UNCOVER THE ECONOMIC IMPORTANCE OF FIRST/LAST MILE FOR COMBINED TRANSPORT IN THE BALTIC SEA REGION

Activity: WP 4, Sub activities 4.1.1 and 4.1.2

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Content:

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1 EXECUTIVE SUMMARY

1.1 Overall conclusions and recommendations

The overall aim of the COMBINE project, funded by the Interreg Baltic Sea Region Programme, is to enhance the share of combined transport in the Baltic Sea Region and thereby contribute to making transport more efficient and environmentally friendly.

The analysis "**Uncover the economic importance of First/Last mile for combine transport in the Baltic Sea Region**" covers sub-tasks 4.1.1 "Uncover the different costs elements in the "door-to-door" supply chain" as well as 4.1.2 "Uncover the different cost drivers on first and last mile transports" of work package 4 "Capacity building for last mile transport", activity 4.1.

This report complements the COMBINE report "Innovative last mile solutions" which is also part of the WP 4.1. The report on "Innovative last mile solutions" have a strong focus on technical innovative solutions to strengthen combined transport, while this report is looking into the economic logistic aspects of the first/last mile transportations.

Together the two reports present an overview of technical/innovative as well as economic/logistic challenges for first/last mile combined transport.

The **overall conclusions** of the analysis are:

Sub-activity 4.1.1 "Uncover the different costs elements in the "door-to-door" supply chain":

- **First/Last mile costs in combined transport most important for shorter distances**

  The percentage of the costs related to First/Last mile transport in combined transport strongly depends on the length of the main haul – the longer the main haul, the less impact these costs have on total transport costs.

  While in some of the examples, the share of First/Last mile costs was calculated to be below 15 pct. of the total transport costs, in general a share of 30-35 pct. for transport with total distances of under 300-400 km can be expected.

- **Selected cases (Billund (DK)-Kaunas (LT) and Berlin (DE)-Stockholm (SE) underline the importance of long transport distances for rendering combined transport competitive**

  In both the selected cases a combined transport solution (using rail and rail/ro-ro ferry respectively) turned out to be cheaper than Door-to-Door road transport. Also, in both cases, a combined transport solution is the most cost-efficient of all investigated and relevant alternatives.

- **Learnings from Jula: Cooperation between stakeholders can help create viable business cases**

As the benchmarking case for the Swedish company Jula shows, transport costs for combined transport solutions can be successfully influenced by a close cooperation between involved partners and stakeholders focusing on optimising the transport solution across all parts of the transport chain.

- **Labour costs are most important in road transport and less important for rail and sea**

The labour costs for truck drivers are identified as a central cost driver in road transports and it can account for between 30 up to 50 pct. of the total transport cost. In rail and sea transport labour costs have a significantly smaller influence on the total transport costs.

- **Labour costs are the primary differentiator in the BSR and favours road transport**

There is a general wide range of prices for the different cost elements in the transport chain across the different countries in the region – but it is most pronounced for labour costs. The Scandinavian average labour costs are 240 pct. higher than the average labour costs in the Baltic countries. This favours truck transport. While recent changes in EU regulation (the so-called Mobility Package) will contribute to narrowing labour costs for local versus posted truck drivers, is not expected to have a significant influence on the current differences in labour costs though.

Conclusion for sub-activity 4.1.2 "Cost drivers on first and last mile"

- The monetary costs of First/Last mile (road) transport are the most important cost driver in First/Last mile transport.
- Empty transport is a general problem in all transport and not a specific cost driver for combined transports

Three main recommendations for more successful cases within combined transport in the Baltic Sea Region:

- Cooperation between partners leads to mutual gains and even stronger partnerships
- One-Stop-Shop offers towards the customers is a must
- Continuous optimisation of services and operations (e.g. better utilisation of rolling stock)

The methodology and detailed conclusions for the sub-activities of the analysis are highlighted in the following paragraphs:

1.2 Methodology

Combined transport in the context of the COMBINE project

The analysis follows official definitions for combined transport and as applied in the other Work Packages of the COMBINE proje

DEFINITIONS *For the purpose of the project, the COMBINE consortium partners have selected the following definitions*
Multimodal transport: Carriage of goods by two or more modes of transport
Intermodal transport: The movement of goods in one and the same loading unit or road vehicle, which uses successively two or more modes of transport without handling the goods themselves in changing modes
Combined transport: Intermodal transport where a major part of the European journey is by rail, inland waterways, or sea and any initial and/or final legs carried out by road are as short as possible
Intermodal Loading Units (ILUs): containers, swap bodies and semi-trailers suitable for combined transport. This is a mix of current definitions on intermodal transport units and intermodal loading units. Road vehicles are considered, in the context of COMBINE, as ILUs as well
Intermodal Terminal: an installation for transhipment of standardized loading units (containers, swap bodies, semi-trailers) with at least one of the modes served must be rail or inland waterway

Source: COMBINE consortium partners, based on UN Economic Commission for Europe[1]

Uncovering the economic importance of First/Last mile

The approach for uncovering the economic importance of First/Last mile for combine transport in the Baltic Sea Region was divided into three overall steps:

Quantifying cost elements

In a first step, cost data was gathered in a comprehensive review of e.g. project reports, conference presentations, literature on freight transport, commercial sources, and interviews. These sources were supplemented with own calculations to harmonise the presentation of cost elements. The results from the cost calculations were presented in ranges when multiple sources were at hand, which also illustrates the differences in prices across countries. The findings were then qualified through interviews with selected stakeholders.

Transport by truck implies mostly variable costs and those cost elements mainly depend on time and distance. They cover by and at large vehicle leasing, the driver, fuel, infrastructure fees, as well as administration fees. There are additional cost elements to be considered in combined transport, such as terminal handling fees, infrastructure fees, administration fees per train etc.

[1] Source: UN Economic Commission for Europe (UN/ECE), the European Conference of Ministers of Transport (ECMT) and the European Commission (EC), «Terminology on Combined Transport», 2001

Case studies

In a second step, the findings were tested and exemplified for relevant cases for freight transport in the Baltic Sea Region. The focus was on cross-border cases in the Baltic Sea Region covering different modes of transport. As a benchmark representing a successful existing combined transport setup, the case of Jula (Sweden) was included in the analysis.

Cost drivers in first/last mile transport

In a third and last step, a qualitative analysis of the importance of relevant cost-drivers in First/Last mile transport was undertaken.

1.3 Findings at a glance

Labour cost differences' prominent role in the comparison of cost elements

On an overall basis, the analysis confirms a significant variation in the cost elements across the different countries of the Baltic Sea Region. The identified cost elements in truck and combined transport can vary due to economic conditions with wealthier countries in general showing higher staff costs. Also, legislation, e.g. regarding organisation of terminal operation, can play a significant role for the price level. Further, the results of the analysis allow the conclusion, that the level of competition on an overall basis or in certain markets is an important driver for the business case of combined vis-à-vis door-to-door truck transport.

While cost elements in general vary across the Baltic Sea Region, one of the main conclusions is that it is predominantly **labour costs that differ widely in the Baltic Sea Region**. The average labour costs in Scandinavia are approximately 37 EUR, compared to 11 EUR in the Baltic countries. This means that the average Scandinavian labour costs are about 240 pct. higher than in the Baltic countries.

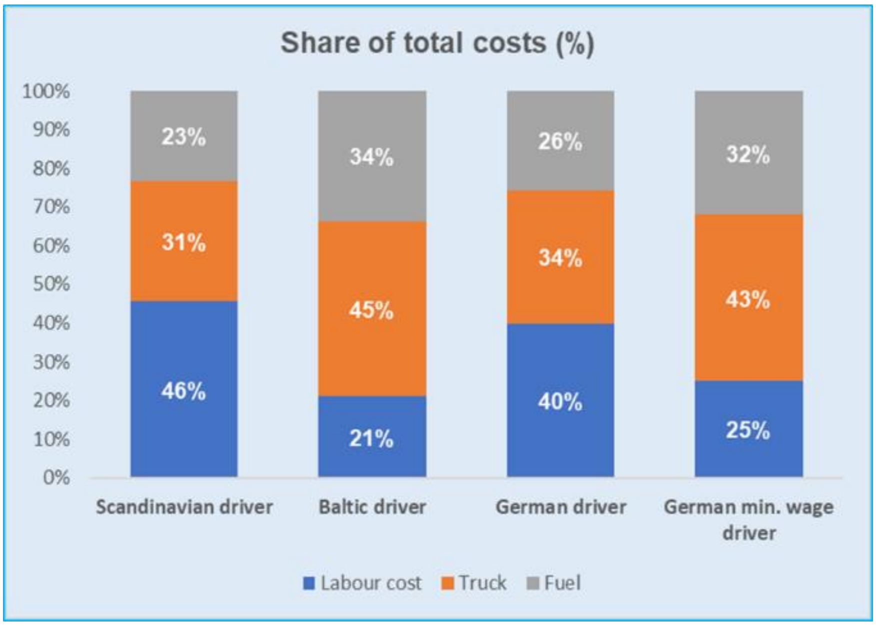
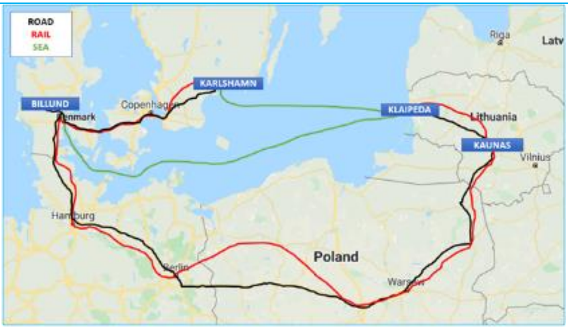


Figure 1 Composition of cost elements in road haulage based on the different labour costs (source: Own calculation)

The importance of cost elements in selected cases

From Billund (Denmark) to Kaunas (Lithuania)

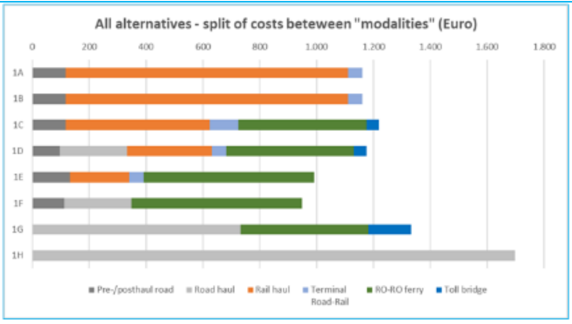
The case was defined as a transport of semi-trailers from Billund (DK) to a freight terminal in Kaunas (LT). 7 different alternatives combining different routings and combined transport set-ups were selected (1A-1G) and compared with the shortest road transport route (1H) from A to B. Due to the barrier effect of the Baltic Sea total distances ranges between 1,100 and 1,550 km.



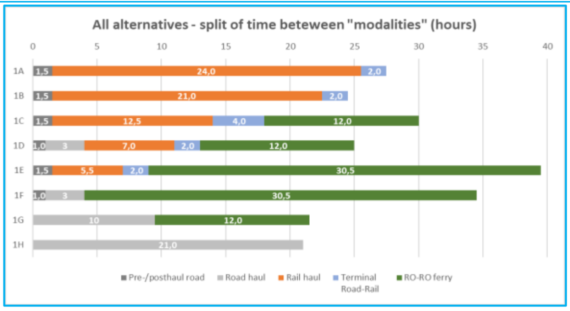
Transport costs range from 950 to 1,700 EUR with the cheapest alternative (1F) including a long ro-ro haul at 950 EUR and the most expensive one (1H) being the Door-to-door road haul at 1,700 EUR.

Due to the long transport distance, the share of First/Last mile transport costs is relatively small.

Consequently, First/Last mile transport is not a significant cost driver in this case.



Transport time span - 21 and 39.5 hours with the fastest being alternative 1H based on Door-to-door road haul and the slowest alternatives 1E and 1F, include a 30-hour ro-ro leg.



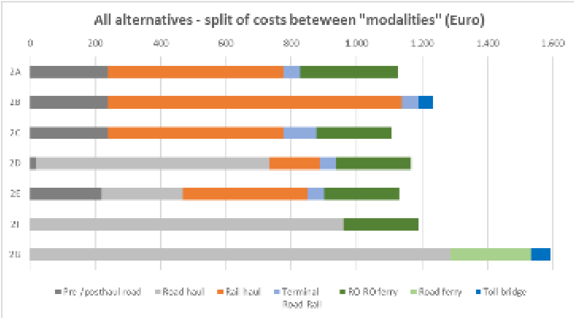
From Berlin (Germany) to Stockholm (Sweden)

The case covers export cargo from Berlin (DE) to the consumer area in the Greater Stockholm region (SE). Today, there are large quantities of cargo transported between Germany and Sweden on rail, road and sea using different routings. In total, 6 different combinations of routes and combined transport chains were chosen and compared to a direct routing by road.

Total transport costs range from 1,100 EUR to 1,600 EUR with a combination of a long rail haul and a ro-ro haul (2C) being the cheapest at 1,100 EUR and the most expensive being a combination of a long road haul and a road ferry 2G at 1,600 EUR.

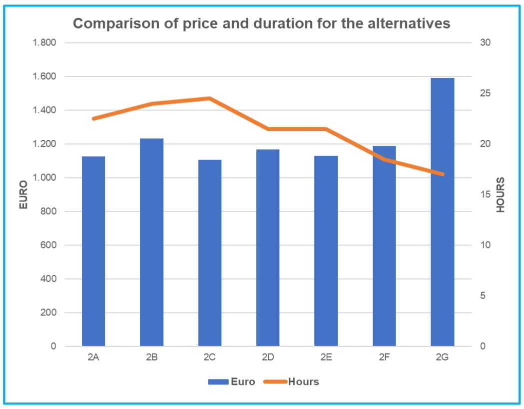
Due to the relatively long First/Last mile distance compared to the total transport distance, the share of First/Last mile costs in the total transport costs is larger than in the Billund (DK)-Kaunas (LT) example.

As a result, First/Last mile costs are a relatively important cost driver for the decision making between combined and road transport.



The comparison of the total transport cost against duration shows the same relation as for the case Billund-Kaunas. The slowest alternatives being the cheapest and vice versa

The differences in price and duration are less pronounced than in the Billund-Kaunas case due to more “direct” routes in the geography of the case Berlin (DE) – Stockholm (SE).



The main conclusion across both cases is that the road alternative is the most expensive alternative compared to the combined transport alternatives.

The key element is the long distances in both cases which results in higher total costs for the road alternative for the road hauls' higher costs on the main haul gives the high prices.

Looking at the relative importance of the different cost elements, the costs for pre/post haul and terminal handling account for 12-18 pct. of total cost in the Billund-Kaunas and 6-31 pct. of total cost in the Berlin-Stockholm case (in most alternatives above 20 pct.). The high share of costs for pre/post haul and terminal handling in Berlin-Stockholm case - primarily relates to 100 km post haul for the stretch Eskilstuna-Stockholm. The primary reason for the choice of a terminal giving a long post haul is that Stockholm is a large and densely populated consumption area. As a result, a lot of consumption goods are imported, while it can be difficult to find export cargo within the Stockholm area. Freight forwarders will thus need to look further outside the region to find cargo for the return southwards.

Jula - the good benchmark case rethinking combined transport

The case of Jula **challenges the usual way of thinking combined transport solutions**. Starting as a dedicated case focusing on developing a climate neutral combined transport solution as a vital part of the strategy, it turned out to be a viable business case.

As one of the most important success factors the cooperation across different businesses and transport operators was identified. It is due to this cooperation that the following principles facilitated the effectivization and therefore cost reductions in the business case:

- Have a base customer to guarantee large volumes to fill the trains and to secure frequency in the main rail haul service
- Focus on continuous optimisation of the different services in the transport chain
- Use longer vehicles (HCT - High Capacity Transport) with 2 x 40' containers for Last mile transport
- The use of spare capacity of locomotives from other set-ups helps reduce costs further

Only by scrutinising all cost elements and optimising the overall transport solution, Jula succeeded in creating a viable intermodal set-up. Clearly, one of the largest successes for this case is that, once the service became operational, new customers decided to shift cargo using spare capacity on the combined transport service and thus increased its profitability.

1.4 Conclusions per sub-activity

Conclusion for sub-activity 4.1.1 "Uncover the different costs elements in the "door-to-door" supply chain"

All in all, two main conclusions regarding the total transport costs and the relative importance of different cost elements influencing the decision-making on combined transport versus road transport can be highlighted for sub-activity 4.1.1:

The competitive advantage changes in favour of road transport on distances below 300-400 km

Comparing a road alternative against a combined road/rail alternative shows that the cost of road haulage is reduced faster than the cost of the rail haulage when reducing the haul length for rail and road, respectively. This is demonstrated in Figure 2 where two alternatives for a freight transport between Berlin (DE) and Stockholm (SE) are shown (2C – pre/post haul, rail, and ro-ro-ferry, and 2G combined road haul and road ferry). In the examples demonstrated, "Full distance" refers to the total transport distance of the two alternatives, respectively. "Half distance" is half the distance of the specific alternative. As distances differ between rail and road routes, "Full distance" and "Half distance" differ between road and rail alternatives.

The break-even point, where the combined transport becomes more competitive compared to road haul, is somewhere in the range 300-400 km.

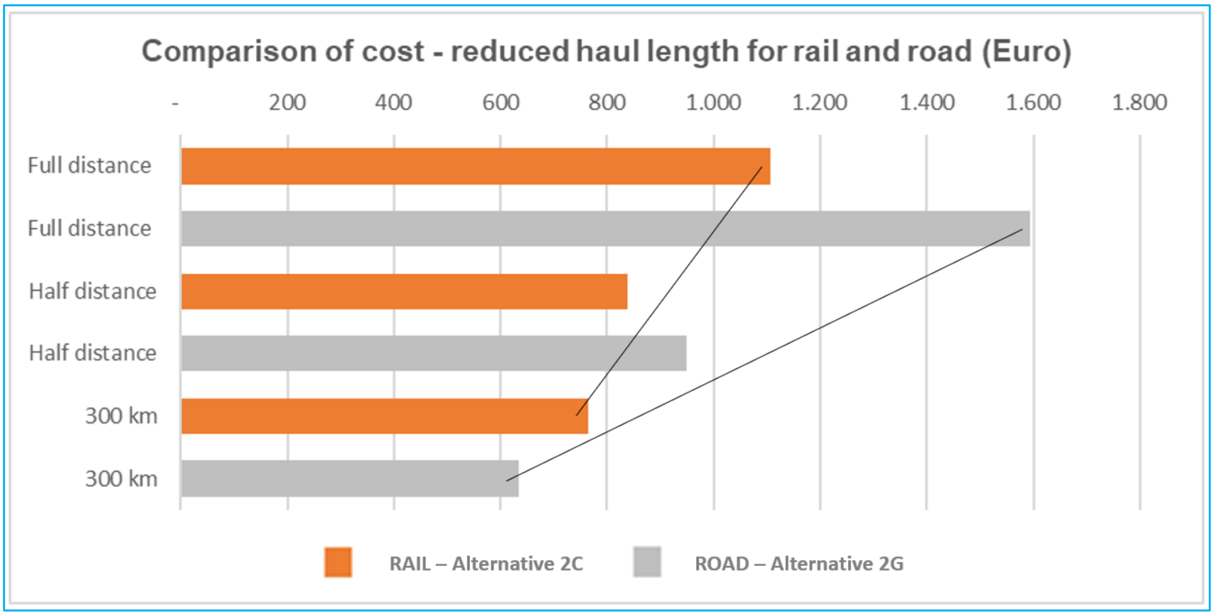


Figure 2 Comparison of costs with reduced haul length for rail and road (Source: Own calculation)

Reducing distance of the rail haul substantially increases the share of First/Last mile transport

In the same example the cost share of First and last mile transport including terminal handling grows from 31 pct. to 44 pct. when reducing the rail haul from 827 to 300 kilometre (see Figure 3).

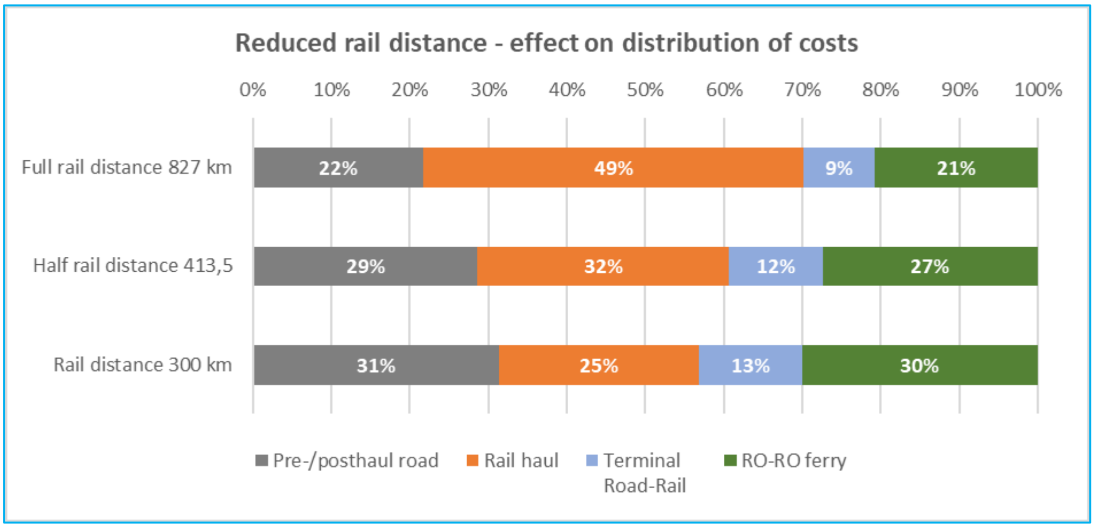


Figure 3 Reduced rail distance - the effect on the distribution of costs (Source: own calculation)

The example underlines the importance of First/Last mile costs in shorter distances compared to longer distances. The longer the distance, the easier the relatively lower costs per km for rail transport compared to road transport can influence the decision towards combined transport – bearing in mind that there are other factors (non-monetary costs) influencing the decision in the specific situation.

