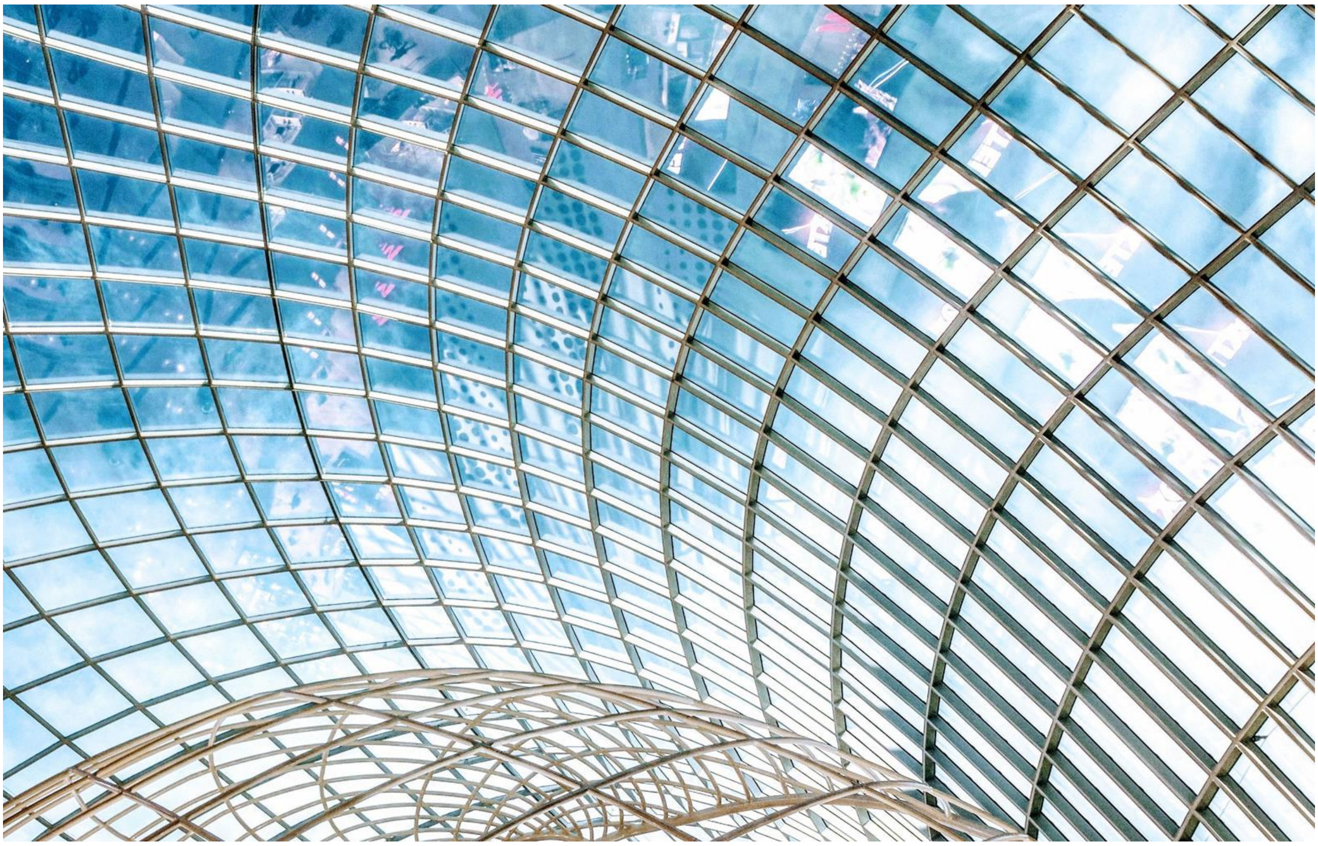

Final version 6.9.2021

Regional development processes of mega-projects

BSR Access, GoA 2.1

#BSRAccess

Publication of the Helsinki-Uusimaa Regional Council C 97-2021
ISBN 978-952-448-562-3
ISSN 2342-1363

Work Package 2, Enhancing corridor development
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Abbreviations

BSRP	Baltic Sea Region Programme
CEF	Connecting Europe Facility
CNC	Core Network Corridors
DG	Directorate-General
EU	European Union
TEN-T	Trans-European Transport Networks

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Background and objectives of the study

BSR Access provides a Project Platform for transport interoperability and regional development within a framework approved by the Interreg V B Baltic Sea Region Programme. This study, ”Regional development processes of mega-projects”, is a part of BSR Access focusing on describing and analysing the wider economic impacts of selected European cross-border transport mega-projects.

Objectives

Impact assessment of mega-projects has no standardized overall method or procedure. However, Cost-Benefit Analysis (CBA) on transport economic impacts has become a standardized process and achieved a strong role in the impact evaluation of large transport projects in EU and in other developed countries. Direct external impacts are included partly in CBA by using shadow prices. There is a broad consensus that investments in transport infrastructure may have wider economic and societal impacts outside the direct external ones. However, it is evident that wider effects can only exist if there are significant positive direct effects to households and firms using the transport infrastructure.

In the decision-making processes, political discussion on large transport projects usually uses justifications referring to project’s wider economic and societal impacts. Often the main content in project promotion is referring to long-term impacts on development of the national economy, structures of the economy, and regional political or geopolitical arguments. In practice, in the political decision-making different projects compete of acceptability and finance. There is an evident need for analytical methods and practical tools by which the comparisons could be made with widely accepted criteria. Analysis of wider impacts should be linked with CBA, direct impacts with the indirect long-term impacts.

Another dimension in impact assessment is time, at which point of the project’s life cycle each impact should be analysed to serve rational political decision making. In practice, political dialogue on a new project starts in raising the indirect long-term impacts and the most profound structural benefits into forefront. At the same time the transport authorities’ project development model starts in assessing direct transport economic benefits and investment costs.

In this study the idea is to collect information from selected mega-projects in cross-border transport development. What are the contents of the analysis and which methods are applied? How was the impact assessment carried out? At what stage is the project? This information should be put in the context of national transport political decision making. In this study the case projects are selected from mega class cross-border railway projects in the EU area. The criteria for the selection and a summary of the projects are included in section 3. However, there are challenges in the comparability of the projects due to significant differences in the objectives, technical solutions and stages of the projects.

The result, a discussion paper, will feed discussion by both planners of the transport systems and stakeholders of the EU-level and national transport policies. The discussion paper aims to support development towards more comprehensive and standardized practice of impact assessment in large transport projects in the EU.

Study design and steering

The study is based on literature reviews based on research on transport economics and planning, and reports and other documents provided by the case projects. In addition, contact persons of each case project were interviewed during the study process.

The interviews were focused on two main themes:

(1) The origins and initiatives of the transport project, the decision-making processes, political discussion and financial considerations of the projects
(2) Evaluations and studies concerning the economic and social impacts of the project, and the role of these in the decision-making.

The literature review is presented mainly in the section 1 in this report. A summary of each case-project is presented in section 2, based on documents available and on the additional information received from the interviewed specialists. Section 3 focuses on the comparative analysis of the case projects with respect to transport systems and accessibility changes, cost-benefit and wider impact analysis, financing modes, decision making and various political aspects. Finally, in section 4, main observations and results are summarized, conclusions on the research questions are presented and lessons to be learned provided.

The study was conducted by a team, consisting of

- Seppo Laakso, Dr.Soc.Sc. (Econ.), Managing Director of Kaupunkitutkimus TA Oy
- Taina Haapamäki, M.Sc. (Tech.), Managing Director of FLOU Oy
- Touko Väänänen, M.Sc. (Tech.), Data Scientist, FLOU Oy.

The study was managed by a steering group, with following members:

- Sakari Saarinen, Project Manager, Helsinki-Uusimaa Regional Council (Chairman)
- Ilona Mansikka, Manager, Regional Planning, Helsinki-Uusimaa Regional Council
- Petri Suominen, Traffic Planning Manager, Helsinki-Uusimaa Regional Council
- Olli Keinänen, Regional Development Expert, independent consultant
- Kari Ruohonen, Transport Expert, independent consultant.

The steering group and the study team are very grateful to the contact persons for the case-projects and the experts interviewed, as well as for the feedback received from the BSR Access partners. We very much appreciate the positive attitude and support we received from our partners and other experts.

1. Framework of the economic impact analysis of transport system and accessibility changes

The development of transport infrastructure and accessibility has had a dramatic impact on trade, economic growth, and social change at regional, national, and even global level. However, the impacts of the transport investments in the rich, developed countries with reasonably well functioning modern infrastructure, cannot be compared with the impacts of the new railways in the nineteenth century as the new projects' impacts on accessibility are mostly incremental, rather than huge improvements. As the transport system develops towards a complicated multimodal network of links and nodes, each improvement becomes more dependent on the overall performance of the system.

1.1. Role of transport systems and accessibility in long-run developments of national and regional economies

1.1.1. Basic forces of regional development

The basic results of regional economics show that, in terms of the production volume and income level, most regions benefit from specializing in those products in which they have relative advantage[1] with respect to other products or absolute advantage relative to other regions, and consequently, from trading with other regions (e.g., Armstrong & Taylor 2000). A precondition for trade between regions is that transporting goods between regions is possible with reasonable costs. In other words, the net benefit of trade after transporting costs must be positive. Consequently, trade of goods and production inputs as well as mobility of people requires a transport system between regions and within regions. Specialization is closely connected both with the possibility of transport and advanced production technology and utilizing of economies of scale, i.e., production in larger units.

The investigation of World Bank (2009) summarizes the driving forces of the development in regional economies by three dimensions: Density, Distance and Division. These dimensions provide a framework for the analysis of regional economic structures and regional developments. **Density** refers to the volume of economic output or number of population or jobs relative to land area. Density is an important dimension of regional development at local level. While larger scale can take place without high density in many industrials, concentration of jobs and population normally increases density in locations where activity is concentrated. When various economic activities are located close to each other, the exchange of goods and services and all kind of communication is easy and efficient. Concentration and high density make it possible to utilize the economics of scale at plant or firm level. In addition, there are so called localization and urbanization benefits connected with agglomeration.

When the number of firms in the same industrial sector increases in an urban area, the growth of the sector makes it possible to increase specialization in their input markets and to create and spread innovations as well as benefitting from large and diverse labour supply. These localization benefits decrease production costs. On the other hand, harder competition in agglomerations forces firms to increase efficiency and this causes benefits for consumers. Increase of the size and the diversity of the industrial structures and consumption possibilities generate urbanization benefits. Firms benefit from the presence of other firms of the same industry but also from the presence of firms from different industries in the same geographical area because this improves the diffusion of innovations between firms. This is important especially when product or

[1] Absolute advantage between regions A and B in producing a certain product refers to a situation where a region A is more productive than region B while relative advantage refers to situation where a certain region is more productive in producing good X relative to good Y.

process innovations require special inputs of knowledge. The large market areas of metropolises provide also the first place to test new products.

Distance is basically the transport distance between different places. From economic point of view the key concept is **accessibility**, which refers to the distance to those locations where economic activity is concentrated, i.e., both distance and the location and density of activities matter. Accessibility is the basic requirement for the transport of goods and mobility of services and labour between regions, and furthermore for trade and specialization. It is also needed for migration and commuting of people. Accessibility is based on geographical factors, but even more on the transport systems consisting of roads, railways, terminals, harbours, and other infrastructure, but also on data communication networks. For this reason, accessibility depends crucially on investments of the society on infrastructure and its maintenance.

Accessibility has an important role in the location choices of firms. The density of cities decreases distances between firms and makes it easier for them to trade and communicate.

Divisions refer to **borders** separating countries and regions from each other, limiting, or even preventing the movements of people, goods, services, factors of production and innovations. The borders between countries with customs operations, payments and bureaucracy decrease trade and other communication between countries. Passports, visas, permissions, and other limitations for travel decrease international mobility of people. Borders hinder countries from international division of labour and specialization and limit smoothing out of development differences. There are also borders within countries limiting communication in various forms and slowing developments. They may be based on language, religion, or cultural divisions. There are borders and divisions also within urban areas. Some areas may be separated from the other city because of lacking transport connections, and this can manifest itself as economic, social, or political isolation.

1.1.2. EU and regional development

The major priority of EU has been to integrate European countries and regions by enabling free mobility for goods, services, people, and capital. This was a central long run goal already in the Rome treaty in 1957 when European Economic Community, then including the six founding members (Belgium, France, Germany, Italy, Luxembourg and the Netherlands), was founded. Since then, EU has both enhanced to several new counties, and successfully lowered borders between EU countries by cancelling barriers of trade and mobility, as well as movement of capital and services. Signing of the Maastricht treaty in 1992 – establishing the European Union – was a crucial step towards a single market of Europe.

Another important priority of EU – connected to free trade and mobility – is to create an integrated and globally competitive transport network that will cover the strategically most significant parts of the European transport infrastructure. Important milestones in the development of EU's transport strategy are the following documents by the Commission:

- The future development of the common transport policy. A global approach to the construction of a Community framework for sustainable mobility (European Commission 1993).
- WHITE PAPER. European transport policy for 2010: time to decide. (European Commission 2001).
- WHITE PAPER. Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system (European Commission 2011).

The White Paper published in 2011 expresses the basic objectives as follows:

Transport is fundamental to our economy and society. Mobility is vital for the internal market and for the quality of life of citizens as they enjoy their freedom to travel. Transport enables economic growth and job creation: it must be sustainable in the light of the new challenges we face. Transport is global, so effective action requires strong international cooperation. The future prosperity of our continent will depend on the ability of all of its regions to remain fully and competitively integrated in the world economy. Efficient transport is vital in making this happen.

A key factor for the competitiveness of Europe is the accessibility based on the Trans-European Transport Network (TEN-T). The new network removes transport bottlenecks, renew infrastructure, and make cross-border traffic smooth, and decrease carbon dioxide emissions from traffic. (European Commission 2020a).

While integration improves competitiveness and economic performance it tends to promote urbanization and concentration of production and population, and at the same time, increase socio-economic differences between regions. For this reason, EU invests locally through its regional policy. Addressed to all EU regions and cities, it contains measures to boost economic growth and jobs and improve quality of life through strategic investments. (European Commission 2020b).

1.1.3. Transport development and regional economic growth, railways as an example

Development of transport technology and investments in transport infrastructure have had a crucial impact on economic developments all over the world. In Europe, the period from 1830s to 1910s was marked by extensive investments in railway network and rapid technological development of both train design and construction and infrastructure construction. Railway development was related to rapid changes in economic and regional structures and economic growth. According to O'Brien (1983) railways widened markets which promoted economies of scale, encouraged the relocation of economic activity, stimulated competition and increased trade and specialization. The speed and capacity of railways made it possible to multiply the volume of transport of both goods and passengers and to increase fast the market share of railways at the cost of inland waterway and road transport. Consequently, transport (as a whole) became a significant industry next to agriculture, manufacturing, and trade. Railway development had also a major impact in investment volumes, labour markets, and financial markets. Railways changed regional structures and gave a strong stimulus to urbanisation and the growth of big cities. Commuter trains made it possible for cities to grow geographically and brought about networks of suburban conurbation around cities.

Finland is a good example of the dramatic economic, regional, and social impact of railway investments while similar processes with some variation took place overall in Europe. The first railway from Helsinki to Hämeenlinna (108 km) was opened in 1862 and the railway from Riihimäki (between Helsinki and Hämeenlinna) to St. Petersburg (371 km) in 1870.The main railway network, covering most parts of the country, was built by the year 1900. According to Zetterberg (2012) railways boosted economic development and had a major impact in the change of regional and economic structures in Finland, like in most countries in Europe. Railways strengthened the position of towns and manufacturing factories located at the railways while regressing the development of regions and towns remaining outside the network. They enhanced the catchment areas of timber, minerals, and other raw material sources. They gave a strong stimulus to manufacturing of metals, machinery, paper, and other wood products. They expanded the export of manufactured goods via major ports to Central and Western Europe. Railways made it also possible to transport both agricultural and manufactured products to St. Petersburg and to the rest of Russia. Finally, they made it possible for ordinary people to make journeys to other regions with low costs. Consequently, personal mobility expanded within a short time causing major social impacts to the whole society.

The planning and construction of railways were a major economic issue due to the high costs of the investments. They were also hot political issues. In Finland there were several divisions concerning the railway investments: canal party vs. railway party (before the decision of the first railways); regional parties fighting about the routes and priority of new railways; long distance trains vs. local trains; private vs. public development and ownership; alternative financing models (the solution in Finland was to collect money to the railway investment fund by taxing spirit sales which was the monopoly of the state) etc.

After the second world war the development of transport was dominated by the expansion of cars and investments to highways and other road construction. The market share of road transport increased fast both in personal transport and goods transport, mainly at the cost of railways. The new development brought about an impact to the regional structure by supporting the development of communities and industries outside the railway network and boosting the suburbanization processes of big cities.

The new increase of railways took place by developing local rail transport in major urban regions since 1970s and rapid long-distance railways since 1980s.

1.1.4. Transport system and accessibility in developed countries today

The starting point for an economic impact of a transport investment is that, in addition to the technical infrastructure, there must be well functioning transport services. The capacity of the infrastructure and respective services need to meet the demand of the users of the transport system. In addition, the connections to other parts of the transport system must run smoothly.

Bannister & Berechman (2000) point out that in developed countries where the quality of the transport infrastructure is basically already at a good level further investment in infrastructure will not on its own result in economic growth. Instead, transport infrastructure investments act as a complement to other underlying conditions which must also be met if further economic development is to take place.

They emphasize the strong dependence of impacts on the structure and size of the regional economy, policy decision-making, and, in the case of new projects, transport conditions. New transport projects usually do not bring about dramatic changes in mobility and transport opportunities, but typically local improvements, which usually also have an impact on the wider transport network. Transport projects do not automatically lead to significant economic impact. The precondition for the effects is that the regional economies can take advantage of the accessibility benefits created through the transport project. In addition, the planning system and policymaking must allow for changes that create the conditions for the effects to materialize.

Bannister & Berechman define three prerequisites for the realization of the economic impact of transport investments:

1. The region shall have adequate economic conditions to benefit from improved accessibility. This requires that there be well-functioning labour market and dynamics in the regional economy so that the region can take advantage from the benefits of better transport system. Large urban areas and the diversity of the industry structure enable the creation and spread of accumulation benefits. A key precondition is that the efficiency of mobility and logistics are important factors for business productivity and the functioning of the labour market.

2. The project must have investment conditions that include e.g., availability of funding, optimal sizing, appropriate timing, and network implications. For example, there is a risk that when a transport project is postponed to its intended area of impact, new land use will be implemented with low efficiency or in another way that undermines the potential of the improved transport link over time.

3. Political and institutional conditions are very important for economic impact. Decisions and measures are needed to support the project. These include e.g. zoning that supports land use development, incentives for the realization of land use changes, and investments that utilize and support accessibility benefits, for example in services.

The conclusion from the above is that the transport project alone, without other conditions, may have only a minor impact on land use and the regional economy. If the region's economic structure is such that companies and the labour market are virtually incapable of reaping the benefits of improved accessibility, the economic impact will be weak, even when positive traffic effects can materialize. If labour-based immigration or mobility between regions is frictional or restricted it limits the region’s capacity to adapt to changed economic environment. If zoning does not allow for more efficient land use and land use change, but “freezes” previous land use, the effects on land use and the regional economy will be limited. If the structural changes of the economy are slowed down the potential of the new opportunities provided by the improved accessibility remain underutilized. It can also be reversed: transport investment does not automatically revitalize a region that is lagging or otherwise declining.

Börjesson (2019) points out that the economic impacts and especially the wider impacts of transport investments in rich developed countries cannot be compared with the effects of railway investments in 19th and early 20th century in Europe or USA. Nowadays there are several transport options at least between major cities (road, rail, air, water). An investment in one transport mode may cause significant user benefits when travellers or goods transporters shift to the improved mode from other modes. There may also be significant regional changes in firm locations, labour markets, population, housing, and property markets. Börjesson points out that they are to a large extent based on shifts of economic activity between regions, not necessary net increase at national level. Based on recent research (e.g., Combes & Gobillon 2015) Börjesson claims that the impacts of accessibility improvements due to transport investments on the productivity of firms and increase in GDP are usually not as significant as generally expected. However, they may still exist and in some cases they may be significant.

