

Transport Market Study: “Quantification of modal shift potential on the Rail Freight Corridor Rhine-Alpine”

SUMMARY REPORT

AUTHORS:

TRT Trasporti e Territorio

TML Transport & Mobility Leuven

M-Five GmbH Mobility, Futures, Innovation, Economics

SSP CONSULT

Lucchini-Mariotta e Associati SA

Milan, 23 January 2019



Co-financed by the Connecting Europe Facility of the European Union

Table of Contents

1	Introduction and overview.....	3
2	State of play in freight transport along the corridor.....	5
2.1	<i>Corridor freight transport demand</i>	5
2.1.1	Rail demand	6
2.1.2	Road demand	7
2.1.3	Inland waterway demand	9
2.2	<i>Interviews with RUs</i>	9
2.3	<i>Stated preference survey</i>	10
3	Topic 1: Heavier trains – ideal train weight for 740m trains	11
3.1	<i>Current limitations on train weight.....</i>	11
3.2	<i>Cost savings for heavier trains.....</i>	12
3.3	<i>Modal shift potential for heavier trains</i>	14
3.4	<i>Recommendations for running heavier trains on RFC RALP</i>	15
4	Topic 2: Faster trains by reduction of stops	16
4.1	<i>Categories and reasons for stops</i>	16
4.2	<i>Time and cost savings for faster trains</i>	18
4.3	<i>Modal shift potential for faster trains</i>	19
4.4	<i>Recommendations for reducing the number and duration of stops</i>	20
5	Topic 3: More reliable trains: punctuality and information on delayed trains (ETA)	21
5.1	<i>Categories and reasons for delays</i>	21
5.2	<i>Market reaction to more reliable trains</i>	25
5.3	<i>Cost savings and modal shift potential for more reliable trains</i>	26
5.4	<i>Recommendations for improving train punctuality and a timely and integrated communication of ETA.....</i>	28
6	Summary of the results	30
7	Conclusions	31

Corridor definition

To avoid misunderstandings regarding the definition of the corridor network, throughout the study the Rhine-Alpine Core Network Corridor is sometimes abbreviated as Corridor, meaning the Rhine-Alpine Core Network Corridor as defined by the European Commission.

Whenever the study means the Rail Freight Corridor Rhine - Alpine as defined according to Regulation (EU) 913/2010, the abbreviation RFC RALP is used.

Unit measure definition

The study presents the result in net tonnes. Unless otherwise specified, the quantities always relate to net values.

1 Introduction and overview

The Rail Freight Corridor Rhine-Alpine (RFC RALP) constitutes one of the busiest freight routes in Europe, connecting the North Sea ports of Rotterdam, Zeebrugge, Ghent, Antwerp, Amsterdam and Vlissingen with the Mediterranean basin in Genoa, via Switzerland and some of the most heavily industrialised regions in Central Europe from the Rhine-Ruhr area in Germany to the agglomeration of Milan in northern Italy. Countries directly involved are the Netherlands, Belgium, Germany, Switzerland and Italy.



Figure 1 Schematic overview of the RFC RALP

In order to introduce infrastructure improvements and measures enhancing the competitiveness of rail freight along the RFC RALP, a more in-depth knowledge of customers' demand on the international rail freight market is needed. In a workshop carried out by the Infrastructure Managers (IMs) and Allocation Body (AB) of the RFC RALP, Railway Undertakings (RUs) were asked to point out the most relevant topics for growth in international rail freight. Many growth factors were discussed regarding the legal framework in the transport sector, the competitive situation of other modes (e.g. technology development, costs of infrastructure) and measures under a more direct and shorter/medium-term influence of the IMs.

It was agreed between RFC RALP and the RUs involved to focus the study on measures under the direct influence of the IMs,

and the following three topics were selected given that the highest growth was expected from them:

- **Heavier trains: ideal train weight for 740m-long trains;**
- **Faster trains: reduction of stops;**
- **More reliable trains: punctuality and information on delayed trains (ETA).**

There are different reasons that prevent the running of heavier trains, faster trains and the adherence to planned timetables. Accordingly, this study provides additional information on the existing issues, constraints and the potential impact and provides suggestions to IMs for the priorities to be addressed.

The expected impact is elaborated for different representative clusters along the RFC RALP:

- **Cluster A: trains crossing the whole RFC RALP**, between the Netherlands or Belgium and Italy;
- **Cluster B: trains running in three countries of the RFC RALP**, between the Netherlands or Belgium and Switzerland or between Germany and Italy;
- **Cluster C: trains running in two countries of the RFC RALP**, between the Netherlands or Belgium and Germany or between Switzerland and Italy.

Furthermore, cluster C was divided in two separate sub-clusters to consider the potential effects in the northern part of the RFC RALP (**cluster C north**) considering **trains running between Germany and the Netherlands and Belgium** and the southern part of the RFC RALP (**cluster C south**) considering **trains running between Italy and Switzerland**.

This approach allowed us to quantify the study results in terms of modal shift potential according to the length of the path, the trade lane considered and the characteristics of the path itself in order to fully understand how existing conditions actually influence the results.

The study then followed a stepwise approach consisting of three work packages (WP) developed in relation to data collection and analysis (WP1), quantification of cost savings (WP2) and quantification of the modal shift potential (WP3).

The study estimated the current rail freight demand on the RFC RALP as well as the demand pertaining to the same catchment areas currently satisfied by other modes (road and inland waterway), and carried out a stated preference survey to gather the market reaction on certain service enhancements by deriving the market responsiveness relating to both price and time variations. With regard to the introduction of heavier (and longer) trains, considering the existing weight restrictions and the average train length for block trains (480m) and intermodal trains (530m), three different scenarios were envisaged:

1. Introduction of 740m-long trains keeping the current weight restrictions;
2. Introduction of 740m-long trains overcoming current weight restrictions due to national regulations (e.g. the Italian network allows a maximum train weight of 1,600 tonnes) but assuming weight limits of 2,700 tonnes.
3. Introduction of a maximum train weight of 2,000 tonnes over the RFC RALP wherever the current limit imposed by regulatory weight restrictions is lower.

The latter scenario was recommended by RUs during the stakeholder consultation and considered the most suitable in the short-term period.

In respect to the second and third study topic – faster and more reliable trains – the analysis followed a similar approach by assuming a reduction in the number/duration of stops and duration of delays in different scenarios. Following an in-depth analysis of the Train Information System (TIS) data sets, train stops were classified as mandatory and non-mandatory and then reduced according to the scenario considered in order to assess the potential cost savings. Similarly, the average delay at destination was assumed to be reduced by 25%, 50% and 100% to measure how delays cause extra costs to RUs and the consequent market reaction. The 100% reduction in delay at destination was only considered in order to measure to what extent delays cause extra cost.

Table 1 Scenarios considered for the cost model analysis for the different study topics

Topic	Reference scenario	Study scenario
Topic 1: heavier trains	Situation as it is with current weight restrictions and average train length of: - 480m for block trains (general cargo, wet bulk and dry bulk); - 530m for intermodal trains.	Base scenario: 740m-long trains with current weight restriction on the line sections. Study scenario: 740m-long trains without weight restriction but assuming weight limits of 2,700t. Alternative scenario: 2,000t trains as ideal train weight whenever the limit imposed by regulatory weight restrictions is lower.
Topic 2: faster trains	The reference parameter for punctuality is 60% according to the Corridor data (Train Information System database)	Scenario 1: 25% reduction in number/duration of non-mandatory stops. Scenario 2: 50% reduction in number/duration of non-mandatory stops. Scenario 3: 50% reduction of non-mandatory stops and 50% of duration of mandatory stops.
Topic 3: more reliable trains		Scenario 1: 25% reduction in delay at destination. Scenario 2: 50% reduction in delay at destination. Scenario 3: 100% reduction in delay at destination

The following section summarises the activities carried out and the main conclusions and recommendations drawn. The three topics are presented individually after a short section on the underlying demand analysis.