Conclusion for sub-activity 4.1.2 “Cost drivers on first and last mile”

Based on the analysis of the specific cost drivers on the overall cost level for the First/Last mile in a combined transport, it can be concluded that it is the monetary rather than non-monetary (time-related) cost-elements that are the primary cost drivers:

The actual costs of First/Last mile (road) transport are the largest cost driver in First/Last mile transport. The primary reason is that the start cost of a truck with a driver is “fixed” and should be distributed over the kilometres driven, along with the distance and time related costs. The longer the distance the truck drives, the lower the cost per kilometre is.

While empty transport to and from terminals was identified as the second largest cost driver, it is a general problem in all transport and not a specific cost driver for combined transports. The main reasons are that it is expensive for any transport business to have a low degree of utilisation for their vehicle fleet.

Thirdly, terminal handling in First/Last mile transport was also identified as an important cost driver. This is mainly because both transhipment (craning) and handling at terminals are relatively expensive.

As regards to short-time storage for transport units this was not identified as an important cost driver. Storage implies that there must be additional handling of the goods in question if it is not possible to collect all units at once when a train arrives.

Terminal fees as such are not an important cost driver either since access fees apply to either the whole train or ship per unit or as a combination. Terminal fees at especially ports can be counterproductive for combined transport though. This is the case if there are co-called gate fees for trains but no corresponding fees for trucks entering or leaving the terminal.

Lastly, limited operating hours at terminals are not a cost driver but a showstopper.

While the analysis confirms the overall message that ***the price of transport usually is the decisive factor in the choice of transport solution*** the results of the analysis also demonstrate that the route towards a more environmentally friendly transport has to embrace the need for creating successful business cases for combined transport by using new ways of thinking the whole transport chain.

Some of the overall conclusions from both the analysis of the specific case studies for the Baltic Sea Region as well as qualifying interviews with stakeholders from academia and market participants are:

- **Cooperation** between different partners is key to develop more efficient transport chains
- **Cooperation** between different partners to offer a "One-Stop-Shop" towards the customers
- **Continuous** optimisation can lead to better and mutual gain for the partners
- **Optimise** the service by looking at the different cost drivers
- **Utilise** the rolling stock as efficiently as possible - the right rolling stock at the right time and place
- **Use** spare capacities in the system
- **Capacity and pricing** according to the free capacity you have in your transport system
- **Consider** the transport conditions. The one paying for the transport can gain from more efficient combined transport set-ups (global transport conditions and rules can be found in Incoterms, also described in vocabulary)
- **Think modular!** In the Jula case the longer truck combinations move the double number of containers (40 ft.) leading to less costs and less emissions per unit

The case of Jula provides useful insight into factors that until now have not been in focus but are crucial for the future success of combined transport. It demonstrates the importance of widening the focus from the various cost elements, to the overall competitiveness of combined transport vis-à-vis Door-to-Door truck transport and towards an optimisation of the whole combined transport chain. To encourage the latter, it would therefore be important to develop a broader toolkit to transfer the experience of Jula to other possible cases. Also, it has to be considered that a successful implementation of similar cases across different countries in the Baltic Sea Region most likely will require a joint effort between different partners in close cooperation, where the different parts of the transport chain is scrutinised continuously in order to find better solutions. This can also be supported by different measures from EU and seconded by the Member States.

2 PURPOSE OF THE ANALYSIS

Political measures to support a shift to more rail freight and combined transport in general are nothing new. With rail freight stagnating or growing at a very small pace in many countries for many years now, many stakeholders question the efficiency of these measures though.

One of the reasons might be that little focus has been on the relevance of especially first and last mile costs in the whole transport as a possible key to strengthening combined transport. Also, there might be important differences between different countries in a region, both in terms of economic conditions as well as specific transport related policies.

The overall purpose of the analysis is therefore to provide a better insight into these issues by:

- Increasing transparency on the influence of various cost elements on the total costs for combined transport
- Assess the importance of costs related to First/Last mile transport
- Demonstrate different conditions in the countries of the BSR
- Demonstrate the influence of other factors supporting the choice of combined transport

To understand the current market position of combined transport it is important to look at the longer-term development: Starting from a position of state-owned incumbents and out-dated infrastructure in the beginning of the 1990's, for a long time the political focus in the EU as well as in the member states was on restructuring the European rail transport market as a precondition to strengthen the position of railways against especially road transport. Then, improving the interoperability and safety of national networks and developing rail transport infrastructure, are indispensable to shape a future-proof European railway network.

Besides rail freight that is seen as a more environmentally friendly alternative to road transport, the EU has also developed the "Motorways of the Sea" concept to introduce new intermodal maritime-based logistics chains in Europe. Again, the aim is to make logistics chains more sustainable, while efficiency also is important.

In line with the above priorities many studies and initiatives conducted in the last 20 years have focused on infrastructure needs regarding railroads and terminals, challenges caused by different legislations in the EU member countries impeding cross-border transport, as well as organisational challenges for organising combined transport that usually entail many stakeholders and elements in the whole transport chain.

While the conditions for a more competitive combined transport are being improved, the final decision for or against a transport mode is often determined by the price-tag: "What does a combined transport cost vis-à-vis a Door-to-Door transport by truck?" With the development of the freight transport market it seems that the decision seldomly is in favour of a combined transport. The argument for combined transport being too expensive is not always evident. One important reason is that not necessarily all cost-elements of a certain transport are visible as "out-of-pocket" costs but rather non-monetary costs. Some of these costs are time-based, e.g. due to an increased need for Just-In-Time planning for companies to avoid costly storage. Here, truck transport has an advantage due to its higher flexibility and punctuality. For a truck, the primary source of delay is road congestion, while there are various potential factors for combined transport, such as waiting time at terminals or the dependence on keeping a specific allotted slot on the railway net.

To sum up, the decision for or against combined transport solutions is not only driven by the visible **monetary costs** but also **non-monetary costs** (see box below) that influence the attractiveness of a given solution.

Cost definitions used in this analysis – Monetary vs. non-monetary costs

The price of a transport service, regardless if freight or passenger transport does not only include the direct out-of-the-pocket monetary costs to the user of the transport (in the following referred to as: monetary costs). It also includes time costs and costs related to possible inefficiencies, discomfort, and risk (e.g. unexpected delays). These are so-called **non-monetary costs**.

However, economic actors often base their choice of transport mode or route on only part of the total transport price. Many shippers or freight forwarders are primarily guided by direct monetary costs when considering the price factor in the modal choice. The narrow focus on direct monetary costs is to some extent attributable to the fact that time costs and costs related to possible inefficiencies are harder to calculate and often can only be fully assessed after the cargo has arrived.

There are significant conditions affecting transport costs and thus transport rates, such as geography (e.g. accessibility – here the Baltic Sea as a potential barrier), economies of scale (shipment size), infrastructure (capacity, limitations, operational conditions), competition (e.g. regulations, safety).

Source: Adapted from transportgeography.org, see also Bruzelius (1981)[2]

If combined transport is to have a realistic perspective for substantial gains in market share, it is key to understand the importance of the various cost elements as drivers for the decision-making of stakeholders on the choice of transport modes. The main purpose of the analysis is thus to systematically uncover the different cost elements in the Door-to-Door supply chain, as well as the different cost drivers on First and Last mile transport.

Since monetary cost elements and other important non-monetary cost drivers influencing transport decisions can expect to differ substantially, the focus in this analysis is on understanding which of these are specifically important in the Baltic Sea Region. Factors such as the willingness to pay for greener transport solutions or the possibility to establish new forms of cooperation for combined transport solutions can be important cost drivers that might differ within the Baltic Sea Region.

[2] Bruzelius (1981). "Microeconomic theory and generalised cost". Transportation. 10 (3): 233–245

This analysis should therefore be a contribution to support a more transparent and informed discussion on the influence of different cost elements as drivers for the decision on Door-to-Door truck transport versus combined transport solutions in the Baltic Sea Region.

The analysis covers the subtasks 4.1.1 and 4.1.2 of the COMBINE project and shall contribute to the main aim of WP4.1, which is to “uncover the economic importance of Last mile transportations in transport chain for combined transport, and identifying possible logistics solutions to make last mile transport more efficient and less costly”.

The COMBINE project aims at enhancing the share of combined transport in the Baltic Sea Region to make transport more efficient and environmentally friendly.

The COMBINE project follows a comprehensive approach to strengthen all parts of the freight transport chain: main leg, terminal handling, and Last mile. New technologies regarding these different parts of the transport chain as well as modern and efficient transport organisation are opportunities for the Baltic Sea Region. To inhibit pure road transport, it is vital to use the benefits of each transport mode and to optimise each part of the transport chain where appropriate.

This analysis covers WP 4 activity 4.1 (Logistics), namely the following two subtasks:

- 4.1.1 Uncover and decomposition of the different cost elements in the supply chains – for both combined freight transport as well as Door-to-Door truck transport - creating a better understanding of different cost elements in the logistics chain and economic benefit for choice of mode.
- 4.1.2 Uncover the different cost drivers on First and Last mile transport – creating a better understanding of the most important cost drivers for First and Last mile transports.

3 APPROACH

As an overall guideline for this study, the approach must ensure both the theoretical foundation as well as practical relevance of the study's outcome for the further work of the Combine project.

With the focus on understanding cost elements and their importance in the choice between combined transport and Door-to-Door truck transport in an international context, the following elements have been important to cover thoroughly:

- Clear definitions and relevant simplifications to ensure that findings can be used across the Baltic Sea Region and communicated to stakeholders
- Focus on, and transparency about data quality with a critical view on sources since transport costs are sensitive from a competitive view
- Case studies for the Baltic Sea Region that cover relevant combinations of modes in combined transport as well as resonate with and thus second the findings of the data analysis

The quality of data collection depends on the clarity of definitions and the reliability of the sources available to investigate hypotheses. To ensure both relevance and quality of the data collected, the data analysis all in all builds on a thorough desktop analysis with stakeholder interviews to qualify findings. The interviews cover both experts within combined transport as well as selected stakeholders of the Combine project. Also, the interviews provide valuable insight regarding the case studies for combined transport in the Baltic Sea Region.

In terms of covering sub-tasks 4.1.1 (quantification of cost-elements) and 4.1.2 (cost-drivers in Last mile transport) of the Combine project, *Chapter 4* provides the foundation for both, while *Chapters 5-7* focus on sub-task 4.1.2 and *Chapter 8* on 4.1.2. The analysis hereby also looks at new legislative development and its possible impact. The most important measure is the so-called Mobility Package, which recently has been adopted by the EU Parliament in the beginning of July 2020, which is expected to give more equal conditions including salaries for truck drivers across EU countries.

As a basis for the analysis of the cost elements for combined versus Door-to-Door truck transport and the importance of different cost drivers for Last mile transport, the relevant definitions and simplifications that apply for the study are presented in *Chapter 4*.

WP 4.1.1 – Cost-elements in combined and Door-to-Door transport

In *Chapter 5* the cost-elements for combined transport and Door-to-Door transport by truck are quantified and the cost incurring for different combinations of modes (ship-truck, train-truck) compared against pure road transport.

This is done in two steps.

First, it must be pointed out that the cost level in general but also the structure of transport costs can be expected to differ between the different countries in the Baltic Sea Region. Therefore, the main dataset for quantifying cost elements is based on the situation for one region/country, i.e. Scandinavia

(Denmark/Sweden). To reflect the differences between those two countries and other countries in the Baltic Sea Region, supplementary information on the Baltic countries has been included and compared to the above: This is mainly done by analysing potential structural differences regarding salaries using data from Eurostat and as a proxy assumption on the application of the Scandinavian/Baltic salary ratio to the overall cost-level calculated for Scandinavia. In a second step, the findings are qualified through interviews with selected stakeholders. One of the most important questions is if the upcoming new EU regulations on salaries for truck drivers can be expected to have a significant influence on the relative competitiveness of trucks versus combined transport.

In *Chapter 6* the findings are exemplified by relevant cases for freight transport in the Baltic Sea Region. Focus has been on demonstrating the differences in cost structure for different types of transport and with and without transhipment. To ensure practical relevance, the cases include only transport that can be realised as of today in terms of the availability of routes, modes and scopes.

Chapter 7 summarises the findings regarding the cost-elements in combined and Door-to-Door truck transports.

WP 4.1.2 – Cost-drivers in Last mile transport

In *Chapter 8* a qualitative analysis of the importance of relevant cost-drivers in Last mile transport is undertaken. As well as for WP 4.1.1 a combined approach of desktop research and qualifying interviews has been chosen.

The identified cost-drivers are analysed one-by-one and in the summary of the chapter, compared in terms of their overall relevance for the choice of combined transport compared to Door-to-Door truck transport.

4 DEFINITIONS

4.1 Combined transport

There are many ways to interpret the vocabulary within intermodal transport, wherefore it is important to use the official definitions:

Definitions
For the purpose of the project, the COMBINE consortium partners have selected the following definitions
Multimodal transport: Carriage of goods by two or more modes of transport
Intermodal transport: The movement of goods in one and the same loading unit or road vehicle, which uses successively two or more modes of transport without handling the goods themselves in changing modes
Combined transport: Intermodal transport where a major part of the European journey is by rail, inland waterways or sea and any initial and/or final legs carried out by road are as short as possible
Intermodal Loading Units (ILUs): containers, swap bodies and semi-trailers suitable for combined transport. This is a mix of current definitions on intermodal transport units and intermodal loading units. Road vehicles are considered, in the context of COMBINE, as ILUs as well
Intermodal Terminal: an installation for transhipment of standardized loading units (containers, swap bodies, semi-trailers) with at least one of the modes served must be rail or inland waterway

Source: COMBINE consortium partners, based on UN Economic Commission for Europe[3]

Combined transport means a combination of rail/sea and road transport, where the main part of the transport chain is via rail or sea transport and the remaining parts are short road transport routes.

For the avoidance of doubt, in the context of this report the term “combined transport” covers both intermodal and multimodal transport. Further, no distinction is made between the terms “First/Last mile transport” and “Pre/post haul”. Both terms hence cover the same part of the transport chain.

4.2 Transport chains as applied in this analysis

In this report simple transport chains are investigated, as described in the two figures below. At the same time, comparisons between road transport chains and combined transport chains are made to see which elements are driving the costs in different transport chains.

Figure 4 illustrates a combined transport chain from origin to destination including First and Last mile transport, terminals, and main haul. Figure 5 Figure 4illustrates full haul from origin to destination by road.

[3] Source: UN Economic Commission for Europe (UN/ECE), the European Conference of Ministers of Transport (ECMT) and the European Commission (EC), «Terminology on Combined Transport», 2001

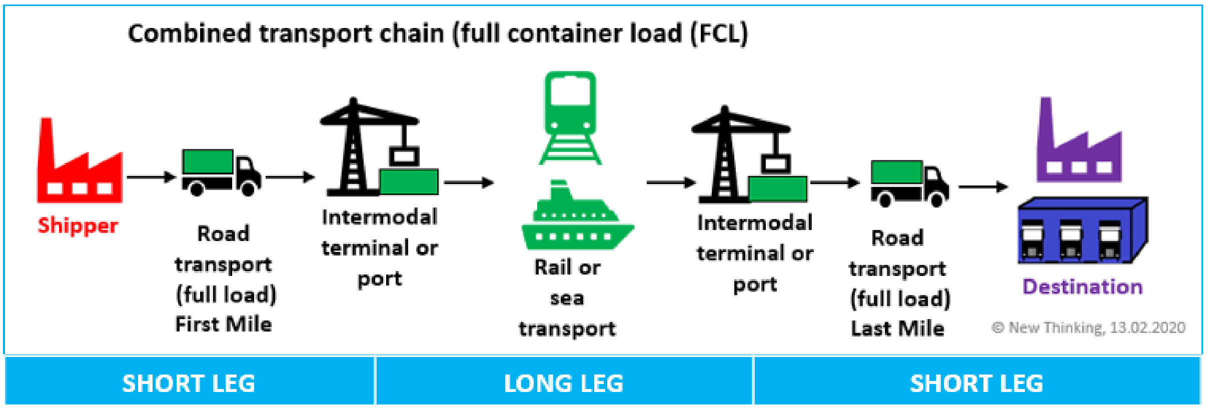


Figure 4 Combined transport chain with truck-rail or truck-sea (Source: Own illustration, New Thinking)

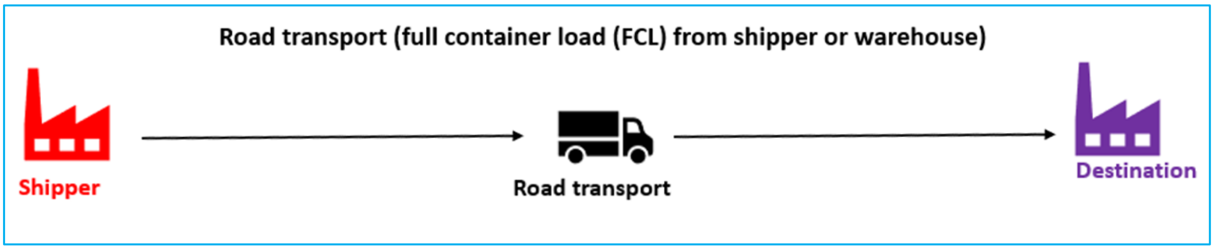


Figure 5 Road transport chain A-B (Source: Own illustration, New Thinking)

5 COST-ELEMENTS IN TRUCK AND COMBINED TRANSPORT

5.1 Defining relevant cost elements in the transport chain

While there are other factors (e.g. lead time) that can influence the decision on the choice of a transport solution, the price (or as seen from the perspective of the customer: costs) for transporting goods from their origin (A) to their final destination (B) are usually decisive.[4] Transport rates are generally determined by the competition between different modes, but the specific price tag for a transport from A to B is usually determined by the provider organising it, who also has the primary responsibility.

To better understand this cost-based decision, an analysis of transport costs should include all elements that are relevant for the decision-making of a customer for using one form of transport rather than another. The perspective taken in this analysis is thus a business perspective. While external costs such as CO_2-emissions, congestion and noise are relevant from a societal perspective, they are only relevant for the customer decision insofar as they can be internalised in the price the customer has to pay for a certain transport. As an example, road pricing can be tailored to capture congestion: the fee for using a specific road would thus be higher during rush-hour (when there is usually a high level of congestion) and lower outside rush-hour.

Also, the price a customer will have to pay for a certain transport from A to B can cover different cost elements depending on the chosen transport solution. While Door-to-Door truck transport usually do not include any transhipment at terminals there are at least two terminal handlings when using either rail, sea, or inland waterways. Further, if it is not possible to tranship the cargo Just-in-Time between the different modes of transport, interim storage of freight in warehouses adds to the total cost of transport.

Cost elements as such might not only cover so-called monetary ("out-of-pocket") costs, i.e. all costs that are directly paid by the customer for the specific deliver but also non-monetary costs, especially in terms of time. For example, the price paid for a transport from A to B might be the same for two transport solutions, but one of the two transport solutions might not ensure that the cargo arrives on expected time. This is a factor that can be critical for the customer, e.g. in the case of Just-in-Time production. In such a case, the consequences for the customer might e.g. be delays in their production due to late delivery of raw materials (opportunity costs of time), higher production costs to catch up with delays (induced costs) and/or even cancellation of orders from their customers (lost turnover).

For most customers there are scheduled and non-scheduled services and for both unforeseen events may occur that will have an impact on transport operations. With the larger complexity of combined transport, where different players are combined to cover for the whole route, this could also affect the whole transport chain. This is mainly a problem for scheduled services as there is a schedule and a plan for each part of the transport chain also tightly linked with other transport chains and schedules. When there is a delay at some point, it could affect also other services and players.

[4] Kronbak et al. (2017), p. 9.

On the railway network, slots must be allocated to all passenger and freight trains and if a specific slot is not kept due to delays it could mean that the specific train gets lower priority on the network and can be stopped several times along the route. This is done to ensure that other trains stay on time and can continue to keep their slots and are therefore prioritised. Ro-ro ferries have their departure times and it can be both difficult and expensive to try to catch up any lost time during the sea passage, as this would mean increasing speed and therefore possibly significant increases in fuel consumption.

For road transport the increasing congestion, especially around larger cities during rush hours, can lead to problems for the driver to comply with regulations on driving time and resting periods as laid down by the common EU regulations[5]. Another issue linked to congestion is the availability of parking lots and rest areas for the prescribed resting time. These should be available with easy access along the route of the specific transport the driver is carrying out and at the specific time when the driver needs the prescribed rest.

All the above are examples that in principle could lead to increased transport costs. These cost elements are important but analysed separately in **Chapter 8**.

On an overall basis standard literature within combined transport mentions the following direct costs that are to be considered when analysing the transport costs in a transport from A to B for a combined solution of truck and ship[6]:

- Truck transport (pre-/post-haulage)
- Port handling - discharging
- Truck transport - port handling and loading
- Warehouse
- Transport insurance
- Sea freight

These overall cost elements can be further split into sub-categories. As regards the handling at terminals, the price the terminal operator charges their customers can thus expect to cover the following costs plus a mark-up for the terminal operator[7]:

- Infrastructure (depreciation and maintenance)
- Cranes or other facilities for transhipment (depreciation on facilities, operation, maintenance, fuel)
- Overhead (mark-up for pricing)

While it would be optimal in terms of uncovering potential areas of cost-reduction to make combined transport more competitive, it is difficult to acquire reliable information on certain sub-categories. Amongst the most obvious reasons are confidentiality of certain business-related information to protect the respective terminal's position against current or potential competitors.