It can be concluded that a new or improved transport connection can work bi-directionally: it can take vitality and economic activity from some regions while increasing attractiveness and enhance market areas in other regions. It depends on the policy and measures mentioned above whether large cities grow at the cost of smaller towns with respect to labour and investments, or do smaller towns find their new role as a part of a larger economic region. Improved accessibility can generate positive economic externalities and create new activities, or it can divide existing activities to new locations.

1.2. Cost-benefit analysis of transport investments

Cost-benefit analysis is a widely used tool for evaluating projects, especially in the field of transportation. The theory for cost-benefit analysis is introduced shortly and the treatment is based on (Layard & Glaister, 1994), (Drèze & , 1987) and (Boadway, 2006). Theoretical basis for cost-benefit analysis comes from welfare economics, which examines how to decide on reallocations or projects that affect multiple people with possibly differing preferences. A guiding principle for such decisions is called the Pareto principle, which states that if the welfare of one individual increases, and the welfare of all others does not decrease, the social welfare increases. In practice, projects that achieve Pareto improvements are hard to find. Therefore, the concept of Kaldor-Hicks improvement has been formulated which states that a project is a Kaldor-Hicks improvement if the people that lose due to the project could be compensated by the winners of said project to form a Pareto improvement through reallocating the resources generated by the project. Basically, it states that a project is an improvement if its benefits exceed its costs. This principle forms the basis for cost-benefit analysis.

The basic concept of cost-benefit analysis is then to evaluate a project by its consequences, weighing the benefits that incur from completing the project against the costs in doing so. Therefore, the basic cost-benefit test is to proceed with the project if the project benefits are larger than the costs, which translates to the cost-benefit ratio being above one. To find out the costs and benefits of a project, the analyst must be able to compare the state of the world with the project and without the project. This is usually done with a model. In addition, the analyst must be able to compare different effects to each other to determine the total amount of benefits that accrue from the project. The usual way is to convert the benefits into monetary terms with shadow prices. The analysis is normally carried out for several decades, including the investment phase and a significant period of the operation phase. The method makes it possible to repeat the analysis at any stage of the project, for example to control the effect of the changes in the plans or in the operation environment.

To capture the social welfare, change of a project, the shadow price for goods must capture the complete social benefit of making one additional unit of the good available. In competitive economies the price of a traded good is equal to its shadow price. However, in the real-world markets are rarely fully competitive and not all goods that are created through projects are traded market goods. Travel time is a relevant example of such a good. In addition, market prices do not take external effects of the created goods into account.

Econometric methods have been created to estimate shadow prices for these goods. Countries that employ cost-benefit analysis for transportation projects have their own guidance on unit values of time and externalities to be used in the analysis.

In practice, when evaluating a transportation project, the analyst must compare a scenario with-the-project with a counterfactual baseline scenario without-the-project (European Commission, 2014). Comparing these two scenarios, it is possible to evaluate the effects that the project has. Typical effects that are appraised in transportation cost-benefit analysis are:

- Travel time savings
- Travel cost savings
- Effects on maintenance costs
- Effects on ticket sales
- Effects on producer costs of public transportation
- Direct effects on tax income
- Effects on traffic safety
- Effects on greenhouse gases
- Effects on local pollution
- Effects on noise pollution

These effects are mentioned for example in the EU guidance for transportation project evaluation (European Commission, 2014). The impacts are assessed for future years, translated to monetary terms with shadow prices, discounted to the year of analysis and summed to gain an estimate of the present value of the project's impacts.

An important factor influencing the sum of benefits from the project is the social discount rate used to calculate the present value of the project. The social discount rate should reflect the social view of how future benefits and costs are to be valued against present ones. A discount rate of zero would give equal weights to the benefits and costs occurring at any moment, so that it does not matter whether a benefit is gained today or in a year. A positive discount rate, on the other hand, indicates a preference for current over future consumption, whereas the opposite is true if the discount rate is negative. In a perfectly competitive economy and under equilibrium, the social discount rate is the same as the financial discount rate, which would correspond to the financial market interest rate. However, this does not apply in the practice, since capital markets are in fact distorted. (European Commission, 2014).

Many decisions and assumptions must be made to gain an estimate of the cost-benefit ratio for a project. Unit prices must be estimated with willingness-to-pay studies, effects on local pollution and greenhouse gasses depend on the assumptions of the pollution levels of current and future pollution levels of transportation technology, travel time savings and ticket revenue depend on the traffic forecast and modal choice model that are applied in the cost-benefit analysis. Transportation theory and econometric estimation methods guide many of these decisions, but some decisions have less established methods with which to choose the best alternative. The appraisal period and rate of discounting being some of those decisions, which differ between the guidelines of countries. In addition, even if countries employ guidelines for the counterfactual, unit values and discount rates, ultimately some major decisions are left for the modeler in constructing the counterfactual that the project is being appraised against.

Because of different choices that can be made regarding the cost-benefit calculation, it best serves in comparing different projects that are appraised with the same methods in the same cost-benefit framework. This ensures that the deficiencies in the calculations are the same and probably of the same order of magnitude. The appraisal methodology is most advanced for road construction projects, which has been the focus of transportation modelling for the longest period.

1.3. Wider economic impacts analysis

Wider economic impacts arise because the benefit of an investment or a policy change in the transport system to society may differ from the benefit perceived by an individual transport user. The sum of user benefits therefore does not necessarily represent the total gain to society.

Direct impacts of a change in the transport system and accessibility are realized as cost changes to consumers (households' travel time and monetary costs, firms' logistics and business travel costs, cost changes to producers (transport operators' revenue and cost) and impacts on safety (traffic accidents etc.) and environment (CO2-emissions, local emissions etc.). They are evaluated in the Cost-Benefit analysis summarized above.

In addition to the direct impacts, accessibility improvements due to an investment can affect the productivity of businesses directly or materialise through the labour market, the product market or the land and property market. Lower transport costs may lead to lower production costs and better productivity. Productivity can increase along with the growth of the size or density of a city or improved transport links between urban centres or other production locations. Enhanced accessibility may lead to larger labour market areas and affect employment rates and the incomes of the working-age population. Consequently, they can influence the tax revenue of the state, regions, and municipalities.

Transport investments improve the accessibility of areas and promote land development. These changes are closely related with direct user and producer benefits, but they can also generate wider impacts. The positive impacts in one region can materialize to some extent at the cost of other regions, for example there may be more mobility of inhabitants, firms, and jobs to the region with positive accessibility change from other regions.

The mechanisms through which transport investments can create wider impacts and their relationship with user benefits from the perspective of passenger transport are illustrated in the figure below. If improved accessibility due to investments in infrastructure decrease journey times and decrease costs of logistics (positive consumer surplus) it may trigger mechanisms leading to concentration of firms and population, better functioning labour markets and impacts on land use and real estate markets. On the other hand, increase of production, jobs and population within the transport zone influences the demand for movement and may raise the number of journeys and volume of cargo. Hence, there may be effects towards direct impacts from wider impacts, as well. This should be considered when direct impacts are evaluated and calculated.

It must be noted that only the factors creating additional value to the national economy in addition to direct impact should be included in the wider economic impacts. Many of the components of direct and wider impacts are connected and consequently, there is a risk to double-counting of benefits. For example, there is evidence that improved accessibility will raise market value of potential building land. However, value increase is in fact based on the capitalization of consumers' net benefit of accessibility improvement to land. For this reason, land value increase cannot be interpreted as a wider economic benefit.

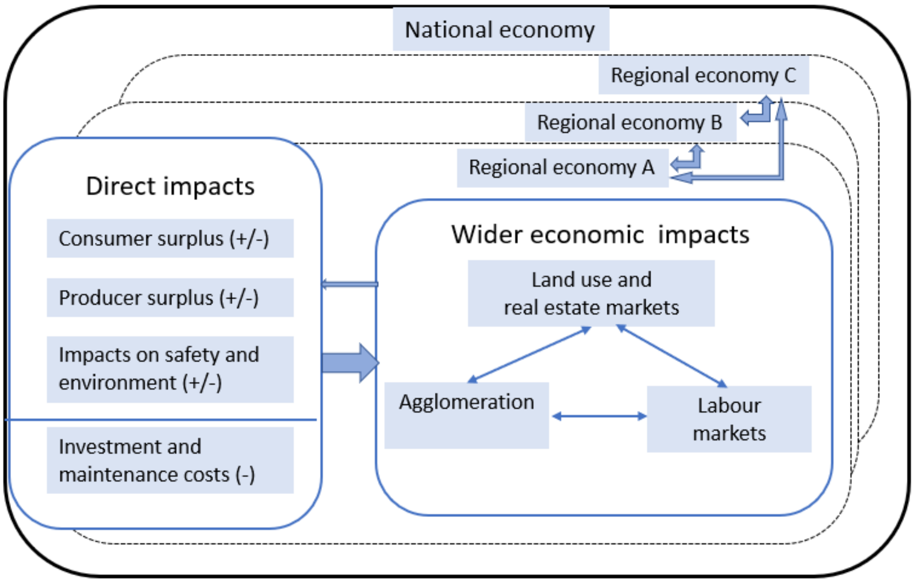


Figure 1. Mechanisms through which transport investments can create direct and wider impacts. (based on: Finnish Ministry of Transport and Communication 2020; Venables 2016)

According to several sources (eg. Andersson et. al 2015; Venables 2016; Laakso et.al 2016) wider impacts are generated by the following influence mechanisms.

Productivity impacts: Improved accessibility and the decrease of transport costs may lead to firms to relocate closer to their intermediate suppliers to enjoy lower upstream (buying) and downstream (supplying) costs. The outcome of this process is intensified regional industrial clustering i.e., agglomeration. This may also facilitate specialisation of economic activities enabling increased efficiency from economies of scale. Further, the improved accessibility increases interaction between economic actors and better transfer of knowledge, which can have positive effect on productivity. The increased agglomeration – as well as the induced impacts – may also have effects on the prices in the region involved.

Changes in the location of businesses resulting from changes in accessibility can lead to the development of larger and more compact business clusters. Agglomeration benefits are created as communication and interaction between businesses and their employees increases thanks to proximity. Improved transport can also act as a stimulus for industrial investments in well accessible locations outside large cities where agglomeration benefits are based on good logistic connections instead of the local density. Studies show that agglomeration benefits have a positive impact on the productivity of businesses, although the impacts vary widely between sectors. **Agglomeration benefits can be interpreted as externalities of transport investments, which create wider impacts, but are not included in transport user benefits.**

Labour market impacts: The improved accessibility can affect labour markets because the higher commuting speed increases the labour accessibility from current locations and attracts more jobs to locate in the region (to benefit from the agglomeration). As travel time and therefore travel costs decrease, the labour force achievable to businesses increases and, on the other hand, the area of potential jobs accessible to the labour force grows larger. The change in achievable jobs leads to an expansion of the labour market. This leads to an increase in labour supply and output, as the travel time saved can be used more on production. The expansion of the labour market and shorter commutes also lead to a better alignment between labour demand and supply as well as workers' competence and employers' needs in that respect, which increases productivity.

Land use impacts: Transport investments affect the value of land and therefore also the housing and commercial property market. As accessibility improves, house prices can be expected to rise especially in those locations whose proximity to job and service hubs increases from a transport perspective because of the investment. Improvements in accessibility add value to land in all locations but especially in areas that become within a threshold of reasonable travel time distance, typically less than one hour in commuting and two hours in business travel.

Changes in prices affect the volume of property development and the supply of housing and business premises. However, these changes are linked with the user benefits to households and firms and therefore the effects in property market cannot directly be considered as additional benefits.

Many of the development impacts of an infrastructure investment are in fact capitalised direct impacts. **Therefore, it is a widely applied rule that the wider economic impacts of an investment project are not to be added to the direct (transport economic) benefits. The estimates of the wider economic impacts will, however, be of great interest in the decision-making process.**

There is no generally accepted methodology or procedure for evaluating wider economic impacts, unlike in the case of cost-benefit analysis. Project evaluation guidelines for different countries assess the effects on productivity, production, and employment due to improved accessibility. There are differences in the guidelines in different countries as to whether the wider economic effects are included in cost-benefit statement or whether they are presented separately. The impact of transport investment on land use is understood in most countries as an indirect impact that can in no case be attributed solely to a transport project.

In the case of publicly financed projects the effects of construction generated by the transport investments on economy have been comprehensively excluded from the assessments although construction has major impacts on aggregate demand, employment, and tax income especially at regional level. The reasoning is that the impact of public investment on the flow of income channelled elsewhere in the economy is offset by the cost to the society. The costs are financed in the long run by taxes, regardless of the form of financing. The net socio-economic impact of public expenditure and private sector direct income is zero because private sector revenue is equal to public cost.

However, the impacts of major transport investments and accessibility changes on output, labour markets, migration and population and land use, as well as the effects of construction are interesting from regional viewpoint, even if some of those impacts cannot be regarded as societal benefits. For that reason, it is advised in many countries to analyse all important impacts but keep the results separate from the standard cost-benefit analysis.

1.4. Indirect long-term dynamic impacts

An alternative approach to the possible additional economic effects outside the direct impacts above is based on the analysis of long-term dynamic effects of the transport investment. The economic impacts of transport investments are commonly divided into short- and long-run economic development effects. The effects in the short-run or in the long-run are associated with investment multiplier effects and regional economic growth effects, respectively (Berechman 2009):

- Short-term multiplier effects: The value of economic activity following the money spent on construction and purchases during the investment period. The multiplier effects of large investments are generally quite high in terms of changes of personal income, jobs and gross regional product. Thus, these impacts are of interest especially among local decision-making.

- Long-term effects on regional economic development: The structural changes in the economic development following the primary transport effects materialize in a long period of time. Significant developments can take pace in land use, demography, economic structures, and other transport system during the following decades. Some of the changes may be related to the transport system changes but there are many other processes going on, as well. It is challenging or even impossible to separate the impact of a transport investment from all other factors. As pointed out above in section 2.1 transport projects do not automatically lead to significant economic impact but the effects depend on the regional economic structures, planning systems and policymaking (Bannister & Berechman, 2000).

- Economic development impact types can generally be categorized as follows: Impacts relating to overall regional economy; economic output, gross regional product, value added, personal income, employment.

- Impacts relating to specific economic development such as productivity, capital investment, property appreciation and fiscal impacts including both public revenues and expenditure.

The most interesting impacts, however, are the indirect, induced and dynamic development impacts:

- Direct mechanism: The most significant impact is the reduction of transport costs. Businesses of the region are offered improved accessibility to markets and resources (labour, materials and equipment) and, the benefits of reduced costs of transport and thus enhanced productivity. Direct impacts of construction on wealth and job creation.

- Indirect mechanism: "Secondary" entities such as local businesses supplying inputs to directly affected businesses.

- Induced mechanism: Increased income leads to increased spending and thus to increased demand.

- Dynamic mechanism: Long-term changes in economic development; business location patterns, work force, labour costs, competition, prices, land use changes, that in turn affect the wealth in the region.

It must be noted that the realization of indirect, induced, or dynamic impacts requires that there be significant direct impacts, like increase of production or jobs, connected with the infrastructure investment or operation of the transport system. The positive consumer-surplus based on time-savings of journeys cannot be considered the type of direct impact which creates major additional value elsewhere to the economy. However, time-savings may have impacts on the welfare of consumers.

The most common application of the indirect impacts on regional economies is based on the calculation of total impacts of the investments consisting of the infrastructure construction and additional construction of housing and business buildings generated by the new or improved transport connection, typically the development of railway station neighbourhoods. Construction generates significant multiplicative effects via supply chains consisting of construction material producers, machinery, logistics, and various services, in addition to the actual construction in the investment locations.

As explained in the end of the previous sub-section the impacts of construction are usually not included in the wider economic impacts which would generate value added at national level. However, from a regional point of view the impacts of construction are interesting because it increases economic activity locally.

2. Overview of selected mega-projects and their economic impact analysis

This study is based on comparative analysis of selected mega-projects. The case projects were selected by the following criteria:

- Cross-border railway connection between at least two countries (EU's priority)
- Location in or a strong connection with the Baltic Sea region (focus of BSR Access project)
- Mega-project (estimated investments costs more than 5 billion € in 2019 price level)
- In planning or construction phase, or completed in the 2000's.

Selected projects:

1. **Öresund Fixed Link** connecting Copenhagen (Denmark) with Malmö (Sweden)
2. **Oslo-Stockholm 2:55** project connecting Stockholm (Sweden) with Oslo (Norway)
3. **Fehmarnbelt tunnel** connecting Lolland Island (Denmark) with Fehmarn Island (Germany)
4. **Brenner Base Tunnel** connecting Innsbruck (Austria) with Fortezza (Italia)
5. **Rail Baltica** from Tallinn (Estonia) to Warsaw (Poland) over Latvia and Lithuania
6. **Helsinki–Tallinn Railway tunnel** connecting Helsinki (Finland) with Tallinn (Estonia) and Rail Baltica (One connection, two separate planning processes).

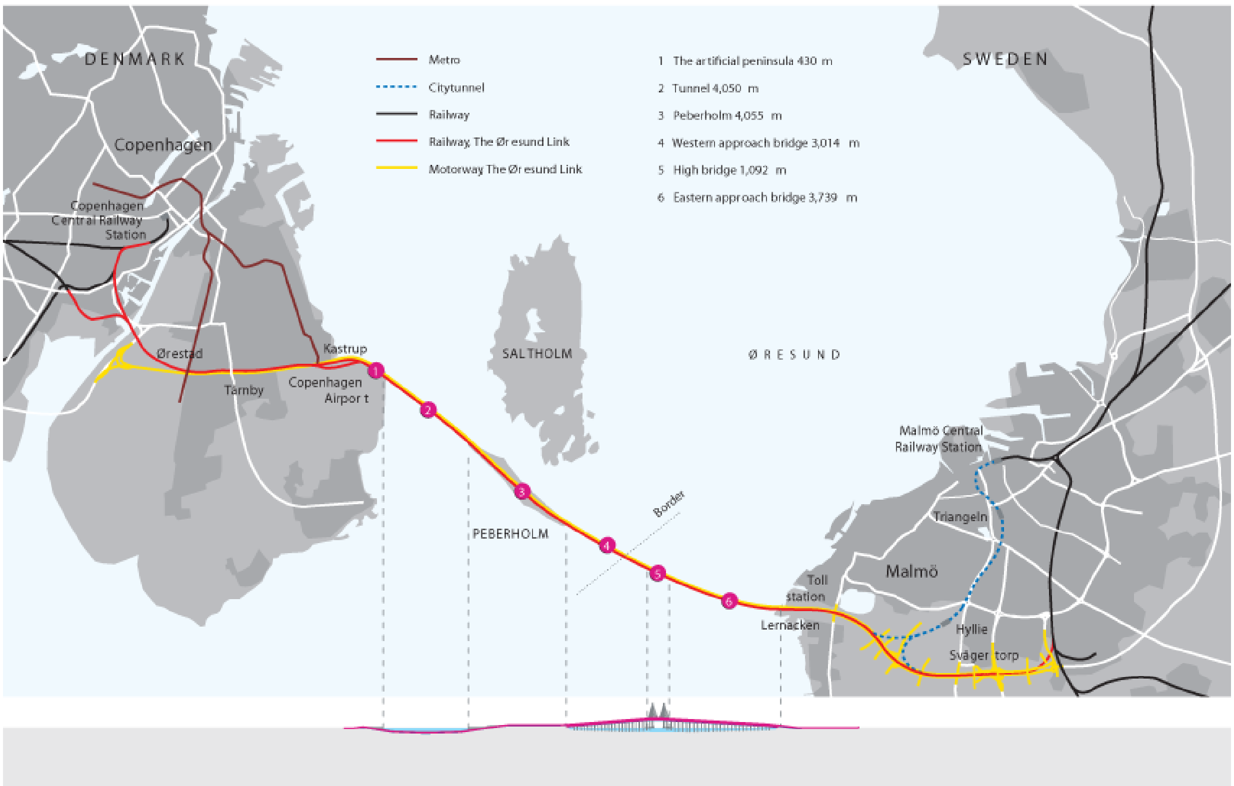
The following summaries of each case project are based mainly on the documents and other material provided by the project organisations or operators. In addition, the information from interviews with project contact specialists have been used to complement the document data.