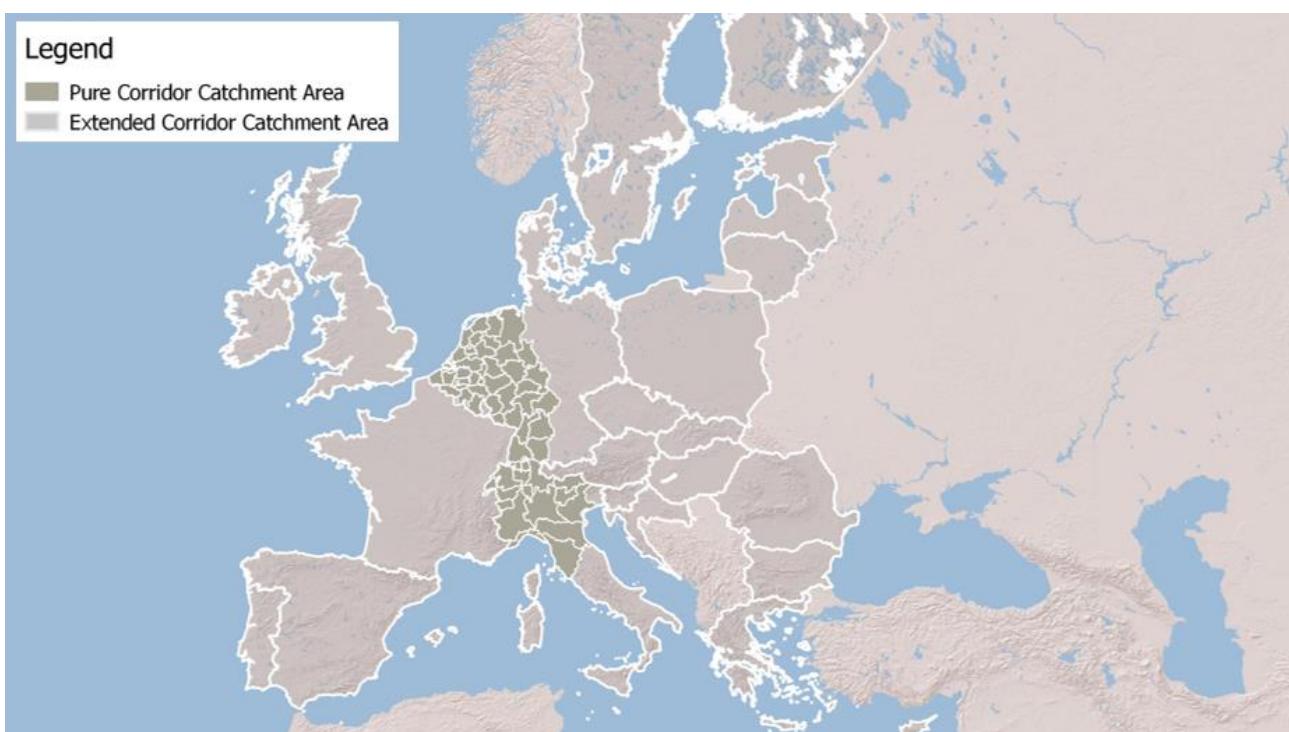
2 State of play in freight transport along the corridor

2.1 Corridor freight transport demand

The freight transport market analysis defined the total amount of international goods transported along the Corridor for each relevant mode. The analysis considered the Corridor-relevant modes of land transport (road and rail) and IWW in the regions concerned. A prerequisite for the demand analysis is the knowledge of the corridor catchment area: the origin and destination of freight transport flows. Two different catchment areas of the corridor were outlined. The first one includes only NUTS2 regions belonging to one of the countries sharing at least a corridor section. This extension of the corridor catchment area was named **pure Corridor demand**. The pure demand indicates the demand directly generated by the geographical scope of the RFC RALP which can be seen as “captive”.

The analysis was enlarged to include a broader catchment area including all EU-28 countries¹ and was defined as **extended Corridor demand**. In particular, this second extension was considered for road and rail to measure to what extent countries not directly connected to the corridor actually reach the corridor through other networks.

Figure 2 Extension of the Corridor catchment areas considered for the demand analysis



According to this definition, the overall international freight demand on the Corridor for 2015 is estimated at 246.8 million net tonnes (pure demand). The largest flows of the Corridor are observed on the trade lanes Netherlands-Germany and Germany-Belgium. These two bidirectional flows represent up to 79% of the total international Corridor traffic, corresponding to 196.6 million net tonnes and they are highly affected by IWW volumes and mostly related to heavy bulk cargo. The highest outbound flows go to the Netherlands with 108.1 million net tonnes (43% of total Corridor demand) followed by Germany with 87.7 million net tonnes (35% of total Corridor demand). Germany also reports the highest inbound flows with 132.5 million net

¹ https://europa.eu/european-union/about-eu/countries_en

tonnes (53% of total Corridor demand). Belgium also has a strong presence both in inbound and outbound flows, totalling 61 million net tonnes, nearly one fourth of the Corridor demand.

Minor volumes are recorded between Switzerland and Belgium, approximately 2 million net tonnes, less than 1% of total Corridor demand. Finally, the trade lanes to and from Italy account for 30.2 million net tonnes with about one third comprising international traffic with Germany.

Table 2 Pure Corridor freight transport volumes, 2015 (all modes; net 1,000 tonnes)

Origin	Destination					
	NL	BE	DE	CH	IT	Total
NL	-	not applicable	100,782	4,158	3,161	108,101
BE	not applicable	-	23,691	1,579	3,881	29,151
DE	45,037	27,127	-	9,477	6,059	87,700
CH	1,179	466	3,085	-	2,551	7,280
IT	2,601	3,330	4,907	3,729	-	14,567
Total	48,817	30,923	132,464	18,943	15,652	246,799

Source: Compilation by the authors based on international freight transport statistics, 2015

Among the three transport modes considered in the analysis, the pure demand in 2015 was split² almost equally between inland waterways on the one hand and rail and road on the other, with the latter two each accounting for a quarter of total Corridor demand: 24.1% rail, 25.1% road and 50.8% IWW.

2.1.1 Rail demand

The pure rail freight demand on RFC RALP for 2015 was estimated at 59.4 million net tonnes, this value increases to 70.8 when considering all places of origin and destination within the EU28. The largest trade lanes were Netherlands – Germany with 22.8 million net tonnes (38% of total rail demand), Germany - Italy with 8.6 million net tonnes (almost 15% of total rail demand) and Belgium - Germany with 7.2 million net tonnes (12% of total rail demand). Germany was therefore the largest place of origin/destination of rail freight traffic with 44.7 million net tonnes. (16,6 as Origin country and 28,1 as destination country).

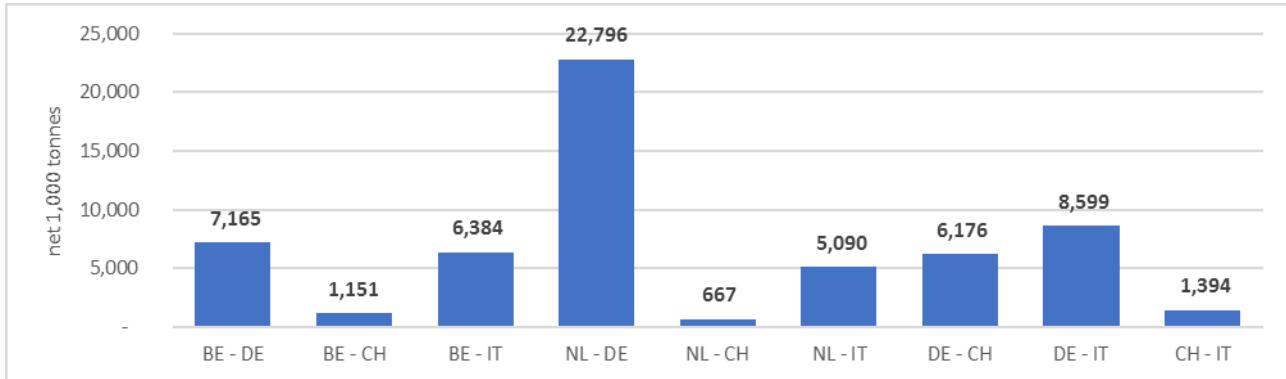
Table 3 Pure rail freight demand on RFC RALP, 2015 (net 1,000 tonnes)

Origin	Destination					
	NL	BE	DE	CH	IT	Total
NL	-	not applicable	19,310	359	2,808	22,477
BE	not applicable	-	3,883	921	3,437	8,241
DE	3,486	3,282	-	4,852	5,002	16,621
CH	308	230	1,324	-	612	2,474
IT	2,282	2,947	3,597	782	-	9,608
Total	6,075	6,459	28,114	6,913	11,859	59,420

Source: Compilation by the authors based on international freight transport statistics, 2015