[5] Regulation (EC) No 561/2006, https://ec.europa.eu/transport/modes/road/social_provisions/driving_time_en

[6] See e.g. Hämälainen et al. (2017), p. 10.

[7] An overview of these cost elements for terminal operation is provided in Kronbak et al. (2017), p. 43.

Therefore, the information on cost elements is provided according to the level of detail available for a specific part of the transport chain between A and B. Moreover, if no information at all is available then the cost element is estimated based on hedonistic pricing, i.e. using available prices of other products with the same characteristics as the price for the product in question. A relevant example is e.g. the salaries of truck drivers. In Germany, the minimum wage can e.g. be a good indicator for the salaries of truck drivers from other countries.

5.2 Overview of relevant cost-elements

For the analysis, the following cost elements for combined transport chains including combinations of rail, road, and sea and for transport chains only using road have been identified. All other combinations such as trimodal transport solutions can be inferred from the below.

5.2.1 Transport by truck from A to B

For a transport by truck from A to B, most cost elements are variable in either time or distance or a combination hereof.

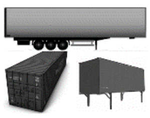
Load unit	**Truck from A to B**
	
Rental of the load unit used in the transport: 40/45" Container Semi-trailer Crane able Semi-trailer Swap body 7,45	From shipper to the destination, i.e. an industry, trading company or a warehouse.
Cost occurring: Daily rental	**Cost occurring:** Vehicle leasing Driver/Staff Insurance Fuel Infrastructure charge Administration

Figure 6 Cost elements for transport by truck (A to B) (Source: Own illustration, New Thinking and Atkins)

First, there are the renting cost of the load unit and they differ between type of load unit e.g. a craneable semi-trailer is more expensive to rent than a normal semi-trailer.

For trucks, there are time-related cost elements such as the salary for the driver and cost elements that depend on the distance of a specific route between A and destination B such as fuel. Moreover, there are costs per transport. The latter include infrastructure charges and administrative costs.

Since for truck transports most cost elements are time and/or distance related. On an overall basis the length of a transport is the most important cost-driver for a transport.

5.2.2 Combined transport truck/train

In combined transport covering the two modes truck and train there are substantial additional cost elements that do not depend on time or distance for a specific transport.

Door-to-Door-transport by truck is monomodal and the transport chain includes no First and Last mile haulage or terminal handling. On the opposite First and Last mile legs and terminal handling are central cost elements in the combined transport chain.

After the First mile transport and before the distribution to its destination (Last mile transport) the load unit needs to be transhipped at an intermodal terminal. The costs occurring related to these transhipments are calculated per lift and are an important cost-driver in the combined transport chain, especially on shorter rail routes. As regards the rail transport leg of the transport chain, there are time and distance-based cost elements, such as fuel or infrastructure charges (distance) and staff costs (time). Cost elements such as insurance and administration are costs that apply to the train as a whole and occurs once with every train transport. Consequently, the costs per load unit on the train will be reduced when adding more load units onto the train.

The effect is a realisation of economies of scale which is an important economic argument for longer train configurations in freight transport. *Economies of scale* in the context of transport are cost advantages achieved by companies when transport becomes efficient, i.e. by increasing the transported cargo per load and therefore lowering unit costs. This happens because costs are shared over a larger amount of cargo.

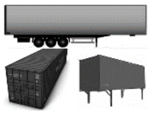
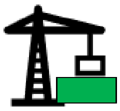
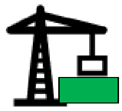
Load unit	First mile	Intermodal terminal	Rail transport	Intermodal terminal	Last mile
					
Rental of the load unit used in the transport: 40/45" Container Semi-trailer Crane able Semi-trailer Swap body 7,45	From shipper to intermodal terminal	The truck delivers the intermodal loading unit to the intermodal terminal, where it is placed in waiting position until the train is ready to be loaded. Later the unit is loaded onto the intermodal rail wagon	The train waggons are collected in the terminal and often taken across borders towards the destination terminal. Along the route staff changes, shunting and change of locomotive can take place.	The train arrives in the intermodal terminal and the units are lifted off the wagons - either directly onto a waiting truck or put in a storage until the truck collects the unit.	The Last mile transport takes the unit from the intermodal terminal to the destination, i.e. an industry, trading company or a warehouse.
Cost occurring: Daily rental	**Cost occurring:** Vehicle leasing Driver/Staff Insurance Fuel Infrastructure fee Administration	**Cost occurring:** Lift load unit Storage short term Access fee Administration	**Cost occurring:** Locomotive Wagon Staff Insurance Infrastructure fee Environmental subsidy Electricity Administration	**Cost occurring:** Lift load unit Storage short term Access fee Administration	**Cost occurring:** Vehicle leasing Driver/Staff Insurance Fuel Infrastructure fee Administration

Figure 7 Cost elements for a transport by truck and train (Source: Own illustration, New Thinking and Atkins

Depending mainly on the length of the rail route, the balance between costs occurring for First/Last mile, terminal costs and costs for the rail haul differs. The longer the rail haul, the smaller the share for terminal and First/Last mile costs. But of course, it also depends on the length of the First and Last Mile transport.

5.3 Quantifying cost-elements case of Scandinavia

The different cost elements identified above can be expected to differ substantially across the Baltic Sea Region. While differences can occur due to local differences in the overall economic conditions with wealthier countries in general showing a higher level of salaries, i.e. higher staff costs, some differences might be substantially influenced by legislation, e.g. organisation of terminal operation, or different levels of competition on an overall basis or certain market segments. Prices and costs vary across countries depending on the level of competition. Variations in the price level reflect thus variations in the level of competition between transhipment terminals in a given local geographic context. Competition will thus be more intense with more terminals having overlapped primary market catchment areas. Further, terminal handling fees also reflect the pay-off needed to cover investments, such as specific handling equipment. Also, the conditions agreed on with the landlord, often a municipality, might have an influence on the price level. Some countries also partly subsidise the transhipment cost, to make combined transport more competitive.[8]

In order to provide a consistent picture of transport costs for both Door-to-Door and combined transports, cost estimates for one country with relatively well-covering and reliable resources have been collected, i.e. the cost estimates provided represent the level of different cost elements and the structural differences between different modes of transport for Scandinavia

The estimate of the actual costs for combined transport within in Scandinavia is thus provided as a basis for comparison of the relevance of cost elements in absolute and relative terms.

The importance of different cost elements is then in the subsequent chapters further analysed regarding differences in other countries (regional differences) as well as exemplified for different cases with a row of different alternative combined routes (in the case studies). For the latter, both the available infrastructure as well as the distance to be covered are important cost-drivers that differ between the options of Door-to-Door transport and combined transport.

The following tables presents costs for different parts of the transport chain and the cost element in these parts of the transport chain.

Reading guide for the below cost tables

- All cost data is gathered in a comprehensive review of e.g. project reports, conference presentations, literature on freight transport, commercial sources and supplemented with own calculations.
- The costs for the elements are presented in spans of costs when there are multiple sources. This also illustrates the differences in prices across countries
- In some cases, data from older resources is included, i.e. when the data still is considered representative for the level of costs in today's transport[9]
- The data sources are referred to in the list of sources (see chapter 10)

Load unit rental
Costs occurring both in Door-to-Door transport as well as along the whole combined transport chain.

Cost occurring	***Cost unit***	***Price***	***Sources***
Semitrailer craneable	€/day	24	2019 WECON GmbH
Semi-trailer	€/day	15-23	2015 AVGT/2020 Ebay.de/2020 USA Internet prices/2020 europa-lastbiler.dk

[8] In general, direct support must be in line with the Combined Transport Directive (92/106/EEC of 7 December 1992, see: https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:31992L0106). As an example, in Germany, with the current guidelines, up to 80 pct. of an investment in new intermodal terminals or expansions of existing terminals, can be paid by the government as outright grant, see the website of the German Federal Ministry of Transport and Digital Infrastructure (BMVI), https://www.bmvi.de/SharedDocs/DE/Artikel/G/umschlaganlagen-foerderrichtlinie.html.

[9] The data e.g. from the Recordit project (2003), the advantage of which is providing coherent data from one single source, was compared to various other figures from more recent sources. Consequently, the level of cost stated in the Recordit project was deemed relevant and not adjusted to 2019-level.

Intermodal terminal - Departure/Arrival

Costs occurring in combined transport exclusively.

Cost occurring	*Cost unit*	*Price*	*Sources*
Lift container SE/DK	€/unit	28-34	2020 TX Logistics/2020 DB Schenker
Lift container DE	€/unit	22-25	2020 TX Logistics
Lift semi-trailer DK	€/unit	38	2020 DB Schenker
Storage short term container	€/day	5-10	2020 TX Logistics
Storage short term non-stackable	€/day	6-20	2020 TX Logistics
Terminal access fee DK	€/unit	3	2020 DB Schenker
Terminal road/rail lift	€/unit	27-49	Recordit 2003
Terminal rail/vessel lift	€/unit	40-80	Recordit 2003

Road transport

Costs occurring in all road transport legs, i.e. regardless of a Door-to-Door or a combined transport.

Preconditions: A truck semi-trailer combination in international transport that drives 150.000 km/year. Driven by a Danish driver with a collectively agreed salary.

Cost occurring	*Cost unit*	*Price*	*Sources*
Vehicle leasing	€/km	0.16	2018 Volvo Dynafleet Manager
Driver cost	€/hour	9.5-42	AVGT 2016/TØEP/EUROSTAT
Insurance	€/km	0.04	AVGT 2016
Fuel	€/l	0.95	AVGT 2016/TØEP/OK Bensin
Infrastructure weight tax and Eurovignet DK	€/km	0.01	LBK no. 1261 of 07/11/2018/LBK no. 195 of 25/02/2019
Infrastructure Maut DE	€/km	0.187	Toll collect
Administration	€/km	0.3	AVGT 2016
Road Line haul	€/km-unit	0.58-1.37	AVGT 2020/Intermodal info/TØEP/Baltic Logistics Hub 2011/Recordit 2003
Road pre/post haul	€/km-unit	1.52-3.78	Recordit 2003
Toll bridge Great Belt	€/unit	99-104	A/S Storebælt
Toll bridge Øresund	€/unit	50-70	Øresundsbron

Rail transport

Costs occurring in combined transport using a rail leg exclusively.

Preconditions: 160.000 km/year for standard electric locomotive with pocket-waggons for 36 semi-trailers.

Cost occurring	*Cost unit*	*Price*	*Sources*
Locomotive(s)	€/month	47,000	2016 MGPB/Correspondence with MRCE and Beacon Rail
Wagons double pocket	€/day	50	2016 MGPB/2019 Wecon GmbH
Wagons container	€/day	28	2019 Wecon GmbH
Locomotive driver/staff	€/month	8,000	2016 MGPB
Infrastructure fee DK	€/km	0.68	BEK no. 49 of 20/01/2020
Environmental subsidy DK	€/ton-km	-0,002	BEK nr 1233 af 25/11/2019
Electricity	€/km	4	2016 MGPB
Rail line haul	€/km-unit	0.46-1.35	MGPB 2016/Intermodal info/TØEP/Recordit 2003
Toll bridge Great Belt	€/unit	900	BEK no. 49 of 20/01/2020
Toll bridge Øresund	€/unit	660	BEK no. 49 of 20/01/2020/Network statement 2020, Trafikverket

Short sea shipping transport[10]

Cost occurring	*Cost unit*	*Price*	*Sources*
Linehaul container/semi-trailer	€/km	0.54-1.67	Recordit 2003
Roro ferry Baltic sea	€/unit	200-800	Sources in roro-transport
Roro ferry Rødby-Puttgarden	€/unit	138-245	Scandlines

5.4 Comparing the importance of cost-elements across the BSR

BSR region and cost differences

The cost-elements demonstrated in 5.3 are based on evidence for Scandinavia (Denmark/Sweden), i.e. for countries with some of the highest labour costs in the European Union. Compared to this, especially the wages in the Baltic countries are relatively low.

Below we have conducted supplementary calculations to demonstrate possible differences and their importance across the geography of the BSR focusing on a comparison of Scandinavia to the Baltic countries.

5.4.1 Cost-elements differ in their importance across the countries in the BSR.

Labour costs differ widely between the countries in the Baltic Sea Region. Figure 8 shows the level of and development in labour cost in "Transportation and storage" from 2008 to 2019.[11] Note that the costs in the figure are actual average labour costs, i.e. including all costs elements relevant from an employer perspective, and not only wages.

Euro	*2008*	*2012*	*2016*	*2017*	*2018*	*2019*	*2008>2019*
FI	27.70	29.70	31.50	30.90	31.70	32.10	16 %
SE	29.30	33.80	33.20	33.30	32.20	31.40	7 %
DK	33.10	37.70	39.40	40.90	41.80	42.00	27 %
DE	23.60	25.50	26.90	26.70	27.10	27.50	17 %
PL	7.40	7.00	7.70	8.20	8.70	9.20	24 %
EE	7.60	8.80	10.80	11.60	12.00	13.10	72 %
LV	6.20	6.90	8.00	8.40	9.50	10.10	63 %
LT	6.50	6.60	8.50	9.30	10.20	9.50	44 %

Figure 8 Development in labour costs in the Baltic Sea Region 2008 to 2019 (Eurostat average labour costs) (Source: Eurostat)

[10] The relatively large span in prices are due to pricing based on e.g. competition with other routes or bridges, route lengths and attractivity based on departure and arrival time

[11] Source: Eurostat (NACE_R2 – LCSTRUCT) - Transportation and storage D1_D4_MD5 - Labour cost for LCI (compensation of employees plus taxes minus subsidies)

In road transport, labour costs are one of the three major cost elements, the other two are fuel and truck. Figures 9 and 10 show the distribution of the three major cost elements in road transport in relative terms and absolute cost. The figures also illustrate how differentiated labour cost between markets, changes the composition of the cost elements.

The figures are based on average labour cost for Scandinavia (Denmark and Sweden), the three Baltic countries, Germany, and the German minimum wage for truck drivers. Note that the costs in the figures are actual average labour costs and do not only cover wage, as described above.

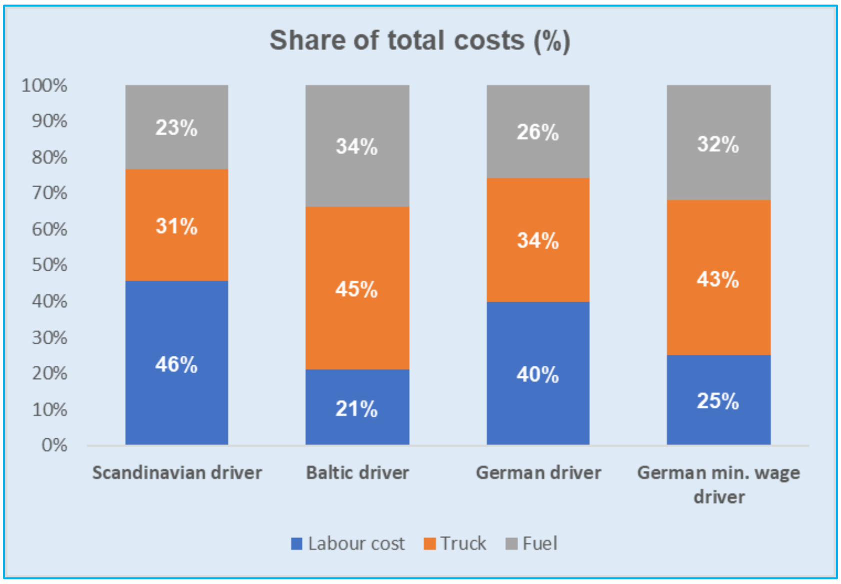


Figure 9 Composition of cost elements in road haulage based on the different labour costs (Source: Own calculation)

Figure 9 shows that in the case of the scandinavian driver the labour costs accounts for close to half of all costs. The german driver is at 40 pct. of total costs and with a baltic driver or a german minimum wage driver labour costs only accounts for around a quarter of the costs.

Looking at actual costs, the cost with a Scandinavian driver adds at least 30 EURO Cent and the German driver around 20 EURO Cent to the road haul kilometre price, compared to a setup with a Baltic driver or a German minimum wage driver. See figure 10.

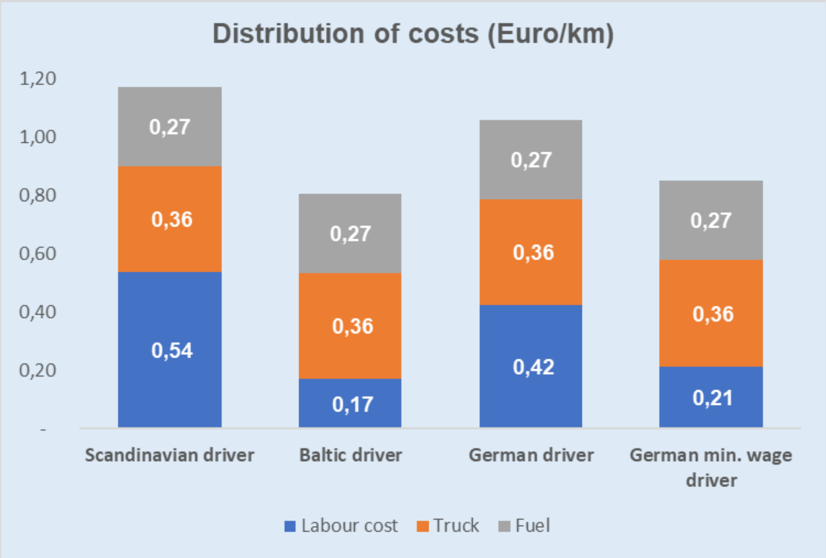


Figure 10 Compositions of cost elements - road haul based on the different labour costs (EUR) (Source: Own calculation)

5.4.2 Central cost drivers differ across modalities in combined transports.

The labour costs for truck drivers are one of the central cost drivers in road transports, as they usually account for a third to half of the total transport costs. In some cases, with e.g. Baltic drivers, they might only account for as low as one fifth of the costs though.

Truck and fuel costs are the two other central cost drivers in road transport. The costs related to the truck itself do not vary much between countries as there are not any possible differentiators, such as registration taxes that must be paid for commercial vehicles. Moreover, trucks used in international transport are new Euro 6 class trucks. Fuel prices differs between countries but trucks/drivers from some countries fill up the tank before crossing the border to keep fuel costs down, reducing the potential effect of different fuel prices.

In rail and sea transport labour costs play a far smaller role. The simple explanation is the relation between number of staff involved and the number of units transported.

Some of the cost elements in the different parts of the transport chain vary in price between countries. This can be due to two reasons: first, the overall price levels vary between the different countries and secondly, there are variations in the level of competition.

In general, the price of many cost elements in the different parts of the transport chain are negotiable depending on volume. It is thus possible to achieve a (fleet) discount on e.g. diesel if a company runs ten trucks and fuel will be even cheaper if the company owns 1,000 trucks. The same goes for truck and trailer leasing, trips on ro-ro ferry, lifts/handling at terminals, storage, insurance etc.

As discussed in 5.4.1, currently there are substantial differences in labour costs between the different countries in the Baltic Sea Region. While Directive (EU) 2020/1057 of 15 July 2020, which forms part of the so-called Mobility Package, clearly can be seen as a step towards amending the overall working conditions for drivers in the transport sector in the European Union, its possible contribution to harmonising labour costs for truck drivers across the European Union is yet to be seen. The directive lays thus down specific rules for posting truck drivers in other member states and thereby amending Directive (EU) 2006/22/EC regarding the enforcement requirements and Regulation (EU) 1024/2012.

Consequently, the general EU regulations regarding minimum wage for posting staff in another Member State than the employee's country of residence, Directive 96/71/EC, will become mandatory to follow for all Member States within transport services. A posted worker in this context is an employee sent by an employer on a temporary basis to conduct cabotage in the host country. The employee does thus not live in the host country on a permanent basis. According to the Directive (EU) 2020/1057, the employer must pay the same wage that a local driver would be entitled to.

The new rules do not apply to bilateral operations for transport of goods and passengers (transport from a Member State where the driver is based to another Member State and vice-versa) and transit though Member States.[12]

With Directive (EU) 2020/1057 applying to cabotage exclusively, a direct effect on the level of labour costs for international transport is not to be expected. Other regulations that form part of the Mobility Package can though contribute to an increased pressure on transport costs upward. As an example, a truck will need to return to its country of registry every 8 weeks. All in all, and with regulations still to be implemented by the Member States, possible effects on the labour costs for international transport might not be expected soon.

[12] See Directive (EU) 2020/1057, Art. 2, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32020L1057&from=DA. Transit is defined as a situation, where the driver passes the Member State without loading or unloading freight.

6 CASE STUDIES

6.1 Selection of representative cases for the BSR

The representative cases that are presented in the following sections (6.2-6.4) illustrate the cost elements discussed above using existing examples or potential cases for combined transport and support an understanding of their absolute and relative relevance to increase the volume of combined transport in the BSR.

The case studies have been selected following the overall criteria of cases:

- Potential cases must demonstrate to have **relevant infrastructure** (road and rail and/or sea) in place for stakeholders to setup a combined transport with short notice
- Each case must cover at least **two countries in the BSR** and thus include cross-border transport
- At least one example covering combined **rail and road** as well as one example covering combined **sea and road** transport
- The alternative to a combined transport must be **Door-to-Door transport by road**

Furthermore, while the aim would be to present cases with their real costs, for competitive reasons it has proven difficult to acquire the actual costs for the selected examples. Therefore, the results of the literature study supplemented with stakeholder interviews has been applied.

While the success of a case depends on various factors, it is also necessary to understand, where and how a success for combined transport can be achieved most efficiently. In other words: looking at a state-of-the-art example for an existing combined transport that has proven successful for a substantial amount of years can provide useful guidance for setting up other future combined transports.