Direct quotations from projects' brochures and other documents are written in italics.

2.1. Öresund Fixed Link

Overview

Öresund Fixed Link is a combined railway and road bridge across Öresund, connecting the Swedish city of Malmö to the Danish capital of Copenhagen (Figure 2). The construction of the bridge started in 1993 and the bridge opened for traffic in the year 2000 (The Öresund Bridge, 2020). The bridge is nearly 8 kilometres long, starting from the Swedish coast and reaching an artificial island Peberholm, from where the link continues as a tunnel until the Danish Island Amager. The link is jointly owned by Swedish and Danish states through state companies that are responsible for the management of the bridge. The bridge is financed through user fees. The project cost around 4 billion euros in 2000 prices (OECD, 2003). During its first full year of operation, almost 3 million cars passed the bridge and in 2019, the figure had risen to almost 7.5 million cars.



Beyond Plan B, author: T. Maier

Figure 2. The Öresund bridge goes from Malmö to Peberholm, where it becomes a tunnel until arriving to Denmark (Beyond Plan B, 2020).

History

The description of the planning history comes mostly from Boge (2006). The first formal suggestion about a bridge over Öresund was a part of a larger plan to build a highway network to Denmark, shown in Figure 3, that was unveiled in 1936. The plan was proposed by a consortium of private Danish and Swedish construction companies and would be later known as motorway H. The first proposal for the bridge was to build it as a combined highway and single-track railroad bridge. The motorway plan came under heavy critique, clashing with the status quo actors of the Danish transportation policy, who advocated for a less centralised transportation planning done by the municipalities. The plan for the motorway was subsequently revised in 1937, in which the highway network over Denmark was reduced and the plan for Öresund bridge was diminished to a highway bridge only. Already then, the bridge was proposed to be a private company that would finance itself through state guaranteed loans and user paid turnpikes.

During the second world war, plans of the bridge were not furthered. After the war however, the original companies that proposed the bridge revised their plans in 1952. They proposed two alternatives, a northern option between Helsingör and Helsingborg or a southern option between Saltholm and Malmö. Both alternatives were studied as a combined highway and railroad connections, with four-lane motorways and dual-track railways. The Swedish Riksdag discussed the proposal and the Nordic Council of Ministers suggested in 1953 that it should be studied further. Danish and Swedish administrations founded respective commissions to study the proposal in 1954. In 1961 the Traffic Economic Commission of Denmark suggested investing in the Öresund bridge. The Öresund link's work groups suggested in 1962, that a combined highway and railroad would be built between Helsingör and Helsingborg. In 1967 however, a new report studying different options suggested that only a four-lane highway between Copenhagen and Malmö would be profitable. However, this connection was feared to increase Copenhagen’s congestion problems, which had been accumulating during the second half of 1960’s. Nevertheless, in the late 1960’s a Danish 15-year transportation infrastructure plan was approved, which included the construction of the Öresund bridge.

In the 1970, an environmentalist movement rose its head in the Danish politics. Due to this change, investment in the Danish highways were greatly reduced. Meanwhile, the first oil price shock reduced the resources of the Danish government and contributed to downwards revised traffic forecasts for the upcoming years. In 1973, the construction of Öresund bridge was approved by the Swedish Riksdagen, but as a result from the trends and possible plans to build an airport to Saltholm, the Danish parliament did not approve of the construction. The two parliaments decided to instead set up a joint commission to re-evaluate the project (Sweden's government, 1991). In 1978, the construction was postponed again even though the project was deemed economically profitable by a joint Danish-Swedish committee just shortly after the decision. The preferred plan then was to build a four-lane motorway bridge from Copenhagen to Malmö and a single-track railway from Helsingör to Helsingborg. At the time, the construction of the Great Belt bridge, that would connect Denmark to the rest of the Europe, was prioritised over the construction of Öresund bridge. The Great Belt bridge was seen as a prerequisite for the Öresund bridge by the Danish government (Sweden's government, 1991).

Figure 3. A revised version of motorway H, which the Öresund bridge is a part of. The revised plan was proposed in 1937 (Boge, 2006).

In 1980 the plan to build an airport to Saltholm were given up on and in the mid-1980's Denmark's tight financial policies eased. Sweden's and Denmark's ministers appointed the *Öresund Commission* in 1984, reviving the planning of the bridge. Later during the year, a working group under an organisation of industrial lobbyists, *European roundtable of industrialists*, published a report *Missing Links*, which proposed to construct a sub-sea railroad tunnel between England and France and a ferry-free connection between Norway, Sweden, Denmark, and Europe. The plan included a connection over Öresund. The Öresund Commission proposed in 1985, that a four-lane highway would be built between Copenhagen and Malmö and a double-track railway between Helsingör and Helsingborg. Two years later, a report from the same commission recommended the construction of a combined highway and railroad bridge due to new technological solutions and operational considerations. This report triggered the Danish Social Democratic Party's environmentalists to jeopardize the construction of the bridge. Also, Swedish Social Democratic Party's environmental movement struggled with the question of constructing the bridge. In 1990, the Danes' approval of the bridge was dependent on the approval of the bridge by the Swedish Social Democratic Party, which approved of the bridge in April 1990.

In 1991, the Öresund Commission finally released a report on what would become the approved solution: A tunnel from Kastrup airport to an artificial island near Saltholm, followed by a bridge across Flintrænden to Limhamn south of Malmö. In March of 1991, the Danish and Swedish officials agreed upon a connection between Copenhagen and Malmö instead of Helsingör and Helsingborg. The Swedish and Danish parliaments approved the connection in June and August of 1991. In the agreement, the building of the bridge was tied into the plan in *Missing links*, as Denmark's government was mandated to plan a fixed link across Fehmarnbelt (Retsinformation, 2020). The construction of the Öresund bridge began in September 1993 and was finished in July 2000.

The financing for the project was kept separate from the state's budget, and it was financed with state guaranteed loans which are being amortised by user turnpikes. Compared to another large project of the time, the Great Belt Connection, Öresund bridge was not a result of a pork barrel deals, as it was mostly seen as a logical extension of the Great Belt Connection (Boge, 2006).

Objectives and benefits

Öresund fixed link has been named as one of the success stories of the EU's North Sea-Baltic Corridor: *The Øresund Bridge is a combined two track rail and four lane road bridge and tunnel across the Øresund Strait between Sweden and Denmark. It is the longest combined road and rail bridge in Europe. Works started in 1995 and the link was opened to traffic on 1 July 2000, with a project cost of EUR 2.7 billion.* (EU Trans-European Transport Network (TEN-T).

The Öresund bridge was seen to have several objectives and benefits during its decision-making process (Danish and Swedish Öresund Delegation, 1987). The objectives can be divided into three categories: regional, transportational and environmental objectives. Regional objectives were to create a more uniform Öresund region by offering good and reliable transportation connections over the Sound. This was seen to strengthen the Nordic cohesion and help in creating a common labour and housing market as well as improving cultural cohesion.

The transport objective was to create connections to mainland Europe that are reliable and carry enough capacity. In addition, the objective was to strengthen connections to Copenhagen airport with both public and private transport. Swedish transport policy goal was also to improve train connections and improve the transport infrastructure between Scania's and Copenhagen's airports.

Environmental goal was to not decrease the quality of the environment surrounding the bridge. The delegations therefore set a goal that the bridge should not disturb the waterflow in the Sound.

Later studies have found that the regional objectives have not developed as fast as was hoped for. Even though the share of commuters in 2012 was 41% among car travellers and 60% among train travellers, there has been frustration to the slow development of the regional integration overall. Also, the level of regional integration was declining at least from 2008 until 2012. The Öresund Committee was appointed as a transnational governance body for the region and its development. The committee consisted of nine local municipalities and three regional bodies. It had 32 indirectly elected politicians split evenly between Swedish and Danish politicians. The committee remained a fairly weak political entity throughout its lifetime. Large barriers to integration such as labour legislation, social security entitlements, institutional mismatches in the education and tax systems seemed to be only solvable by national governments, which seemed to lack interest in any concerted efforts in solving these barriers to further integration. The Öresund committee was finally dissolved and merged into other governmental bodies in 2016 (Olesen & Metzger, 2016).

On the other hand, the environmental goals have been met and the waterflow in the Sound has not been affected by the bridge and the environmental conditions had returned to normal in three years after the construction (Gray, 2006). The bridge has also shown to be able to finance itself with the user fees collected from the travellers.

From socio-economic perspective the bridge was evaluated *ex-ante* as socio-economically profitable with benefit-cost ratio of 1.68 (Danish and Swedish Öresund Delegation, 1987). In 2013, an *ex-post* analysis was made which evaluated that the bridge had so far created a consumer surplus of two billion euros in 2000 prices, which should be compared to the four billion euros investment to the bridge. They also estimated that over a 50-year appraisal period the bridge should generate benefits that lead to a benefit-cost ratio of 2.2.

Organisation and decision making

The project organisation for the Öresund bridge was founded right after the decision to build the bridge. The bridge is owned and maintained by the Öresundsbro consortium, which is co-owned by a Swedish state-owned company SVEDAB AB and Danish state-owned company A/S Öresund. Throughout the project, the company has operated independently from political decision-making. As the bridge investment was financed through loans, the company is responsible for the repayments.

FinanceT

The investment cost of the project was 4 billion euros in 2000 prices (OECD, 2003), which translates to 5.63 billion euros in 2019 prices. The project was financed with loans guaranteed by the Danish and Swedish governments, which are amortised with user payments.

2.2. Oslo-Stockholm 2:55

Overview

Oslo-Stockholm 2:55 is a planned rail connection between the capitals of Norway and Sweden. It is a collection of new rails and improvement of old rails to shorten the travel time between Stockholm and Oslo to two hours and fifty-five minutes. The estimated cost of the planned project is approximately 6.5 billion euros.

The areas between the two capitals are major regions for both Sweden and Norway. Approximately 3.4 million people live along the route between Oslo and Stockholm. The two cities also have strong business ties and around 1.4 million flight trips are made between them each year. The number of rail trips between the two cities is around 200 000 a year. The current railway track consists of double tracks from Stockholm up until Laxå, after which the railway is of single-track right until Oslo.

Figure 4 shows the existing and proposed railway tracks between the two capitals. Currently the journey by train takes approximately five hours and twenty minutes in comparison with air travel, which takes approximately three hours including access and egress journeys. To reduce the travel time by train to under three hours, Oslo – Stockholm 2.55 AB suggests that two new railways are built, and several existing links are improved to increase their capacity. In Figure 4 the new links are shown in blue, and existing links that are to be improved, are shown in red.

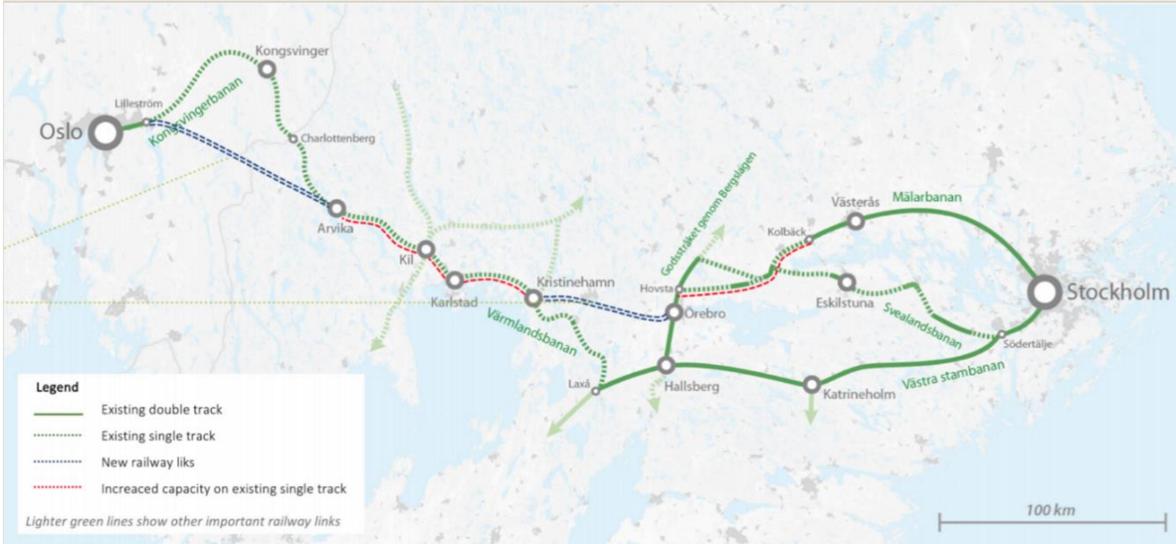


Figure 4. Existing and proposed railway tracks in the Oslo-Stockholm 2:55 plan. (Oslo - Stockholm 2.55 AB, 2019)

History

Although parts of the track have been in discussion before, first mention of a plan to reduce the travel time between Oslo and Stockholm to under 3 hours by train was found in a report concerning new ways to finance Swedish transportation infrastructure (Hasselgren, Attefall, Kinhult, Larson, & Wetterstrand, 2015). The report, which was released in October 2015, mentioned the railway as a project that is seeking funding. A company that furthers the project, Oslo-Stockholm 2.55 AB, was founded in November 2015 (Oslo - Stockholm 2.55 - Crunchbase Company Profile, 2020).

The first owners of the company were Region Värmland, Region Örebro län, Örebro municipality and Västerås municipality after which Karlstad municipality and Region Västmanland have joined the company. Founding a company to argue for a railway project had been done before for Ostlänken, a railway connection between Järna and Linköping, with good results. As transportation projects in Sweden are state funded and approved, any project that is to be constructed needs to be discussed in the Swedish parliament. The agenda for the parliament is heavily contested and therefore large transportation projects like Oslo-Stockholm 2.55 need to be actively argued for. The company has been in discussions with Stockholm and Oslo to join it, but thus far the push for improving the connections have come from the smaller municipalities in-between the two capitals. These areas have also a lot to gain in improving their connections to Oslo and Stockholm.

Deficiencies in the transport infrastructure between Stockholm and Oslo were studied in 2017 by Trafikverket, Sweden's transport infrastructure authority (Lindgren, et al., 2017). The study concluded the that largest deficiencies in the area were lack of punctuality of the train service and capacity problems. Goals that were set for the transport system were to improve the regions accessibility and facilitate a functional region, positive societal development, and competitive economy. The study also proposed that in the long run (year 2040) double track railways would be built between Västerås and Örebro, Kristinehamn and Kil, Örebro and Kristinehamn and Karlstad-Oslo. During the same year, an analysis of the socio-economic benefits of the proposed plan was released. The analysis was commissioned by Oslo-Stockholm 2.55 and included the standard cost-benefit analysis of the project and an analysis of the wider economic benefits (Lundberg, et al., 2017). The analysis concluded that the Oslo-Stockholm 2.55 project would be socio-economically profitable with benefits of 67.2 billion SEK and estimated cost ranging from 48.4 billion SEK to 57.4 billion SEK. Many other effects were also studied in the report. They included the benefits for accessibility, housing market, job market, firms, goods transportation, students, social effects, integration, and the environment. The planning analysis suggested, that by the year 2030, the capacity and punctuality issues concerning the current railway tracks would be resolved and by the year 2040, the two new railway tracks, Nobelbanan and Gränsbanan, would be constructed.

Since then, the proposal Oslo – Stockholm 2.55 AB has been studied further, and analysis of the financing of the project was released in 2019 (Oslo - Stockholm 2.55 AB, 2019). The financing report suggests that the two new railway tracks would be financed with a concession model, where the state would provide credit guarantees to keep the cost of capital low, and a project company that builds the track, would generate revenue from standard railway fees and special track fees paid by the train operator. Compared to the planning analysis by Swedish Transport Administration, the report suggests that Nobelbanan and Gränsbanan would be completed by 2030 with this model. The funding model has raised some interest in Sweden, as all of Sweden's transportation infrastructure is funded by the government apart from the Öresund bridge.

In 2019, Oslo-Stockholm 2.55 AB released an analysis of the project concerning the United Nations Agenda 2030 objectives. Agenda 2030 is the United Nations program for sustainable development, which consists of 17 goals divided into 169 subgoals. From the 169 subgoals, 50 were relevant for the Oslo-Stockholm 2.55 project. The project was seen to have a positive effect for 31 subgoals, risk for negative effect for 3 subgoals and ambiguous effect for 16 subgoals. The project was seen to further possibilities for education, productivity, sustainable infrastructure and achieving climate change goals. The largest risks were seen in disrupting local environment especially while building the new tracks.

Objectives and benefits

The project Oslo – Stockholm 2:55 has recognized several benefits from the realisation of the project:

- *Two growing capitals and three of the greatest Scandinavian country regions will form a new corridor region.*
- *For freight transport higher train loads, better on time delivery and higher cost-efficiency.*
- *Great benefits for climate and society.*
- *Lower travel times and much higher accessibility.*
- *Reduced climate impact when the majority chooses the train instead of the flight.*
- *Stronger labour market regions and more jobs.*
- *Sharply increased housing construction.*
- *Major positive effects on the social and economic dimensions of sustainability and on the climate.*
- *More people would have access to new jobs and the opportunities for higher education.*

(https://www.oslo-sthlm.se)

Organisation and decision making

Oslo-Stockholm 2.55 AB is a company owned by Karlstad Municipality, Region Värmland, Region Västmanland, Region Örebro County, City of Västerås and Örebro Municipality. The company aims to accelerate the expansion of better train traffic between Oslo and Stockholm and on the sections in between.

Finance

The financing plan of the project is based on a concession model which includes revenue risks. The State is not burdened by any revenue risks, but instead issues credit guarantees to keep capital costs down. The project company (the Concessioner) receives their revenue from the train operators via user-fees (standard track fees plus a special track fee). The concession is issued to the owner company by the State and the assets will be transferred to public ownership. (https://www.oslo-sthlm.se)

2.3. Fehmarnbelt

Overview

The Fehmarnbelt fixed link is a planned tunnel connecting the Danish island of Lolland to the German island of Fehmarn. The planned location for the tunnel is shown in Figure 5. The length of the tunnel is 18 kilometers, planned to run from Puttgarden to Rödbyhamn, crossing the Fehmarn belt and replacing the current ferry-based crossing of the strait. The estimated cost for the project is 5.5 billion euros in 2008 prices (8 billion in 2016), which is financed by state guaranteed loans and repaid by user fees for crossing the tunnel.

The tunnel will connect Denmark and Scandinavia even better to the Central Europe, decreasing the travel time over the Fehmarnbelt from current 45 minutes to 7 minutes by rail and 10 minutes by car. This results in a travel time of around three hours from Copenhagen to Hamburg, compared to the current travel time of 4.5 hours. (Femern A/S, 2013).