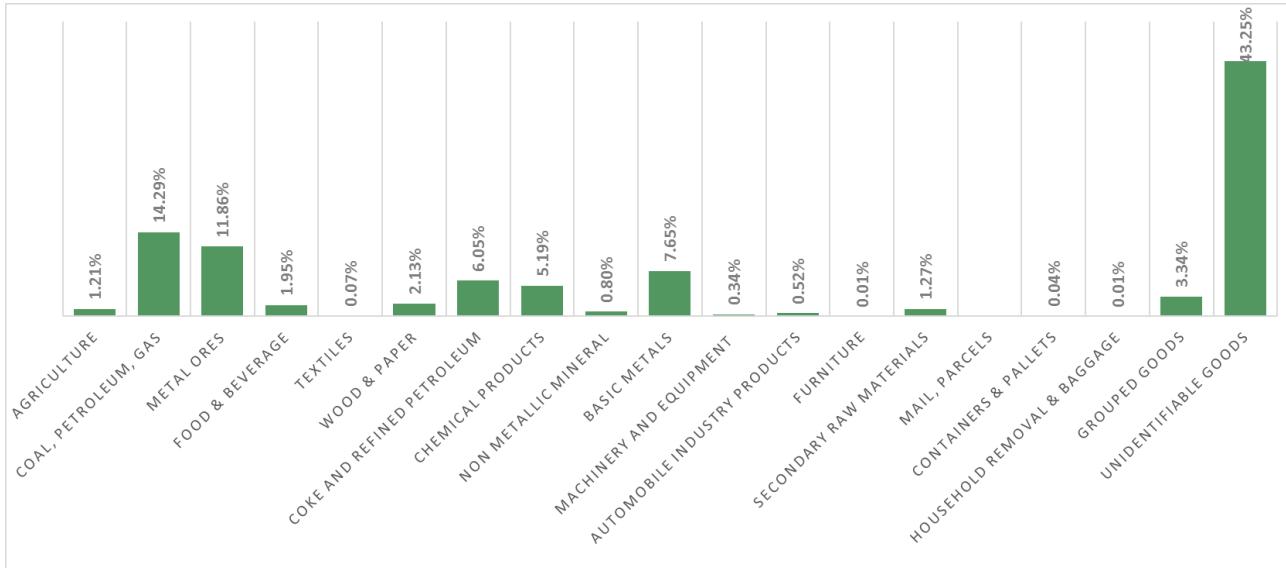
² Road and rail catchment areas are slightly different for trade lanes with NL-DE-BE-CH and the modal split is consequently affected by this.

Figure 3 Pure rail freight demand on RFC RALP, 2015



In 2015, rail was the most important mode of transport on several RFC RALP trade lanes: Italy - Belgium (89%), Italy - Netherlands (88%), Italy - Germany (78% of freight demand), Switzerland - Belgium (56%) and Switzerland - Germany (49%). With respect to commodity types, rail showed a high percentage of unidentifiable goods (NST19) with 43% of total demand. Goods included in this group are, in most cases, moved in containers or other Intermodal Transport Units (ITU) by unaccompanied combined transport; typically, these include food and beverage (NST 4), textiles (NST 5), machinery and equipment (NST 11). Such goods have a strong presence in all the trade lanes with Italy, which is the origin or destination of 70% of these goods.

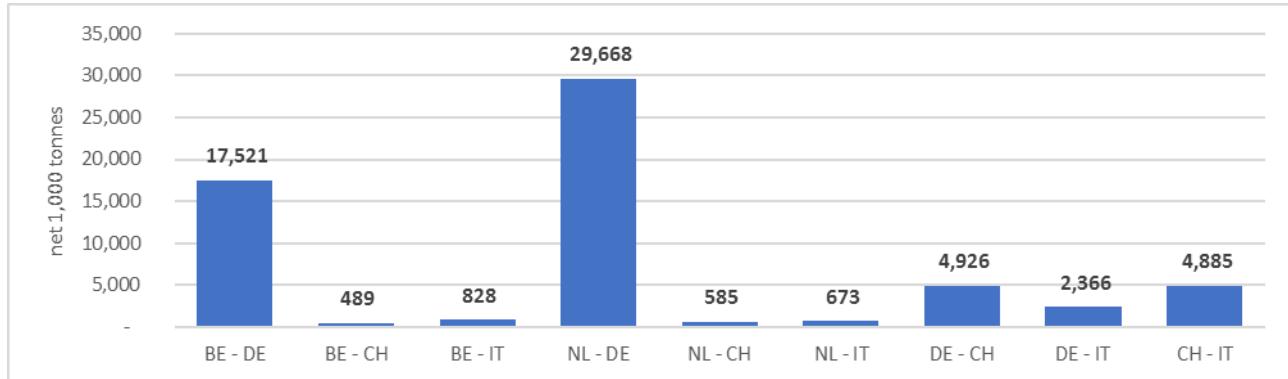
Figure 4 Commodity split (NST 1 - NST18) for rail freight volumes, 2015



2.1.2 Road demand

The pure road freight demand on the Corridor was estimated at 61.9 million net tonnes for 2015. In road transport, Germany confirms its pivotal role within the Corridor. The highest volumes of road traffic are between the Netherland and Germany with 29.7 million net tonnes (48% of total road demand), between Belgium and Germany with 17.5 million net tonnes (28%) and between Germany and Switzerland with 4.9 million net tonnes (8%). In 2015, road represented the most relevant mode of transport only for the trade lane Italy - Switzerland (78% of trade-lane demand).

Figure 5 Pure road freight demand on the Corridor, 2015



The study also determined the current road demand that could be attracted by the RFC RALP. This demand is part of the international demand that currently runs through the corridor by road, and the international demand currently using other routes. Under certain circumstances, this could potentially be transferred to rail transport. The following issues were considered for the quantification of the shift potential demand:

- For some trade lanes, different routes can link the same catchment area. For example, between Italy and Germany, most of the freight flows go through the Brenner axis, mainly because of cost implications in terms of road tolls. Different routes are also available between the Netherlands and Germany;
- The competitiveness of RFC RALP is mainly limited to the corridor-related catchment area along the trade lanes considered. For example, between Italy and Germany, the catchment area only covers north-western Italy and western Germany;
- Rail freight services become competitive over a certain distance threshold, especially in the case of intermodal trains, which require a last-mile service by road. This increases the service costs and the shipping time due to handling operations at terminals, reducing the competitiveness of rail compared to door-to-door road service;
- Some commodities are traditionally transported using a specific mode. For example, food and beverages (NST4) and grouped goods (NST18) are mainly transported by road, while metal ores (NST3) or coal, petroleum and gas (NST2) are typically transported by bulk (wagonload) trains.

Therefore, the following road traffic was not considered as potential rail demand:

1. All international road freight traffic within a range of 300 km, except the flows originating to and from the corridor's seaports. Rail is, in fact, more competitive when goods are shipped directly from ports.
2. All international road freight flows that strictly belong to other European freight corridors, for which the RFC RALP is not competitive from a geographical point of view. These include the ScanMed Corridor concerning exchanges between Italy and Germany and the North Sea-Baltic Corridor concerning exchanges between the Netherlands, Belgium and Germany.

The following table summarises the potential corridor-related road freight demand and the road demand running through other routes, namely “outside corridor demand”.

Table 4 Potential road freight demand for the RFC RALP, 2015 (net 1,000 tonnes)

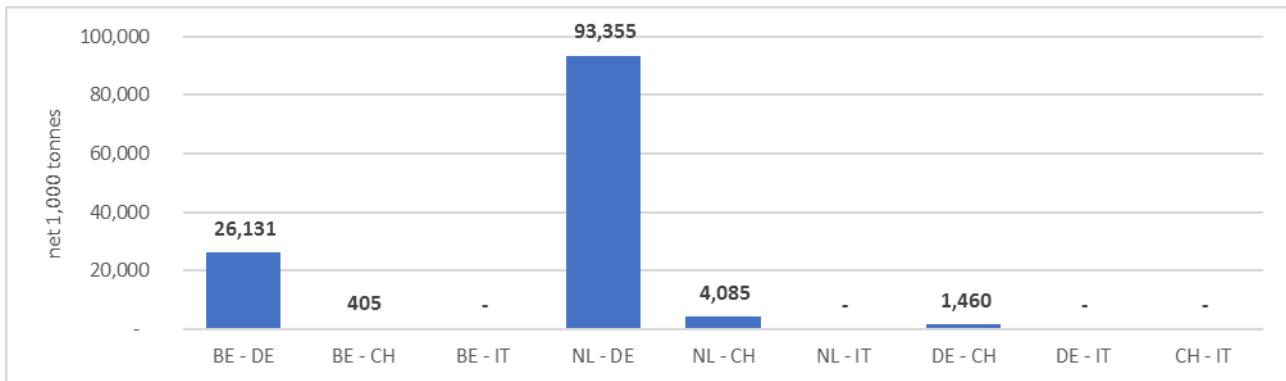
Trade lane	Corridor-related demand	Outside-Corridor demand
NL-IT	569	1,478
BE-IT	700	1,119
CH-IT	1,833	9
DE-IT	1,800	3,620
BE-CH	372	717
NL-CH	445	372
DE-CH	2,248	6,414
BE-DE	6,531	11,354
NL-DE	11,146	28,291
Total volume	25,643	53,375

Source: Compilation by the authors based on international freight transport statistics, 2015

2.1.3 Inland waterway demand

According to the Observatory of European Inland Navigation, more than two thirds of all goods carried by European waterways are transported on the Rhine, Europe's busiest waterway. IWW freight demand on the Corridor for 2015 is estimated at 125.4 million net tonnes.