In all the alternatives discussed in the selected case studies semi-trailers are used as the transport unit. The main reason for this choice is that they are the most common transport unit in continental transport and the best transport unit to use when comparing combined transport and Door-to-door road haul.

The Swedish case of “Jula” (6.2) has thus been chosen as a benchmark for the other cases presented in the subsequent paragraphs (6.3-6.5). Focus for the “Jula” case is on the characteristics that are relevant for its success. Those cases are then compared to the benchmark case in terms of how well they suit these characteristics.

6.2 Theoretical case 1: Denmark (Billund)-Lithuania (Kaunas)

The first theoretical case chosen is a transport of semi-trailers from Billund to a freight terminal in Kaunas. Different routings as well as different combined transport set-ups are included in the analysis, and compared with road transport from A to B.

The purpose of comparing different combined routings, is to compare the different cost elements in different set-ups. Some of the alternatives are theoretical, as there today are no available services on parts of the routes. However, the alternatives are foreseen to indicate prise structures and price levels according to the different set-ups.

The alternatives are chosen based on a combination of routes used, coverage of the countries along the Baltic Sea and coverage of the coming Rail Baltica project.

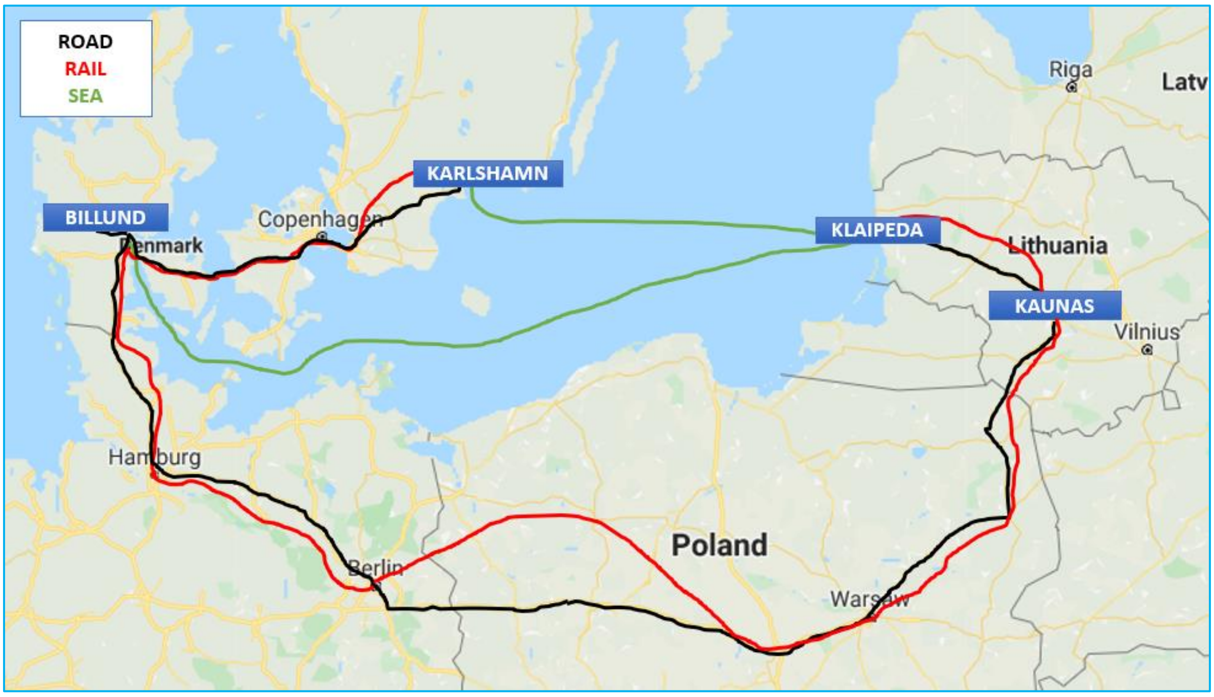


Figure 11 Geography of the Billund-Kaunas case (Source: Own illustration, Atkins)

The eight alternatives

The table shows the transport chain for each of the eight alternatives

Alternative 1A	Combined transport with road Billund – Taulov, rail Taulov – Kaunas via Germany and Poland
Alternative 1B	Combined transport with road Billund – Taulov, rail Taulov – Kaunas via Germany and Poland using the coming Rail Baltica connection.
Alternative 1C	Combined transport with road Billund – Taulov, Rail Taulov – Karlshamn, RoRo ferry Karlshamn – Klaipeda and rail transport to Kaunas.
Alternative 1D	Combined transport with road Billund – Taulov, Rail Taulov – Karlshamn, RoRo ferry Karlshamn – Klaipeda and road transport to Kaunas.
Alternative 1E	Combined transport with road Billund – Fredericia, RoRo Fredericia – Klaipeda and rail transport to Kaunas.
Alternative 1F	Combined transport with road Billund – Fredericia, ro-ro Fredericia – Klaipeda and road transport to Kaunas.
Alternative 1G	Road transport Billund – Karlshamn, ro-ro ferry Karlshamn – Klaipeda and road transport to Kaunas.
Alternative 1H	Road transport Billund – Kaunas via Germany and Poland

6.2.1 The different route elements of the transport chains

The eight alternatives have different routes and combines different route elements in each transport chain. The different route elements are described and mapped below. See Appendix A for a more comprehensive descriptions of the route elements.

Loading at Billund – Alternatives 1A-1H The cargo is picked up in Billund by a truck with a semi-trailer. Origin for all alternatives	
First mile Billund – Taulov – Alternatives 1A -1D The vehicle transports the semi-trailer to the nearest intermodal terminal in Taulov	
First mile Billund – Fredericia Port – Alternatives 1E & 1F The vehicle transports the semi-trailer to the ro-ro terminal in the port of Fredericia	
Terminal handling In Taulov – Alternatives 1A - 1D The semi-trailer is taken over by staff in the intermodal terminal and lifted on to the rail wagon	
Port handling in Fredericia, Karlshamn and Klaipeda – Alternatives 1C - 1F The semi-trailer is taken over by port or ferry staff in the ro-ro terminal.	
Intermodal terminal handling in the port of Karlshamn and the port of Klaipeda - Alternatives 1C & 1D The semi-trailer is lifted onto or off the intermodal rail wagons by reach stackers.	
Intermodal transport Taulov – Karlshamn – Alternatives 1C & 1D The semi-trailer is transported by rail	
Road transport Billund – Karlshamn – Alternative 1G The semi-trailer is transported by road	
RoRo ferry Fredericia – Klaipeda with DFDS ferry – Alternatives 1E & 1F The semi-trailer is transported by ro-ro ferry.	
RoRo ferry DFDS Karlshamn – Klaipeda - Alternatives 1C, 1D & 1G The semi-trailer is transported by ro-ro ferry.	

<table>
<tr><td>Intermodal transport Taulov – Kaunas – Alternatives 1A & 1B
The semi-trailer is transported by rail most of the distance</td><td rowspan="2"></td></tr>
<tr><td>Road transport Billund – Kaunas - Alternative 1H
The semi-trailer is transported by road only</td></tr>
<tr><td>Klaipeda – Kaunas with railway - Alternatives 1C & 1D
The semi-trailer is lifted onto a pocket wagon in the rail terminal at the port of Klaipeda for rail transport to the intermodal terminal in Kaunas.</td><td rowspan="2"></td></tr>
<tr><td>Klaipeda – Kaunas with truck - Alternatives 1d, 1F & 1G
A tractor picks up the semi-trailer in the parking area by the ro-ro terminal in Klaipeda and transport it to Kaunas.</td></tr>
</table>

6.2.2 Cost elements in the theoretical case 1 (Denmark - Lithuania)

The tables below give an overview over the distribution of distances and costs between “modalities“ in the transport chain for the eight alternatives. A more comprehensive description of the transport chains is shown in Appendix A.

Alternative 1A:
Combined transport with road Billund – Taulov, rail Taulov – Kaunas via Germany and Poland.

	Pre/post haul road	*Rail haul*	*Terminal road-rail*	*Sum*
Distance/lifts/trips	59	1,526	2	-
Price (€)	118	992	50	1,160
%	10 %	86 %	4 %	100 %

Alternative 1B:
Combined transport with road Billund – Taulov, rail Taulov – Kaunas via Germany and Poland using the future Rail Baltica connection.

	Pre/post haul road	*Rail haul*	*Terminal road-rail*	*Sum*
Distance/lifts/trips	59	1,526	2	-
Price (€)	118	992	50	1,160
%	10 %	86 %	4 %	100 %

Please note that the figures for alternative 1B are the same as in alternative 1A since it is the same route in both alternatives. The only difference between alternatives 1A and 1B is that the second one takes less time due to the future Rail Baltica connection.

Alternative 1C:
Combined transport with road Billund – Taulov, Rail Taulov – Karlshamn, RoRo ferry Karlshamn – Klaipeda and rail transport to Kaunas.

	Pre/post haul road	*Rail haul*	*Terminal road-rail*	*Ro-ro ferry*	*Toll bridge Great Belt rail*	*Toll bridge Øresund rail*	*Sum*
Distance/lifts/trips	59	780	4	1	1	1	-
Price (€)	118	507	100	450	25	19	1,172
%	10 %	42 %	8 %	37 %	2 %	2 %	100 %

Alternative 1D:
Combined transport with road Billund – Taulov, Rail Taulov – Karlshamn, RoRo ferry Karlshamn – Klaipeda and road transport to Kaunas.

	Pre/post haul road	*Road haul*	*Rail haul*	*Terminal road-rail*	*Ro-ro ferry*	*Toll bridge Great Belt rail*	*Toll bridge Øresund rail*	*Sum*
Distance/lifts/trips	49	215	457	2	1	1	1	-
Price (€)	98	237	297	50	25	19	450	1,176
%	8 %	20 %	25 %	4 %	2 %	2 %	38 %	100 %

Alternative 1E:
Combined transport with road Billund – Fredericia, RoRo Fredericia – Klaipeda and rail transport to Kaunas.

	Pre/post haul road	*Rail haul*	*Terminal road-rail*	*Ro-ro ferry*	*Sum*
Distance/lifts/trips	66	323	2	1	-
Price (€)	132	210	50	300	692
%	19 %	30 %	7 %	43 %	100 %

Alternative 1F:
Combined transport with road Billund – Fredericia, RoRo Fredericia – Klaipeda and road transport to Kaunas.

	Pre/post haul road	*Road haul*	*Ro-ro ferry*	*Sum*
Distance/lifts/trips	56	215	1	-
Price (€)	112	237	300	642
%	17 %	36 %	46 %	100 %

Alternative 1G:
Road transport Billund – Karlshamn, RoRo ferry Karlshamn – Klaipeda and road transport to Kaunas.

	Road haul	*Toll bridge Great Belt road*	*Toll bridge Øresund road*	*Ro-ro ferry*	*Sum*
Distance/lifts/trips	665	1	1	1	-
Price (€)	732	90	60	450	1,332
%	55 %	7 %	5 %	34 %	100 %

Alternative 1H:
Road transport Billund – Kaunas via Germany and Poland

	Road haul	*Sum*
Distance/lifts/trips	1 543	-
Price (€)	1,697	1,697
%	100 %	100 %

6.2.3 Comparison of costs, cost split, distance, and time

To identify the key differences between combined transport and road transport, the eight alternatives in the Billund-Kaunas case are compared on costs, distance, and time in the following four figures.

Figure 12 shows how different the split of costs between "modalities" are in the alternatives. It also shows that cost related to First/Last mile transport (Pre/post haul and terminal) represent 12-18 pct. of the total transport cost across the alternatives.

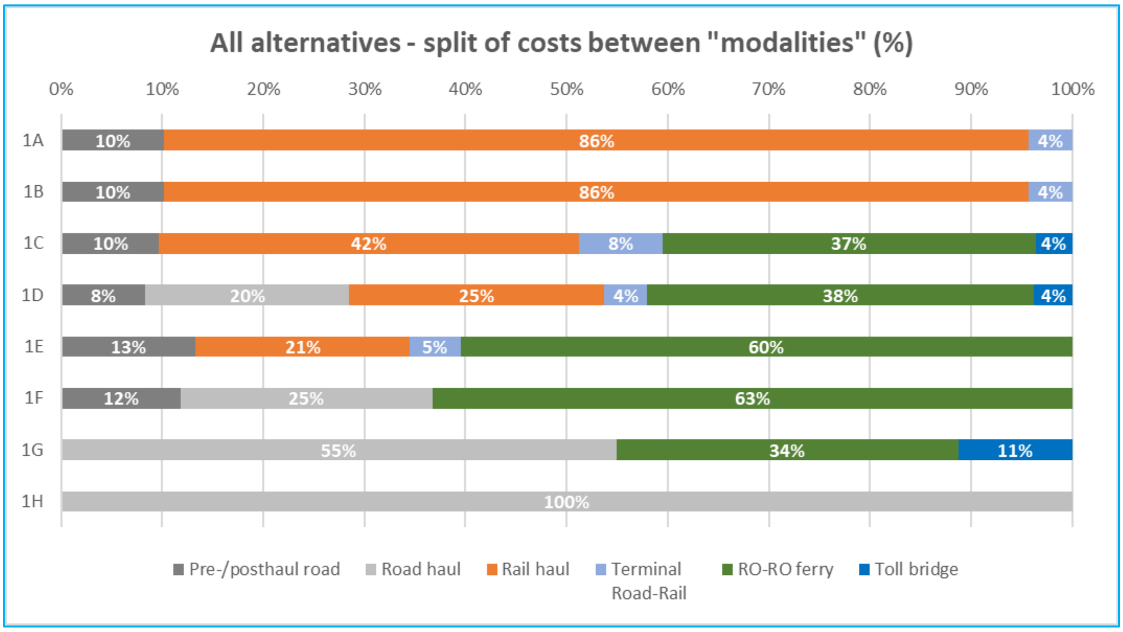


Figure 12 Comparison of the distribution of costs in percent between the alternatives (Source: Own calculation)

When looking at actual costs they range from 950 to 1,700 EUR in the alternatives. The cheapest alternative is 1F with a long ro-ro haul at 950 EUR. The most expensive is almost double the price and it is alternative 1H which is Door-to-door road haul.

If you do the calculation on alternative 1H with a Baltic driver, instead of a Scandinavian driver, the cost of the road haul the price is reduced from 1,700 to 1,250 EUR.

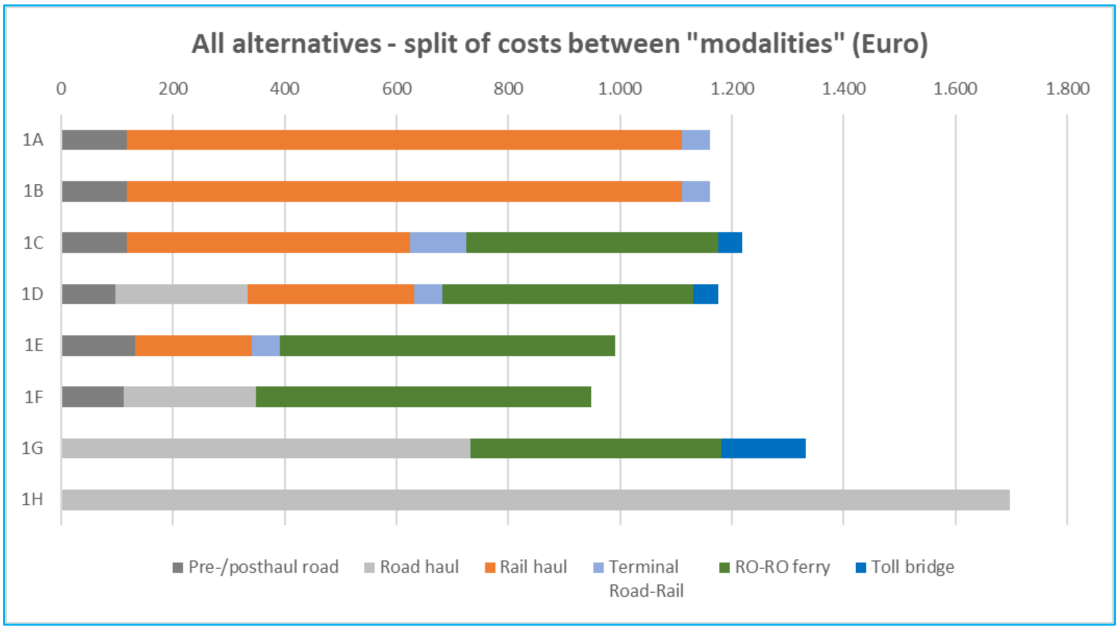


Figure 13 Comparison of the distribution of costs in EUR between the alternatives (Source: Own calculation)

When comparing distances for the alternatives in figure 14, the geography of the Baltic Sea Region gives the alternatives using a ro-ro-connections across the Baltic Sea an advantage. The total distance range between 1,100 and 1,550 kilometre and alternatives primarily based on rail or road transport being the longest. Usually the road transport would have an advantage towards rail transport, as the roads often provide more direct routes and make it possible to make short cuts, compared to the routing of the rail tracks. Due to the Baltic Sea's barrier effect, this is not the case here.

In this case, the First-/Last mile of the transport chain only accounts for a smaller share of the cost for the transport chain in the different alternative routes. This is mainly because it is a very long route all in all, and the short distances for First- and Last mile transport only play a minor role.

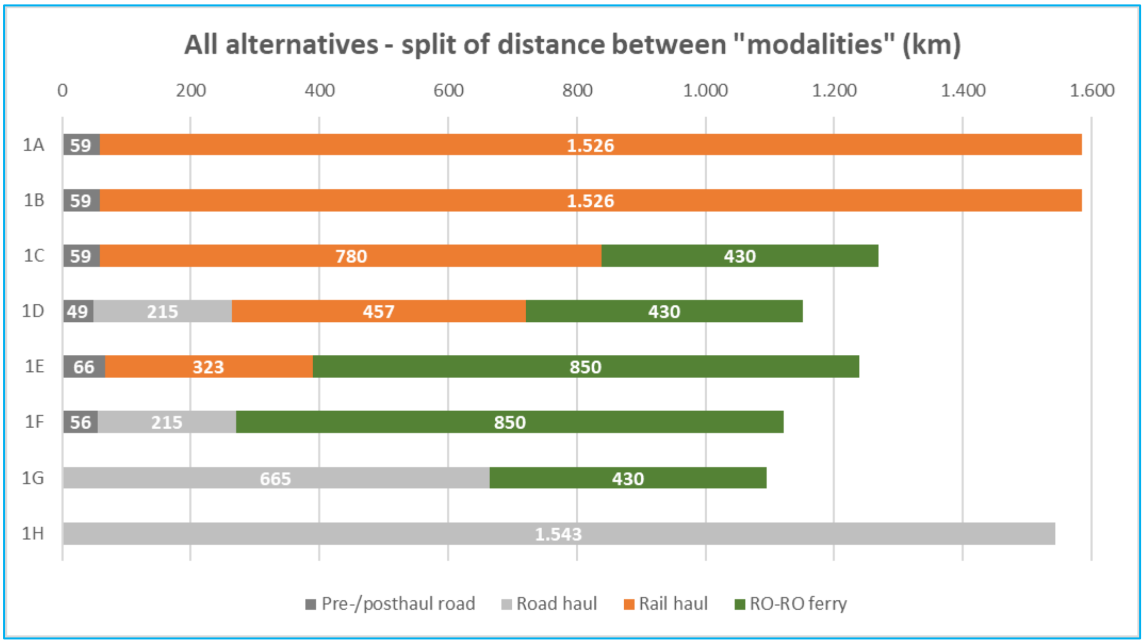


Figure 14 Comparison of distance for different modes between the alternatives (Source: Own calculation)

Time is an important aspect in transport, the total transport time for the alternatives are in a range between 21 and 39.5 hours. The fastest being alternative 1H based on Door-to-door road haul, while the slowest alternatives 1E and 1F, include a 30-hour ro-ro leg. If fast delivery is a necessity road transport is fastest, but also by far the most expensive referring to figure 14. Opposite the slowest alternatives with the long ro-ro leg being the least expensive alternatives.

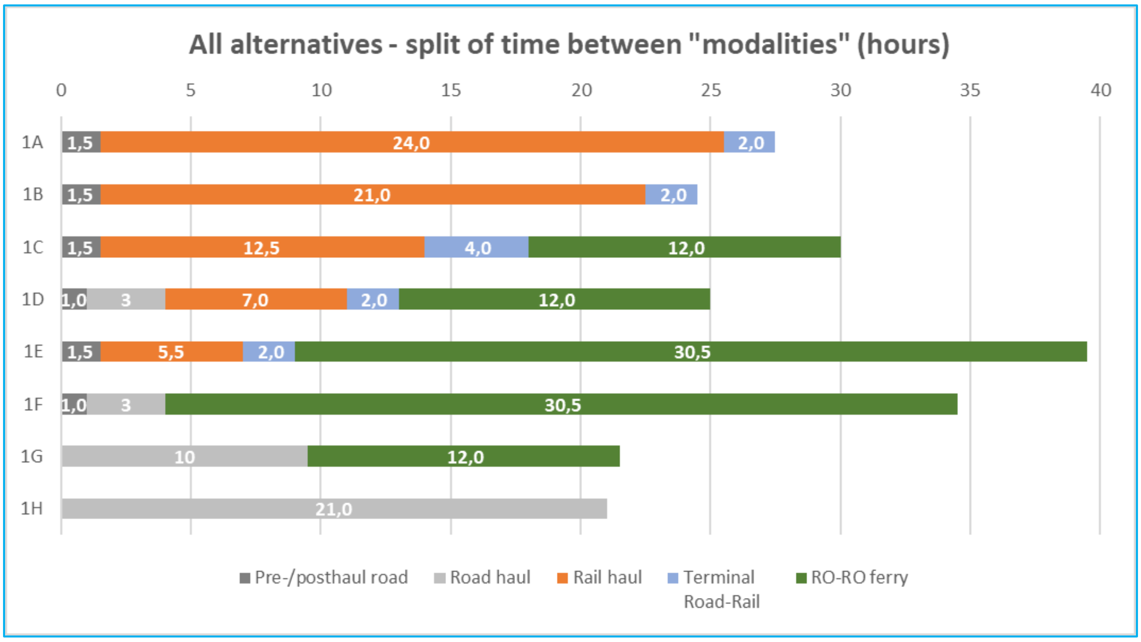


Figure 15 Comparison of the distribution of time for different modes between the alternatives (Source: Own calculations)

When comparing the alternatives across costs and duration, they have different characteristics. Depending on e.g. delivery window, product value, freight category or freight weight /dimensions some alternatives will be more suitable than others.