Figure 5. Planned connection between Lolland and Fehmarn, running between the cities of Puttgarden and Rödby. (Femern A/S, 2013)

History

The idea for a fixed link over the Fehmarnbelt surfaced already in a 1936 plan for a larger Danish highway network known as motorway H (Figure 3). The plan included a ferry or bridge connection over Fehmarn, but apparently the bridge connection was not prioritised, as in a 1937 revision of the plan, the connection over Fehmarn belt was planned as a ferry connection. During the German occupation of Denmark in the second world war, the German Nazi executive considered a ferry connection over the strait more cost-effective than a bridge. In 1941 an agreement was made between the Danish Ministry of Public Works and German Ministry of Traffic to construct the ferry terminals in Rödbyhavn and Fehmarn. (Boge, 2006)

The question of a fixed connection over Fehmarnbelt resurfaced when the *Missing Links* report was published. The report envisioned a ferry-free connection from Scandinavia to Central Europe, including the Fehmarnbelt fixed link (Boge, 2006). Subsequently, in the 1991 agreement between Denmark and Sweden to build the Öresund bridge, Denmark agreed to further the fixed link over Fehmarnbelt if environmental and economical preconditions for the link can be fulfilled (Retsinformation, 2020). In April 1991, the Fehmarnbelt fixed link appeared in the agenda for the Danish parliament for the first time. The next year Denmark and Germany agreed on conducting initial studies concerning the connection. The studies were done between 1995 and 1999, culminating in a feasibility study of eight different proposals for the fixed link (Femern A/S, 2020). The study deemed the connection socio-economically profitable and an immersed tunnel with two car lanes and one railway track being the socio-economically most viable option (COWI & PLANCO Consulting Gmbh, 1999).

In 2001, the connection across Fehmarnbelt was included in the EU's list for Trans-European Network (TEN) projects, which attempt to remove transportational bottlenecks across Europe. Due to Germany's economic difficulties in the beginning of 2000's the project was about to be completely buried. In 2003 Germany's government did not allocate any funds for the project in their long-term transportation plan, even if Denmark had suggested that the link would be fully paid for by turnpikes. Already in the same year however, EU's transport commissioner recommended the completion of 18 TEN-projects by the year 2010, the fixed link across Fehmarnbelt being among those projects. Later that year the Fehmarnbelt connection was considered eligible to up to 20 percent EU financing (Boge, 2006).

In 2004, a Danish cost-benefit analysis considered the connection economically profitable using a 50-year appraisal period. Contrary to the cost-benefit analysis made in 1999, this report deemed the cable stayed bridge option more socio-economically profitable than the immersed tunnel, the difference being tunnel's larger construction cost (COWI, 2004). Later that year, European Parliament and the European Commission approved of the TEN-project list, which the Fehmarnbelt was a part of. This paved way for the next Danish-German agreement on building the fixed-link as a four-lane highway and double-track railroad either as a bridge or a tunnel (Boge, 2006).

In 2008, Fehmarnbelt was designated a key project, which connects Scandinavia and the rest of the Europe together, by the European Union. The EU Commission granted 200 million euros for a six-year period to undertake necessary surveys and preparations for the connection to be built. During this, environmental and other concerns mounted, and the German Nature and Biodiversity Conservation Union published a report criticising the traffic forecasts underlying the economical calculations of the fixed link. The report also casts a shadow over the planned solution of a cable stayed bridge, claiming that there are large cost risks involved in building the bridge (Vieregg - Rössler GmbH, 2008). In 2010, a study that compares different solutions for the fixed link concludes, that a tunnel would be the preferred solution to construct the fixed link instead of the cable stayed bridge that was planned before. The risks involved in constructing the fixed link as a bridge would be greater compared to a tunnel, as the bridge would need new technical solutions that have not been thoroughly tested yet (Femern A/S, 2010).

As a part of the Environmental Impact Assessment (EIA), the production facilities for the tunnel are decided to be built to Rödbyhamn. This was due to new EU requirements, that the impacts of the production facilities to environment should also be assessed. The time schedule for the tunnel is revised, but shortly after, the schedule is revised again as the approval process in a cross-border project appears more complex than expected. The Danish EIA is completed in 2013, just months after the project begins to search for contractors for the tunnel. In late 2013, Femern A/S, the company that furthers the project, submits its application for plan approval to the German authorities. The plan goes through two public consultations, gathering several thousands of comments from the public. In 2015 Denmark and Germany approve of the final construction acts for the project. Femern A/S publishes an updated financial analysis of the project in 2016, the same year when the concerns from the first public hearing for the German project plan have been answered for in the plan. The plan goes through a second round of consultations, which completes in 2017. The project plan is finally approved by German authorities in early 2019 and preparatory construction works begin the same year. In March 2020, the European Commission approves of the financing model for the Fehmarnbelt fixed link and construction of the tunnel element factory gets underway the same year. (Femern A/S, 2020)

Objectives and benefits

Fehmarnbelt has been named as one of the main bottlenecks and missing links of the EU's Scandinavian-Mediterranean Corridor: *The Fehmarnbelt Fixed Link crossing is a key component in the main north-south route between Central Europe and the Nordic countries. This cross-border bottleneck will be removed by the construction of the new immersed rail/road tunnel under the 18 km wide, Fehmarn Strait, between Rødby in Denmark and Puttgarden in Germany.* (EU Trans-European Transport Network (TEN-T).

The Femern-organization has recognized several benefits from the realisation of the project:

The Fehmarnbelt tunnel is an important part of the European transport network. Along with the Øresund fixed link between Copenhagen and Malmö, the Fehmarnbelt link will bring Scandinavia and Central Europe closer together via the so-called North-South corridor.

The traffic corridors that bind Europe together still contain bottlenecks and expansion of the infrastructure across land borders is still required. Fehmarnbelt tunnel will close a gap in the European transport network and remove a bottleneck between northern and southern Europe. This is the reason why the Fehmarnbelt tunnel is a European project, which is receiving financial support from the EU.

The tunnel will mean that the population of the Fehmarnbelt region will gain a new, strong link, which will stimulate growth and prosperity. Nine million people currently live in the region, which extends between the cities of Hamburg, Kiel, Lübeck, Copenhagen and Malmö.

(https://femern.com)

Organisation and decision making

Femern A/S was appointed in 2009 by the Danish Minister of Transport to undertake preparatory work, investigations, and the planning of a fixed link across the Fehmarnbelt.

Femern A/S is part of Sund & Bælt Holding A/S, which is 100 per cent owned by the Danish Ministry of Transport. Sund & Bælt Holding A/S is also responsible for the fixed link across Storebælt. (https://femern.com)

Finance

The construction budget for the tunnel, including the Danish land works, is about 8,000 million € (62,000 million DKK, in 2016). Assumed EU funding during construction of the tunnel and land works is about 750 million € (5,900 million DKK). The costs outside EU funding are financed by state guaranteed loans and repaid by user fees for crossing the tunnel. (https://femern.com)

2.4. Brenner Base Tunnel

Overview

The Brenner Base Tunnel (BBT) is a straight, flat railway tunnel connecting Austria and Italy. It runs for 55 km through the base of the Eastern Alps beneath the Brenner Pass between the town of Innsbruck (Austria) and the village of Fortezza (Italy). Adding the Innsbruck railway bypass, which has already been built, the entire tunnel system is 64 km long. The Brenner Base Tunnel can therefore be considered the world's longest underground railway connection. In a wider context the BBT is the main element of the new Brenner railway from Munich to Verona (425 km). The BBT belongs as a part to the Scandinavian-Mediterranean TEN Corridor from Helsinki (Finland) to La Valletta (Malta). The European Union is promoting the expansion of this transnational multimodal corridor and considers it to be of very high priority.

The main tubes of the tunnel have been under construction since 2011, although preliminary works had already started in year 2007.

The tunnel consists of two tubes, each 8.1 m wide, running 40-70 m apart from one another. These tubes are each equipped with a single track, meaning that train traffic through each tube is one-way. The slope in the base tunnel is 4-7 ‰. The apex height is 790 above sea level, lying 580 m below the Brenner Pass itself.

A peculiar feature of the Brenner Base Tunnel (BBT) is the exploratory tunnel, which lies between the two main tunnels and about 12 m below them and with a diameter of 5 m. The exploratory tunnel currently provides information on the rock mass and thereby reduce construction costs and times to a minimum. It will be also essential for drainage when the BBT becomes operational.

The BBT is meant primarily for freight transport, allowing a modal shift of traffic from road to rail. Passenger trains can also travel through the tunnel. Thanks to the virtually horizontal tunnel train traffic will no longer have to contend with the steep up- and downhill slopes on the over 150 years old Brenner railway line.

(https://www.bbt-se.com/)

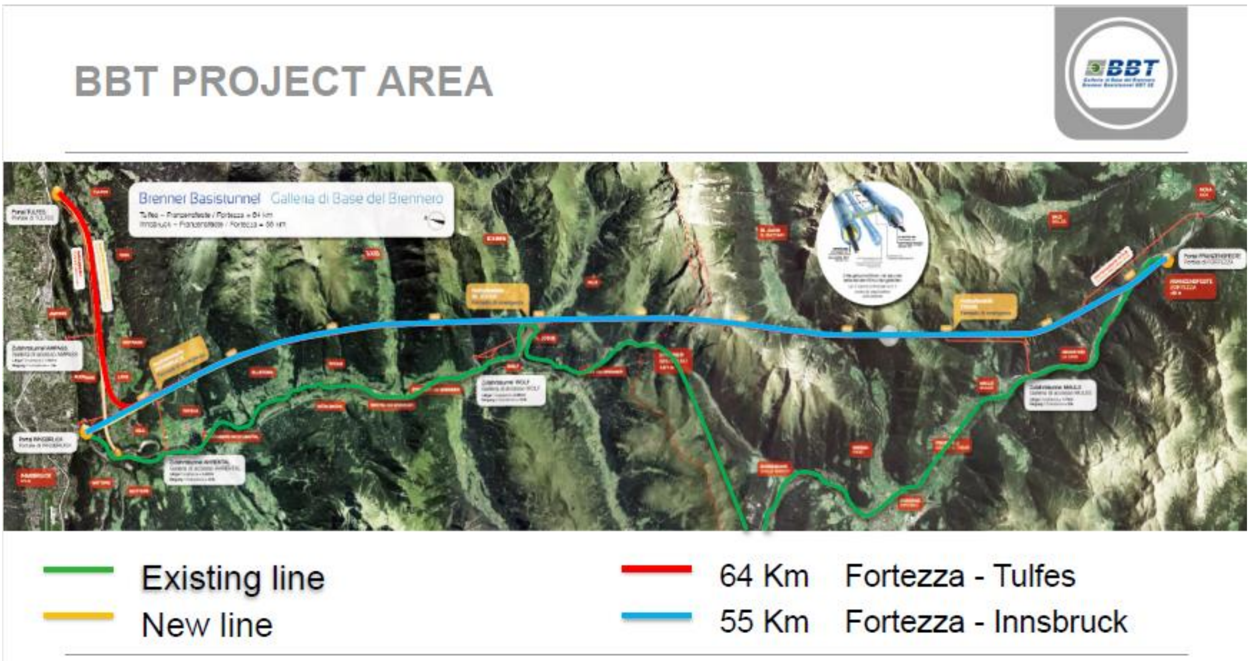


Figure 6. The route of Brenner Base Tunnel (https://www.bbt-se.com/).

History

The railway line through the Brenner Pass was built already in the late 19th century. It has for a long time presented significant limitations in terms of capacity and of track configuration, making the use of more tractor units necessary because of the slope that in some points can reach 26 ‰.

Several ex-ante evaluations, investigations and feasibility studies have been performed since the end of the 1970s. In view of the deteriorating situation regarding to traffic in transit across the Alps since 1980, the Ministers of Transport of the Republic of Austria, the Italian Republic and the Federal Republic of Germany agreed on a feasibility study for a Brenner Base Tunnel railway.

1989: Completion of the feasibility study on the Brenner base tunnel and declaration of the Ministers that this is the “basis for all further work”.

1996: The European Parliament and the Council (Decision n° 1692/96/EC) add the Berlin-Naples railway axis with the Brenner Base Tunnel as Number 1 to the list of priority projects for the construction of the TEN-T.

1999: The Ministers of Transport of Austria and Italy decide to found a European Economic Interest Grouping (EEIG), in order to start the necessary planning activities for the construction of the Brenner Base Tunnel. The EEIG (European Economic Interest Grouping) was founded by the Austrian company Brenner Eisenbahn GmbH (BEG) and the Italian company Ferrovie dello Stato S.p.A. (FS). The preliminary project, planning phase I, for the Brenner Base Tunnel begins.

2002: The planning phase II for the Brenner Base Tunnel starts with the Memorandum of Rome, a joint declaration of the Ministers of Infrastructures and Transport of Austria and Italy.

2004: Austria and Italy finalized the basic agreement for the construction of the Brenner Base Tunnel with the bilateral agreement of Vienna. The "Shareholders' Agreements" were signed.

2009: The Environmental Impact Assessment (EIA) was completed in Austria. The Federal Ministry for Transport, Innovation and Technology (BMVIT) granted the building authorization for the Brenner Base Tunnel. The authorizations pertaining to water management, protection of cultural resources and disposal sites and nature protection were granted.

2009: In Italy the final project for the Brenner Base Tunnel on the Munich-Verona railway axis was approved by the CIPE (Inter-Ministry Committee for Economic Planning). The report for the CIPE also includes the sources of financing to cover the costs of the project as concerns the total amount to be financed by the Italian government.

2011: The Extraordinary Shareholders' Assembly for BBT SE approved the new Statute of BBT SE, which provided for the integration of the object of the company to include the mandate concerning the construction of the Brenner Base Tunnel. During the same Extraordinary Shareholders' Assembly for BBT SE the transfer of the company's headquarters from Innsbruck to Bolzano was also decided. The construction phase (Phase III) began.

2015: On March 20th, 2015 the former Commissioner for Transport of EU, together with the Ministries of Transport of the Alpine States (Austria, Switzerland, Italy, France, Germany, Slovenia and Liechtenstein) signed in Innsbruck the declaration on the further promotion of sustainable transport in the alpine region, agreeing that the Alpine States, the European Commission and implementing bodies shall pursue their commitments aiming at the completion of the major alpine crossing railway tunnel project.

Objectives and benefits

The Brenner pass has been named as one of the main bottlenecks and missing links of the EU's Scandinavian-Mediterranean Corridor: *The cross-border alpine connection between Munich and Verona represents a major bottleneck on the corridor and will be alleviated by the construction of the Brenner Base Rail Tunnel, when it becomes operational. The removal of this bottleneck is crucial for the realisation of the entire corridor, linking Northern and Southern Europe. The BBT will help to achieve the environmental objectives set by the EU and ensure the modal shift from road to rail, necessary for the future of the ecologically sensitive alpine region. (EU Trans-European Transport Network (TEN-T).*

According to transport forecasts made as part of the set of documents produced for the approval of the final project (2007/2009), if the tunnel were not built, the existing railway would reach the limits of its capacity by 2025 (approx. 18 million net tons per year) and that road transport will mainly account for the increase in total goods traffic. Regarding transport by road, the saturation point on the Brenner motorway, at 45 million net tons, would be reached by 2025. The construction of the Brenner Base Tunnel and its access routes will therefore respond both to traffic predictions and the objective of modal shift, removing a capacity bottleneck and allowing sustainable transport development. The study also clearly shows that besides a modern and competitive railway infrastructure, a framework of traffic policy conditions must be created, in order to achieve the hoped-for shift of freight traffic from road to rail.

The construction of the base tunnel is set against this background characterized by strong traffic growth and limited infrastructure capacity. The aim of the project is to create a modal balance with road traffic, which is constantly increasing on the Verona-Bolzano/Bozen-Brenner-Innsbruck-Munich axis. Thanks to the new Brenner tunnel the travel time from Innsbruck to Bolzano will amount to just 50 minutes instead of the current 120 minutes, and travel time from Verona to Munich will be 3 hours instead of 5.5 hours. The entire route will be equipped with the latest technology of the European Rail Traffic Management System ERMTS and the European Rail Traffic Management System ETCS/level II. The tunnel will allow the Brenner line to increase significantly its capacity, of which 80% meant for freight and 20% for passenger traffic.

Feasibility studies have also found significant impacts on the social and economic effects of the BBT in the regions located in the vicinity of the route. The Provinces and Regions of Verona, Trento, Bolzano, Tyrol and Bavaria with the pertinent Chambers of Commerce founded the Action Community for the Brenner Railway (CAB/AGB) in 2012. The CAB's main objective is promoting the expansion of the Munich-Verona axis railway line on behalf of the local population and the regional economy. It has been noted that the BBT will be fully efficient once the expansion of the Munich-Verona line has been completed as required.

By networking in Italy, Austria and Germany and with the relevant European authorities, decisions on railway expansion in this area can be steered in the interest of the neighbouring populations and the regional economy. The CAB works to improve railway transport on the existing railway stretch between Munich and Verona and for the construction of new stretches of the line. According to a 2012 CAB study, with the construction of the Brenner Base Tunnel, transport capacity will increase, thereby allowing, via appropriate political measures in terms of transport policy, a modal shift of freight traffic from road to rail.

Organization and decision making

A European public limited company BBT SE is responsible for the construction of the railway tunnel between Austria (Innsbruck) and Italy (Fortezza). At the request of the Republics of Austria and Italy and the European Union, BBT SE is planning and building the Brenner Base Tunnel.

BBT SE is a transnational type of company provided for by European law. It is 100% publicly owned. Half of the shareholders are from Austria and half from Italy.

In Austria, ÖBB (Österreichische Bundesbahnen, the Austrian railway company) is the only shareholder with 50% of the company's shares. Tyrol region (Land Tyrol) withdrew from the shareholder role for financial reasons when the construction phase started in 2011 but participates still the project, e.g. by a membership in the Supervisory Board. The holding company TFB (Tunnel Ferroviario del Brennero Holding AG) holds 50% of the company's shares for Italy. TFB is owned in turn by RFI (Rete Ferroviaria Italiana) with 89.74% share, and the rest are owned by the provinces of Bolzano (6.38%), Trento (3,55%) and Verona (0.33%).

BBT SE uses a dual management system. The company is managed by two CEOs, one located in Austria and one in Italy. The Supervisory Board oversees the activities of the CEOs and the company. Half of the members of the Supervisory Board represent Austrian and half Italian partners.

Finance

The current estimate of the basic costs for the Brenner Base Tunnel is 7,067 million €. Including risks and price valorisation, total cost for the BBT is estimated in a range between 8.4 and 9.3 bln €.

- 60% engineering works,
- 15% outfitting,
- 10% planning, services and internal costs,
- 1% parcels of land and related issues and
- 14% risk provision.

As the transalpine stretch of the SCAN-MED Corridor, the Brenner Base Tunnel receives substantial funding from the European Union, covering about 50% of the costs for “Studies” Activities and 40% of the costs for the “Works” Activities (construction of the main tubes). Austria and Italy will each cover half of the remaining costs (about 60%).

2.5. Rail Baltica

Overview

Rail Baltica is a rail transport infrastructure project with a goal to integrate the Baltic States in the European rail network. The project includes five European Union countries – Poland, Lithuania, Latvia, Estonia and indirectly also Finland. The Baltic part of the Rail Baltica project is referred to as the Rail Baltica Global Project. (www.railbaltica.org).

The route of Rail Baltica will run from Tallinn to Warsaw via Pärnu, Riga, Panevežys, Kaunas and Bialystok. It will also be connected by sea to Helsinki (possibly by rail in the future), and by rail to Riga Airport and to Vilnius. From Warsaw it is connected to Berlin and further to major centres of Central and Western Europe. The Rail Baltica project will construct the railway from Tallinn up to the border of Lithuania and Poland. From there the route will continue along the existing Polish track to Bialystok and Warsaw. However, the railway will be upgraded there, and a part of new railway will be constructed to enable higher speeds.

The length of the route from Tallinn to the border between Lithuania and Poland is 870 km (Tallinn – Warsaw about 1,100 km).