Figure 6 International IWW freight demand on the Corridor, 2015



The main IWW traffic takes place between Germany and the Netherlands (both directions) with 93.3 million net tonnes (74% of the total IWW demand) and between Germany and Belgium with 26.1 million net tonnes (21% of the total IWW demand). Germany is the main country involved in IWW freight traffic with almost 121 million net tonnes of import/export and 4.5 million net tonnes of transit flows.

2.2 Interviews with RUs

The work carried out in WP1 includes the involvement of relevant RUs, i.e. companies that currently run freight trains along the corridor, with the objective of cross-checking the findings related to the overall structure of the transport market on the corridor and providing a detailed description of representative corridor train paths. In particular, the specific objectives of submitting the questionnaire to relevant RUs were to:

- collect real market-based information (costs);
- collect general parameters needed as input for the cost model (WP2);
- identify path-dependent operational issues and related costs;
- collect feedback about the relevance of the market study topics (heavier, faster and more reliable trains).

The interviews involved a pool of 10 RUs operating on the RFC RALP, respectively in Italy, Switzerland, Germany, Belgium and the Netherlands. A sample of nine train paths was extracted from the data collected during the interviews with RUs in order to set up a representative number of corridor train paths according to the three study clusters.

2.3 Stated preference survey

In order to reach the main goal of this study and quantify the modal shift potential from road to rail (on the RFC RALP) induced by specific improvements, a Stated Preference (SP) survey was conducted among shippers, freight forwarders and logistics operators with the aim to better understand to what extent a change in terms of cost, time and punctuality would generate a modal shift towards rail. This method consists of investigating under which conditions (of price, time and reliability) the involved stakeholders would shift from road to rail freight services.

The survey was designed based on the cost savings analysis carried out in WP2 and submitted to the identified market stakeholders to investigate to what extent the estimated savings would lead to a modal shift. Price changes of freight transport services could, in fact, have many effects on freight transport demand according to the current strong competitiveness of certain modes especially on long runs. These effects are often expressed in terms of elasticity of demand, defined as follow: "*an elasticity gives the impact of a change in an independent (or stimulus) variable on a dependent (or response) variable, both measured in percentage changes*" (De Jong and Gunn, 2001).

The SP survey was used to investigate the impact of having heavier (and longer) trains, faster trains and more reliable trains by submitting different alternative scenarios and collecting feedback on the willingness to use rail. The alternative scenario describes the competition among rail and road services as evidenced by shipping costs, shipping time and average punctuality.

The survey ran in April and May 2018 for a six-week period during which the stakeholders were approached by mail and by telephone. The survey questionnaire was submitted using the online cloud-based software SurveyMonkey, which was also used to design and set up the online questions.

The sample was identified by the consortium at different levels in order to cover, to the best extent possible, the various loads and operations performed, including the various commodities transported as well as the different sections of the corridor (origin and destination countries, and different distance ranges). The survey sample included shippers, freight forwarders and logistics operators and those who are usually in charge of planning the shipping of goods and could benefit from a more competitive and efficient rail service.

Responses from 80 companies were collected. These companies were mainly based in Italy and Germany, and a smaller portion in Belgium, Switzerland and the Netherlands. Respectively, 50% were Italian stakeholders, 25% were from Germany, 15% were from Belgium and the Netherlands, and 10% were based in Switzerland. It may be noted that many were international companies working across different European countries. Almost half of the sample consisted of logistics operators, a third of freight forwarders and a fifth of shippers.

3 Topic 1: Heavier trains – ideal train weight for 740m trains

The aim of introducing heavier trains is to make rail freight transport more efficient by increasing capacity using existing infrastructure. In other words, allowing for heavier trains is a good example of “doing more with less”, i.e. using rail assets, rolling stock, infrastructure and personnel in a more intensive and cost-effective way. Although most of the RFC RALP sections allow to run 740m-long trains, the actual average train length is 480m for block trains (general cargo, wet bulk and dry bulk) and 530m for intermodal trains, also due to some limitations on train length and maximum weight, especially in Italy. According to this, the study considered a reference scenario with actual weight and length restriction, while the base scenario assumes 740m-long trains suitable on the whole corridor. The difference between base and reference scenario may be seen as the remaining gap to fulfil the 740m-long train standard.

3.1 Current limitations on train weight

Rail vehicle axle loads in Europe range from 17 to 25 tonnes per axle. The TEN-T regulation³ stipulates that, by 2030, the railway infrastructure of the core network must fulfil at least 22.5 tonnes axle load for freight lines. On the RFC RALP, an axle load of 22.5 tonnes is already allowed.

The average gross train weight carried south-north is mostly around 1,450 tonnes, ranging from 600 (for an empty train) to 2,700 tonnes. In the opposite direction, the minimum and maximum values are much closer to the average of 1,550 tonnes. The average typical train length is around 530 metres, ranging from 300 to 670 metres. In the preparation of this study several RUs stated that the optimal weight would be around 2,000 tonnes, while the 740-metre standard is recognised as a binding objective to allow heavier intermodal trains on the RFC RALP.

There are two major constraints limiting train weight in the context of the RFC RALP. The first concerns the topography of the RFC RALP as relevant gradients on line sections (particularly across the Alps and near the BE-DE border in Aachen) limit the maximum traction power and hence the towable weight (the base tunnel projects partially solve this problem in Switzerland). A workaround that is already in use is the deployment of additional locomotives when needed. However, this requires additional shunting operations for adding/removing locomotives and extra costs which may compromise the competitiveness of rail services compared with the road. Secondly a regulation at national level in Italy imposes an upper limit of weight of 1,600 tonnes.

Heavier trains do not necessarily mean trains carrying heavy commodities, but rather trains running at the maximum allowed weight according to regulations and market interest. The Study Long Trains (740m)⁴ outlined the existing relationship between commodity, train weight and length. The potential for longer and heavier trains depends on the type of freight. Generally, due to the comparably low weight, freight trains carrying automotive or combined traffic have the biggest potential for longer trains. The following figure indicates the commodities limited by train weight and by train length, taking into account a heavy train threshold indicated by RUs for intermodal trains in the preparation of this study. The threshold indicated by RUs could also be considered as an ideal weight on the basis of a theoretical calculation about the maximum train weight for a 740m-long train with two locomotives⁵.

³ REGULATION (EU) No 1315/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 December 2013 on Union guidelines for the development of the trans-European transport network and repealing Decision No 661/2010/EU.

⁴ RFC RALP (2013) Study Long Trains (740 m) on Corridor Rotterdam-Genoa.

