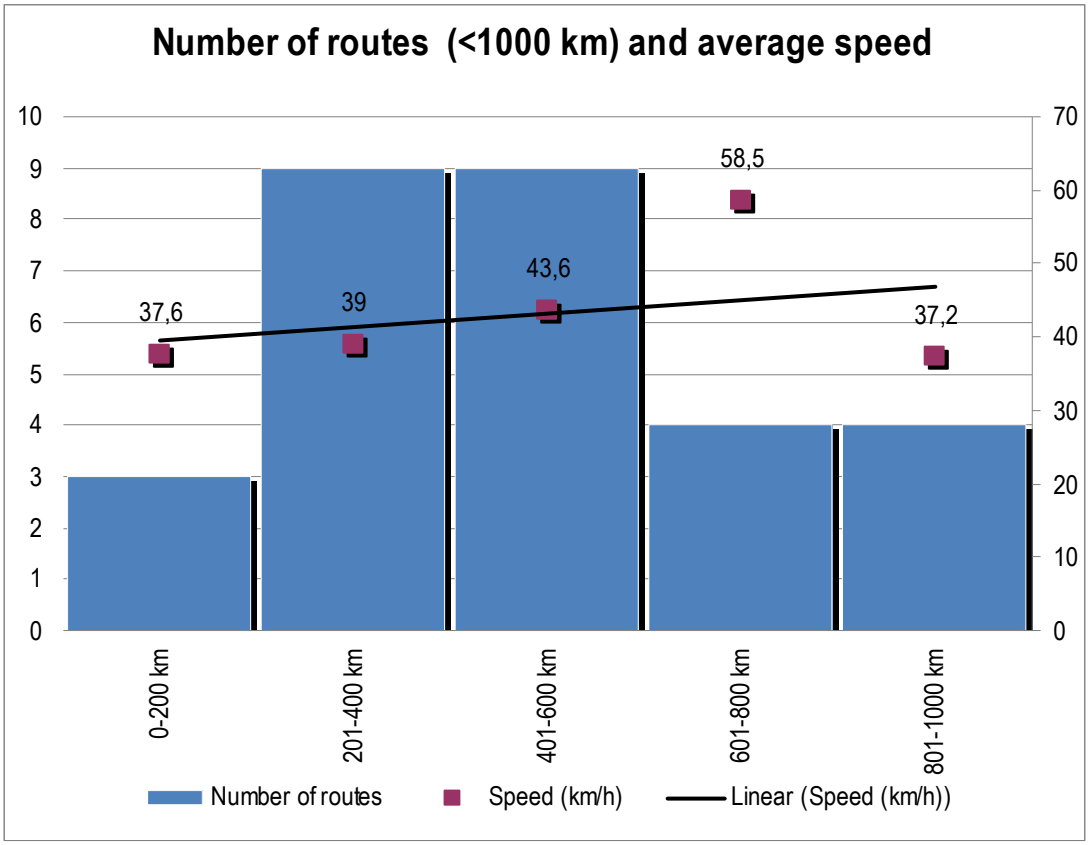
In countries with a low degree of economic development, trains are important means of transportation in outlying regions, mainly for labour mobility and long trips. Ticket price is the leading indicator for these routes. Functionality of railway traffic expands with economic development, whereby the role of ticket price, as choice factor, decreases. On these routes, however, the importance of speed and comfort increases.

Studies of current international services in the BSR show that long routes normally also connect the largest cities of the region, crossing a number of countries, and changing gauge. Route length increases substantially according to these three parameters. Correlation analysis shows that the amount of stations and country crossings decelerate speed. A substantial correlation (r=0,7, α=0,01) can be found between gauge and travel time - if gauges are wider, or of different width, travel time becomes longer. Fewer stations along the long routes (100 km routes) proved to have lower average speed and longer travel time.

[6] Route Malmo-Copenhagen is to some extent an exception, since train do not stop between the cities It is considered by measuring average speed, the distance is the shortest distance between the end stations of the route.

The optimal route length is 400-800 km, while the determinant factor is a gauge – either 1,435 mm or 2,520/1524 mm. A substantial correlation (r=0,6, α=0,01) appears in frequencies of train runs and amount of stations. Train runs are also more frequent if there are more stations per each 100 km. Another connection (r=-0,3, α=0,01) was found between train speed and frequency: more trains run on a particular route if the train speed is higher.