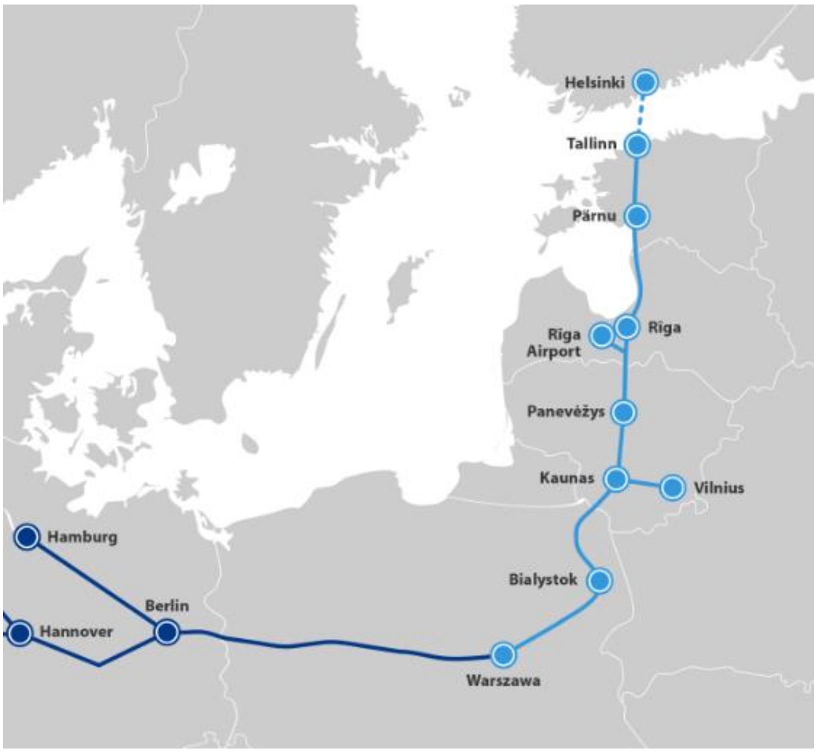


Figure 7. The route of Rail Baltica with principal links. (www.railbaltica.org).

The railway will be built using the standard European gauge (1435 mm) which enables the interoperability with the Polish and German gauge. The existing rail network in the Baltic States in based on 1,520 mm gauge, like in most other ex-soviet states, as well as in Finland.

Trains will be provided for both passenger and freight traffic. The power is based on electricity, producing less emissions, noise, and vibration. Design speed will be 249 km/h for passenger trains and 120 km/h for freight trains. The travel time from Tallinn to Warsaw is planned to be about 7 hours, and Tallinn – Riga 2 hours. There will be four types of passenger trains: High-Speed Trains with few stops, Night Trains for long-distance international overnight services, Regional Express trains to connect regional centres, and RIX shuttle trains between Riga Central and Riga Airport and between Tallinn and Helsinki (conditional to Helsinki-Tallinn railway tunnel).

The route is part of the EU's North Sea Baltic TEN-T corridor. The construction period is planned to be 10 years. The target year of the opening has been 2026 but it is possible that the schedule will be delayed.

Estimated investment cost of the project is about 5,800 million €.

History

The core rail network in Baltic states were constructed in the second half of 1800s and in the beginning of 1900s when the area was a part of the tsarist Russia. It was built using the gauge of 1,520 mm, adopted in Russia in mid 1800s. The three Baltic states were connected by rail with Poland and Germany – using the European gauge of 1,435 mm – during the first decades of 1900s. There was a regular train connection from Tallinn to Berlin still in late 1930s. (Siivonen 2020).

First ideas and visions for a new, modern railway connection between the Baltic states and Central Europe were raised during Pan-European transport conferences in the first half of 1990s, after the re-independence of the Baltic states in 1991. The Rail Baltica concept first appeared in the joint policy document “Vision and Strategies around the Baltic Sea 2010” as an important element for spatial development in the Baltic Sea region in 1994.

A cooperation agreement was signed by Estonian, Latvian and Lithuanian transport ministers in 2001. Rail Baltica was included in the list of priority projects in the proposal submitted to the European Council by the European Commission in 2003 and it was included in TEN-T priorities list in 2004.

European Commission issued a tender for the entire Cohesion-fund pre-feasibility study on the Rail Baltica project in 2005. Initial research was conducted by COWI AS in 2007. European Commission decided on TEN-T co-financing for Latvian, Lithuanian and Estonian projects in 2008. A memorandum was signed by representatives of the transport ministries from Poland, Lithuania, Latvia, Estonia, and Finland in 2010. Feasibility Study was carried out and published by AECOM in 2011.

RB Rail AS was established in 2014 to be the main coordinator of the Rail Baltica project. EU CEF1 Grant Agreement was signed, and a declaration was issued by the transport ministers of the Baltic States, Poland, and Finland, together with the EU Commissioner of transport in 2015. A Cost-Benefit Analysis was completed in 2017.

In 2018 EU Commission adopted the Implementing Decision on the Rail Baltica cross-border project on the North Sea- Baltic TEN-T Corridor and EU CEF3 Grant Agreement was signed. Rail Baltica Design Guidelines were approved. Route setting and spatial territorial planning for Rail Baltica railway finalised in all three Baltic states, except for the section in the same year. In 2019 the first design contract for the Rail Baltica main line signed. (www.railbaltica.org).

Objectives and benefits

Rail Baltica has been named as the main missing link of the EU’s North Sea-Baltic Corridor: *The main missing links of the North Sea-Baltic Corridor are the new Rail Baltic 1435 mm gauge double track direct high-speed line from Tallinn to the Lithuanian/Polish border; upgrades to the existing line from the Lithuanian/Polish border to Bialystok, and a further upgrade to the line from Bialystok to Warsaw*. (EU Trans-European Transport Network (TEN-T).

Rail Baltica project aims at ensuring a safe, fast, and high-quality connection between the Baltic States and the major economic, administrative, and cultural centres of Western Europe. (AECOM 2011).

The Rail Baltica project is one of the priority transports projects of the European Union because it will remove bottlenecks, build missing cross-border connections, and promote modal integration and interoperability. It will be an important catalyst of continued economic development of the Baltic States. The construction phase creates hundreds of new jobs and contributes to the region’s GDP through various direct, indirect, and induced effects from infrastructure investments. In the operational phase it enhances Baltic market accessibility and trade competitiveness, boosts foreign investment attractiveness, and fosters sustained productivity gains. It increases competitiveness of the Baltic transport and logistics industry. (www.railbaltica.org).

Organization and decision making

The Rail Baltica project is being implemented by the Baltic States, whose three ministries responsible for the transport sector are the Beneficiaries of the Rail Baltica Global Project:

- Lithuania: Ministry of Transport and Communications
- Latvia: Ministry of Transport

- Estonia: Ministry of Economic Affairs and Communications.

The central coordinator for the Rail Baltica project is RB Rail AS which is a multi-national joint venture of the Republics of Estonia, Latvia, and Lithuania.

The Rail Baltica project's national implementing bodies in Estonia, Latvia and Lithuania are responsible for implementing the project in their respective countries.

Finance

The total estimated construction cost of the project is approximately 5 800 million €. It will be financed by EU (CEF) and the states of Estonia, Latvia, and Lithuania. The share of EU finance is planned to be about 85% which is mainly financed from "Connecting Europe Facility" (CEF) funding instrument. The national shares will be financed directly from the state budgets in the Baltic states. (www.railbaltica.org).

2.6. Helsinki-Tallinn Railway tunnel

Overview

The Helsinki-Tallinn link is a part of the North Sea – Baltic route of the EU's TEN-T transport network. However, in the EU's documents the fixed link is not a priority with respect to sea connection.

The Finnish and Estonian authorities, representing the states of Finland and Estonia, Helsinki-Uusimaa Regional Council, Harju County Government, and cities of Helsinki and Tallinn, signed in 2016 a Memorandum of Understanding to develop transport connections between Helsinki and Tallinn.

A parallel project to plan and build the fixed link between Helsinki and Tallinn was initiated in May 2016 by a group of Finnish businessmen. The background of the initiative was to support the development of the integration of Helsinki and Tallinn as a world-class centre of innovative businesses, start-up networks and universities. The project was named as **Finest Bay Area,** and the planning of the link was started in the autumn 2016. It is based on private finance. However, the participation of the public sector is not excluded.

The feasibility study of the Helsinki-Tallinn Transport Link, **FinEst Link**, ordered by the public authorities above and carried out by a consortium of consulting companies, was published in 2018. Since then, no decision has been made to continue the planning the railway tunnel based on the feasibility study, nor to cancel the project.

In each project plan the objective is to build a tunnel under the Finnish Gulf and implement a rapid railway connection between the regions of Helsinki and Tallinn. The 1435 mm gauge (European width) railway would serve both personal and freight transport. The end stations for personal transport would be in Helsinki-Vantaa Airport and in Ülemiste in Tallinn. In addition, there would be a cargo terminal North of the Helsinki-Vantaa Airport. In both plans the new railway would connect to Rail Baltica in Tallinn and the Finnish railways in Helsinki. The length of the railway would be about 105 km. However, the plans differ in detail.

Finest Bay Area

Since the start in 2016 the project has continued by studying alternative routes and carrying out technical planning. The environmental impact assessment program following the Finnish legislation was published in 2018 (Pöyry Finland Oy, 2018). It includes a description of alternative routes, technical plan, a summary of the state of the environment and a plan of the impact assessment process.

The plan includes four alternative routes for the tunnel and railway (Figure 8). According to the plan there will be separate tracks for personal and cargo transport which allows for higher speed and shorter travel time, about 20 minutes in passenger transport. The estimated passenger volume requires a frequent interval for trains which improves the service level of the passenger transport.

The track tunnels will be implemented as two tunnel tubes. The first tunnel includes two tracks for passenger trains. The second tunnel operates freight trains. Both tunnels include a tube for rescue operations.

The stations are planned to be in Otaniemi Espoo, and in Helsinki-Vantaa airport. In alternative routes there are options for stations in Ilmala/Pasila and Helsinki centre. The project includes a vision of an artificial island to be built on the Finnish side providing large potential for real estate development. It acts as a disposal area for rock to be excavated from the tunnel.

The passenger volume is estimated to be 52 million trips by 2040 (9 million on ferries in 2019). The estimated cargo volume will reach 22 million tons (4 million on ferries in 2017).

Total tunnel investment is estimated to be 15 billion euros.

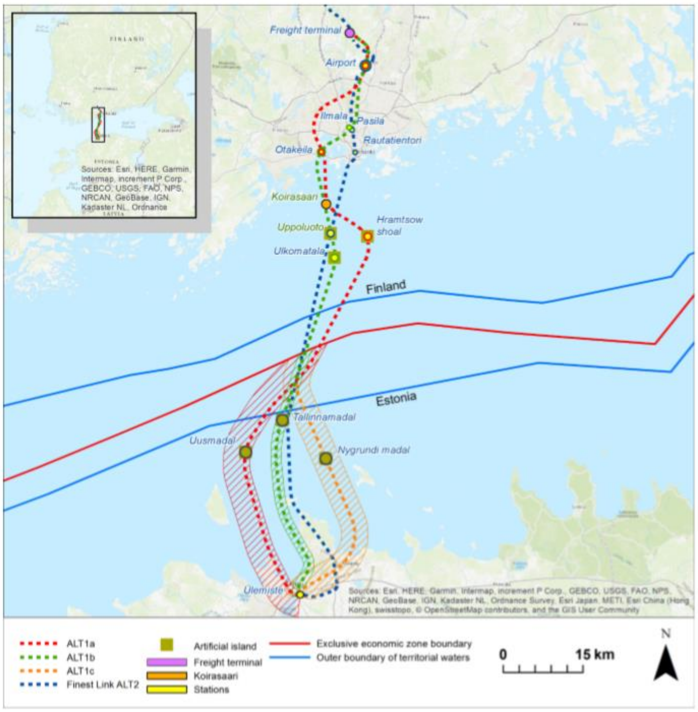


Figure 8. The planned route alternatives of Finest Bay Area. (Finest Bay Area Environmental Impact Assessment).

FinEst Link:
The project has not been active since the year 2018.

The technical concept of FinEst Link is based on a railway tunnel with two rail tunnels and a service tunnel. The stations are in Helsinki city centre, Pasila and Helsinki-Vantaa airport for passengers, and there is a freight terminal area close to the airport with connection to the Finnish railway network (1,524 mm gauge). In

Tallinn, there is a passenger station at Ülemiste in Tallinn and a freight terminal near the airport. A connection to Rail Baltica is provided for passengers and freight. The plan includes only one route alternative (Figure 9).

Travel time was planned to be ca. 30 min between Helsinki-Vantaa Airport and Ülemiste.

The demand in passenger transport in the main scenario is estimated to be 12.5 million trips in tunnel and 10.5 million on ferries in 2050 (9 million on ferries in 2019). The demand in freight transport in is estimated to reach 4 million tons in tunnel and 4 million on ferries in 2050 (4 million on ferries in 2017).

Cost estimation of the railway tunnel, terminals, and stations is 13–20 billion euros.

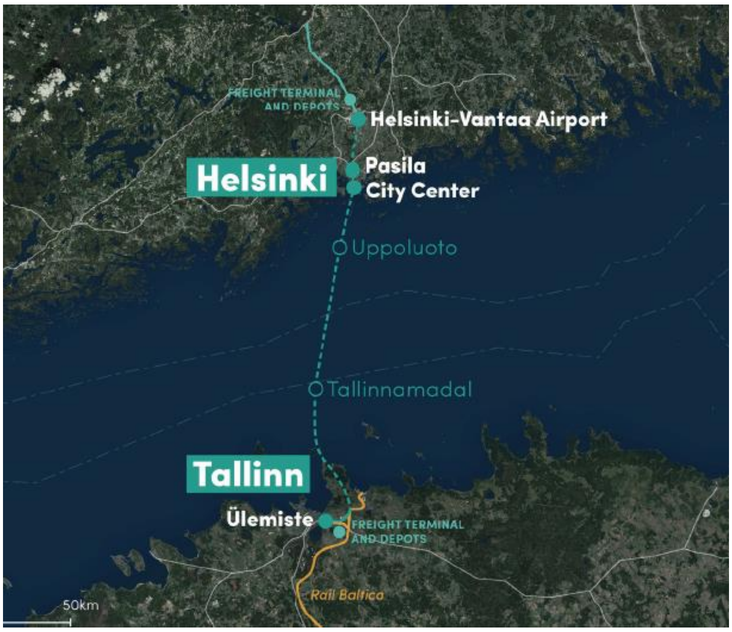


Figure 9. The planned route of FinEst Link. (FinEst Link Feasibility Study 2018).

History

The re-independence of Estonia and other Baltic states in 1991 started a fast growth of economic and social interaction between Estonia and Finland, primarily between Tallinn and Helsinki regions. This generated a rapid increase in transport between the cities, especially by sea. The number of journeys between cities grew from 2 to 9 million between years 1993 and 2017. A significant part of the transport growth was based on business and work journeys due to the rapid integration of cross-border labour markets and growing business between regions. This created demand for faster and more efficient transport connection between the cities.

The first concrete initiative in the 1990s was based on the activity of the Helsinki-Tallinn society (founded in 1992) and their vision on the development of rapidly increasing interaction and integration of the capital regions of Finland and Estonia. The first review concerning the geological possibilities for the tunnel construction was made by a group of officials of the city of Helsinki and published in 1994. The conclusion was that the railway tunnel between the cities would be technically possible. The state authorities considered the project unrealistic within the next decays and the media was mainly very critical about the idea.

The idea of the fixed link revived due to a rapid growth of transport and economic interaction between the cities. Helsinki-Tallinn Transport and Planning Scenarios (H-TTransPlan) project in the first half of 2010s concluded that the twin-city model proceeds and there are good reasons to study the preconditions and realism of the fixed link (Tapaninen 2012).

In 2016, Finland and Estonia agreed on transport co-operation, which included further research related to the tunnel connection. EU provided a grant of about one million euros to determine the viability of the tunnel connection. The feasibility study was published in 2018 (FinEst Link Project 2018).

After the publication of the feasibility study Finnish Ministry of Transport and Communications established a taskforce to assess the need for and impacts of further investigation related to the tunnel. In 2018, the taskforce communicated that the realisation of the project requires contributions from the private sector. However, they did not make any conclusion how the process should be continued, or what should be the role of the states. Since year 2018 no decision has been made to continue the planning the railway tunnel, nor to cancel the project.

In the autumn of 2016, the private project developer Finest Bay Area Development Oy started designing an alternative concept for the tunnel; in the spring of 2018, the decision was made to start the preliminary project design and environmental impact assessment procedure for assessing the environmental impacts of both the FinEst Link and Finest Bay Area concepts.

Objectives and benefits

The plans emphasize the benefits of the connection in slightly different ways.

Finest Bay Area: *The vision is that the planned railway tunnel would merge the Helsinki region and Tallinn into a single metropolis. The tunnel would connect Asia and Europe into a single hub for business, travel and traffic, since the tunnel project would make it possible to travel to Tallinn by train directly from Helsinki Airport. On the Estonian side, the possible connection with the Rail Baltica project would connect the region even more closely to Central Europe. (https://finestbayarea.online/)*

FinEst Link*: Helsinki-Tallinn railway tunnel and Rail Baltica together form a European Gateway that connects an intensive cross-border area between two capitals. Improved connectivity is a necessity to enable their full metropolitan growth. The FinEst Link combines Finland's and Estonia's transport networks and the local twin-city commuting systems. The greatest direct beneficiaries of the railway tunnel are citizens, workers, students, and tourists as passengers. When considering the wider impacts, the railway tunnel would benefit remarkably businesses, trade, investments, and culture related to the Helsinki-Tallinn twin-city development. (Finestlink.fi).*

Organization and decision making

Finest Bay Area: The owner of the project is the company **Finest Bay Area Development Oy**. It is developing the project in a consortium with the following partners:

- Afry (previously Pöyry), an international consulting and engineering company
- AINS - A-insinöörit, a Finnish engineering company
- China Railway Group Limited (CREC)
- Fira Group, a Finnish construction company.

FinEst Link: No project organization for the time being.

Finance

FinEst Bay: The investment is planned to be financed totally by private international investors. Project finance methodology is based on Rail Reform Toolkit provided by World Bank and PPIAF (2017). The investment will be paid back by the income from passenger and cargo sales.

The financial plan[2] is based on the following assumptions:

- Total tunnel investment 15 billion €
- Discount Interest rate 6%
- Inflation rate 2%
- Passenger volume: 51 million trips per annum; tariff3: 50 € single, 100 € return, 2 499 € annual pass
- Cargo volume: 22 million tons per annum; tariff 0.093 €/Ton-km.

With the above assumptions and cumulative cash flow calculation the payback period of the investment is 17 years.

FinEst Link: The financing plan of the Feasibility study: *The project could be financed with a publicly supported debt-financing model with subsidy payments of approximately 170 million euros per year from the beginning of the operational period, adding up to 4.8 bn euro subsidy payments. Without the assumed (EU) grants of 40% the payment would be approximately 507 million euros in year 1 of the operating period so the grant would have a material effect on the project feasibility and ratio of costs and benefits to the Finnish and Estonian states.*

[2] FinEst Bay Area Development: Financial indicators.
[3] Current price level

3. Comparative study on economic impact analysis of case projects

3.1. Analysis of transport system and accessibility changes

Accessibility refers to people's and goods possibility to reach places, activities and services. Therefore, it consists of the places around the people whose access is measured and their possibilities to move between these places. Transport projects increase accessibility by increasing people's and goods' mobility by decreasing travel times and travel costs. The exact change in accessibility is then affected by the land use around the project, as the number of new activities, services and places accessible through the new infrastructure is key. Accessibility can be measured in many ways, but mostly they follow the same general effective density formulation.

$$ED_i = \sum_j A_j * f(d_{ij})$$

Where the effective density of a zone i is a sum over all zones j of a product where A_j is the land use of zone j measured in jobs, retail floor space, population or other similar metric, d_{ij} is the distance between zones i and j measured in generalised travel cost, travel time or other similar metric and f is a function that describes how the importance of an activity decays as the distance to the activity increases. By choosing different functional forms, different accessibility metrics can be defined.

Accessibility changes were not analysed or reported very thoroughly in the reports of the selected megaprojects[4]. The value of travel time savings of each project was calculated, but this is a very aggregated measure of accessibility changes as its possibilities to take land use into account are limited. Also, spatial analysis of the distribution of the accessibility changes was completely lacking except for the Oslo-Stockholm 255 and Helsinki–Tallinn projects. In the Helsinki–Tallinn project accessibility analysis was conducted to assess its wider economic benefits, but the accessibility changes themselves were not reported. These kinds of analyses would make it possible to assess the spatial and to some extent socio-demographic distribution of the projects' benefits. Therefore, we concentrate here to the analysis of the travel time savings and connections of the main centers of land use that the project connects to.