⁵ The theoretical calculation takes into account an axle load of 22.5t

Figure 7 Limitations for trains (with one locomotive – limitation of 740-metre-long trains) – section Basel - Genoa per commodity group – not taking into account regulatory limits

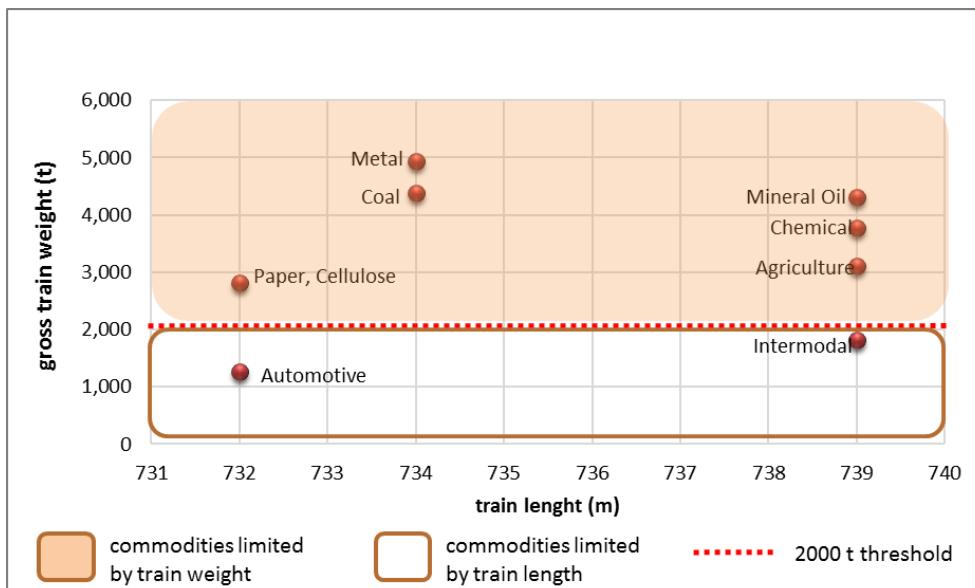
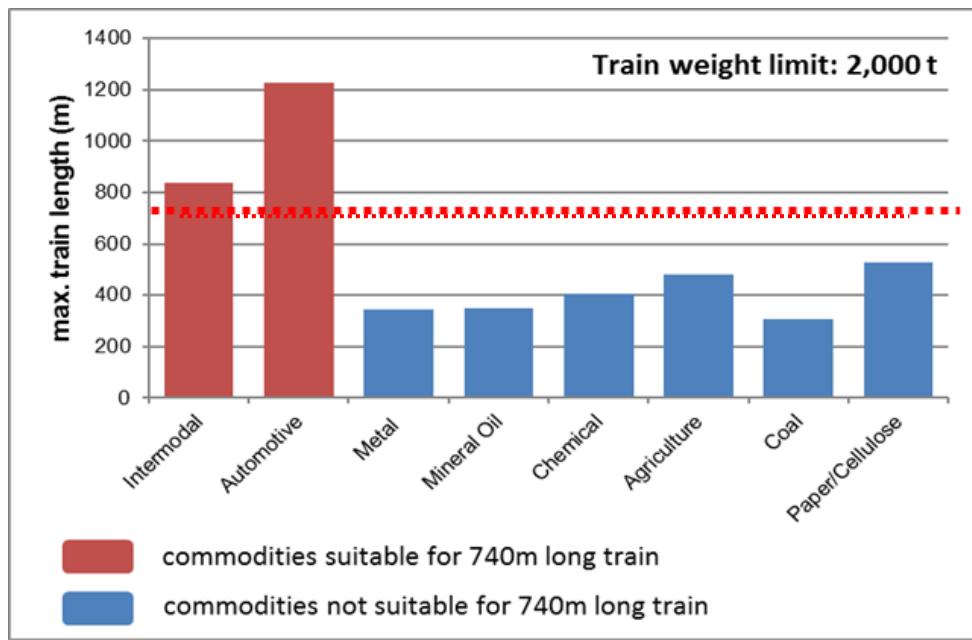


Figure 8 Maximum tractable length of trains for different commodity groups assuming a weight limit of 2,000 tonnes (with one locomotive) – section Basel-Genoa (red line shows the 740m length)



3.2 Cost savings for heavier trains

Overall, by increasing the train weight, the service costs increase accordingly. As the train is heavier and longer it requires more energy to be moved and more wagons are needed, so that the cost for renting wagons increases. However, the fixed costs are such that the increase of variable costs for carrying more goods does not produce higher cost per tonne transported.

Introducing longer trains with the existing weight limits would restrict the beneficial effect to the transport of light commodities, typically by intermodal or automotive trains, as heavy goods trains (general cargo and bulk) already exploit the maximum capacity and would not be affected as long as the weight limits are in place.

The effect of introducing 740m-long trains shows a reduction of rail costs for the RUs, between 12% and 20% compared to the current average situation. This could translate into a reduction of the door-to-door shipping price between 9% and 12% for intermodal trains.

The most relevant effects are estimated when removing the regulatory weight restrictions, especially in Italy, where the current maximum train weight is 1,600 tonnes. In this case cost reductions for intermodal trains is about 20%, while general cargo and bulk would be up to 30%, with lower benefits in the northern part of the RFC RALP where heavier trains already run with smaller margins for improvements.

Note that for O/D services not involving Italy and/or Switzerland, the alternative scenario imposes lower weights for bulk than are currently transported in the reference scenario. Hence, compared to the reference scenario, keeping a weight limit would produce a negative impact.

Figure 9 Rail cost variation for intermodal trains related to heavier trains scenario

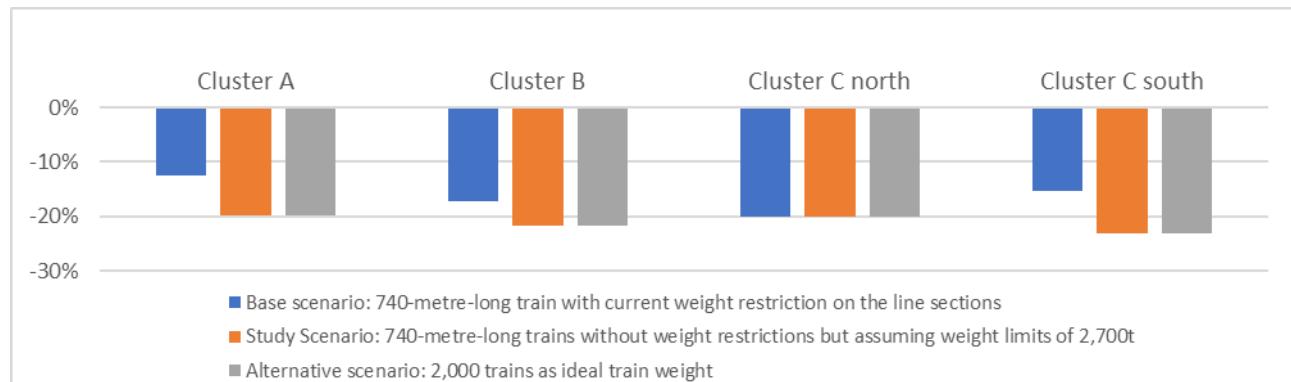


Figure 10 Rail cost variation for general cargo trains related to heavier trains scenario



Figure 11 Rail cost variation for bulk goods trains related to heavier trains scenario (average between dry and wet bulk values)



3.3 Modal shift potential for heavier trains

The challenge of running heavier trains was explored through the stated preference survey. According to the analysis of the results, the demand elasticity depends on the type of commodity and the shipping distance. As expected, the values of elasticity are higher for bulk and general cargo (in general lower-value goods) and for short distances, where margins of improvement are higher than for longer distances and for which competition by road presents a challenge. The lower values (around -0.50) are related to intermodal traffic.