Figure 16 shows a comparison of price and duration for the alternatives and in the Billund-Kaunas. There seems to be to be a relation between price and the duration of the transport, with the slowest alternatives which include long ro-ro hauls being the cheapest and the fastest. Door-to-door road haul is identified as the most expensive alternative.

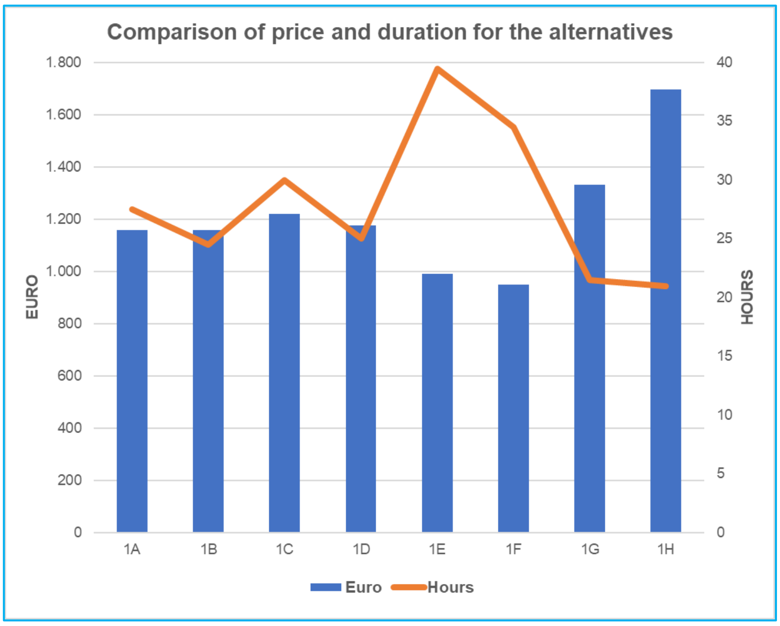


Figure 16 Comparison of price and duration for the alternatives (Source: Own calculations)

6.2.4 Summary - Billund-Kaunas Case

To sum up, the analysis of the different alternatives in the Billund-Kaunas Case allow the following conclusions:

First/Last mile transport related costs (Pre/post haul and terminal) represent 12-18 pct. of the total transport cost across the alternatives. The total costs for the different transport alternatives range from 950 to 1.700 Euro. The cheapest of the investigated alternatives includes a long ro-ro haul and the most expensive one is the Door-to-door road haul alternative.

Due to a barrier effect of the Baltic Sea, one peculiarity of this case is that total transport distances for the different alternatives range from 1,100 to 1,550 km. Accordingly, the duration of transport alternatives range from 21 to 39.5 hours. The fastest alternative is the Door-to-door road haul and the slowest include a 30-hour ro-ro leg.

All in all, there is a relation between price and duration with the slowest alternatives being the cheapest and the fastest the most expensive.

6.3 Theoretical case 2: Germany (Berlin) - Sweden (Stockholm)

This case covers the transport of export cargo from Germany to the large consumer area in the Greater Stockholm region. There are large quantities of cargo transported between Germany and Sweden on rail, road, and sea. Transport solutions use different routings, where the bulk of the rail cargo use the route via Denmark and only a small part uses the rail ferries between Trelleborg and Rostock.

In this case both the transit route via Denmark and the ferries between Germany and Sweden are analysed, and both ro-ro ferries for trucks and rail ferries, as all the alternatives could work as real combined transport routes.

The purpose of comparing different combined transport routings, is to compare the different cost elements in different set-ups. Some of the alternatives are theoretical, as there today are no available services on parts of the routes. However, the alternatives are foreseen to indicate prise structures and price levels according to the different set-ups.

Eskilstuna is chosen as terminal, as there is an existing rail service, but also as Stockholm is a typical a large and densely populated consumption area, like many bigger cities. This means that it can be difficult to find export cargo within the Stockholm area, which implies that the freight forwarders will need to look further outside the region, to find cargo for the return southwards.

Figure 17 Geography of the Berlin-Stockholm case (Source: Own illustration, Atkins)

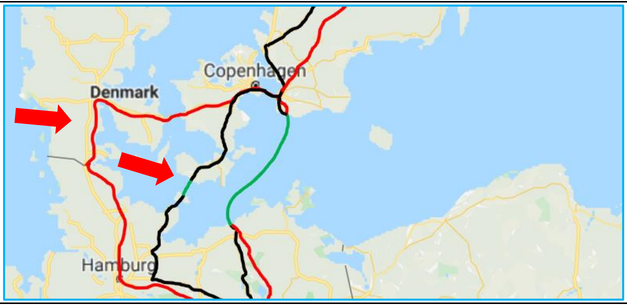
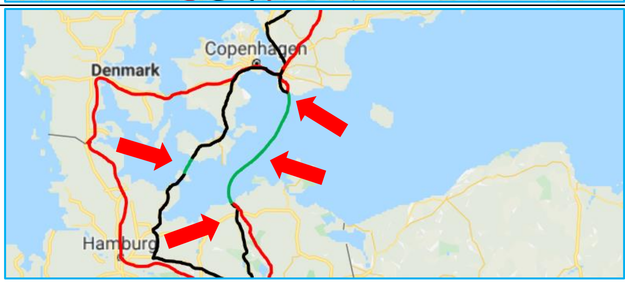
The seven alternatives

The table shows the transport chain for each of the eight alternatives:

Alternative 2A	Berlin – Eskilstuna on rail, incl. on the rail ferry Rostock – Trelleborg, which means rail transport on the whole route. Last mile on road to Stockholm.
Alternative 2B	Berlin – Eskilstuna on rail in transit via Denmark, an alternative, with rail on the whole route. Last mile on road to Stockholm.
Alternative 2C	Berlin – Rostock on rail, ro-ro ferry Rostock – Trelleborg, Trelleborg – Eskilstuna on rail (so called Gebrochener Verkehr). Last mile on road to Stockholm.
Alternative 2D	Berlin – Rostock on rail, ro-ro ferry Rostock – Trelleborg, Trelleborg – Eskilstuna on rail (so called Gebrochener Verkehr). Last mile on road to Stockholm.
Alternative 2E	Berlin – Rostock on road, ro-ro ferry Rostock – Trelleborg and Trelleborg – Eskilstuna on rail and Last mile on road to Stockholm.
Alternative 2F	Berlin – Rostock on road, ferry Rostock – Trelleborg and Trelleborg – Stockholm on road
Alternative 2G	Berlin – Stockholm on road (A-B), via the ferry Puttgarden - Rødby and the Øresund bridge.

6.3.1 The different route elements of the transport chains

The seven alternatives have different routes and combines different route elements in each transport chain. The different route elements are described and mapped below. See Appendix B for more comprehensive descriptions of the route elements.

First mile on road to intermodal terminal in Berlin – Alternatives 2A - 2D The cargo is picked up in Berlin by a truck with a semi-trailer	
Berlin Grossbeeren kombiterminal - Alternatives 2A -2D The semi-trailer is taken over by staff in the intermodal terminal and lifted on to the rail wagon	
Eskilstuna kombiterminal - Alternatives 2A - 2E The semi-trailer is taken over by staff in the intermodal terminal and lifted on to the rail wagon	
Intermodal transport Berlin – Rostock – Alternatives 2A, 2C & 2D The semi-trailer is transported by rail	
Road transport Berlin – Rostock – Alternatives 2E & 2F The semi-trailer is transported by road	
Intermodal transport Berlin – Eskilstuna – Alternative 2B The semi-trailer is transported by rail	
Road transport Berlin – Stockholm via Puttgarden – Rødby and the Øresund Bridge - Alternative 2G The semi-trailer is transported by road	
Handling in the Port of Rostock and the port of Trelleborg Alternatives 2A & 2C - 2E The semi-trailer is towed on or of the ferry by port or ferry staff	
Rail and ro-ro ferry Rostock – Trelleborg - Alternatives 2A & 2C – 2F The semi-trailer is transported by rail or ro-ro ferry.	
Ro-ro ferry Puttgarden – Rødby – Alternative 2G The semi-trailer is transported by ro-ro ferry	
Intermodal transport Trelleborg – Eskilstuna – Alternatives 2A & 2C - 2E The semi-trailer is transported by rail	

<table>
<tr><td>Road transport Trelleborg – Stockholm – Alternative 2F
The semi-trailer is transported by road</td><td rowspan="2">
</td></tr>
<tr><td>Last mile transport on road Eskilstuna – Stockholm - Alternatives 2A & 2C - 2E
The semi-trailer is transported by road</td></tr>
</table>

6.3.2 Cost elements in the theoretical case 2 (Berlin - Stockholm)

The tables below give an overview over the distribution of distances and costs between "modalities" in the transport chain for the seven alternatives. A more comprehensive description of the transport chains is shown in Appendix B

Alternative 2A:
Berlin – Eskilstuna on rail, incl. on the rail ferry Rostock – Trelleborg, which means rail transport on the whole route. Last mile on road to Stockholm.

	Pre/post haul road	*Rail haul*	*Terminal road-rail*	*Ro-ro ferry*	*Sum*
Distance/lifts/trips	120	827	2	1	-
Price (€)	240	538	50	300	1,128
%	21 %	48 %	4 %	27 %	100 %

Alternative 2B:
Berlin – Eskilstuna on rail in transit via Denmark, an alternative, with rail on the whole route. Last mile on road to Stockholm.

	Pre/post haul road	*Rail haul*	*Terminal road-rail*	*Toll bridge Great Belt rail*	*Toll bridge Øresund rail*	*Sum*
Distance/lifts/trips	120	1,383	2	1	1	-
Price (€)	240	899	50	25	19	1,233
%	19 %	73 %	4 %	2 %	2 %	100 %

Alternative 2C:
Berlin – Rostock on rail, RoRo ferry Rostock – Trelleborg, Trelleborg – Eskilstuna on rail (so called Gebrochener Verkehr). Last mile on road to Stockholm.

	Pre/post haul road	*Rail haul*	*Terminal road-rail*	*Ro-ro ferry*	*Sum*
Distance/lifts/trips	120	827	4	1	-
Price (€)	240	538	100	230	1,108
%	22 %	49 %	9 %	21 %	100 %

Alternative 2D:
Berlin – Rostock on rail, RoRo ferry Rostock – Trelleborg and Trelleborg – Stockholm om road (Also Gebrochener Verkehr, but with a longer road leg in Sweden)

	Pre/post haul road	*Road haul*	*Rail haul*	*Terminal road-rail*	*Ro-ro ferry*	*Sum*
Distance/lifts/trips	10	646	240	2	1	-
Price (€)	20	711	156	50	230	1,167
%	2 %	61 %	13 %	4 %	20 %	100 %

Alternative 2E:
Berlin – Rostock on road, RoRo ferry Rostock – Trelleborg and Trelleborg – Eskilstuna on rail and Last mile on road to Stockholm

	Pre/post haul road	*Road haul*	*Rail haul*	*Terminal road-rail*	*Ro-ro ferry*	*Sum*
Distance/lifts/trips	110	226	587	2	1	-
Price (€)	220	249	382	50	230	1,130
%	19 %	22 %	34 %	4 %	20 %	100 %

Alternative 2F:
Berlin – Rostock on road, ferry Rostock – Trelleborg and Trelleborg – Stockholm on road

	Pre/post haul road	*Ro-ro ferry*	*Sum*
Distance/lifts/trips	872	1	-
Price (€)	959	230	1,189
%	81 %	19 %	100 %

Alternative 2G:
Berlin – Stockholm on road (A-B), via the ferry Puttgarden - Rødby and the Øresund bridge.

	Pre/post haul road	*Ro-ro ferry*	*Toll bridge Øresund road*	*Sum*
Distance/lifts/trips	1,171	1	1	-
Price (€)	1,288	245	60	1,593
%	81 %	15 %	4 %	100 %

6.3.3 Comparison of costs, cost split and time

To identify the key differences between combined transport and road transport, the seven alternatives in the Berlin-Stockholm case on costs, distance and time are compared in the following four figures.

Figure 16 shows how different the split of costs between "modalities" are in the alternatives. Moreover, it shows that cost related to First/Last mile transport (Pre/post haul and terminal) represent 6-31 pct. of the total transport cost across the alternatives, most of them with a share over 20 pct. At this level, the cost related to First/Last mile transport play a bigger role as a cost driver. The high costs are related to the 100-kilometre-long post haul from Eskilstuna to Stockholm in these alternatives.

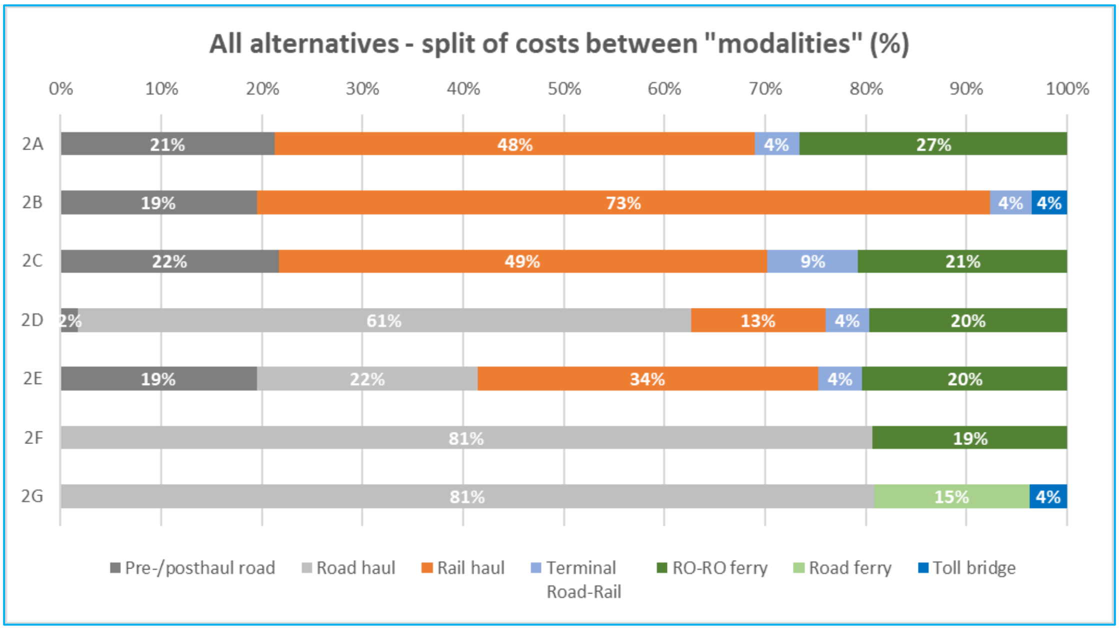


Figure 18 Comparison of the distribution of costs in percent between the alternatives (Source: Own calculations)

When looking at actual costs those range from 1,100 to 1,600 EUR in the alternatives. The cheapest alternative is 2C with a combination of a long rail haul and a ro-ro haul at 1,100 EUR. The most expensive is alternative is 2G with a combination of a long road haul and a road ferry, see figure 19.

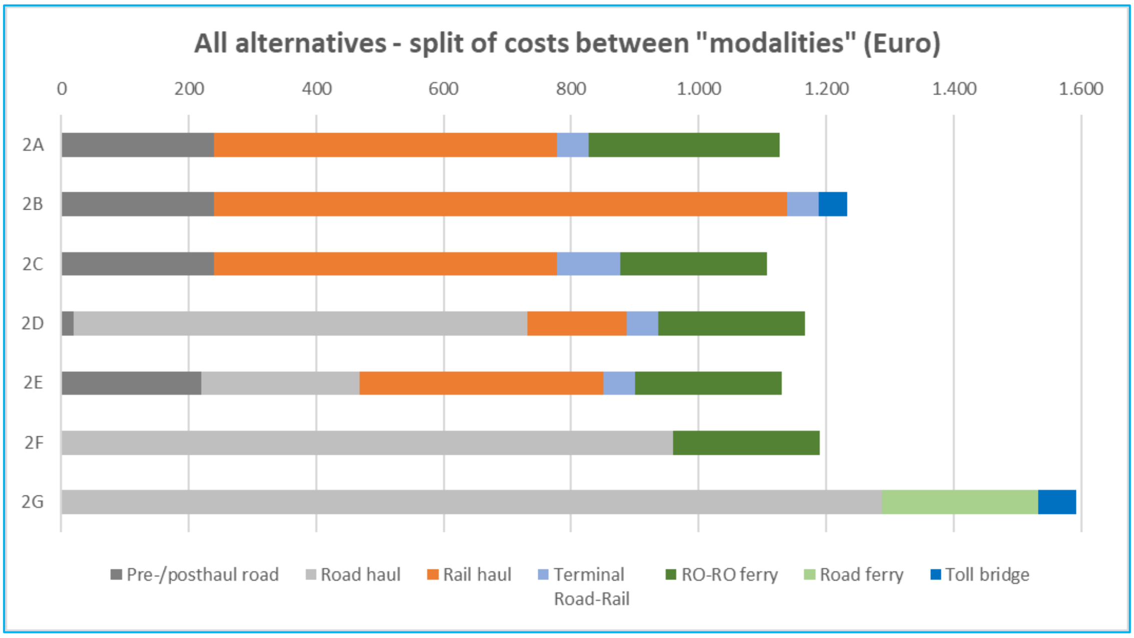


Figure 19 Comparison of the distribution of costs in Euro between the alternatives (Source: Own calculation)

When comparing distances for the alternatives in figure 20, the alternatives are all almost all in the range from 1,050 to 1,200 kilometres. Only alternative 2B with the long rail "detour" via Padborg surpass this range with a total distance of 1,500 kilometres.

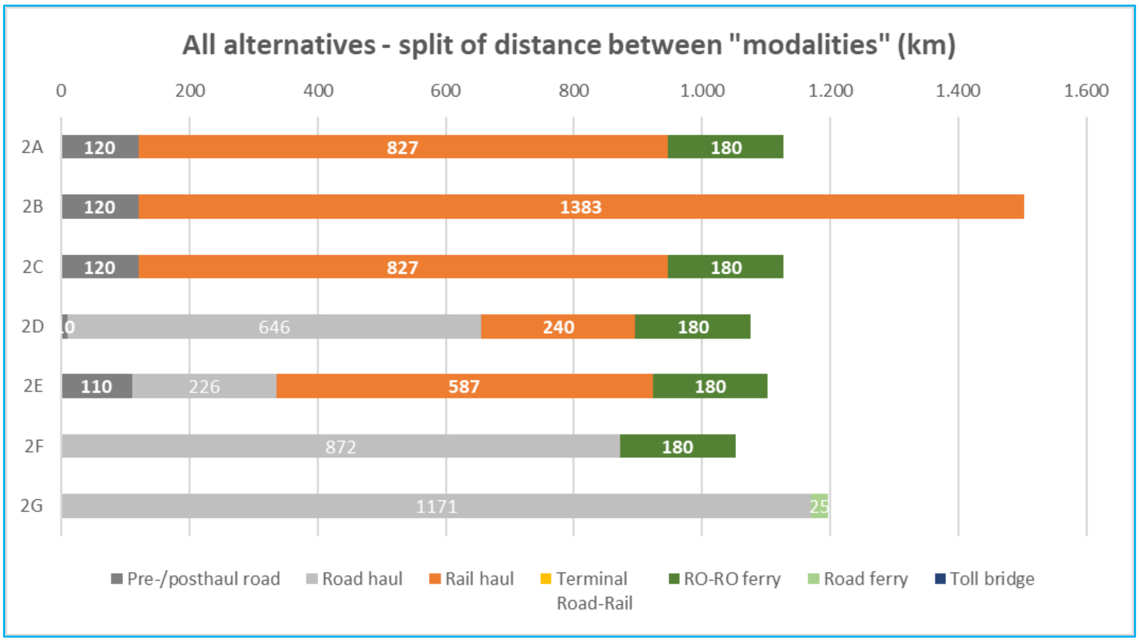


Figure 20 Comparison of the distribution of distance for different modes between the alternatives (Source: Own calculation)

Time is an important aspect in transport, the total transport time for the alternatives are in a close range between 17 and 24.5 hours. The fastest (2G) is the alternative which is based on road haul and a road ferry, but it is also the most expensive alternative with an almost 50 percent higher price than the cheapest, alternative (2C).