**Chart 4. Comparison of international passenger services in the BSR with regard t route length (below 1,000km) and average speed**



# 5. Important regional centres and international connectivity

## 5.1. Accessibility by train: international connections

The structure of international passenger rail connections in the Baltic Sea Region shows that there are at least four cities that serve as main hubs for passenger traffic: Berlin, St. Petersburg, Warszawa and Copenhagen[7]. These cities, called MEGAs, show a major number of trains departing to diverse destinations in the region. Berlin as the major hub has 113 weekly services to nine Baltic Sea Region destinations; St. Petersburg has 100 weekly services to 7 destinations; Warszawa has 112 weekly services to 5 destinations; and Copenhagen has 617 weekly services to 5 destinations. The following table shows number of routes, destinations and route frequency for the main hubs in detail.

**Table 18. Main hubs of international train connections in the Baltic Sea Region**

| MEGA | Number of routes | Route | Route frequency, trains per week |
|---|---|---|---|
| **Berlin** | 9 | Arhus | 7 |
| | | Copenhagen | 7 |
| | | Gdansk | 7 |
| | | Poznan | 35 |
| | | Szczecin | 6 |
| | | Warszawa | 34 |
| | | Kaliningrad | 7 |
| | | St. Petersburg | 7 |
| | | Moscow | 3 |
| **St. Petersburg** | 7 | Helsinki | 28 |
| | | Tallinn | 7 |
| | | Riga | 7 |
| | | Vilnius | 7 |
| | | Minsk | 37 |
| | | Warszawa | 7 |
| | | Berlin | 7 |
| **Warszawa** | 5 | St. Petersburg | 7 |
| | | Moscow | 14 |
| | | Minsk | 49 |
| | | Sestokai | 14 |
| | | Berlin | 28 |
| **Copenhagen** | 5 | Berlin | 7 |
| | | Stockholm | 21 |
| | | Goteborg | 80 |
| | | Hamburg | 89 |
| | | Malmo | 420 |

[7] International passenger rail connections with Moscow were included in the study, if they connect at least two cities in the Baltic Sea Region. Therefore, routes Helsinki-Moscow, Tallinn-Moscow, Riga-Moscow, Warszawa-Moscow and Berlin-Moscow have been included in the study.

## 5.2. Missing links

**City-regions on both sides of the border**

Copenhagen and its airport providing ample global connections, has a very busy connection to Malmo with more than 60 runs per day and average speed of 81 kmph. The connection, therefore, demonstrates a very successful integration of two neighbouring cities of different countries.

Similar situation could be with Berlin-Szczecin (only 127 km distance), and Helsinki / Vantaa / Espoo – Tallinn (approx. 80 km distance), but currently there is only marginal train service for the route between Berlin and Szczecin and no direct connection between Helsinki and Tallinn. Only 6 runs per week with the average speed of 60 kmph are operating between Berlin and Szczecin. In fact, no train connection between Helsinki and Tallinn exists due to separation by the Baltic sea, where there are only ferry and airline services available.. Helsinki – Tallinn route can be covered between 1:40 and 2:30 hours by fastest ferries, and 2:25 hours by airplane (including time for check-in and check-out). Therefore, the existing connections by alternative means of transport provide an average speed of approx. 30 kmph.

**Hence, we advise to develop international passenger train connections between Berlin and Szczecin and between Helsinki / Vantaa / Espoo and Tallinn in the long-term vision of the Baltic Sea Region.** Our recommended target speed is approx. 80kmph, which will considerably improve connectivity between the cities; therefore, proximity between Berlin and Szcecin would improve by 25% and between Helsinki and Vantaa by more than 50%.

**Linking MEGAs with 1,435mm gauge**

An analysis of current international railway services showed that the average speed of trains on routes where combined tracks (1,435 mm and 1,520/1,524 mm) are used is notably lower than the average speed for then whole region. This indicates that the time consuming change of gauge cannot be compensated with comparatively longer distances. Train speed is extremely low on routes where wheels need to be changed.