Figure 12 Price elasticity of demand per type of goods and shipping distance

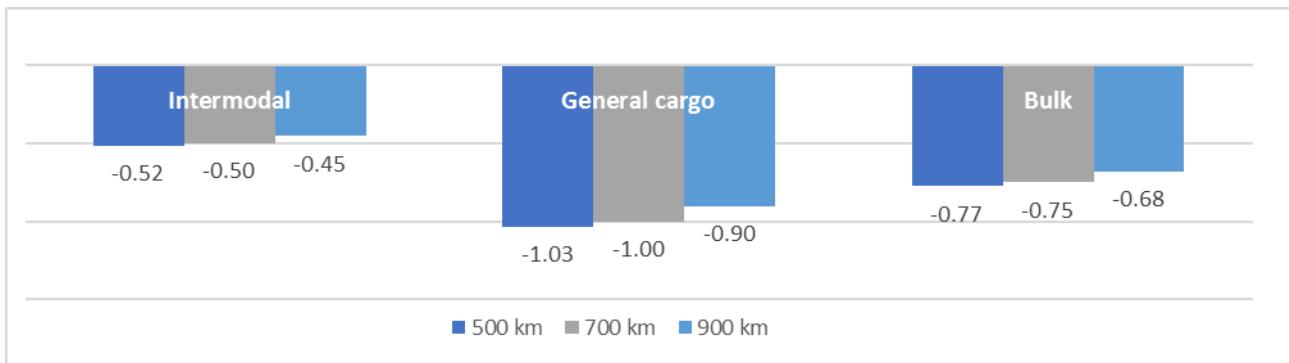
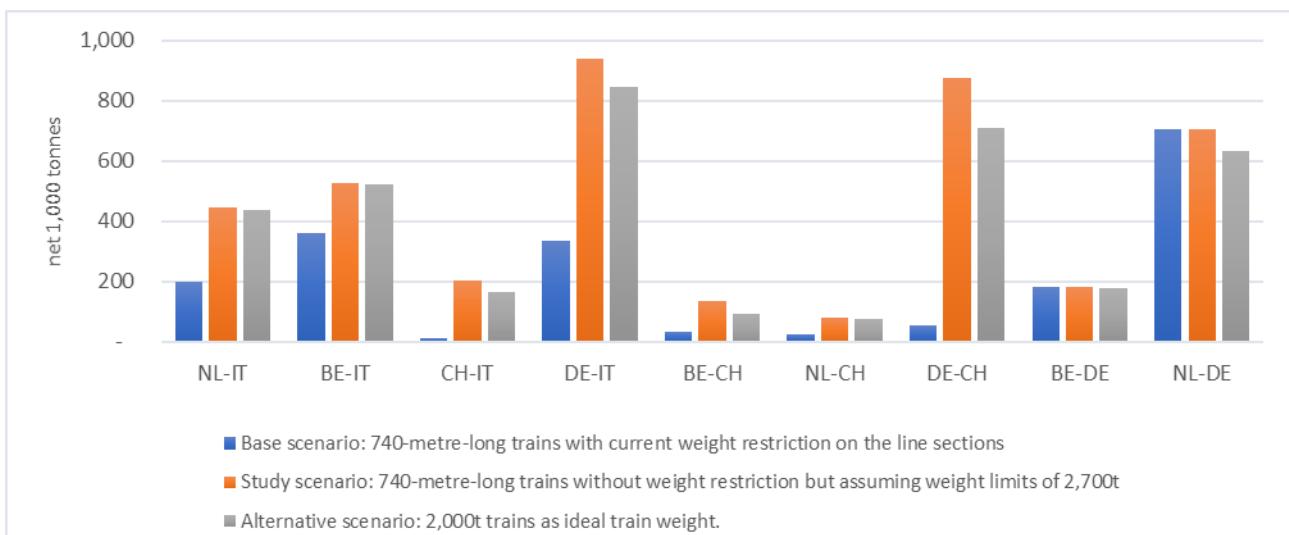


Figure 13 Modal shift potential on RFC RALP related to heavier trains scenario (net 1,000 tonnes)



Based on such elasticities, the scenario assuming 740m-long trains (base scenario) shows a modal shift potential of 1.9 million net tonnes, that concentrates mainly on traffic between the Netherlands and Germany (0.71 million net tonnes), Italy and Belgium (0.36 million net tonnes) and between Italy and Germany (0.33 million net tonnes). Removing the weight limits (study scenario), the potential modal shift grows to 4.1 million net tonnes. This additional traffic is concentrated mainly between Italy and Germany (0.98 million net tonnes) and between Switzerland and Germany (0.87 million net tonnes); the massive growth on these trade lanes is due to existing limitations on the maximum weight applied in Switzerland and Italy. The following table summarises the modal shift potential per scenario and type of cargo.

Table 5 Modal shift potential related to heavier trains scenario (net 1,000 tonnes)

	Intermodal	General cargo	Dry bulk	Wet bulk	Total
Base scenario	1,365	463	0	75	1,903
Study scenario	1,769	1,511	495	319	4,094
Alternative scenario	1,769	1,511	248	130	3,658

Table 6 Potential RFC volumes compared to current volumes related to heavier trains scenario (extended corridor rail transport volumes, 2015)

	Base Scenario	Study Scenario	Alternative Scenario
RFC volumes, 2015 (Million net tonnes)	70.8	70.8	70.8
Potential modal shift (Million net tonnes)	+1.9	+4.1	+3.7
Potential RFC volumes (Million net tonnes)	72.7	74.9	74.5
Potential percentage increment ($\Delta\%$)	+2.6%	+5.7%	+5.1%

3.4 Recommendations for running heavier trains on RFC RALP

The heavy train topic analysis has shown a high potential for cost reduction. However, the main effect of cost reduction is obtained by allowing 740m-long trains over the whole RFC RALP. Although this is already a definite target, it is important to highlight the relevance of it as shown by the results of the base scenario. The improvement should involve, besides the IMs, the terminal and port operators that should be able to operate longer trains within their boundaries.

Many differences still persist with respect to the maximum allowed weight. The study has demonstrated that the only strong regulatory limitation on the maximum allowed weight is found in the Italian part of the corridor, where the maximum weight is fixed at 1,600 tonnes. The Italian IM already allows the circulation of heavier trains under specific circumstances and under the responsibility of the RU. The removal of this limitation is seen as the main enabler to the development of rail freight traffic towards the objectives set.

However, the rationale for the limitations applied in Italy concerns safety aspects and in particular safe braking conditions. If the removal of the general limitation over the entire Italian network can be seen as a long-term target, specific rules may be adopted sooner for Rail Freight Corridors, and in particular for the RFC RALP.

On the other hand, trains that are heavier as a result of their increased length should not affect the axle load and should thus not require major network adaptions, unlike those required to allow for longer trains. They primarily require a check of the robustness of infrastructures such as bridges and viaducts.

The required action, in particular to overcome physical network limitations such as steep gradients found in the Alpine crossings as well as on the border crossing between Belgium and Germany (as stated before), primarily relates to the power and the torque delivered by locomotive engines. They can be increased either by using more powerful locomotives or by adding a (pushing) locomotive over longer sections. While this potentially entails additional costs, these are likely to be lower than the benefits provided in terms of towing mass.

The use of longer and heavier trains may reduce the number of trains carrying the same quantity of goods. This could have a positive effect in terms of alleviating capacity constraints, but as a trade-off slower trains could reduce the capacity due to slower operating speed and longer time to brake/accelerate. This has to be tested in order to correctly allocate capacity usage.

By way of conclusion in relation to those trains that actually show some potential when increasing train length (intermodal trains) the maximum dimension can be fixed at 2,000 tonnes as a corridor standard. As demonstrated in the analysis, this standard allows the operation of efficient intermodal trains and the best exploitation of the potential for modal shift.

4 Topic 2: Faster trains by reduction of stops

The second topic deals with the reduction of stops in order to speed up freight trains along the RFC RALP. The Planned Stop Time (PST) represents a very relevant part of the Planned Travel Time (PTT) and its relevance mainly depends on the train path. According to the data analysed, the Planned Stop Time (PST) represents between 11% and 40% of the Planned Travel Time (PTT) and its relevance depends on the train path. In the opinion of the RUs, there are planned stops that could be reduced in time and others that could be skipped. The latter case occurs when the stop is not requested by the RUs but is somehow imposed by the characteristics of the infrastructure or national rules. In all cases, stops involve an increase in travel time and idle time that can be seen as a cause of additional costs for the RUs (e.g. energy consumption, labour cost of the train drivers, etc.). The study focussed on those stops that for some reason are considered non-mandatory and may be avoided.

4.1 Categories and reasons for stops

Ideally, a train should run without stopping from origin to destination but this is not feasible due to many technical reasons, including the need to change locomotive, the loading/unloading of freight and shunting operations. Additionally, the altitude profile represents a major issue in the southern part of the RFC RALP as the slopes in northern Italy and in Switzerland partly require an additional locomotive to overcome the power limits, as well as at the border between Belgium and Germany (Aachen) where additional power is required. The stop time for changing a locomotive is between 15 and 30 minutes; in case this stop occurs at a border, the RUs tends to combine it with other administrative operations. Furthermore, there are stops determined by national and international rules: e.g. train controls at borders (customs operations) or driving shifts, especially for long-distance trains. A driver change can also be requested at a border crossing, where the knowledge of a different language and the corridor stretches are required.

The amount of time that could be saved by reducing either the number or the time of the stops, varies on the basis of the type of stops that occur on the specific path. The analysis of stops was carried out combining input from RUs and the data embedded in TIS provided by the IMs. Generally, stops not requested by RUs have been considered as non-mandatory, hence stops that could be reduced.