Öresund fixed link

Before the opening of the fixed link, there were three ferry routes between Copenhagen and southern Sweden. Two connected to Malmö and one to Landskrona. A bit further north, a ferry connection also existed between Helsingör and Helsingborg. Since the opening of the bridge, the southern connections have been shut down, but the one between Helsingör and Helsingborg still exists. The construction of the bridge decreased the travel time between Denmark and Sweden significantly, from almost two hours to under one hour, and connected the city of Malmö with around 260 000 residents at the time to the city of Copenhagen with around 500 000 residents at the time. The increase in accessibility can be seen especially in the number of Danes living in Malmö and the number of commuting over the Sound. Between 2001 and 2009, the number of Danes living in Malmö has increased from 3,200 to 12,000, the number of commuters has increased from 3,800 to 20,400. The total consumer surplus from generalised travel cost savings over 50 years is expected to be 10.2 billion euros in 2000 prices according to an ex-post cost-benefit analysis of the bridge. (Knudsen & Rich, 2013).

[4] The data for accessibility analysis was not available on Brenner Base Tunnel. The analysis fort the Helsinki-Tallinn tunnel project was based on the data of the FinEst Link Feasibility study.

Fehmarnbelt

Currently there is a ferry connection over the Fehmarnbelt between Rödbyhavn and Puttgarden. The trip takes 45 minutes with ferries leaving every 40 minutes throughout the whole day. After the completion of the fixed link the travel time over the Fehmarnbelt is 10 minutes by car and seven minutes by train. This means significant travel time benefits for travellers that cross the Fehmarnbelt for the whole eastern part of Denmark. For example, the travel time between Copenhagen and Hamburg decreases from 4.5 hours to around 3 hours. The smaller towns closer to the tunnel benefit even more in relative travel time reduction. Travel time reliability should also increase as travellers are not reliant on the timetables of the ferries. Even if there are no large cities in the immediate vicinity of the tunnel, the accessibility gain is expected to be very high, as the travel cost savings and ticket revenue from the bridge amount to 3.4 billion euros according to the newest cost-benefit analysis of the project.

Oslo-Stockholm 2.55 railway

There is currently a railway between Stockholm and Oslo, with a travel time of 5 hours and 15 minutes and frequent flights that take around 3 hours with the access and egress journeys included. The proposed railway would decrease the travel time by train to 2 hours and 55 minutes and better connect the two capitals with populations of 950 000 in Stockholm and 625,000 in Oslo. Additionally, the railway would decrease the travel time of several other smaller cities between the two capitals. Figure 10 shows the travel times between the cities along the railway now, and in 2040 after the construction of the railway. The figure shows that the planned railway connection would significantly reduce the travel times by train between the cities along the railway. The consumer surplus that the travel time reductions would bring over the 60-year analysis period were appraised to 4.29 billion euros.

TÅG 2016

Restid i minuter	Oslo	Lilleström	Arvika	Karlstad	Örebro	Västerås	Stockholm C
Oslo	0	31	109	151	280	330	315
Lilleström	31	0	140	180	275	330	335
Arvika	110	160	0	50	160	260	230
Kil	164	195	30	23	115	210	185
Karlstad	151	195	60	0	100	140	180
Kristinehamn	190	220	85	20	70	160	138
Karlskoga/Degerf	205	160	115	45	50	145	120
Örebro	250	280	145	95	0	50	110
Västerås	340	370	195	140	50	0	55
Stockholm C	315	350	205	150	120	60	0

TÅG 2040

Restid i minuter	Oslo	Lilleström	Arvika	Karlstad	Örebro	Västerås	Stockholm C
Oslo	0	9	43	62	98	134	175
Lilleström	9	0	34	53	89	125	166
Arvika	43	34	0	32	68	104	144
Kil	67	58	23	8	44	80	121
Karlstad	62	53	32	0	35	72	112
Kristinehamn	82	73	52	20	29	65	105
Karlskoga/Degerf	93	84	63	30	18	54	95
Örebro	98	89	68	35	0	36	76
Västerås	134	125	104	72	36	0	40
Stockholm C	175	166	144	112	76	40	0

Figure 10. Travel times between cities along the proposed railway. Upper table shows the current travel times in minutes and the lower table shows travel times in 2040 after the construction of the new railway. (Sweco, 2017)

The report also included an accessibility assessment where the number of workplaces reachable in 60 minutes, 90 minutes, and 120 minutes was analysed. The spatial resolution of the analysis was still quite coarse, as the results were only reported city-wise. According to the analysis, the accessibility to workplaces would increase or at least nor decrease for each reported city. In the studied regions the number of reachable workplaces would increase by 17% for 60-minute cut-off, 27% for 90-minute cut-off and 57% for 120-minute cut-off. There are great differences between the cities. While in Lekeberg and Stockholm the number of workplaces reachable within 60 minutes would only increase 0% and 1%, the corresponding numbers in Degerfors and Arvika are 268% and 228%. More accurate results for the 60-minute cut-offs are shown in Table 1.

Table 1. Number of workplaces reachable in 60-minutes for selected cities along the Oslo-Stockholm 2:55 railway.

City	Without-the-project	With-the-project	Difference
Stockholm	1,595,700	1,605,800	1%
Västerås	215,600	248,100	15%
Örebro	129,000	245,000	90%
Lekeberg	71,600	71,600	0%
Degerfors	23,800	87,800	268%
Karlskoga	70,000	83,400	19%
Kristinehamn	48,400	115,800	139%
Karlstad	66,400	107,000	61%
Arvika	14,200	46,500	228%
SUM	**2,234,800**	**2,611,000**	**17%**

Brenner Base Tunnel

Currently where the new tunnel is being constructed, there is a railway line with functional limits and a highway with a limited allowed amount of heavy traffic. The speed and the load, the trains are currently maximally allowed to gain, are the most limiting factors of the current track caused by the steepness of the current Alpine track. The new tunnel will not only increase the number of trains a day (from 214 to finally 450) but will also allow more weight each train can tow (approx. +80%) therefore greatly increasing the capacity of freight and passengers. Moreover, the travel times of the fastest trains will decrease from 75 minutes to 25 minutes for the part of the track. From Innsbruck to Bolzano the travel time will decrease from 120 minutes to 50 minutes and from Verona to Munich to 3 hours instead of 5.5 hours.

The new Brenner Base Tunnel will most importantly help maintaining and increasing the transportation of goods. In the Austria's accession agreement to the EU, the restrictions on road traffic through Austria were heavily emphasized which leads to limited number of heavy vehicles and therefore transportation of goods between Germany and Italy. From the broader EU-perspective, the aim of the new Brenner Base Tunnel is also to enhance the multimodal corridors through EU, which are part of increasing the internal cohesion of the Union. The Brenner Base Tunnel is part of the Scandinavian-Mediterranean corridor, which acts as a link between the North and the South of EU.

Rail Baltica

Currently there is no railway operating in the corridor where Rail Baltica is planned to run. The mode options consist of car, bus and plane. Figure 11 shows the travel times between the cities along the Rail Baltica route and the travel time difference compared to the planned train option. From the figure it can be seen that the planned connection would decrease the travel time compared to car and bus travel times. The travel time would be around the same as with plane in the shorter connections. On the longer trips, plane would still be the fastest option. Rail Baltica would connect the capitals of Baltic countries tighter together, as it would bring another travel option with plane-like travel time to choose from. The current populations of the cities are

435,000 in Tallinn, 630,000 in Riga, 560 000 in Vilnius and 290,000 in Kaunas. The consumer surplus from travel time savings for freight and passengers are appraised at 2.54 billion euros during the analysis period of the cost-benefit analysis.

Route	Personal cars	ΔRB	Buses	ΔRB	Airplanes*	ΔRB	RB
Riga - Tallinn**	4:05	-2:10	4:20	-2:25	1:50	+0:05	1:55
Riga - Kaunas	3:19	-1:54	3:50	-2:25	-	-	1:25
Riga - Warsaw	8:20	-4:20	11:50	-7:50	2:30	+1:30	4:00
Riga - Berlin	15:40	-8:00	19:20	-11:40	3:00	+4:40	7:40
Riga - Vilnius	3:30	-1:30	4:00	-2:00	1:50	+0:10	2:00
Tallinn - Riga**	4:05	-2:10	4:20	-2:25	1:50	+0:05	1:55
Tallinn - Kaunas	7:24	-4:04	8:40	-5:20	-	-	3:20
Tallinn - Warsaw	12:10	-6:10	16:20	-10:20	2:40	+3:20	6:00
Tallinn - Berlin	17:00	-7:20	23:50	-14:10	3:20	+6:20	9:40
Tallinn - Vilnius	7:00	-3:05	8:50	-4:55	2:10	+1:45	3:55
Vilnius - Riga	3:30	-1:30	4:00	-2:00	1:50	+0:10	2:00
Vilnius - Tallinn	7:00	-3:05	8:50	-4:55	2:10	+1:45	3:55
Vilnius - Warsaw	6:00	-2:50	7:45	-4:35	2:10	+1:00	3:10
Vilnius - Berlin	11:20	-4:30	16:30	-9:40	3:00	+3:50	6:50
Vilnius - Kaunas***	1:10	-0:35	1:30	-0:55	-	-	0:35
Kaunas - Riga	3:19	-1:54	3:50	-2:25	-	-	1:25
Kaunas - Tallinn	7:24	-4:04	8:40	-5:20	-	-	3:20
Kaunas - Warsaw	5:30	-3:10	7:10	-4:50	-	-	2:20
Kaunas - Berlin	10:50	-4:50	14:20	-8:20	-	-	6:00
Kaunas - Vilnius***	1:10	-0:35	1:30	-0:55	-	-	0:35

* Including security check in and boarding time - 1 hour
** Currently there is a 1520 mm train operating between Tallinn - Tartu- Valga/Valka - Riga. Journey takes approximately 8 hours
*** Currently there is a 1520 mm train operating between Vilnius and Kaunas. The journey takes between 1:09 hours and 1:36 hours.

Figure 11. Travel times between cities along the planned Rail Baltica route (EY, 2017).

Helsinki-Tallinn Railway tunnel / FinEst Link project

The connection between Helsinki and Tallinn is currently operated by several ferry companies with the travel time of around 2 hours. The proposed tunnel would reduce the travel time to 40 minutes. In the cost-benefit analysis, it is also argued that the waiting time will decrease by 20 minutes and access time by 30 minutes. The final time saving would therefore be two hours and ten minutes. In the cost-benefit analysis, the consumer surplus from the project is valued at 3.3 billion euros during the 30-year analysis period. The consumer surplus is divided into travel time savings for current users (1 186 million euros), level of service benefits (91 million euros) and consumer surplus for new users (1 767 million euros).

The tunnel would connect two capitals, Tallinn, and Helsinki closer together, bringing the capitals with the population of 635,000 in Helsinki and 425,000 in Tallinn closer together. In the final report of the feasibility study for the project bases its wider economic impact analysis on the accessibility change of the NUTS 4 regions in Finland, Estonia and Latvia. The accessibility changes themselves are not reported, as only the wider economic impacts of the project calculated through the accessibility changes are shown.

Summary

The comparison of accessibility changes of megaprojects shows that they all significantly decrease the travel time between large cities. However, most project appraisals lack a spatial analysis of accessibility changes that consider changes in reachable land use. Such analyses would help analysing regions that gain and lose due to the project.

3.2. Standard cost-benefit-analysis

A standard cost-benefit analysis was found of nearly all projects in the study[5]. The analyses were compared in terms of effects appraised, length of the analysis period, discount factor used and general results. Table 2 and Table 3 show the comparisons for each cost-benefit analysis.

The cost-benefit analyses showed some differences in the effects appraised. Clearly the later analyses include more effects compared to the earlier ones. The EU guidance for transportation project evaluation (European Commission, 2014) that guides the cost-benefit analysis for European countries might have standardised the analyses since its release[6]. The cost-benefit analysis of Fehmarnbelt fixed link in 1999 also included the regional employment effects, which are not part of the standard analysis anymore. This has a rather large effect on the cost-benefit ratio (CBR) of the project, as without the regional employment effects, the ratio falls into the range of 1.03–1.48, which on the other hand is closer to the later CBR made by the Danes. This analysis found that the CBR for the immersed tunnel version of the project was exactly 1. The projects also differed in their definition of benefits and costs. Some projects defined only the investment cost as an economic cost when others included residual value and maintenance costs to the cost of the project. These differences in the definitions do not change the net value of the project but do influence the benefit-cost ratio. The definition in the EU guidance is to include maintenance cost and residual value to the cost of the project (European Commission, 2014).

A direct comparison of the cost-benefit analyses is difficult, since the appraisal periods and discount factors differ a lot between the projects. Shortest appraisal period of the projects was 30 years and the longest was 100 years, which was deemed as the life cycle of the Fehmarnbelt tunnel in the 1999 cost-benefit analysis. The most used appraisal period was that of 30 years, which is also the EU guidance benchmark for rail projects. The discount factors for the analyses differed between 3% and 6%, which influences the future benefits of the project. The discount factor controls how valued future benefits are compared to benefits closer to present day. A higher discount factor implies that the decision maker values future benefits less compared to present benefits than with a lower discount factor.

The newest EU guideline for cost-benefit analyses sets the benchmark discount rate to 5% for cohesion countries and 3% for other member states. The benchmark also allows for different rates if *i) justification is provided for this reference based on an economic growth forecast and other parameters; ii) their consistent application is ensured across similar projects in the same country, region or sector.* The Commission also encourages member states to provide their own discount rates and use them consistently in project appraisal at national level. (European Commission, 2014).

Another difference in the appraisals are the exact methods for the analyses. The methods with which the benefits are appraised were not discussed in length regarding many of the projects, which makes it difficult to assess their validity. Some projects have also been under criticism for the demand analyses made about the projects. A thorough assessment of the travel time savings and travel cost savings achieved through a project requires a travel demand model and a good description of the baseline scenario and appraisal scenario. The difference in the analysis tools relates to unavailability of common travel demand models, as not every country has a national model and even when they exist, the models need to be combined when evaluating cross-border projects.

[5] The availability of Cost-benefit data was limited for Brenner Base Tunnel. The analysis for the Helsinki-Tallinn tunnel project was based on the data of the FinEst Link Feasibility study, while the Finest Bay Area project, based on private finance, has not published a CB-analysis.
[6] An earlier version was European Commission (2008).

Keeping these differences in mind, the projects seemed to be socio-economically profitable with the only exception of Helsinki–Tallinn tunnel which had a CBR of 0.45. The costs and benefits of each project are measured in billions of euros.

Table 2. Effects that were appraised in the cost benefit analyses.

	Travel time savings	Travel cost savings	Maintenance costs	Ticket sales	PT costs	Tax income	Safety	Green-house gasses	Local pollution	Noise
Öresund Fixed Link (1987)	X	X	X							
Fehmarnbelt (1999)	X	X	X					X	X	X
Fehmarnbelt (2004)	X	X	X	X	X	X	X	X	X	X
Oslo-Stockholm 2.55 (2017)	X	X	X	X	X	X	X	X	X	X
Brenner Base Tunnel (2019)	X	X	(is mentioned but hidden in calculations)				X (acci-dents)	X	X (environ-mental costs)	X (environ -mental costs)
Rail Baltica (2017)	X	X	X	X	X	X	X	X	X	X
Helsinki-Tallinn (FinEst Link 2018)	X	X	X	X	X		X	X	X	

Table 3. General results from the cost benefit analyses of the megaprojects.

	Time period (yr)	Discount factor (%)	Price level	Cost (bn€)	Benefits (bn€)	Net benefits (bn€)	CBR	Notes
Öresund Fixed Link (1987)	30	5	1985	0.99	1.66	0.67	1.68	Sensitivity analysis with 7% discount factor leads to BCR of 1.23
Fehmarnbelt (1999)	100	3	1996	3.55	4.5 – 6.1	1.06 – 2.86	1.27 – 1.72	Two different values of time savings used. Includes regional employment effects (value 0.86 M€)
Fehmarnbelt (2004)	50	6	2003	10.75	10.88	0.13	1	Converted from Danish unit values.
Oslo-Stockholm 2.55 (2017)	60	3.5	2016	6.05	7.37	1.32	1.22	
Brenner Base Tunnel (2019)								The values were not available in the report.
Rail Baltica (2017)	30	5	2015	4.577	5.46	0.88	1.19	
Helsinki-Tallinn (FinEst Link 2018)	30	3.5	2017	11.2	5	-6.2	0.45	Many sensitivity analyses made, in which BCR varies between 0.16 and 1.

Table 4 compares the different cost-benefit categories of the projects. The categories are divided mostly as in the EU guide to cost-benefit analysis. The reports of the analyses differed in their way of reporting the results. Some analyses had divided the categories further than others and, in some reports, only the aggregate results were reported as discounted values. Some reports reported the calculated values for the more accurate division only for some target year and not as aggregated and discounted value. In the Table 4, X marks an effect that was not appraised in the cost-benefit analysis and O marks an effect that was appraised, but not reported as an independent value. The comparison shows that most megaprojects accrue almost all their benefits from travel time savings. The projects that finance themselves through user charges have also large producer surplus benefits, which come from the user payments to use the constructed infrastructure. Rail Baltica is the only project that has sizeable environmental benefits, which is probably explained by goods transportation changing mode from trucks to rails.

Usually, the cost-benefit analysis is used as a tool to compare different alternatives for the project in terms of size and exact position of the project. This was not the case in all of studied projects though, as the analyses for Helsinki – Tallinn tunnel (FinEst Link) and Oslo-Stockholm 2.55 only included one alternative in the evaluation. Interestingly, in Öresund Fixed Link and Fehmarn Fixed Link the alternative with the best benefit-cost ratio was not the one chosen in the end. In both projects an alternative that had larger capacity, but smaller benefit-cost ratio was chosen.

Table 4. Comparison of the cost-benefit categories of the projects. X marks an unappraised effect and O marks an effect that was appraised, but not reported as an independent value.

	Fehmarn-belt (1999) VOT 1	**Fehmarn-belt (1999) VOT 2**	**Fehmarn-belt (2004)**	**Helsinki-Tallinn**	**Öresund fixed link**	**Oslo-Stockholm 255**	**Brenner Base Tunnel**	**Rail Baltica**
Total benefits	**5.5**	**7.8**	**9.75**	**5**	**1.19**	**7.18**	**-**	**5.28**
Consumer surplus	**5.5**	**7.3**	**3.38**	**3.3**	**1.19**	**4.29**	**-**	**2.54**
Travel time savings	2.5	4.3	2.73	1.3	1.19	4.29	-	0.68
Travel cost savings	2.7	2.7	0.65	0	X	0	-	0.66
Travel time and cost savings of new travellers	0.3	0.3	O	1.7	X	O	-	O
Freight carrier surplus	X	X	X	0.3	X	X	-	1.20
Tax revenue	**0**	**0**	**-0.26**	**0**	**0.00**	**0.11**	**-**	**-0.31**
Direct effects on tax income	X	X	0	X	X	0.11	-	-0.31
Tax distortion	X	X	-0.26	X	X	X	-	X
Producer surplus	**0**	**0**	**6.37**	**1.7**	**0.00**	**2.31**	**-**	**0.79**
Effects on ticket sales	X	X	6.37	2	X	3.15	-	0.79
Effects on producer costs of public transportation	X	X	0	-0.3	X	-0.85	-	0.00
External costs	**0.5**	**0.5**	**0.26**	**0**	**0.00**	**0.46**	**-**	**2.27**
Effects on traffic safety	O	O	O	0	X	0.29	-	0.25
Effects on greenhouse gases	O	O	O	0	X	0.24	-	0.85
Effects on local pollution	O	O	O	0	X	O	-	0.92
Effects on noise pollution	O	O	O	0	X	O	-	0.24

Total costs	**5.3**	**5.3**	**7.93**	**11.2**	**0.51**	**5.76**	**-**	**4.41**
Effects on maintenance costs	1.8	1.8	1.04	0.6	-0.48	-0.07	-	X
Residual value of investments	0	0	X	-1.6	X	-0.22	-	-0.17
Investment cost	3.5	3.5	6.89	12.2	0.99	6.05	-	4.58
Benefit-cost ratio	**1.13**	**1.47**	**1.23**	**0.45**	**2.35**	**1.25**	**-**	**1.20**

All case studies are cross-border rail projects, in which case the essential question is which country's cost-benefit calculation guidelines and standards are followed. There is no uniform practice in this regard based on the case-study data. For example, in the case of Fehmarnbelt, different calculations were made in the project according to Danish and German guidelines. Rail Baltica's CBA was conducted uniformly for all countries in accordance with EU guidelines. The feasibility study of the Helsinki-Tallinn tunnel (FinEst Link) included a CBA calculation in accordance with the Finnish guidelines, but the Estonian guidelines do not differ significantly from the Finnish guidelines.