There are a number of MEGAs that are not connected to the 1,435mm gauge railway. This refers to Helsinki and Turku in Finland, Tallinn in Estonia, Riga in Latvia, Vilnius in Lithuania, Minsk in Belarus and St. Petersburg in NW Russia. Application of a simple modified Gravity Model showed that there is a potential for connections like these. Considering economic development trends, the potential of those lines will increase as the countries continue their development.

**Therefore, we advise to consider including the following 1,435mm railway lines for passenger services in the long-term vision of VASAB construction:**

**- Warszawa-Vilnius-Minsk;**

**- Helsinki-Tallinn-Riga-Vilnius-Minsk, with further connection to St. Petersburg from Helsinki or Tallinn;**

**- Riga-Kaliningrad;**

**- Vilnius-St. Petersburg.**

We see these lines as an addition to the RailBaltica line. If RailBaltica would be constructed as a 1,435mm gauge line, it would remain a single line, meaning additional operational costs for maintenance and other technical services due to two different systems. An additional construction of lines will improve the viability of RailBaltica and increase attractiveness of fast passenger rail services among the MEGAs in the BSR.

This would enhance integration of West and East in the BSR, and improve the accessibility to MEGAs by train in the region. Our suggested target for average speed is 100 … 150 km/h; this would require the construction of railway tracks with design speed of at least 160…200…250 km/h.

In particular, the Warszawa-Vilnius-Minsk line in the Warszawa-Kaunas section follows the RailBaltica route. Adding Vilnius and Minsk to RailBaltica will increase the viability of the RailBaltica line. Furthermore, connecting Vilnius and Minsk to the 1,435mm gauge railways would diminish bottlenecks in passenger services caused by exchange of wheels whenever the gauge type changes. This, again, would increase train speed in the BSR and connect the region to cities outside the BSR (Moscow, for example).

The Helsinki-Tallinn-Riga-Vilnius-Minsk line is part of RailBaltica (section Helsinki-Tallinn-Riga). The section Riga-Vilnius (via Panevezis, or if RailBaltica is constructed in section Riga-Kaunas as 1,435mm gauge – via Siauliai and Panevezis) would require the construction of totally new line. Furthermore, an extension of the line to St. Petersburg from Helsinki or Tallinn should be considered as well.

The Riga-Kaliningrad line is, in fact, a direct route to Berlin, which is the most important international passenger railway hub for the BSR. Theoretically there are two options: 1. via Liepaja-Klaipeda, thus improving regional connectivity among important regional centres in Lithuania and Latvia; 2. via Siauliai, using existing railway track, which is a double-track railway line (except approx. 70km). This track is today not used for either passenger or cargo transport.

Finally, Vilnius-St. Petersburg could be considered as a future 1,435mm gauge line, connecting St. Petersburg via Helsinki or Tallinn. Today this line is of minor importance for cargo: in fact, it is mainly used for infrequent and comparatively slow passenger traffic (international). This would require a long-term strategic approach and further detailed studies.

The model data shows that these railway lines have rather low potential if compared to existing railway lines in the region. The simple and modified gravity model which was here applied in order to compare the existing connections. However, if the speed factor was applied, it demonstrates the need to build a higher speed lines or even high speed lines in order to achieve enough potential for those new lines.

## 5.3. Improvements of existing connections

In general, existing international rail passenger services operate with speeds below 100 km/h. This means that trains s are not competitive to road travel , and show very low competitiveness to air travel, even on shorter routes.

Therefore, as a goal, we advise to improve connections for international passenger services by long-term increasing the speed of trains. This can be achieved by combining a number of measures:

- to improve the technical conditions of tracks;
- to increase design speed of trains;
- to plan new high speed routes (with optimal alignment), or routes allowing considerably higher speeds.

To become competitive with airline services on distances between 200 and 400 km, we suggest upgrading the average speed of trains to 100 km/h (the highest value in the region today. This would eliminate existing differences in travel time between trains and airplanes. Besides that, railway connections could become competitive. Competiveness could increase even more when considering that train stations are located in city centres, while airports require additional travel time from / to the city centre.

Passenger rail services could also compete with airline services on distances between 400 and 600 km if high-speed train connections would be introduced.

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