Table 7 Stop reasons and classification as mandatory and non-mandatory stop

Stop reason	Mandatory/non-mandatory
Changing locomotive due to lack of interoperability	Non-mandatory as is due to infrastructure/locomotive characteristics
Adding/removing locomotive	Mandatory if due to infrastructure characteristics (gradient). It can be combined with other stops (e.g. driver shifts)
Driver shifting depending on working time regulations. Based on this, RUs have to plan stops for driver rest and driver change	Mandatory due to required rest period during working hours
Driver change might occur if the driver does not meet the language and technical skills needed to operate in another country	Non-mandatory and avoidable with staff training
Handover and customs operations occur at border crossings or customs clearance operations need to be performed	Non-mandatory if related to the change of national railway (e.g. trains between NL and DE do not stop at the border NL-DE), while this has been considered mandatory if due to required operations at borders (customs)
Priority rules and track capacity forces planned stops to avoid disturbances along the path	Non-mandatory as never requested by RUs
Changing direction is needed depending on the characteristics of the network	Mandatory due to infrastructure characteristics

Based on the categories of stops outlined above, the amount and duration of stops was described for nine representative train paths on the RFC RALP belonging to the aforementioned clusters. The most frequent reason for a stop (n° of stops) is driver change, involving about one third of all stops performed on a train run (34%). As expected, when the PTT increases, the driver must be changed more often. In fact, for train runs belonging to cluster A (longer PTT) the train driver changes on average 6 times, while for train runs belonging to cluster B and C the driver changes on average 4 and 3 times, respectively. Changing driver takes approximately 3 to 15 minutes and it usually follows national rules on driver shifts. According to this, running faster trains would have effects especially on routes over 700km.

Another relevant reason for stops is operations/capacity management (24% of stops due to operations to manage the railway congestion), especially during day time when passenger trains share the same lines. Other reasons for the number of stops are the change of locomotive for interoperability reason (14%), the addition or removal of locomotives (8%) and shunting/changing direction (6%), which concentrate at Swiss border crossings, in Aachen-West and sometimes in Novara.

Figure 14 Stop reasons concerning the three-corridor clusters

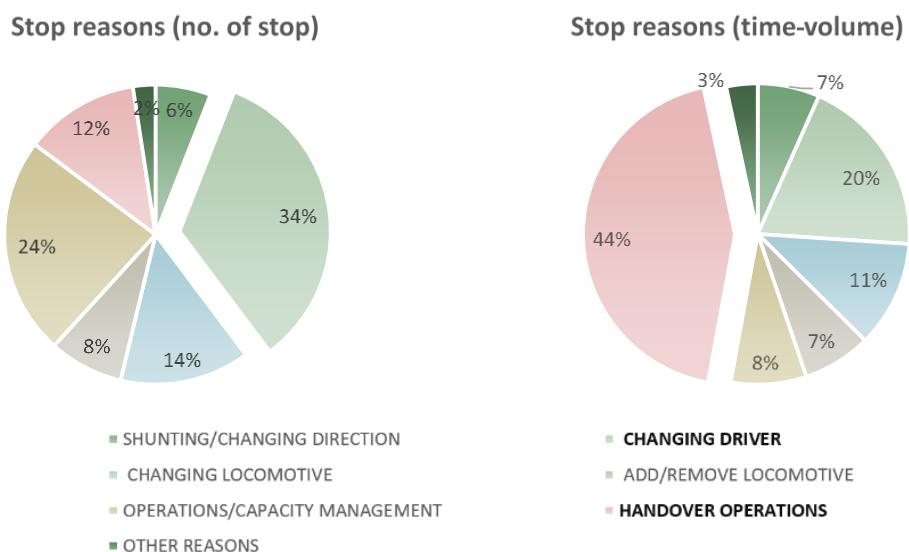
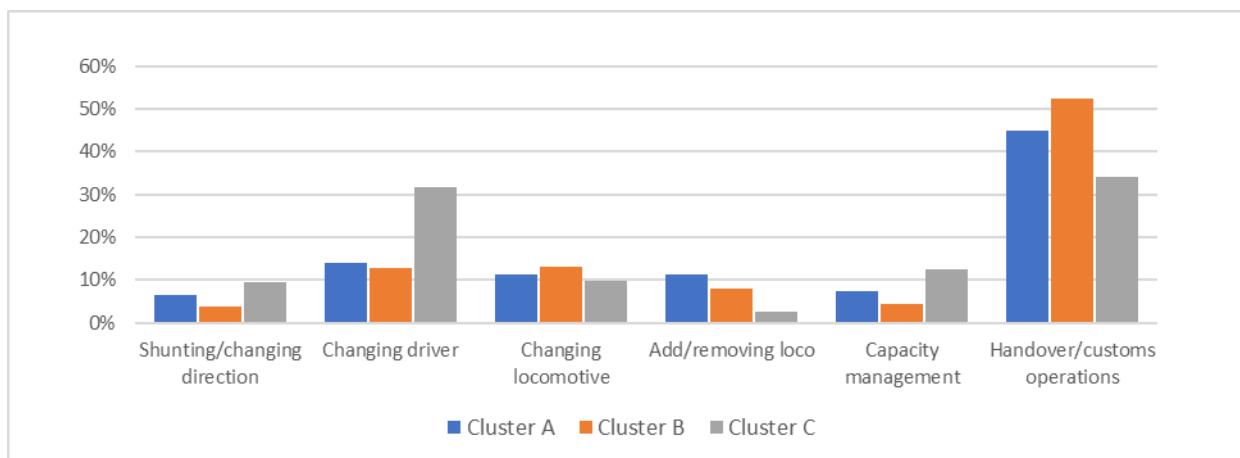


Figure 15 Stop reasons (time-volume) concerning trains running on Cluster A, B and C



Handover operations account for 44% of stop time for a train run. This share is approximately the same across all three clusters, although it is slightly lower for trains belonging to cluster C (36% of the total stop time) and higher for trains belonging to cluster B (53% of the total stop time). Handover operations include administrative procedures which take place mainly at border stations. The analysis highlighted the very long

time spent at border crossings between Italy and Switzerland in Chiasso and between Switzerland and Germany in Basel, where customs operations take up to two hours. RUs confirmed that by speeding up customs operations, handover stops could be reduced significantly. This and other impacts are investigated in the cost analysis Work Package (WP2), which considered both a reduction in the number of stops and the duration of stops, to assess the potential cost savings related to specific stop reasons.

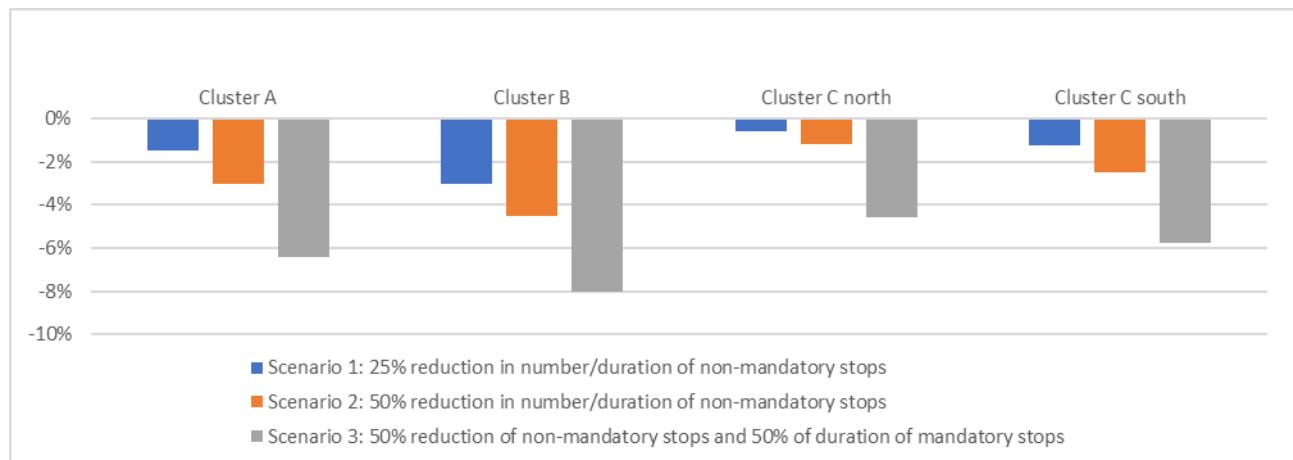
4.2 Time and cost savings for faster trains

The direct effect of reducing the number of stops is measurable as time saving. It may produce an indirect cost saving as there are many cost items depending on time. Furthermore, the driver shift is also organised based on travel time. On longer trips, drivers require rest periods based on the duration of the trip and faster connections may reduce rest hours and may make driver shifts more efficient.