3.3. Wider impact and indirect long-term impact analysis

There are major differences with respect to the analysis of wider economic impacts or indirect dynamic long-term impacts. There is no widely accepted common methods or procedures for the analysis, unlike for the cost-benefit analysis. There is a wide consensus about the possibility that significant accessibility changes can result wider impacts, in addition to direct user and producer benefits and costs. Still, there are differing views about the conditions, mechanisms, assessing methods and magnitude of the impacts.

However, in every case project selected for this study, the possibility for wider impacts outside the cost-benefit analysis have been recognized and dealt with in the documents at some level. In addition, some projects have generated studies carried out by academic researchers and various regional organisations outside the project organisations.

There are major differences between projects with respect to the geographical dimension of the impact. Brenner Pass and Fehmarnbelt have been identified by EU as bottlenecks and missing links in the Scandinavian-Mediterranean TEN-T Corridor which is one of the main logistic zones in Europe. Respectively, Rail Baltica has been named as the main missing link of the EU's North Sea-Baltic TEN-T Corridor. These projects are expected, after being completed, to increase the efficiency and decrease costs of logistics with significant economic impacts in a very large area in Europe. In addition, they are expected to create significant consumer surplus in terms of timesaving in passenger transport. These effects have been included in the Cost-Benefit-calculations which have had an important role in the decision making. The projects will generate also wider economic impacts to the regions located in the vicinity of the railways. These impacts have been studied both inside and outside the project organisations with varying objectives, approaches and results. However, according to the information received in the interviews, wider economic impacts have only had a minor role (if any) in the decision making of the investment. Instead, they have been used as pieces of information to improve the acceptability of the projects by showing that the projects benefit the regions and the firms locating and people living there.

Oslo-Stockholm 2:55 and Helsinki-Tallinn fixed link represent very different cases, with the focus in the economic impacts on the major city regions in both ends of the connection, and in the case of Oslo-Stockholm also in the station regions alongside the rail. Neither project belongs to the priority list of EU's TEN-T corridors. Both railways are planned to serve logistics, as well, but its role is rather minor. Instead, the focus is passenger transport. Direct impacts are mainly based on time savings of passengers, especially business journeys and commuting. Consequently, there are high expectations of significant direct benefits via consumer surplus but also wider economic impacts via labour markets, property markets and agglomeration. In these projects wider economic impacts have been studied within the project separately or as a part of the feasibility studies, applying various approaches and methods. While the decisions of implementing the projects have not been made it is too early to conclude what is the role of this information in the decision making.

Öresund fixed link was constructed without EU's contribution in 1990s but afterwards it has been recognized as an important link in the Scandinavian-Mediterranean TEN-T Corridor. During and after the construction of the link several studies have been published on wider economic impacts, and the regional development has been monitored by various indicators especially from the viewpoint of the city regions of Copenhagen and Malmö. However, when the decision of the investment was made, wider economic impacts did not have a major role.

Table 5. General results from the wider impact analyses of the megaprojects.

	GDP	Producti-vity / agglo-meration	Employ-ment	Population	Real estate markets / land use	Regional competiti-veness	Impacts of construc-tion of investment
Öresund Fixed Link			X	X	X	X	
Fehmarnbelt		X	X				
Oslo-Stockholm 2.55		X	X	X	X	X	
Rail Baltica			X				X
Helsinki-Tallinn FinEst Link		X	X		X	X	X
Helsinki-Tallinn Finest Bay	X		X	X	X		X
Brenner base tunnel			X				X

Öresund fixed link

In the proposal of the Swedish Government (1991) on the construction of the fixed connection over Öresund, possible impacts on regional competitiveness, economic integration and growth, labour markets, population growth, housing or real estate markets etc. was not dealt with or were given very little weight. Instead, the main arguments for accepting the project were:

- transport economics: faster and more efficient connections; reasonable financial plan
- improving cohesion between the Swedish and Danish regions around the Öresund
- environmental aspects.

It is not fully clear what kind of role the wider economic impacts had in the planning stage and in the decision making of the fixed link in the regional or national levels.

However, the realisation of the Öresund fixed link generated a lot of analysis and follow up studies about the cross-border integration of labour and housing markets, regional competitiveness, and innovation development.

Öresunds statistic och analyser http://www.orestat.se/sv/analys was an active producer of descriptive analysis on the whole Öresund region (covering Skåne in Sweden and Sjælland, Lolland, Falster, Møn and Bornholm in Denmark) up till mid-2010s. Themes: regional economy, population, business structure and clusters, labour markets, commuting, housing markets, mobility, Copenhagen airport, transport etc.

The book Öresundsregionen – den dynamiska metropolen (Öresund region – the dynamic metropolis) by Åke Andersson, David E. Anderson and Christian Wichmann Matthiessen (2013) study the theoretical background of regional economic development, the profile and role of Öresund region in Scandinavia, the impact of fixed link on the economic development of the region and its potential for further growth. They found the role of the fixed link very significant for the economic and social development in the whole region but especially in the city of Malmö and its neighbourhood.

The paper by M. Aa. Knudsen and J. Rich (2013) presents an ex-post socioeconomic assessment of the Öresund Bridge since the opening in July 2000. The study applies historical microdata to reconstruct the travel pattern with no bridge in place and compare this to the current situation. To complete the socio-economic assessment, the consumer benefits including all freight and passenger modes, are compared with the cost profile of the bridge. The monetary contributions are extrapolated to a complete 50-year period. It is revealed that the bridge from 2000–2010 generated a consumer surplus of 2 billion € in 2000 prices discounted at 3.5% p.a., which should be compared with a total construction cost of approximately 4 billion €. Seen over the 50 years period and by assuming a medium growth scenario the bridge is expected to generate an internal rate of return in the magnitude of 9% corresponding to a benefit-cost rate of 2.2. While significant direct impacts are a necessary condition for wider impacts, the results indicate that the fixed link has had a positive wider impact on the regional economy in the Öresund region.

Fehmarnbelt

According to the documents published by the Fehmarnbelt project the decision making of the project has been based on the technical preconditions, cost-benefit analysis, environmental assessments, financial calculations, and legal considerations.

Intraplan Consult GmbH (2019) carried out a study of dynamic transport effects of the Fehmarnbelt fixed link (FBFL) in addition to those considered in the FTC study (Femern A/S 2014). The objective of the study is to show that infrastructure projects lead among others to "induced traffic". Induced traffic is defined as traffic which would not take place without the projects, neither on other routes, with other modes or to other destinations. There are two main categories of "induced traffic":

- Additional or more frequent trips or transports to existing destinations (attractors) and from existing generators because travel times or travel costs are reduced by the project.
- Additional trips or transports due to effects of the project on local/regional economy, housing, tourist sites, logistics sites, etc. that means due to changes in the numbers of generators and/or attractors.

The study complains that if induced traffic is considered in the case of FBFL, the transport volumes would be 18% higher than without induced traffic.

The model used in the study considers intensified interaction due to better accessibility. It is noted that there is a certain inertia with settlement and social structures. The dynamic effects probably take some time to set in structures. The results should also be a motivation for the regions along the axis Hamburg – Oresund region to push regional development of economy, tourism and social interaction. FBFL opens big chances to develop this axis to a centre of growth resp. an axis of growth between Central and Northern Europe.

Christian Wichmann Matthiessen (2015) analyses the impact of FBFL on the economy of the whole Baltic Sea region. According to his view there has been a missing link between Denmark and Germany and when a major missing link is replaced with a fixed link it has a major impact on the economy of a large geographical area. He considers the connection between the FBFL with Öresund fixed link (opened 2001) and Great Belt bridge (1998) which together will improve remarkably the accessibility between Sweden and Denmark and Central Europe. The dynamic effects of the tunnel under the Fehmarnbelt will enhance the potential of cities on the international stage. It is about the development of functional, cross-border urban regions where new economies of scale can be established and new specialisations developed, with all that implies in terms of new value growth. However, his analysis is based purely on a theoretical framework without any empirical investigation or other estimations of the impact magnitude.

Oslo-Stockholm 2.55 railway

A special report “Oslo-Stockholm Wider Socioeconomic Benefit Analysis 2040” was published by Sweco (2017). The study analyses the socioeconomic benefits from eight different perspectives:

1 Travel time savings (monetary value of benefit)

- Accounting of user benefits via travel time saving based on the methods applied by transport authorities and assumptions made by the project.

2 Benefits for the labour market (number of new jobs, monetary value of benefit)
- Accounting of benefits based on by transport authorities' DYNLOG and SAMLOG -models and assumptions of the project.

3 Benefits for the business sector (monetary value of benefit)
- Accounting of benefits based on by transport authorities' DYNLOG and SAMLOG -models and assumptions of the project.

4 Real Estate and Housing benefits (number of new dwellings, monetary value of benefit)
- Number of new dwellings and their location and completing time distributions.
- Economic benefit of new dwellings.

5 Social benefits (monetary value of benefit or harm reduction)
- Definition and quantifying of social benefits which depend on several local processes.

6 Benefits for the integration (of foreign migrants)
- Improvements for asylum seekers and new arrivals to facilitate integration into society.

7 Study benefits
- Improvements for more people to receive increased opportunities for higher education.

8 Environmental benefits (monetary value of benefit)
- Accounting of environmental benefits based on by transport authorities' models for socioeconomic impact assessment of the project.

In the report the mechanisms and processes concerning the connection between the railway project have been described clearly. However, the calculation methods and assumptions of the monetary values and other quantitative indicators remain unclear in some themes.

Rail Baltica

Wider economic impacts have not been dealt with in the two main reports of the project (Aecom 2011; EY 2017). However, the basic arguments for the Rail Baltica were based deeply on the objectives of the Baltic states to integrate to the European transport network and economically and socially with EU (see section 3.4).

A general presentation of socio-economic and other benefits of Rail Baltica is included in the information set of the project (https://info.railbaltica.org/en):

- *A Powerful Catalyst for Sustainable Economic Growth in the Baltic States*
- *A New Standard of Passenger and Freight Mobility*
- *New Economic Corridor Will Emerge*
- *Sustainable Employment and Educational Opportunities*
- *An Environmentally Sustainable Infrastructure*
- *New Opportunities for Multimodal Freight Logistics Development*
- *New Intermodal Transport Solutions for Passengers*
- *Safety and Performance Improvements*
- *A New Value Platform for Digitalization and Innovation*
- *Completion of Baltic integration in the European Union transport ecosystem.*

Each benefit statement has been explained by a short text but the reasonings are very brief and general. In addition, a calculation of the employment impacts of the investment construction has been provided.

However, some studies have been made on the wider (or indirect / induced / dynamic) economic impacts applying various approaches, methods, and regional definitions (eg. Lentso 2017; Terk et. al. 2019). The studies have served as catalyst for public debate about the project and to improve the acceptability of the project. However, their role in the decision making has been only marginal.

Brenner Base Tunnel

The Brenner pass has been named as one of the main bottlenecks and missing links of the EU's Scandinavian-Mediterranean TEN-T Corridor. Consequently, the main objective of the BBT project is the removal of this bottleneck and making it possible to increase the capacity and effectiveness of the cargo logistics between Italy and Central and Northern Europe. Another main objective is to reduce major adverse environmental impacts to the sensitive Alpine environment by transferring traffic to the tunnel and by the modal shift from road to rail. Consequently, the analysis of the impact has been concentrated in the direct ones: cost saving benefits of logistics and environmental effects. These analyses have been in the focus of the decision-making process since the start of the project.

The regional organizations have carried out some studies on the economic impacts from the point of view of the regions near the connection. The Chamber of Commerce of Bolzano commissioned a study on the construction of the BBT in 2012. The focus of the study was on the direct and indirect impact of the construction phase and operating phase on value added and employment of the region. (Actionsgemainshcaft Brennerbahn 2012).

Helsinki-Tallinn Railway tunnel

The feasibility study of **FinEst Link** (2018) included an analysis of the wider economic impacts. It was carried out following the assessment instructions of UK (Department for Transport, 2014). The theoretical framework and basic lines of the procedure are explained in section 2.3 and a summary of the results concerning the assessment of FinEst Link in section 3.6.

The study on wider economic impacts focused on the growth of the national economies of Finland and Estonia and on macro-regional development. The estimation of wider impacts (see section 2.3) was based on the model and evaluation instructions developed in the UK.

According to the results, the wider economic impacts to GDP in total, in the whole impact area, range between +4,000 and +6,900 million euros in 30 years (present value, interest rate 3.5%). The agglomeration impact, based on the positive effect of increased accessibility on the productivity of firms in Finland and Estonia, forms the most important positive factor. Increase of jobs via work relocation due to improved attractiveness and improved productivity forms another major component of the wider economic impacts. In addition, labour supply increase via better match within more integrated labour markets create economic benefits. Finally, benefits of increased competition between firms due to enhancing market areas has a small effect on the economies.

It was estimated that a half of the wider impact net benefits would come to the Helsinki region, more than a third to Tallinn region, one tenth to the rest of Finland, and about 5% to the rest of Estonia and Riga region in Latvia.

The effects of the fixed link on the property markets and land use in Helsinki and Tallinn was also analysed separately from the wider impact analysis referred above. According to the results the accessibility change decreases fast with respect to distance from the stations and consequently, the price effect will be focused on business property around the stations. The raise of property prices due to higher demand would stimulate the property development activity and increase the density of the urban structure in the impact areas.

The employment impact (direct and multiplicative) of the investment during the construction phase were also estimated while the impacts of the construction have not been included in the wider economic impacts.

The **Finest Bay Area** project differs from the other mega-projects selected in this study because it is not based on public finance neither from the states of Finland and Estonia, nor EU. Instead, its finance is based on private international investors. Consequently, the focus is on the business plan and cash flow calculations.

The project has not carried out a standard Cost-Benefit analysis which is normally required in the publicly financed projects. Still, the project has made and published analysis on the impacts of the project on GDP and employment in Helsinki and Tallinn regions.

The main economic impacts to the countries and regions of the project are based on the construction of the tunnel and railway, construction of housing in the station neighbourhoods in Helsinki and Tallinn regions, and the effects generated by new inhabitants and jobs.

As explained above (section 3.2) in the case of projects based in public finance the economic impacts of construction should not be included as the benefits of the projects at national level. The reasoning is that the net socio-economic impact of public expenditure and private sector direct income is zero because private sector revenue is equal to public cost (at national and EU level). However, the situation is different in the case of private investments, and the employment generated by the investment can be considered as a net addition to the total employment at regional and national level.

3.4. Comparison of financing models

Öresund bridge and Fehmarnbelt: State guaranteed loans and turnpikes, railroads not in large role due to EU regulation.

Öresund bridge is financed through loans on domestic and foreign financial markets. The loans are repaid over time through revenue from the bridge, in that customers pay a fee to cross the bridge.

The Fehmarnbelt link will be built according to the Danish state guarantee model, which also financed the fixed links across Storebælt and Øresund. The model is based on state-guaranteed loans, which will be repaid over time using revenue from users. In addition to user payment, the project receives co-financing from the EU. This money is granted by the European Commission within the framework of its TEN-T programme. The EU support need not be repaid.

The project’s self-financing capacity is the key element in the state guarantee model: it means that even if certain parameters in the project should change for the worse – e.g. lower initial traffic volume or higher interest rates than anticipated in the original financial calculations – this does not require new policy decisions or mean the risk of ongoing capital injection by the owner. Such variations during the actual operation of the project can instead be absorbed in the form of adjustments to the repayment period – as long as the project does not reach a point where the net profit is not able to cover the year-to-year interest payment on the debt. Another significant advantage of the state guarantee model is that it has low and stable finance costs – only marginally higher than the state’s own finance costs and thus significantly lower than for private financing. Additionally, the state can maintain control of a number of strategic decisions in the project, for example, the tender strategy and fixing toll charges. The state continues to bear the residual risk in the project. If it turns out that the project does not live up to expectations, and that revenue from user payment is not sufficient to repay the debt, the state will ultimately have to cover the resulting shortfall. With private financing solutions that risk is transferred to private investors. Hence the higher finance costs of the private solution. Few or no private funding companies in the market have the size and strength to take on such mega-projects covering more than a decade of construction and several decades of repayment period.

Oslo-Stockholm 2.55: (Oslo - Stockholm 2.55 AB, 2019) State guaranteed loans, state and municipality direct loans, own investment. Amortisation of loans through special track fees paid by the train operators and possibly grants.

The public authority, in this case the Governments (the project owner), will transfer all responsibility for project planning, construction, funding and promoting the goal of the concession (infrastructure and establishment) to the SPV - (the Concessioner) as well as the risks involved to the private operator. We propose that the SPV (the Concessioner) assumes the commercial risks (hereafter, "traffic risks") in connection with the use of the infrastructure and establishment. The infrastructure user (the train operator) shall pay standard user-fees for the use of the tracks as well as a special fee (special track fees), i.e., in line with the principle that "the user pays". In the absence of user-fees from the users (the train operators), SPV shall bear the deficit burden. User-fees shall be agreed to be the train operator's responsibility for the first year and can thereafter be adjusted upward depending on the number of additional trains put into operation. The concession will be issued by the State and be based on a 10-year agreement period or more. In this case, the concession will be issued by the state for a period of 6+44 years. The state will ensure allocation of capacity to the SPV during the period of concession. The SPV will arrive at agreements for contracted periods of 10 years or more with the train operators.

The interested investors have provided Oslo-Stockholm 2.55 with estimates of general terms and conditions that can be expected with regards to debt financing. The project is based on the assumption that 90% of the investment amount will be financed via loans, and that the State and the regions will borrow 25% respectively, and the remaining part shall be provided by private banks. The following nominal interest rates are applicable according to the financial actors who participated in the project:

- The State: 1.2%
- Regions: 1.8%
- Private banks: 2.8%

Other conditions have been simplified and show that loans will have a period of grace during the construction period. However, the interest will be accumulated. For the first 5 years, the loans will be installment-free while interest will be paid in full. Commencing from the sixth year of operations, the entire loan will be payable over a 30-year period.

In order for the amortisation schedule to add up as planned, grants are necessary. A less aggressive amortisation schedule would allow the project to fully finance itself.

Rail Baltica: (EY, 2017) Financial analysis shows that undiscounted revenues from the project are almost four times smaller than undiscounted expenses. As a result, the project is forecasted to have negative 5.48% financial rate of return, and negative financial net present value. As the EU plans its financial support initiatives for the development of transport infrastructure in the context of multi-annual financing framework periods, the financing plan has been divided into two parts. It is assumed that the project will have the current Base case funding gap rate and EU co-financing rate of 85% during the 2015-2020 period. Therefore, various EU co-financing rate scenarios for the period after 2020 have been analysed. Moreover, some alternative scenarios include an assumption that the proportion of CAPEX, which does not have a funding gap, will be covered by some other financing facility. For lower co-financing rates than 85%, financing the investment by high leverage rates amounts is not feasible, since these loans will need to be serviced with the help of State subsidies afterwards. Bridge financing facility is not estimated here as this element would be within the scope of subsequent Rail Baltica global project studies, such as the long-term project business plan.