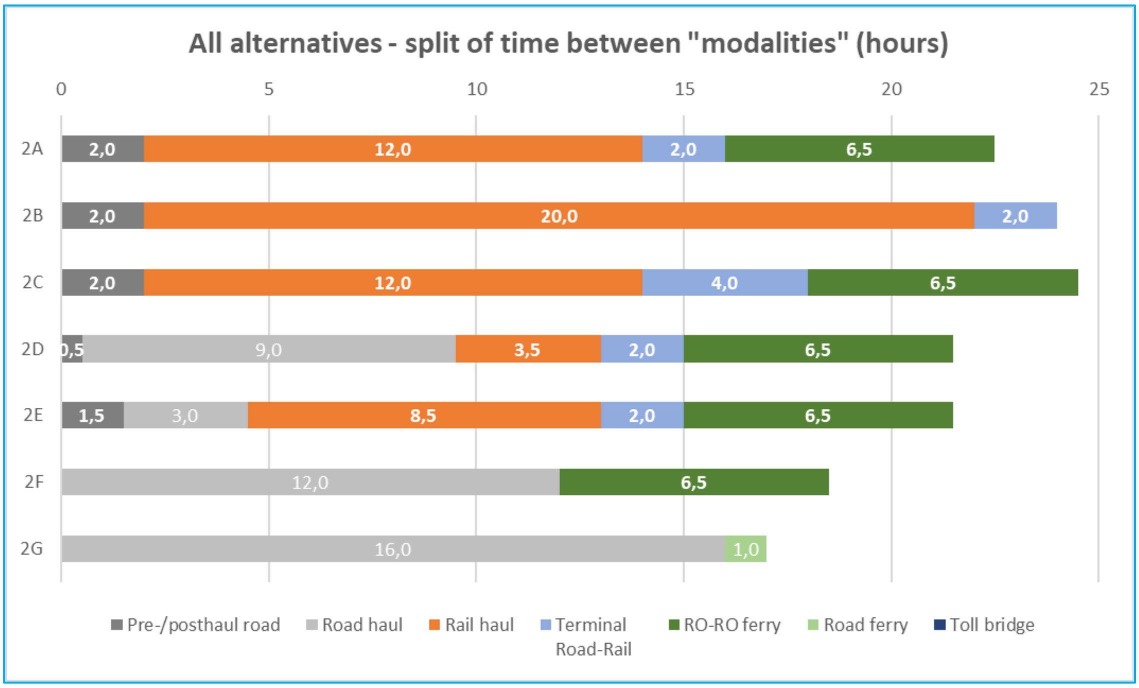


Figure 21 Comparison of the distribution of time for different modes between the alternatives (Source: Own calculation)

When comparing the alternatives across costs and duration, they have different characteristics. Depending on e.g. delivery window, product value, freight category or freight weight /dimensions some alternatives will be more suitable than others.

In figure 22 price and duration for the alternatives and in the Berlin (DE) - Stockholm (SE) case are compared. The same relation between price and transport duration as in the Billund (DK) - Kaunas (LT) case can be seen with the slowest alternatives being the cheapest and the fastest being most expensive. In the Berlin (DE) - Stockholm (SE) case the differences are not as big as in the Billund (DK) - Kaunas (LT) case, which is due to more “direct” routes for all the alternatives.

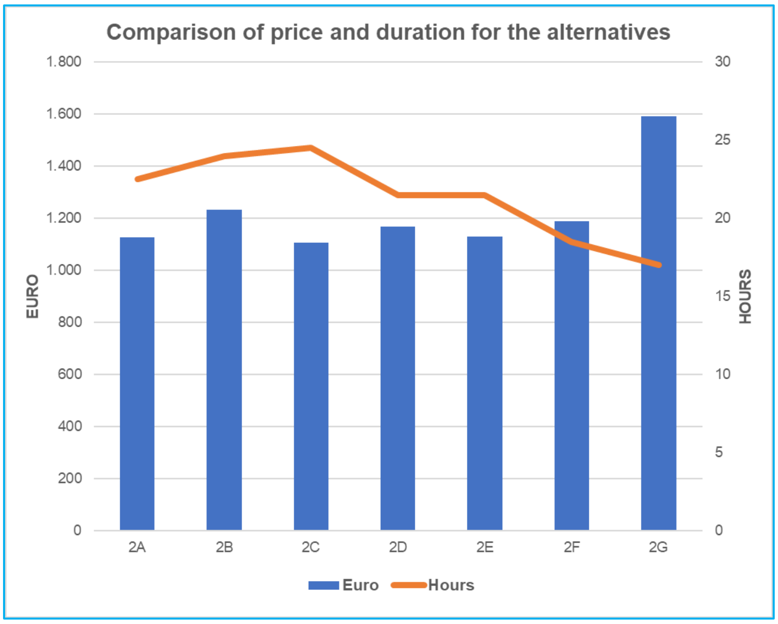


Figure 22 Comparison of price and duration for the alternatives (Source: Own calculation)

6.3.4 Summary - Berlin-Stockholm Case

All in all, the Berlin (DE) - Stockholm (SE) Case can be summed up as follows:

The First/Last mile transport related costs (Pre/post haul and terminal) represent 6-31 pct. of the total transport cost across the alternatives, most of them with a share over 20 pct. The total transport costs range from 1,100 to 1,600 EUR, and the cheapest alternative is a combination of a long rail haul and a RoRo haul, while the most expensive one combines a long road haul and a road ferry. Total distances ranges between 1,050 and 1,200 km apart from one alternative of over 1.500 km due to a long rail "detour" via Padborg (Danish/German border). The transport time range from 17 to 24.5 hours. The fastest alternative (2G) is based on road haul and a ro-ro ferry, while also being the most expensive one. The slowest alternative (2C) is a combination of a long rail and ro-ro haul.

Like the Billund (DK) - Kaunas (LT) example there is a clear relation between price and duration with the slowest alternatives being the cheapest and the fastest ones the most expensive. Compared to the Billund (DK) – Kaunas (LT) case, the ranges in cost and time are lower for the Berlin (DE) -Stockholm (SE) case, due to a more direct "routing".

6.4 The benchmarking case Jula

Additionally, the combined transport solution of the company Jula has been selected as a benchmarking case as it has been followed closely by Rickard Bergqvist of Gothenburg School of Economics since it was started. Thereby it has been possible to make specific details on costs etc. available for this analysis, as well as input on the importance of different measures, to continue operations and increase efficiency.

Jula is both a relevant and special case for combined transport in the Baltic Sea Region, because it challenges existing hypotheses on necessary conditions to make combined transport a success: first of all, the rail leg in the transport case is very short, and secondly the same applies to the Last mile transport. As a result, the split of costs between rail operation, terminal handling, and Last mile very different to most other combined transport chains, with longer rail legs.

Jula is in other words the proof that combined solutions for total transport distances below 300 km can be profitable.

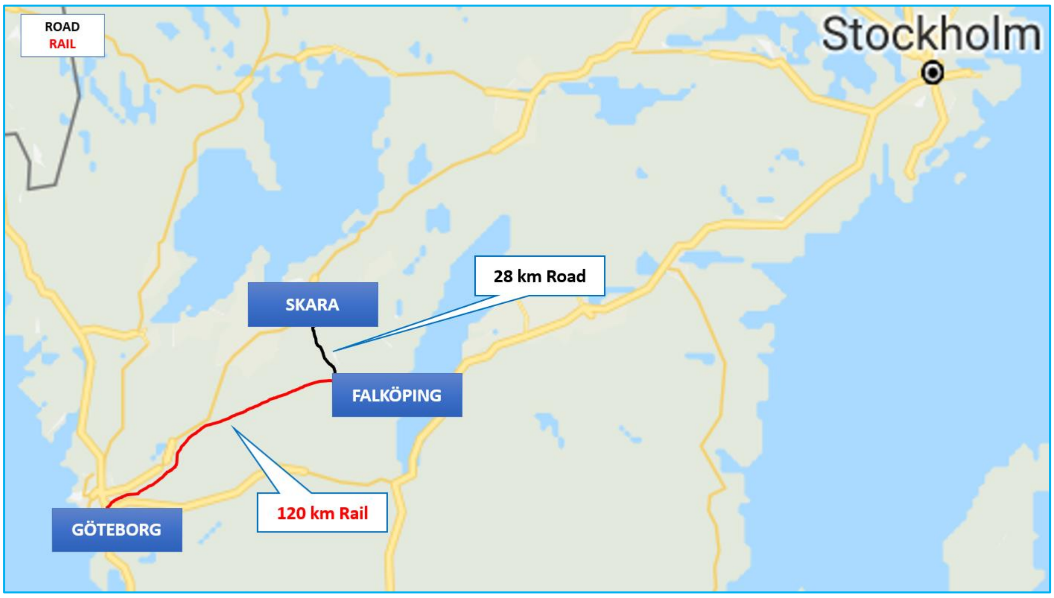


Figure 23 Geography of the Jula case (Source: Own illustration)

6.4.1 About Jula

Jula is a family-owned company group within retail of products for handy people and a turnover of some 7 billion SEK (some 680 million EUR). The group has 54 stores in Sweden, 34 in Norway and 13 in Poland.

Jula has set a goal to be climate neutral by 2030 and transport to department stores must become 100 pct. fossil-free by 2025. They work with many different solutions e.g. use extra high pallets, their own rail solution, effective road transport and their overseas transport uses “slow steaming” (less fuel consumption). They also have demands for lowering environmental impacts in their contract with external product and transport suppliers.

With the help of the sister company Jula Logistics’ rail shuttle and the Dryport in Falköping (Jula’s own area in the terminal), containers are now running from the Port of Gothenburg to Falköping by rail. From there the containers are transported by special permission on extra-long trucks to the central warehouse in Skara. On an annual basis this results in a reduction of about 6,000 transport by truck between Gothenburg and the central warehouse in Skara.

6.4.2 The rail shuttle

Skaraborg Eco Shuttle is an intermodal concept for import and export containers via the Port of Gothenburg.

The company Jula import large amounts of different types of products via the Port of Gothenburg that then are transported to their main hub in Skara, some 150 km from Gothenburg. Before the intermodal set-up was launched, all the containers were transported on numerous trucks every week on road between the Port of Gothenburg and the Jula central warehouse in Skara.

The new concept contains of a rail transport and a truck transport. The rail transport is a shuttle between the Port of Gothenburg and the intermodal terminal Skaraborg Logistics Centre in Falköping, a trip of 120 km on rail.

Skaraborg Logistics Centre includes 6 different terminals with 5 tracks and operates 6-7 trains per day and has container flows of more than 30,000 TEU/year. Around 1 million tonnes of cargo are handled in the logistics centre every year.

In 2013 Jula invested in the establishment of a Dryport in the Falköping logistics centre and in 2018 they invested further, by acquiring further 300,000 m2 ground next to the Dryport to be able to expand their terminal further.

6.4.3 Extra-long vehicles for Last mile transport

From the terminal the containers are transported as long vehicles on a special permit from the Swedish Transport Agency, thereby enabling transport of 2 x 40' containers with each truck load (normal trucks can only handle 1 x 40' with each load). The road transport part is 28 km.

6.4.4 Defining criteria for good cases

The success story of this concept is the dedication to enhance intermodal transport for an important flow of inbound cargo to the Jula central warehouse and hereby combining a short rail route with a short Last mile transport by road. By scrutinizing the different cost elements, it has been possible to establish a viable intermodal route, in an environment, where road transport is an easy and cheap alternative. The dedication of the company Jula to reduce their CO2-emissions has been a vital part of the strategy, leading to this.

Since the shuttle train started in 2013 quite a lot of other customers have joined, e.g. IKEA and many local logistics and other companies. Further to this, Samskip Rail now has started an intermodal rail shuttle between their hub in Duisburg and the Falköping intermodal rail terminal with 4 weekly departures. This shuttle is in merged operation with the Skaraborg Eco Shuttle between Gothenburg and Falköping.

To achieve the most favourable rates on rail, several steps of optimisation of the set-up has taken place in the years since the service was established. Now the shuttle train is using spare capacity of locomotives that were dedicated to other longer routes, meaning that these locomotives achieve a higher utilisation degree by operating the Gothenburg-Falköping route in a time period where the locomotives before were idle.

The continuous optimisation of resources in all different parts of the transport chain, together with great collaboration between many different partners are most essential for the success and expansion of such a service.

Further to this, the Last mile transport with 32 m long vehicles (HCT trucks) has been vital to this set-up. The Last Mile with 2 x 40' containers in the same transport has led to large reductions in the trucking costs, as the normal trucks only allow for 1 x 40' container to be transported with the same truck. The HCT trucks delivers 2 x 40' to Skara and bring back 2 x 40' empty to the terminal, for short storage, loading with other cargo or return to the shipping line depot.

What makes Jula a good case?

The case of Jula challenges the normal way of thinking of combined transport and how to actually make a business case in combined transport.

Among the most important takeaways from its success are the following:

- ✓ The concept was conceived as a green solution it also ended up being a good business case
- ✓ The case shows the importance of cooperation across businesses and transport operators
- ✓ Continuously improving the cooperation model, whereby also other participants use the rail shuttle service
- ✓ Jula started with a basic customer who already provided large volumes to fill the trains and with increasing volumes.
- ✓ A strategic opening towards other users helped increasing the frequency of the rail shuttle and made the service even more attractive to others
- ✓ Continuous optimisation of the services in the transport chain enhanced the business case
- ✓ Using longer HCT vehicles with 2 x 40' containers made Last mile transport more cost effective
- ✓ Using spare capacity of locomotives from other set-ups helped reduce costs further

6.5 Stakeholder views qualifying the case studies

To qualify the results of both the literature research and calculation as well as the theoretical case studies, relevant stakeholders were interviewed for the analysis. We selected stakeholders with a thorough expertise within intermodal transport from different perspectives – academic, operational, and general. Input was also given from other stakeholders, whereas deeper interviews were made with:

- Rickard Bergqvist, Professor, Gothenburg School of Economics
- Torgny Nilsson, Business Development Manager, Port of Trelleborg
- Kristoffer Skjutare, Project Manager, CLOSER and Partner in Combine

All in all, they approved the approach chosen, confirmed price levels generally and that the project has included relevant ideas and thoughts.

Some of the more specific comments to the results of the analysis are exemplified below:

- A share 30-35 pct. of the total costs for First/Last mile was considered a good and realistic average cost figure, when looking at shorter (less than 300 km) combined transport routes.
- The length of the First/Last mile differs a lot and therefore plays a vital role in the set-up but is less important on longer routes.
- It is important to remember all monetary and non-monetary cost elements, also those that are avoided by combined transport, like congestion charges as well as delays caused by congestion, that are getting more and more common in large cities.

6.5.1 Useful insights for the planning of future combined transport solutions in the BSR

The interviewees also provided useful insights regarding the cases and possible conclusions for creating successful combined transport in the Baltic Sea Region.

- **Cooperation** between different partners is key to developing more efficient transport chains and through common efforts search for options to enhance the services and possibly also reduce costs together.
- **Consider cooperation** between different partners to offer a “One-Stop-Shop” towards the customers. This approach gives the customer single point access to different partners working together to develop viable transport solutions.
- **Continuous optimization** can lead to better and mutual gain for the partners, meaning that overseeing the different parts thoroughly and continuously can give room for optimization of parts of the transport chain, which also can be a gain for other parts of the transport chain.
- **Optimize the service**, by looking at the different cost drivers to see whether there could be other operational solutions to achieve a better service.
- **Utilize the rolling stock** as efficiently as possible, i.e. the right rolling stock at the right time and place.
- **Use spare capacities in the system**, for example rolling stock that otherwise would be idle.
- **Price according to the free capacity** you have in your transport system, whereby you increase the utilisation of your transport system and can reduce the cost per unit.
- Consider the **transport conditions** since the one paying for the transport can gain from more efficient combined transport set-ups (See Incoterms).
- **Think modular!** In the Jula case, the HCT-trucks moves the double number of containers and there are different ways to enhance the transport chain, by thinking modular.

6.5.2 Basics - setting up a new combined transport service

To get enough service level, most customers are interested in a daily service and this means that at least 5 departures per week should be provided. As a rule of thumb, a full train contains some 36 semi-trailers. This means that for a full train service with 5 departures per week, you would need a volume of some 8,000 – 9,000 semi-trailers in a year. When starting up a service, 2-3 departures/week could be enough, but seldom are in the longer run. This also means that already from the start, there is the perspective of having a daily service in the long run, but it is important to start with what is achievable.

The operator will probably start by optimising his resources (locomotives, staff etc.) to build up a new service with as many departures that would fit to his available resources and to accommodate the demand from the customers. This could be 2-3 departures per week, depending on available rolling stock etc. When the new service is up and running, an extension of the number of departures and hereby better service level can be made operable. This could however mean the need of another dedicated locomotive or other expensive resources that will have to be accommodated in the pricing.

One of the main issues in rail and combined transport is the allocation of risks among the players in the case there is not enough volume to fill the trains. The rail freight operators normally have low margins, and should they need to take the responsibility for this risk of not having enough cargo to fill the trains, they also need to calculate with this risk in their rates. A common rule has been to at least have 80 – 90 pct. of the train load in contract with one or more customers and then anything above that would help the operator with his margin. Otherwise the rail operator will have to calculate with only 80 pct. filling rate, to ensure that his costs and a bit of margin is covered.

This can of course lead to higher rates than the customer is willing to pay, especially as many customers also want a frequent service, preferably with daily departures, that would offer a good flexibility. Here it also must be considered that combined transport always includes at least one lift in each end and a pre- and post-haul, that also can be expensive. But, with proper agreements, volumes etc. the costs for First-/Last mile transport can also be reduced.

To accommodate the large risk taking of filling the trains and hereby be able to reduce the costs, sharing the risk between different stakeholders often through new and cooperative business models, can be a viable solution. In such set-ups the different actors together discuss how to ensure that the trains are as fully loaded as possible, which then also can be reflected on the costs and the actual rates for transporting the cargo to its destination.

Therefore, new, and different business models is often seen as a good measure, to enhance combined transport services. This could be a different way to split the risk between the different actors involved or different agreements between the involved actors as well as an enhancement of the cooperation between the actors in a combined transport chain.

Example - a possible business model is Swedish Real Rail.

Real Rail started as a cooperation between the two large freight forwarders and competitors Schenker and DHL when the Norwegian intermodal train supplier CargoNet stopped its intermodal routes in Sweden in the beginning of 2012 caused by low rentability on the Swedish routes. At the time, Real Rail offered all major Swedish Cargonet customers to join, but only Schenker and DHL joined. Sandahl (back then the largest Schenker haulier) owned 60 pct. of the company and Norwegian Cargonet 40 pct. Real Rail has since been fully taken over by the Sandahl Group.

Real Rail tenders the rail operation to Green Cargo and many of the terminals, i.e. the new intermodal terminal near the Port of Gothenburg, are now operated by another company within the Sandahl Group. This implies that the Group has significantly increased its interests in the intermodal business in Sweden.

Sandahl and DHL have from the beginning shared the risk of filling each train and if one of the companies does not have enough trailers for their share, they ask the other. Otherwise they will still have to pay for the entire share even if they have empty wagons on the train. This risk sharing is an important factor to the success, as none of them could have filled the trains on own risk alone. In this set-up Sandahl and DHL use rail as a base in these routes and use road transport as regulator of freight volumes.

Since then, Real Rail has expanded its network further and now operates some 110,000 TEU per year in their combined transport services in Sweden. Today they run 10 different routes between terminals in southern and northern Sweden, with many weekly departures, operated by the largest Swedish rail freight operator Green Cargo.

7 CONCLUSIONS ON THE COST-ELEMENTS COMPARING COMBINED AND DOOR-TO-DOOR TRANSPORT

In both elaborated cases the Door-to-door road haul alternative is the most expensive alternative, compared to the combined transport alternatives. With the long distances in the cases, the high cost of road haul has a large impact on total cost of the transport chain in the alternatives with Door-to-door road haul.

The long distances in the transport chains also reduces the costs related to First/Last mile's share of total costs. When looking at costs related to First/Last mile transport for (Pre/post haul and terminal handling) they account for:

- 12-18 pct. of total cost in the Billund (DK) – Kaunas (LT) case
- 6-31 pct. of total cost in the Berlin (DE) - Stockholm (SE) case, but in most of the alternatives a minimum of 20 pct.

The relatively high share of costs for pre-/post haul and terminal handling in the Berlin (DE) -Stockholm (SE) case primarily relates to the 100-kilometre-long post haul from Eskilstuna (SE) to Stockholm (SE).

Below we have made an example with alternatives from the cases to show when the break-even point is reached.

Example – when does the competitive advantage change in favour of road transport?

In this example two alternatives on costs related to distance of main haul are compared. This is to get an indication on when costs in these transport chains change in favour of road transport. The two alternatives are:

- *2C: Berlin – Rostock on rail, RoRo ferry Rostock – Trelleborg, Trelleborg – Eskilstuna on rail (so called Gebrochener Verkehr). Last Mile on road to Stockholm.*
- *2G: Berlin – Stockholm on road (A-B), via the ferry Puttgarden - Rødby and the Øresund bridge*

In Alternative 2C the main haul is done by rail, while 2G is road haul all the way.

Figure 24 shows that when reducing the distance, the cost of the road haul falls faster than the cost of the rail haul (see the two lines in the figure).

The figure also shows that the break-even point, where the road haul gets cheaper than the combined transport, is somewhere in the range 300-400 km.

"Full distance" is the full distance of the alternative i.e. full distance of alternatives 2C and 2G. "Half distance" is half the distance of the specific alternative. As distances differ between rail and road routes, "Full distance" and "Half distance" differ between road and rail alternatives

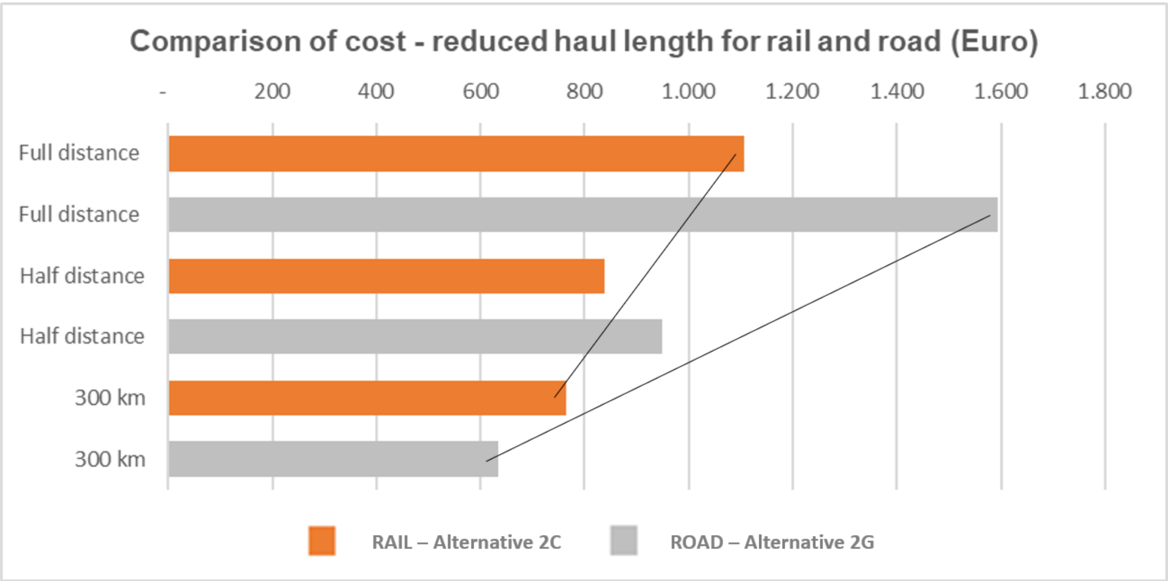


Figure 24 Comparison of costs with reduced haul length for rail and road (Source: Own calculations

In the example demonstrated, "Full distance" refers to the total transport distance of the two alternatives respectively. "Half distance" is half the distance of the specific alternative. As distances differ between rail and road routes, "Full distance" and "Half distance" differ between road and rail alternatives.

The choice of an alternative in a specific different case depends on cargo type, cargo volume, transport time demand, as well as the reliability and flexibility in service the customer is relying upon.

Ro-ro transport across the Baltic Sea is a cheaper solution than using the land route. It depends on the number of departures available with the ferries though if it is an attractive option for transport customers.

8 FIRST AND LAST MILE COST DRIVERS

8.1 Overview of relevant cost drivers

Below, the importance of different processes and facilities in terms of their productivity related to handling of load units at terminals are analysed. The guiding question is if the respective process or facility and the productivity of their operation or disposition can be characterised as a main cost-driver for the level of cost elements in combined transport.

The main processes and facilities that possibly are relevant cost drivers are:

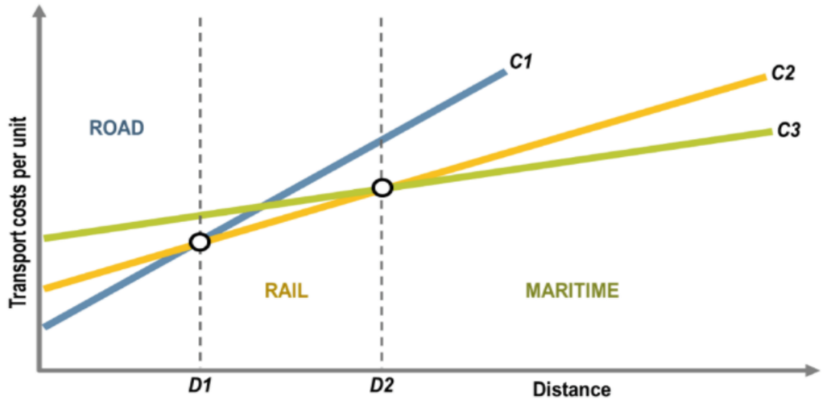
- The actual costs of First/Last mile (road) transport
- Empty transport to and from terminals
- Terminal handling for First/Last mile transports
- Storage possibilities and terminal fees for First/Last mile transports
- Late arrivals at terminals and ports for time-critical transports

The "weight" of the costs related to First and Last mile transport in combined transport are strongly dependent on length of main haul – the longer the main haul is the less impact these costs have on the total transport costs.

In the text box below, there is a model explaining the relation between transport cost per unit and distance for road, rail, and maritime transport.

Different cost functions according to the serviced distance[13]
Transportation modes have **different cost functions** according to the serviced distance. Using a simple linear distance effect, road, rail, and maritime transport have respectively a C1, C2, and C3 cost functions. While road transport has a lower cost for short distances, its cost increases faster than rail and maritime costs. At a distance D1, it becomes more profitable to use rail transport than road transport while from a distance D2, maritime transport becomes more advantageous. These are referred to as break-even distances.

[13] Source: The Geography of Transport Systems, FIFTH EDITION, Jean-Paul Rodrigue (2020), New York: Routledge, 456 pages. ISBN 978-0-367-36463-2



Source: The Geography of Transport Systems

As an illustration, an example using an alternative from the above cases showing how the cost share of costs related to First and last mile transport grows when reducing the mail haul distance is used below:

Example – How does the distribution of cost change when reducing distance of the rail haul?

In this example the rail haul distance is reduced first by half and then to 300 km total. In the calculations *Alternative 2C is used: (Berlin – Rostock on rail, ro-ro ferry Rostock – Trelleborg, Trelleborg – Eskilstuna on rail (so called Gebrochener Verkehr). Last Mile on road to Stockholm).*

Figure 25 shows a comparison between calculation with the full-length rail haul, with the rail haul reduced to half and a rail haul distance of 300 km total. The cost share of First and last mile transport including terminal handling grows from 31 pct. to 44 pct. when reducing the rail haul from 827 to 300 kilometre.

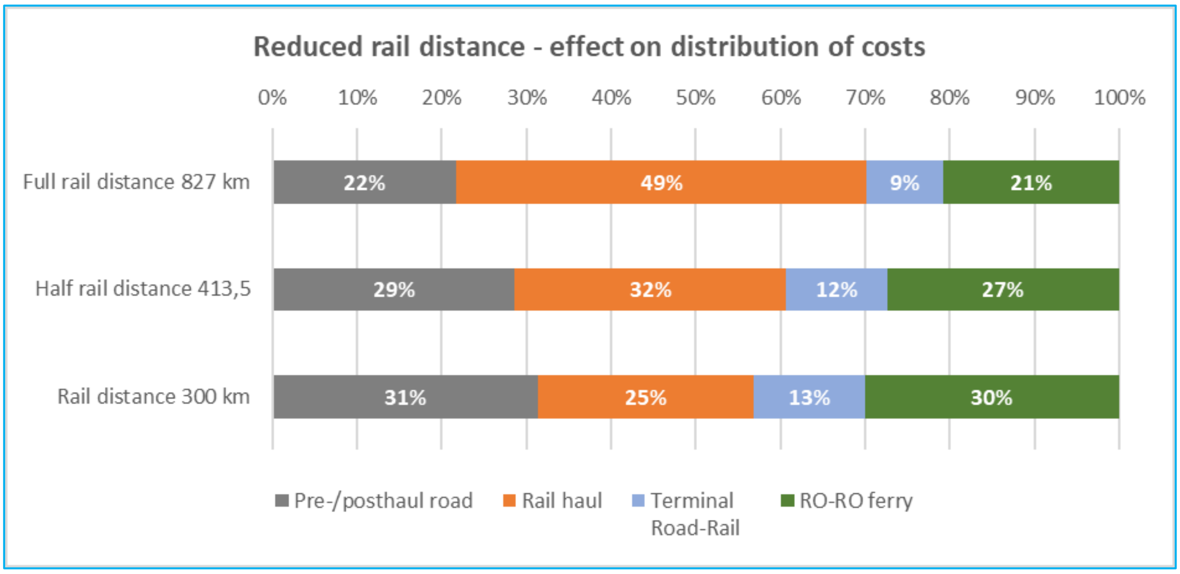


Figure 25 Reduced rail distance – the effect on the distribution of costs (Own calculations)

8.1.1 Empty transport to and from terminals

Empty runs are a general problem within the transport industry, and it comes from imbalances in freight volumes from and to the terminals. Most often you will have better usage of the trucks capacity when leaving the terminal compared to the trip back to the terminal.

Goods are consolidated at terminals, so when leaving the terminal, the trucks will usually carry a high volume of “the primary product” e.g. consumer gods, food products, intermediate goods or raw materials. Returning to the terminal it will most often carry a lower volume of empty packaging, residual products, return products or other goods picked up on the return trip. A good example of this is the retail business where food and consumer goods are delivered to several stores and trucks returns to the terminal with empty packaging, empty pallets, and roll cages. The packaging, pallets and roll cages can fill a substantial part of the truck floor, although it does not really contain any cargo, and it is also a vital part of the transport chain, especially for shops etc. that do not have large storage facilities and therefore need to return these as soon as possible. There are also costs (penalty fees) occurring for the pallets and roll cages if the shop does not return them the soonest possible.

Using **triangular traffic routes** - meaning that after the cargo is delivered to the customer there is a short empty run to another customer where then the next load of cargo is collected - is often a good solution in order to reduce the empty runs. To succeed, a lot of logistics planning is needed to reduce empty runs, while weighing in the time consumption and costs that occurs, when rerouting vehicles to pick up suitable cargo elsewhere. This is of course done daily for a lot of vehicles, to optimise the operational set-up of vehicles, drivers, and cargo as effectively as possible.

The same is done by different shipping lines as regards to the containers and customers they are supplying. Here the logistics planning within the shipping line, owning the container also plays a vital role. Can another load be ensured for the specific container within the vicinity of where it is unloaded, to reduce the empty runs?

The trucking company performing the Last mile transport of containers also sees the empty container as cargo, even if it only needs to be taken to a terminal or depot after emptying at the customers premises and this means that he expects to get paid also for the transport of the empty unit. The customer might have a different view on this, but his transport includes the container, that mostly is expected to be brought back to the nearest depot.

Another issue to consider is that there might be cargo to be loaded in the vicinity, but is it for the same shipping line and thereby the same container?

Furthermore, there is also the issue about who has ordered the transport and on what terms. Incoterms[14] lays down the rules for this and there are many different varieties, where the ownership of the transport changes along the transport chain.

[14] https://iccwbo.org/publication/incoterms-2020-introduction/

A seller of a product can offer FCA – Free Carrier and this means that he is responsible for the transport until it is taken over by the first carrier mostly very close to the seller's premises, and the buyer will then have to decide about the transport conditions from that point on.

A totally different example is the transport condition DDP – Delivery Duty Paid, where the seller has the obligation and risk of the transport chain all the way to the buyer's premises. And there are a lot of different transport conditions in between these, where the risk is then taken over at different points during the transport chain.

Combined transport is more complex and require more planning, compared to road transport. Therefore, one would expect a greater focus on reducing empty runs in road transport to and from the terminal, as it is a relatively large cost element in the combined chain. With that in mind, combined with the fact that it is a general problem in the transport industry, empty runs and imbalances in the cargo flows are not a significant cost driver specifically for combined transport, as it is a general problem in the transport industry as well as for shippers and customers.

8.1.2 Late arrivals at terminals and ports

Large terminals and ports run 24 hours a day year-round. However, at smaller terminals and ports operators sometimes limit opening hours and services to periods with enough business. This keeps costs down and make it possible to run a profitable business. In some cases, this practice gives problems for customers e.g. if they need to operate during the night-time to make their transport chain work.

An example is a customer who has a train that arrives at the terminal at 2 a.m. in the morning but the trailers was not unloaded until 5 a.m. in the morning. In this case the unloading of trailer was too late for the customer's morning distribution to work out and they stopped using train transport to this terminal.

Limited opening hours or services is not a significant cost driver in combined transport, it is more a showstopper as it limits the possibilities of combined transport services. This is especially crucial for certain commodities where the cargo has to be delivered to the customer's premises in the early morning.

8.1.3 Inefficient terminal handling for First/Last mile transport

Terminal handling is usually a central cost element in First/Last mile road transport. There are different issues to consider for achieving efficient terminal handling. The availability of the terminal, with the opening hours the customers need, is a vital factor. Some customers want their cargo delivered early in the morning (not to get stuck in rush hour traffic or other restrictions for road transport i.e. in inner cities) and if the terminal does not open until 06 a.m., this could be the dealbreaker.

The efficiency within the terminal is also an important factor – from the arrival of the train with maybe 40 units simultaneously, and until the specific unit is loaded onto the correct truck - as waiting time to get the specific unit can lead to further delays and extra costs. It is not always possible to have all the trucks lined up at specific minute slots to be available at the perfect time when the crane or reach stacker lifts the unit off the wagon. This means that there often are extra costs as the unit will have to first be lifted to a parking area if the specific truck cannot be at the exact location at the exact time. When the truck arrives for pick up, the unit will then be lifted onto the truck from the parking area. And vice versa for delivery of units to the terminal. There are terminals that work with slot times, i.e. in Hamburg, where you cannot enter the port area on other times than the slot you have been given. This is done to save time and reduce the queuing in the port area disturbing the traffic flow.

Another important issue is efficient communication between the terminal and the truck drivers. With specific slot times, online systems are used for communication, but that is not often the case in intermodal terminals or port terminals. It is especially important should there be delays on the route or in the terminal, that the truck drivers need to know, to be able to adjust their plans and also ensure that they follow the strict rules of working time for drivers etc.

Other examples can be a terminal layout that always acquires two lifts of the unit from train to truck at the terminal, leaving the direct lift to the truck impossible to perform.

From that point of view inefficient terminal handling that increase the costs of terminal handling will be a significant cost driver in combined transport.

8.1.4 Storage possibilities and costs

Intermodal terminals and ports are also used for storage of intermodal units, especially between the use by different customers. For this service for the customers there are different fees depending on how long a period they are standing in the terminal and space in the terminal available for such services.

This also implies at least one extra lift within the terminal, to place the unit in the storage area.

At the same time not all units arriving with a train can be collected directly and might therefore be placed in a parking area before a truck can collect, which also means further lifts.

8.1.5 Terminal fees

Many intermodal terminals and ports have access fees. The fee either apply to the whole train or ship, or the unit - or sometimes a combination of the two. In the end this fee is a cost for every unit transported in this combined transport chain and constitutes an additional cost compared to road transport alternatives. Usually it is only a small amount per unit. In the case studies the total transport costs in the range of 900 to 1600 EUR and terminal fees in intermodal terminals are usually 3-5 EUR per unit. From that point of view the fees only represent an exceedingly small part of the total transport costs. Terminal fees at especially ports can be counterproductive for combined transport though. This is the case if there are co-called gate fees for trains but no corresponding fees for trucks entering or leaving the terminal.

8.1.6 Conclusions on the impact of cost-drivers on Last mile transport

The actual costs for (road) the physical movement of cargo/units are the largest cost driver in First/Last mile transport. The primary reason for this is that the start cost of a truck with a driver is “fixed” and must be distributed over the kilometres driven, along with the distance and time related costs. The longer the distance the truck drives, the lower the cost per kilometre becomes. At the same time, when this is part of a longer combined transport chain, the share for First/Last mile will decrease in significance.

While empty transport to and from terminals was identified as the second largest cost driver, it is a general problem in all transport and not a specific cost driver for combined transport. The main reasons are that it is expensive for any transport business to have a low degree of utilisation for their vehicle fleet at the same time as it is not always possible to find suitable return flows nearby, where you have just made you delivery. Many metropolitan cities have large needs for consumer cargo coming in, but often not as much industry that have cargo for the other direction. Examples hereof are both Copenhagen and Stockholm.

Thirdly, terminal handling in First/Last mile transport was also identified as an important cost driver. This is mainly due to both transhipments from rail by crane or reach stacker and handling at terminals or ports, like from vessel by terminal tractors or similar are relatively expensive. At the same time more than often one handling at both ends will be necessary for the best productivity of the terminal or port.

As regards short time storage of transport units, this was not identified as an important cost driver. Storage implies that there must be additional handling of the goods in question if it is not possible to collect all units at once when a train arrives.

Terminal fees as such are not an important cost driver either since access fees do not seem to be remarkably high and apply to either the whole train or ship per unit or as a combination.

Lastly, limited operating hours at terminals are not a cost driver but more of a showstopper as it limits the possibilities regarding the Last mile transport for some cargo segments that require early morning delivery.

9 OVERALL CONCLUSIONS AND RECOMMENDATIONS

Covering WP 4.1, namely subtasks 4.1.1 and 4.1.2, of the Combine project, this analysis focused on uncovering the economic importance of First/Last mile transport in the transport chain for combined transport as well as on identifying possible logistics solutions to make First/Last mile transport more efficient and less costly.

> ***"In freight transport price is usually the decisive factor in the choice of transport solution"***

First/Last mile costs in combined transport most important for shorter distances

The most important conclusion of the analysis is that the percentage of the costs related to First/Last mile transport in combined transport strongly depends on the length of the main haul – the longer the main haul is, the less impact these costs have on the total transport costs.

While in some of the examples, the share of First/Last mile costs was calculated to be below 15 pct. of the total transport costs, in general a share of 30-35 pct. for transport with total distances of under 300-400 km can be expected.

The case of Jula demonstrates that combined transport also is possible for shorter distances

As the case of Jula (Sweden) demonstrates, even in a challenging setting with very short transport distances (below 300 km), it is possible to establish viable combined transport solutions. To achieve this, it is important to establish a close cooperation between partners focusing on optimising the transport solution across its elements – i.e. from start to end. Optimisations means also to continuously consider cost factors and to continuously focus on reducing these. The example also demonstrated that it is important to build a case around a larger transport buyer/receiver guaranteeing a starting point to expand the case with additional customers.

Differences in prices for cost elements across the region

The cost data collected in this analysis show a wide range of prices for the different cost elements in the transport chain across the different countries in the region. Especially for labour costs there is a substantial variation between e.g. Scandinavia and the Baltic countries. Data from Eurostat show that average labour costs for workers in "Transportation and storage" are almost two and a half times higher in Scandinavia compared to the Baltic countries. Calculations are based on the actual labour from an employer perspective and include all costs related to taxes and social insurance.

There also differences regarding other cost elements e.g. lifts at terminal, fuel, truck lease insurance and storage, but their span is generally not as big as in the case of labour costs'.

Labour costs' importance in combined and road transport

The labour costs for truck drivers are identified as a central cost driver in road transport, as it usually accounts for a third to half of the total transport cost. In some cases, e.g. when employing Baltic drivers, the share of labour costs can be substantially lower, i.e. approximately one fifth of the costs. In rail and sea transport labour costs play a significantly smaller role for the total transport costs. The simple explanation is the relation between number of staff involved and the number of units transported.

The effect of the new EU road directive and the other elements of the so-called Mobility Package on the price level for road transport and its possible influence on the competition between different transport modes is yet to be seen. With the directive applying to the case of cabotage exclusively, a possible direct effect on international transport across countries in the Baltic Sea Region cannot be derived.

First/Last mile cost drivers in combined transport

The costs related to First/Last mile transport – lifts at terminals and the First/Last mile road transport – are usually a central cost driver in combined transport. In our case studies they range from 12-18 pct. of total cost in the Billund-Kaunas case and 6-31 pct. in the Berlin-Stockholm case. The high share in some of the alternatives in the Berlin-Stockholm case are due to a Last mile haul of 100 kilometres.

These cases show that the percentage of the costs related to First/Last mile varies substantially between the different transport chains in combined transport. The cases also demonstrate that the percentage of the costs related to First/Last mile transport in combined transport strongly depend on the length of the main haul – the longer the main haul is, the less impact these costs have on the total transport costs.

Empty transport is a relevant but not primary cost driver for First/Last mile in combined transport

The level of monetary costs for First/Last mile transport was identified as primary cost driver for First/Last mile transport.

Empty transport to and from terminals was identified as the second biggest cost driver, it is a general problem and not a specific cost driver for combined transport. Empty transport is expensive for any transport business to have a low degree of utilisation for their vehicle fleet.

Prices are negotiable

In general, the price for most of the cost elements are negotiable depending on volume. It is thus general practice to get (fleet) discount on e.g. diesel for a company having ten trucks in their fleet, and it will be cheaper if a company owns 1.000 trucks. The same goes for e.g. truck and trailer leasing, trips on ro-ro ferries, lifts at terminals, storage, and insurance.

Final remarks

The study at hand is an important contribution to widen the understanding of the different cost elements included in combined transport. By exemplifying the different cost drivers of a combined transport, with a specific emphasis on First / Last mile transport and making these readily available, the results can be used as an important input to the discussion on how to induce more combined transport on the market. Even though the exemplified cases do not include the actual negotiated prices in certain business relations available on the market, it becomes obvious that the cost of transport is not the only motivation for transport buyers to choose Door-to-door road transport. Lead times and not least the convenience in purchasing road transport are deemed to be, if not equally, but important factors influencing the choice of transport. To overcome these hurdles, it is important to take notice of and duplicate success factors from already existing combined transport services. This includes not least the importance of cooperation between the different stakeholders willing to develop the combined transport market in favour of robust, reliable and cost-efficient transport.

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11 VOCABULARY

Sidelifter

A sidelifter loads and unloads containers via a pair of hydraulic powered cranes mounted at each end of the vehicle chassis. (https://en.wikipedia.org/wiki/Sidelifter)

EU truck

The expression EU truck is used for the normal trucks in international road transport in Europe. It contains a tractor unit () and a semi-trailer and the vehicle is normally <16,5 m long.

Tractor unit

The tractor unit is the truck engine with 2- or maybe 3-axles, where the driver operates the truck.

normally a 2axled unit, sometimes a 3-axled is used for heavy cargo

Semi-trailer

The semi-trailer is a loading unit with wheels that is connected to the tractor unit via the king pin. Some 90 pct. of European semi-trailers are normally not craneable, which means that they cannot be lifted by a reach stacker or a crane. Craneable semi-trailers have stronger body frame and yellow pockets showing where it can be lifted.