Helsinki-Tallinn:

Finest Bay Area: The investment is planned to be financed totally by private international investors. According to the financial plan the investment will be paid back by the income from passenger and cargo sales. With assumptions based on the estimated passenger and freight volumes, tariffs and investment costs, interest rates and inflation, the payback period of the investment is 17 years.

However, the estimated demand volumes for both passenger and freight demand with assumed tariff levels are very optimistic, considering the size and expected growth rates of the capital regions of Helsinki and Tallinn.

(FinEst Link, 2018) An availability based private financing model (low level of risk transfer, no payments from Finland & Estonia before operational phase) could be feasible with a yearly service payment/ subsidy starting at approximately 280 million euros per year during the operational period.

The project could be financed with a publicly supported debt-financing model with subsidy payments of approximately 170 million euros per year from the beginning of the operational period, adding up to 4.8 bn euro subsidy payments.

Without the assumed (EU) grants of 40% the payment would be approximately 507 million euros in year 1 of the operating period so the grant would have a material effect on the project feasibility and ratio of costs and benefits to the Finnish and Estonian states

Sensitivities show that various risks such as lack of grants or lower than expected revenues and higher than expected capital expenditures will influence the cost to the public project owners and to the comparison of public benefits and costs.

The project is most financially feasible when financed with a combination of EU grants and long-term financing backed by a public transportation support payment (subsidy or availability based) over the long term. A privately financed PPP model could be available with a subsidy payment starting at 280 M€ per year, and a public model with lower costs but increased risks for the public sector could be estimated to require a subsidy starting at 170 M€ per year.

3.5. Comparison of organization and decision-making structures

The organization and decision-making structures of the projects vary depending on the financial model.

Generally, the responsibility of both the construction of the project and the operation of railway / highway have been given to a company which is in almost all cases of this study owned by the states and/or regions, i.e. by public sector organisations.

Owners of the company are represented by the members of Supervisory Board (or an equivalent body) which role is to steer and supervise the management. The operative management is responsible for managing the construction or the operation.

Table 6. Ownership of the mega-projects.

Mega-project	Company	Owners
Öresund Fixed Link	Öresundsbro consortium	SVEDAB AB (Swedish state-owned company); A/S Öresund (Danish state-owned company)
Oslo-Stockholm 2.55	Oslo-Stockholm 2.55 AB	Karlstad Municipality; Region Värmland; Region Västmanland; Region Örebro County; City of Västerås; Örebro Municipality
Fehmarnbelt tunnel	Femern A/S	Sund & Bælt Holding A/S (owned by the Danish Ministry of Transport, 100%)
Brenner Base Tunnel	BBT SE	ÖBB (Österreichische Bundesbahnen), 50%; TFB (Tunnel Ferroviario del Brennero Holding AG), 50%, owned by RFI (Rete Ferroviaria Italiana), and provinces of Bolzano, Trento and Verona
Rail Baltica	RB Rail AS	Republic of Lithuania (Ministry of Transport and Communications); Republic of Latvia (Ministry of Transport);

		Republic of Estonia (Ministry of Economic Affairs and Communications)
Helsinki–Tallinn Railway tunnel	FinEst Link: No company	
	Finest Bay Area Development Oy	AFRY Group Finland Oy; A-insinöörit Oy; China Railway Group Limited (CREC); Fira Group;

3.6. Political processes, interest groups, neighbour country issues

According to the interviews, the political processes for transport project approval can be divided into two categories: parliamentary decisions and civil servant decisions. The formal processes for cross-border projects start with a memorandum of agreement by governments of both countries and continue with their respective national processes. The interviewees generally did not find any major clashes between the decision-making processes but noted some grievances with possible differences in the timeline of the approval. Especially concerning the Fehmarnbelt fixed link, the civil servant lead process for the project's approval was vastly slower compared to the Danish parliamentary decision to build the fixed link. No general notions could be drawn about the speed of the different processes, as the Swedish civil servant lead process was said to be effective. Difficulty in the parliamentary process can results to difficulties in getting the project on the parliament's discussion agenda, as they are time constrained in handling all the matters that need to be addressed.

Usual interest groups in addition to political parties and transport ministries include environmental organisations, regional economic organisations, affected companies and to some extent the local population. For example, the Öresund bridge and Fehmarnbelt fixed link can be at least partly attributed to the European Roundtable of Industrialists and their report on missing transport links in Europe published in the 1980's. Environmental organisations have been worried about the environmental consequences of the projects and have had some success in tightening the environmental oversight and ambition of the projects. Having positive experiences on well executed environmental oversight also seems to alleviate similar concerns in countries, as the Fehmarnbelt fixed link did not raise similar environmental concerns in Denmark as Öresund bridge did. At the same time, environmental organisations in Germany opposed the Fehmarnbelt fixed link. The railway projects have also been promoted by the project organisations as environmentally friendly due to their projected decreases of greenhouse gasses. Companies that are affected by the mega-projects include regional firms which recognise the possibilities brought by the improved access. On the other hand, transportation companies that have served the connection before, have advocated against the projects. This has been especially clear in the Öresund, Fehmarnbelt and Helsinki-Tallinn projects, where the connection has been served by ferry companies before the construction of the link. Local population has had mixed feelings about the projects, as they have worried about the disruption caused by construction and additional traffic volumes in the area but have also promoted the increased mobility and possible integration of the regions that the projects bring.

4. Conclusions and lessons to be learned

4.1. Summary

Cost-Benefit Analysis on transport economic impacts has become a standardized process and achieved a strong role in the impact evaluation of large transport projects in EU and in other developed countries. There is a broad consensus that investments in transport infrastructure may have wider economic and societal impacts outside the direct external ones, but the wider effects can only exist if there are significant positive direct effects to households and firms using the transport infrastructure.

In this study we make a comparative analysis of selected cross-border transport mega-projects in Europe. How was the impact assessment carried out? What are the contents of the analysis and which methods are applied? For a background we present a framework of the economic impact analysis of transport system and accessibility changes, based on a literature review. The result, a discussion paper, will hopefully feed discussion by both planners of the transport systems and stakeholders of the EU-level and national transport policies. The discussion paper aims to support development towards more comprehensive and standardized practice of impact assessment in large transport projects in the EU.

Economic background

The major priority of EU has been to integrate European countries and regions by enabling free mobility for goods, services, people, and capital. Within EU transport has been understood to be fundamental to the economy and society.

Accessibility is the basic requirement for the transport of goods and mobility of services and labour between regions, and furthermore for trade and specialization. It is also needed for migration and commuting of people. The development of transport infrastructure and accessibility has for a long time had a dramatic impact on trade, economic growth, and social change at regional, national, and even global level. However, the impacts of the transport investments in the rich, developed countries with reasonably well functioning modern infrastructure, cannot be compared with the impacts of the new railways in the nineteenth century.

In a developed, modern country transport projects do not automatically lead to significant economic impact. The precondition for the effects is that the regional economies can take advantage of the accessibility benefits created through the transport project. In addition, the planning system and policymaking must allow for changes that create the conditions for the effects to materialize.

Impact analysis

Cost-Benefit Analysis (CBA) is a widely used tool for evaluating projects, especially in the field of transportation. The basic concept of CBA is to evaluate a project by its consequences, weighing the benefits that incur from completing the project against the costs in doing so. To find out the costs and benefits of a project, the analyst must be able to compare the state of the world with the project and without the project. This is usually done with a model in which different effects are compared to each other to determine the total amount of benefits that accrue from the project. The usual way is to convert the benefits into monetary terms with shadow prices. Typical effects that are appraised in transportation cost-benefit analysis are: travel time savings, travel cost savings, effects on: maintenance costs, ticket sales, producer costs of public transportation, tax income, traffic safety, greenhouse gases, local pollution, and noise pollution.

Wider economic impacts arise because the benefit of a change in the transport system to society may differ from the benefit perceived by an individual transport user. The sum of user benefits therefore does not necessarily represent the total gain to society. In addition to the direct impacts, accessibility improvements due to an investment can affect the productivity of businesses directly or materialise through the labour market, the product market or the land and property market. Lower transport costs may lead to lower production costs and better productivity. Productivity can increase along with the growth of the size or density of a city or improved transport links between urban centres or other production locations. Enhanced accessibility may lead to larger labour market areas and affect employment rates and the incomes of the working-age population. Consequently, they can influence the tax revenue of the state, municipalities, and regions. Decisions on mega-projects are normally based on national level transport policy. However, the regions and municipalities have a crucial role in creating the conditions by which the positive wider economic impacts can realize, e.g. regional and local land use planning, station area design and development, and improvement of connecting transport.

There is no generally accepted methodology or procedure for evaluating wider economic impacts, unlike in the case of cost-benefit analysis. Project evaluation guidelines for several countries assess the effects on productivity, production, and employment due to improved accessibility. There are differences in the guidelines as to whether the wider economic effects are included in cost-benefit statement or whether they are presented separately. In the case of publicly financed projects the effects of construction generated by the transport investments on economy have been comprehensively excluded from the assessments. The reasoning is that the impact of public investment on the flow of income channelled elsewhere in the economy is offset by the cost to the society. However, the impacts of major transport investments and accessibility changes on output, labour markets, migration and population and land use, as well as the effects of construction are interesting from regional viewpoint, even if some of those impacts cannot be regarded as societal benefits.

Indirect impacts on regional economies consist of alternative approaches to the possible additional economic effects outside the direct impacts above. It consists of various identified procedures:

- Short-term multiplier effects: The value of economic activity following the money spent on construction and purchases during the investment period.
- Long-term effects on regional economic development: The structural changes in the economic development following the primary transport effects.

An alternative approach is to identify various mechanisms by which the direct impacts are forwarded to other parts of the economy:

- Direct mechanism: The most significant impact is the reduction of transport costs. Businesses of the region are offered improved accessibility to markets and resources and, the benefits of reduced costs of transport and thus enhanced productivity.
- Indirect mechanism: “Secondary” entities such as local businesses supplying inputs to directly affected businesses.
- Induced mechanism: Increased income leads to increased spending and thus to increased demand.
- Dynamic mechanism: Long-term changes in economic development; business location patterns, work force, labour costs, competition, prices, land use changes, that in turn affect the wealth in the region.

Case projects

This study is based on comparative analysis of selected mega-projects. The case projects were selected by the following criteria:

- Cross-border railway connection between at least two countries (EU’s priority)
- Location in or a strong connection with the Baltic Sea region (focus of BSR Access project)
- Mega-project (estimated investments costs more than 5 billion € in 2019 price level)
- In planning or construction phase, or completed in the 2000’s.

Selected projects:

7. Öresund Fixed Link connecting Copenhagen (Denmark) with Malmö (Sweden)
8. Oslo-Stockholm 2:55 project connecting Stockholm (Sweden) with Oslo (Norway)
9. Fehmarnbelt tunnel connecting Lolland Island (Denmark) with Fehmarn Island (Germany)
10. Brenner Base Tunnel connecting Innsbruck (Austria) with Fortezza (Italia)
11. Rail Baltica from Tallinn (Estonia) to Warsaw (Poland) over Latvia and Lithuania
12. Helsinki–Tallinn Railway tunnel connecting Helsinki (Finland) with Tallinn (Estonia) and Rail Baltica.

Comparative study on economic impact analysis of case projects

Analysis of transport system and accessibility changes of case projects is based on effective density measure. Accessibility refers to people's and goods possibility to reach places, activities and services. Transport projects increase accessibility by increasing people's and goods' mobility by decreasing travel times and travel costs. The comparison of the accessibility changes of megaprojects show that they all significantly decrease the travel time between large cities. However, most project appraisals lack a spatial analysis of accessibility changes that consider changes in reachable land use. Such analyses would help analysing regions that gain and lose due to the project.

A standard cost-benefit analysis was found of nearly all projects in the study. The analyses were compared in terms of effects appraised, length of the analysis period, discount factor used and general results. The cost-benefit analyses showed some differences in the effects appraised, the later analyses including more detailed analysis compared to the earlier ones. The EU guidance for transportation project evaluation (2014) might have standardised the analyses since its release.

A direct comparison of the cost-benefit analyses is difficult, since the appraisal periods and discount factors differ a lot between the projects. A higher discount factor implies that the decision maker values future benefits less compared to present benefits than with a lower discount factor. Another difference in the appraisals are the exact methods for the analyses. The methods with which the benefits are appraised were not discussed in length regarding many of the projects, which makes it difficult to assess their validity. A thorough assessment of the travel time savings and travel cost savings achieved through a project requires a travel demand model and a good description of the baseline scenario and appraisal scenario. The difference in the analysis tools relates to unavailability of common travel demand models, as not every country has a national model and even when they exist, the models need to be combined when evaluating cross-border projects.

Keeping these differences in mind, the projects seemed to be socio-economically profitable with the only exception of Helsinki–Tallinn tunnel which had a Cost-Benefit-ratio (CBR) of 0.45.

There are major differences with respect to the **analysis of wider economic impacts** or **indirect dynamic long-term impacts**. In every case project selected for this study, the possibility for wider impacts outside the cost-benefit analysis have been recognized and dealt with in the documents at some level. In addition, some projects have generated studies carried out by academic researchers and various regional organisations outside the project organisations. There are major differences between projects with respect to the geographical dimension of the impact.

Brenner Pass and Fehmarnbelt have been identified by EU as bottlenecks and missing links and Rail Baltica has been named as the main missing link in their TEN-T Corridors. These projects are expected, after being completed, to increase the efficiency and decrease costs of logistics with significant economic impacts in a very large area in Europe. In addition, they are expected to create significant consumer surplus in terms of timesaving in passenger transport. Wider economic impacts have only had a minor role (if any) in the decision making of the investment. Instead, they have been used as pieces of information to improve the acceptability of the projects by showing that the projects benefit the regions and the firms locating and people living there. Öresund fixed link was constructed without EU's contribution in 1990s but afterwards it has been recognized as an important link in the TEN-T network. During and after the construction of the link several studies have been published on wider economic impacts, and the regional development has been monitored by various indicators. However, when the decision of the investment was made, wider economic impacts did not have a major role.

Oslo-Stockholm 2:55 and Helsinki-Tallinn fixed link represent very different cases, with the focus in the economic impacts on the major city regions in both ends of the connection, and in the case of Oslo-Stockholm also in the station regions alongside the rail. The focus of both projects is passenger transport while they would also serve logistics. Direct impacts are mainly based on time savings of passengers, especially business journeys and commuting. There are high expectations of significant direct benefits via consumer surplus but also wider economic impacts via labour markets, property markets and agglomeration. In these projects wider economic impacts have been studied within the project separately or as a part of the feasibility studies, applying various approaches and methods. While the decisions of implementing the projects have not been made it is too early to conclude what is the role of this information in the decision making.

4.2. Conclusions

Cost-Benefit Analysis

The impacts that are appraised in modern CBA are quite standardized. The appraisal methods however are rarely discussed, and it is difficult to validate the results. For example, the social discount rate adopted in the EU appraisal seems high compared to national guidelines.

The cost-benefit ratios (CBR) are generally above one in the case of projects having proceeded to the construction phase and having received AU funding. The CBR of the Helsinki-Tallinn tunnel project (FinEst Link organised by the states, regions, and capital cities) is the main exception with CBR under 0.5. This is one reason why the project has not proceeded. The appraisals seem to matter for the decision-making of the projects.

A critical component within the CBA is the estimation of the expected passenger and cargo volumes with assumed prices. Transport volumes significantly affects the results of consumer surplus estimates. The CBA-reports and other documents are not in all cases transparent with respect to the models and assumptions with respect to demand volumes.

Is there a tendency to over-estimate transport volumes? For example, the two Helsinki-Tallinn tunnel planning projects ended up to very different estimates with respect to the passenger volume in 2050: FinEst Link: 12.5 million, FinEst Bay 52 million.

Another critical component is the investment cost which in many cases ends up to significantly larger sums than estimated in the planning phase. However, there were not enough data available to carry out a cost history analysis in this study.

We recommend that in all publicly financed major project the estimations of passenger and cargo volumes and investment costs should be verified by an expert body that is completely independent of the client, financiers and those responsible for the design and initial calculations.

For the comparative analysis of the mega-projects, it is important that the main documents of the project from all stages of the project are publicly available, especially if the project receives funding from EU.

Wider economic impacts

There are major differences between mega-projects with respect to their capacity to generate wider economic impacts. These impacts seem to have a minor role in the decision making of transport projects having a high priority in the EU's transport strategy. The logistic importance of a potential transport infrastructure project in some of the TEN-T corridors is a key factor in the decision making and financing. Especially the TEN-T "missing link" projects have normally high CB-ratios which is an important criterium in the decision making.

The projects connecting two or more cities by rail and focused on passenger transport have a major challenge to show that project may have wider benefits. These projects may have significant wider impacts due to agglomeration, labour markets, and land use, in addition to direct net benefits. But there may also exist negative impacts outside the projects impact area, due to shifts of population, firms, and jobs between locations, and they should also be counted. The problem is that the methods and data are still under-developed and not standardized for this kind analysis. It is also possible that such wider impacts do not exist which could be considered as net benefits in addition to the direct impacts calculated in the CBA. Still, for example real estate development potentials and other land use impacts may be important at regional and local level even, when they may add nothing to the CBA.

We recommend that projects in which passenger transport plays an important role are required to analyse the wider impact, from the viewpoint of regional changes of at least enterprises, labour markets, land use and population. The analysis should include the potential shifts of activities between the regions and both the positive and negative effects in various regions involved.

In the analysis of wider impacts, it is important also to identify the conditions by which the positive impacts can be realized, e.g., regional development strategy, cooperation between regions, land use planning, station design, and development of transport connections. Another important issue is, how can the negative impacts in the outside locations be prevented?

It should also be noted that the impacts on transport volumes via labour markets and land use changes should be included in the CBA. For example, if improved accessibility due to a new railway connection lead to the real estate development and new inhabitants and jobs in station neighbourhoods, this may provide additional users and increasing demand for the railway. This can be considered if the demand forecasting is dealt with as an iterative process.

In any case, wider impacts have a role in political discussion, marketing of the project and improving its acceptability.

A lot of new research has been published on wider economic impacts since year 2000. New articles and reports seem to show that impacts are generally smaller than thought earlier (in 1990s). Impact mechanisms are also better known. In addition, national instructions for impact evaluation have been developed in many BSR Access countries.

Decision making and finance

Most of the case project have their origins far behind in the history. First initiatives have been presented several decades ago in several cases.

Transportation projects compete especially about time in parliamentary decision-making processes. Cross-border projects are not necessary very high on the priority list of national governments, compared with projects within a country and connecting several regions. The role of EU and the status of a cross-border project in the TEN-T network is therefore important.

Strong political willingness seems to be key in furthering mega-projects.

The project organisations mostly want to be seen as a neutral provider for information even when advocating for the project.

The mega-projects that include car connections seem to be funded or there are plans to fund them through user-financing e.g., turnpikes.

4.3. Lessons to be learned

Political will is the most important asset for a project to be realised.

Project organisations should have a clear strategy for furthering the project bit by bit in the political system.

Credibility of analyses matter and can be used to collect political capital for the project.

Analyses can and should be used to gain political capital for the projects.

Political pork barrel deals might matter when projects mostly benefit certain regions.

The over-estimation of the transport demand and under-estimation of the investment costs are major risks for the successful implementation of transport infrastructure project. Estimates of passenger and cargo volumes as well as investment costs should be verified by an expert body that is completely independent of the client, financiers and those responsible for the design and initial calculations.

Methodologies of appraisal in the CBA should be more standardised or overseen. The usage of the infrastructure brings most benefits in the CBA and there might be incentives to overstate it in the appraisal.

Instructions for the evaluation of wider impacts should be produced including instructions for the spatial analysis of accessibility changes.

Projects with passenger transport having an important role should be required study the wider impact, from the viewpoint of regional changes of at least enterprises, labour markets, land use and population.

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