There are also special systems that can move non-craneable semi-trailers between rail wagons and ground, i.e. the Nikrasa system and other systems for intermodal transport.

Incoterms (https://iccwbo.org/publication/incoterms-2020-introduction/)

The global Incoterms sets the basic rules and responsibilities of seller and buyer, delivery, risk and the relationships between these and the different partners in the transport chain.

Rules applying to any mode of transport:

- EXW – Ex Works
- FCA – Free Carrier
- CPT – Carriage Paid To
- CIP – Carriage and Insurance Paid To
- DAP – Delivery at Place
- DPU – Delivery at Place Unloaded
- DDP – Delivered Duty Paid

Rules for sea and inland waterway transport:

- FAS – Free Alongside Ship
- FOB – Free on Board
- CFR – Cost and Freight
- CIF – Cost Insurance and Freight

Appendix A

Theoretical case 1: Denmark (Billund)-Lithuania (Kaunas)

Overview - Alternative 1A: Combined transport with road Billund – Taulov, rail Taulov – Kaunas via Germany and Poland.

Mode	Prehaul road	Terminal	Rail haul	Rail haul	Rail haul	Rail haul	Terminal	Posthaul road	Sum
From	Billund	Road	Taulov	Flensburg	Kunowice	Mockava	Rail	Kaunas	
To	Taulov	Rail	Padborg	Frankfurt O	Trakiszki	Kaunas	Road	Kaunas	
Distance (km)	49		102	557	752	115		10	1585
Duration (hours)	1	1	1,5	8	12,5	2	1	0,5	27,5

	Pre-/posthaul road	Rail haul	Terminal Road-Rail	Sum
Distance/lifts/trips	59	1.526	2	-
Price (€)	118	992	50	1.160
%	10%	86%	4%	100%

Overview Alternative 1B: Combined transport with rail Taulov – Kaunas via Germany and Poland using the coming Rail Baltica connection.

Mode	Prehaul road	Terminal	Rail haul	Rail haul	Rail haul	Rail haul	Terminal	Posthaul road	Sum
From	Billund	Road	Taulov	Flensburg	Kunowice	Mockava	Rail	Kaunas	
To	Taulov	Rail	Padborg	Frankfurt O	Trakiszki	Kaunas	Road	Kaunas	
Distance (km)	49		102	557	752	115		10	1585
Duration (hours)	1	1	1,5	8	10	1,5	1	0,5	24,5

	Pre-/posthaul road	Rail haul	Terminal Road-Rail	Sum
Distance/lifts/trips	59	1.526	2	-
Price (€)	118	992	50	1.160
%	10%	86%	4%	100%

Overview Alternative 1C: Combined transport with Rail Taulov – Karlshamn, RoRo ferry Karlshamn – Klaipeda and rail transport to Kaunas.

Mode	Prehaul road	Terminal	Rail haul	Toll Bridge	Toll Bridge	Rail haul	Terminal	RO-RO ferry	Terminal	Rail haul	Terminal	Posthaul road	Sum
From	Billund	Road	Taulov	Great Belt	Øresund	Malmø	Rail	Karlshamn	Road	Klaipeda	Rail	Kaunas	
To	Taulov	Rail	Malmø			Karlshamn	Road	Klaipeda	Rail	Kaunas	Road	Kaunas	
Distance (km)	49		264			193		430		323		10	1269
Duration (hours)	1	1	4			3	1	12	1	5,5	1	0,5	30

	Pre-/posthaul road	Rail haul	Terminal Road-Rail	RO-RO ferry	Toll bridge Storebælt rail	Toll bridge øresund rail	Sum
Distance/lifts/trips	59	780	4	1	1	1	-
Price (€)	118	507	100	450	25	19	1.175
%	10%	42%	8%	37%	2%	2%	100%

Overview Alternative 1D: Combined transport with Rail Taulov – Karlshamn, RoRo ferry Karlshamn – Klaipeda and road transport to Kaunas.,

Mode	Prehaul road	Terminal	Rail haul	Toll Bridge	Toll Bridge	Rail haul	Terminal	RO-RO ferry	Road haul	Sum
From	Billund	Road	Taulov	Great Belt	Øresund	Malmø	Rail	Karlshamn	Klaipeda	
To	Taulov	Rail	Malmø			Karlshamn	Road	Klaipeda	Kaunas	
Distance (km)	49		264			193		430	215	1151
Duration (hours)	1	1	4			3	1	12	3	25,00

	Pre-/posthaul road	Road haul	Rail haul	Terminal Road-Rail	Toll bridge Storebælt rail	Toll bridge øresund rail	RO-RO ferry	Sum
Distance/lifts/trips	49	215	457	2	1	1	1	-
Price (€)	98	237	297	50	25	19	450	1.176
%	8%	20%	25%	4%	2%	2%	38%	100%

Overview Alternative 1E: Combined transport with RoRo Fredericia – Klaipeda and rail transport to Kaunas.

Mode	Prehaul road	RO-RO ferry	Terminal	Rail haul	Terminal	Posthaul road	Sum
From	Billund	Fredericia	Road	Klaipeda	Rail	Kaunas	
To	Fredericia	Klaipeda	Rail	Kaunas	Road	Kaunas	
Distance (km)	56	850		323		10	1239
Duration (hours)	1	30,5	1	5,5	1	0,5	39,5

	Pre-/posthaul road	Rail haul	Terminal Road-Rail	RO-RO ferry	Sum
Distance/lifts/trips	66	323	2	1	-
Price (€)	132	210	50	600	992
%	13%	21%	5%	60%	100%

Overview Alternative 1F: Combined transport with RoRo Fredericia – Klaipeda and road transport to Kaunas.

Mode	Prehaul road	RO-RO ferry	Road haul	Sum
From	Billund	Fredericia	Klaipeda	
To	Fredericia	Klaipeda	Kaunas	
Distance (km)	56	850	215	1121
Duration (hours)	1	30,5	3	34,5

	Pre-/posthaul road	Road haul	RO-RO ferry	Sum
Distance/lifts/trips	56	215	1	-
Price (€)	112	237	600	949
%	12%	25%	63%	100%

Overview Alternative 1G: Road transport Billund – Karlshamn, RoRo ferry Karlshamn – Klaipeda and road transport to Kaunas.

Mode	Road haul	Toll Bridge	Toll Bridge	RO-RO ferry	Road haul	Sum
From	Billund	Great Belt	Øresund	Karlshamn	Klaipeda	
To	Karlshamn			Klaipeda	Kaunas	
Distance (km)	450			430	215	1095
Duration (hours)	6,5			12	3	21,5

	Road haul	Toll bridge Great Belt road	Toll bridge øresund road	RO-RO ferry	Sum
Distance/lifts/trips	665	1	1	1	-
Price (€)	732	90	60	450	1.332
%	55%	7%	5%	34%	100%

Overview Alternative 1H: Road transport Billund – Kaunas via Germany and Poland

Mode	Road haul	Sum
From	Billund	
To	Kaunas	
Distance (km)	1.543	1.543
Duration (hours)	21	21

	Road haul	Sum
Distance/lifts/trips	1.543	-
Price (€)	1.697	1.697
%	100%	100%

Different route elements of the transport chains

Loading at Billund – Alternatives all

The cargo is picked up in Billund by a truck with a semi-trailer, but depending on alternative route, different vehicles will be used.

For simplification, we assume 1 hour for loading the vehicle and that this can be done while the driver waits. Vehicle: Tractor unit with semi-trailer – normal 16,5 m. EU-vehicle.

This means that in this case, we assume that the loading can be done without other support or lifting devices and that it will not be necessary to use a sideloader, to lift the unit onto the trailer.

First mile Billund – Alternatives 1A -1D

For the first four alternatives, the vehicle is transporting the intermodal unit to the nearest intermodal terminal in Taulov after pick-up in Billund. The tractor unit parks the semi-trailer in the terminal waiting area and leaves the terminal.
This is a normal procedure, as all the vehicles cannot arrive in the precise timing, where all the intermodal units for the specific train should be loaded. Normally the unit will then be parked for a while in the terminal, awaiting the loading of the train.

First mile Billund – Fredericia – Alternatives 1E & 1F

For alternatives five and six, the vehicle is transporting the semi-trailer to the RoRo terminal in the port of Fredericia and needs to be there at least 2 hours in advance of departure, at the latest. He will then decouple the semi-trailer and park it in the waiting area.

Terminal handling In Taulov – Alternatives 1A -1D

At the intermodal terminal in Taulov, the semi-trailer is loaded onto the pocket wagon, when the train is being filled.

Port handling in Fredericia, Karlshamn and Klaipeda – Alternatives 1C - 1F

The semi-trailer is taken over by port or ferry staff in the RoRo terminal and will be transported to and from the ferry with tugmasters, and securely fasten on board the ferry. This is a normal operation in many Roro ferry ports, as unaccompanied trailers are common, meaning that the tractor and driver can be used for other purposes, than being transported on the ferry.

RoRo ferry Fredericia – Klaipeda with DFDS ferry – Alternatives 1E & 1F

The DFDS ferry has departure Tuesdays at 20.30 from Fredericia and arrives in Klaipeda Thursday at 03.00.
On board the ferry, the driver can have his rest, should he accompany the trailer. In these cases, however, we assume that the semi-trailer is travelling on the ferry without the tractor unit and driver. At arrival the opposite operation takes place, the semi-trailer is handled by tugmasters from the ferry and to the terminal parking, where either a tractor unit can pick it up, or it can be placed on an intermodal rail wagon.

Intermodal transport Taulov – Kaunas – Alternatives 1A & 1B

There are no direct intermodal rail routes between Taulov and Kaunas today, wherefore a theoretical approach to this rail route has been used. Normally, when there is no direct rail route, intermodal hubs would be used. This could for example be Hamburg and/or Warsaw, both large intermodal hubs with different terminals available.
We are also looking into the routing that will be available, once the Rail Baltica corridor is in place, which is planned to be in 2025. Some parts of this EU-corridor are under construction, but the whole corridor that links Poland with Lithuania, Latvia and Estonia with a normal gauge rail line is still pretty far from being accomplished.

Intermodal transport Taulov – Karlshamn – Alternatives 1C & 1D

There are presently no existing intermodal trans between Taulov and the port of Karlshamn, so this will be calculated based on a theoretical case.

Road transport Billund – Karlshamn – Alternative 1G
The semitrailer is picked at Billund by a tractor unit and transported to Karlshamn by road, via the toll bridges at Great Belt and Øresund.

Intermodal terminal handling in the port of Karlshamn and the port of Klaipeda - Alternatives 1C & 1D
Both ports have intermodal terminals, hereby connecting the Seagoing cargo with different rail connections. At arrival or departure in the port by rail, the intermodal units are lifted onto or off the intermodal rail wagons by reach stackers.

RoRo ferry DFDS Karlshamn – Klaipeda - Alternatives 1C, 1D & 1G
The semi-trailer is lashed on the truck deck for a safe crossing on the RoRo ferry.

Klaipeda – Kaunas with railway - Alternatives 1C & 1D
The semi-trailer is lifted onto a pocket wagon in the rail terminal at the port of Klaipeda for rail transport to the intermodal terminal in Kaunas.

Klaipeda – Kaunas with truck - Alternatives 1d, 1F & 1G
As an alternative route, a tractor unit picks up the semi-trailer in the parking area by the RoRo terminal in Klaipeda, to be transported to Kaunas for delivery at the de.

Road transport Billund – Kaunas - Alternative 1H
As a unimodal alternative we will also analyse the cost elements for a pure road transport from Billund to the terminal in Kaunas, via Germany and Poland.

Appendix B

Theoretical case 2: Germany (Berlin) - Sweden (Stockholm)

Overview - Alternative 2A: Berlin – Eskilstuna on rail, incl. on the rail ferry Rostock – Trelleborg, which means rail transport on the whole route. Last mile on road to Stockholm.

Mode	Prehaul Road	Terminal	Rail haul	Rail ferry	Rail haul	Terminal	Posthaul Road	Sum
From	Berlin	Road	Berlin	Rostock	Trelleborg	Rail	Eskilstuna	
To	Berlin	Rail	Rostock	Trelleborg	Eskilstuna	Road	Stockholm	
Distance (km)	10		240	180	587		110	1.127
Duration (hours)	0,5	1	3,5	6,5	8,5	1	1,5	22,5

Mode	Pre-/posthaul road	Rail haul	Terminal Road-Rail	Rail ferry	Sum
Distance/lifts/trips	120	827	2	1	-
Price (Euro)	240	538	50	300	1.128
%	21%	48%	4%	27%	100%

Overview - Alternative 2B: Berlin – Eskilstuna on rail in transit via Denmark, an alternative, with rail on the whole route. Last Mile on road to Stockholm.

Mode	Prehaul Road	Terminal	Rail haul	Rail haul	Toll Bridge	Toll Bridge	Rail haul	Terminal	Posthaul Road	Sum
From	Berlin	Road	Berlin	Padborg	Great Belt	Øresund	Malmø	Rail	Eskilstuna	
To	Berlin	Rail	Flensburg	Malmø			Eskilstuna	Road	Stockholm	
Distance (km)	10		460	366			557		110	1.503
Duration (hours)	0,5	1	6,5	5,5			8	1	1,5	24

Mode	Pre-/posthaul road	Rail haul	Terminal Road-Rail	Toll bridge Great Belt rail	Toll bridge Øresund rail	Sum
Distance/lifts/trips	120	1.383	2	1	1	-
Price (Euro)	240	899	50	25	19	1.233
%	19%	73%	4%	2%	2%	100%

Overview - Alternative 2C: Berlin – Rostock on rail, RoRo ferry Rostock – Trelleborg, Trelleborg – Eskilstuna on rail (so called Gebrochener Verkehr). Last Mile on road to Stockholm.

Mode	Prehaul Road	Terminal	Rail haul	Terminal	RO-RO ferry	Terminal	Rail haul	Terminal	Posthaul Road	Sum
From	Berlin	Road	Berlin	Rail	Rostock	Road	Trelleborg	Rail	Eskilstuna	
To	Berlin	Rail	Rostock	Road	Trelleborg	Rail	Eskilstuna	Road	Stockholm	
Distance (km)	10		240		180		587		110	1.127
Duration (hours)	0,5	1	3,5	1	6,5	1	8,5	1	1,5	24,5

Mode	Pre-/posthaul road	Rail haul	Terminal Road-Rail	RO-RO ferry	Sum
Distance/lifts/trips	120	827	4	1	-
Price (Euro)	240	538	100	230	1.108
%	22%	49%	9%	21%	100%

Overview - Alternative 2D: Berlin – Rostock on rail, RoRo ferry Rostock – Trelleborg and Trelleborg – Stockholm om road (Also Gebrochener Verkehr, but with a longer road leg in Sweden)

Mode	Prehaul Road	Terminal	Rail haul	Terminal	RO-RO ferry	Road haul	Sum
From	Berlin	Road	Berlin	Rail	Rostock	Trelleborg	
To	Berlin	Rail	Rostock	Road	Trelleborg	Stockholm	
Distance (km)	10		240		180	646	1.076
Duration (hours)	0,5	1	3,5	1	6,5	9	21,5

Mode	Pre-/posthaul road	Road haul	Rail haul	Terminal Road-Rail	RO-RO ferry	Sum
Distance/lifts/trips	10	646	240	2	1	-
Price (Euro)	20	711	156	50	230	1.167
%	2%	61%	13%	4%	20%	100%

Overview - Alternative 2E: Berlin – Rostock on road, RoRo ferry Rostock – Trelleborg and Trelleborg – Eskilstuna on rail and last mile on road to Stockholm

Mode	Road haul	RO-RO ferry	Terminal	Rail haul	Terminal	Posthaul Road	Sum
From	Berlin	Rostock	Road	Trelleborg	Rail	Eskilstuna	
To	Rostock	Trelleborg	Rail	Eskilstuna	Road	Stockholm	
Distance (km)	226	180		587		110	1.103
Duration (hours)	3	6,5	1	8,5	1	1,5	21,5

Mode	Pre-/posthaul road	Road haul	Rail haul	Terminal Road-Rail	RO-RO ferry	Sum
Distance/lifts/trips	110	226	587	2	1	-
Price (Euro)	220	249	382	50	230	1.130
%	19%	22%	34%	4%	20%	100%

Overview - Alternative 2F: Berlin – Rostock on road, ferry Rostock – Trelleborg and Trelleborg – Stockholm on road

Mode	Road haul	RO-RO ferry	Road haul	Sum
From	Berlin	Rostock	Trelleborg	
To	Rostock	Trelleborg	Stockholm	
Distance (km)	226	180	646	1.052
Duration (hours)	3	6,5	9	18,5

Mode	Road haul	RO-RO ferry	Sum
Distance/lifts/trips	872	1	-
Price (Euro)	959	230	1.189
%	81%	19%	100%

Overview - Alternative 2G: Berlin – Stockholm on road (A-B), via the ferry Puttgarden - Rødby and the Øresund bridge

Mode	Road haul	Road ferry	Road haul	Toll Bridge	Road haul	Sum
From	Berlin	Puttgarden	Rødby	Øresund	Øresund Bridge	
To	Puttgarden	Rødby	Øresund Bridge		Stockholm	
Distance (km)	371	25	172		628	1.196
Duration (hours	5	1	2,5		8,5	17

Mode	Road haul	Road ferry	Toll bridge Øesund road	Sum
Distance/lifts/trips	1.171	1	1	-
Price (Euro)	1.288	245	60	1.593
%	81%	15%	4%	100%

Different route elements of the transport chains

First mile on road to intermodal terminal in Berlin – Alternatives 2A-2D

The semi-trailer is transported by a tractor unit to the departing customers premises, where the semi-trailer is loaded. Thereafter the tractor unit goes to the intermodal terminal in Berlin Grossbeeren and delivers the unit in the parking area in the terminal.

Berlin Grossbeeren kombiterminal and Eskilstuna kombiterminal - Alternatives 2A -2D and 2A-2E

The intermodal unit is parked in the terminal, until it is time to load the train. Thereafter the crane or a reach stacker lifts it onto an intermodal rail wagon.

Berlin – Rostock on rail – Alternatives 2A, 2C & 2D

When the trains is filled, it departs for the large intermodal terminal in the port of Rostock.

Berlin – Eskilstuna on rail – Alternative 2B

When the train is filled, it will depart in direction Hamburg and use the transit route via Denmark for the final part towards the Eskilstuna kombiterminal. The transit route via Denmark is the most used for rail freight transport between The Continent and Scandinavia, and especially for intermodal trains.

Berlin – Rostock on road – Alternatives 2E & 2F

For the alternatives, where road transport is used on the first leg of the transport chain, the tractor unit and trailer will pick-up the cargo at the premises of the departing customer and will bring it to the port of Rostock and the parking area for the RoRo ferry, for further handling there.

Handling in the Port of Rostock and int the port of Trelleborg - Alternatives 2A & 2C - 2E

The intermodal units arrive and depart on rail or road to the intermodal terminal and port area, where the port or shipping company takes over the handling. This could be lifting the intermodal unit of the intermodal wagon in the container terminal and bring it to a parking area, and thereafter a tugmaster will be used as tractor, to load the intermodal unit onto the ferry – or the other way around at arrival in the port. .
Both ports have intermodal rail terminals and also storage and parking areas.

Rail and RoRo ferry Rostock – Trelleborg - Alternatives 2A & 2C – 2F
In both ports there are specific berths for the rail ferries, with rail connection. The Stena Line ferries on the route have both RoRo lanes for road vehicles and rail tracks for rail wagons. The rail tracks can also be used for road vehicles, should there be no rail wagons on board.

Road ferry Puttgarden – Rødby – Alternative 2G
The truck with the semi-trailer drives onboard the ferry at Puttgarden and drives off the ferry upon arrival at Rødby.

Rail transport Trelleborg – Eskilstuna– Alternatives 2A & 2C - 2E
After the arrival at the intermodal terminal in the port of Trelleborg, the train for Eskilstuna is loaded and as soon as it is full, it is sent off towards Eskilstuna kombiterminal.

Road transport Trelleborg – Stockholm – Alternative 2F
As an alternative, the intermodal units, especially semi-trailers can use road transport to and from the port of Trelleborg. This is very common. A tractor unit then goes by road towards the final destination at a cargo terminal in Stockholm, from where the cargo is distributed.

Last mile transport on road Eskilstuna – Stockholm- Alternatives 2A & 2C - 2E
The kombiterminal is one option in order to achieve intermodal transport with rail as base. There are also other terminals in the Stockholm area that could suffice. Choosing Eskilstuna could be as The is a lot of cargo imported to the big consumption area of Stockholm, whereas the amounts of export cargo from the area is very low, wherefore the intermodal unit needs to go outs side region, in order to find goods again. Hereby Eskilstuna offers a good hub, as there are quite a lot of exporting industries in the area.
A tractor unit picks up the intermodal unit in the kombiterminal and delivers it to the cargo terminal in Stockholm. Thereafter the tractor unit and semi-trailer can make a short empty trip in order to collect export cargo for the return trip and then return to Eskilstuna kombiterminal with he loaded semi-trailer.

Road transport Berlin – Stockholm via Puttgarden – Rødby and the Øresund Bridge – Alternative 2G
As the unimodal road transport alternative, we are analysing the different cost elements of a road transport, that includes the RoRo ferry between Puttgarden and Rødby, as this is a much shorter route than using the Flensburg/ Padborg border-crossing. The road transport vehicle will then be routed via the Øresund Bridge but could also use the Helsingør (Elsinore) – Helsingborg RoRo ferry. However, due to the waiting time in connection with the ferry, it seems that more and more road vehicles tend to use the bridge, as there is no waiting time. The route is a little bit longer, but efficiency is important.
The road vehicle delivers the semi-trailer at the cargo terminal in Stockholm for emptying and can then go to a new customer to pick up new cargo, somewhere outside the Stockholm area.