A further consideration pointed out by RUs concerns the energy required to restart trains once they have stopped. Ignition usually requires more energy than driving, therefore reducing the number of stops would reduce energy consumption.

Considering the costs as a function of time, the analysis estimated the value of time over different trade lanes, based on the planned stops and related duration of each of them. The stop reduction has been estimated according to two different scenarios where non-mandatory stops are reduced in number/duration by 25% and 50%, respectively. Although the focus is on the reduction of non-mandatory stops, a third scenario encompasses a reduction in time for all the stops (50% reduction of non-mandatory stops and 50% of duration of mandatory stops).

Figure 16 Rail cost variation for intermodal trains related to faster trains scenario



Overall, the cost savings are lower compared to those estimated for heavier trains. As expected, the higher impact is on longer trips which usually require more stops (changing driver due to a lack of interoperability of train personnel at border crossings or due to driver shifts).

The major benefits are observed on the trade lane with Italy with a maximum effect of -9% for IT-DE. Some handover operations are normally unavoidable stops (e.g. custom operations). However, according to RUs they can be reasonably reduced and the expected impact would be relevant for all trains on the RFC RALP. As expected, the possibility to reduce handover stops and other mandatory stops, as investigated in the third scenario (50% reduction of non-mandatory stops and 50% of duration of mandatory stops), showed the highest impact compared to the other scenarios (e.g. Figure 16).

4.3 Modal shift potential for faster trains

The challenge of running faster trains was explored through the stated preference analysis. In order to evaluate the effect of faster trains, respondents were asked to indicate their modal choice in four scenarios of shipping different types of goods door to door from origin to destination with different durations (including handling and last mile). The following table summarises the potential time saving compared to the planned travel time over three different ranges of distances.

Generally, running faster trains would have different impacts based on the commodity transported: bulk goods and general cargo are typically moved by train and IWW, while intermodal demand is more time-sensitive. Importantly, the competitiveness of rail services compared to road transport is based on shipping time and reliability of the service rather than on shipping costs.

Table 8 Potential time reduction by cluster compared to the Planned Travel Time

	Scenario 1: 25% reduction in number/duration of non-mandatory stops	Scenario 2: 50% reduction in number/duration of non-mandatory stops	Scenario 3: 50% reduction of non-mandatory stops and 50% of duration of mandatory stops
Cluster A (900-1000km)	-3.0%	-5.9%	-13.4%
Cluster B (600-700km)	-3.0%	-6.1%	-12.0%
Cluster C (400-500km)	-1.7%	-3.5%	-11.0%

Figure 17 Modal shift potential on RFC RALP related to faster trains scenario

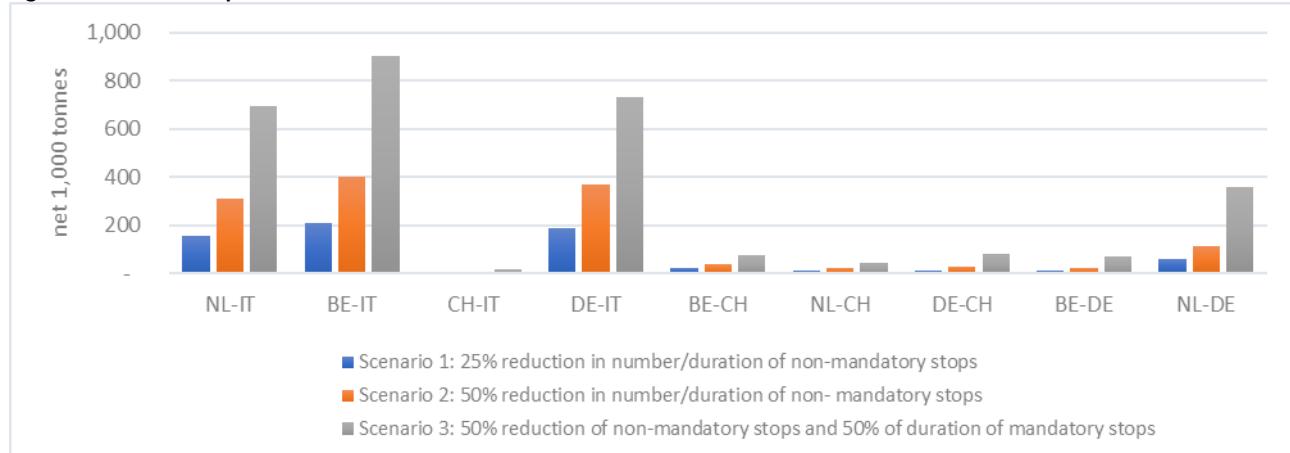


Table 9 Modal shift potential related to faster trains scenario (net 1,000 tonnes)

	Intermodal	General cargo	Dry bulk	Wet bulk	Total
Scenario 1	518	73	56	14	662
Scenario 2	1,036	128	112	29	1,306
Scenario 3	2,312	289	301	76	2,978

In particular in relation to intermodal traffic, the modal shift potential related to the second scenario (50% reduction in number/duration of non-mandatory stops) is dominated by the traffic between Italy and Belgium (380,000 net tonnes) and between Italy and Germany (270,000 net tonnes). On the other hand, considering the same scenario, general cargo and bulk goods show significantly lower values: the maximum shift is around 60,000 net tonnes between Italy and Germany.

According to this, faster trains are more focused on serving intermodal traffic over longer routes where rail freight service has already been shown to be competitive against road. It is important to underline that these results are valid if the improvement of travel time is also accompanied by adherence to the schedules.

Indeed, the lack of competitiveness of rail transport is only partially linked to travel time itself, as there is additional time that is not governed by IMs and RUs, e.g. time to enter or leave a terminal. The market reaction to a change in travel time is positive, but this should be accompanied by a coherent planning of all related activities.

Table 10 Potential RFC volumes compared to current volumes related to faster trains scenario (extended corridor rail transport volumes, 2015)

	Scenario 1	Scenario 2	Scenario 3
RFC volumes, 2015 (Million net tonnes)	70.8	70.8	70.8
Potential modal shift (Million net tonnes)	+0.7	+1.3	+3.0
Potential RFC volumes (Million net tonnes)	71.5	72.1	73.8
Potential percentage increment ($\Delta\%$)	+0.9%	+1.8%	+4.2%

4.4 Recommendations for reducing the number and duration of stops

The Faster Trains topic has demonstrated a lower potential in terms of modal shift and in terms of attractiveness for the stakeholders involved. RUs as well have indicated this having a lesser priority.

With PaP and more generally with improved and integrated planning of paths, Rail Freight Corridors are already moving towards offering more competitive paths in terms of journey time and reduction of stops. IMs and RUs are therefore already aware of the difficulties of designing timetables that can guarantee both dense and fast paths.

The reduction of the planned stops both in terms of number and duration also entails a reduction of “buffer times” that can be used to recover part of the delays that are often accumulated. Therefore, without taking other action to manage rail traffic, reducing the planned time might increase the risk for delays and the consequences of delays due to the density of paths.

The analysis of data extracted from TIS showed that there is a possibility of avoiding some “operational” stops and of reducing the time of some stops, including the long stops planned at border crossings between Switzerland and Italy and between Germany and Switzerland. However, since the potential for cost reduction is low and hence a potential for modal shift is lower than for the other topics, it seems reasonable to introduce improvements in steps.

As said above, there is already a tendency to offer high quality paths. The option of faster paths could be evaluated only for specific paths against the market request.

Faster paths could be offered subject to specific conditions, for example:

- the use of fully interoperable locomotives;
- the respect of punctuality standards, involving not just the LRU and the other RUs involved but also the Multimodal Transport Operator (MTO) at departure terminals that are often (jointly) responsible for delays at origin.

5 Topic 3: More reliable trains: punctuality and information on delayed trains (ETA)

Punctuality is an important performance indicator for the competitiveness of the rail freight sector. Poor reliability of rail transport is often cited to be one of the main factors that hamper a more tangible modal shift towards rail.

In many countries the timetable for passenger trains is arranged with a clock-face (or cyclic) schedule. Consequently, the system embeds a certain level of rigidity depending on the level of congestion and the heterogeneity of trains. Under this system, the slots available for freight trains are the same over the entire day, forcing them to follow a cyclic schedule too. The problem with time slots is that any disturbance may have a knock-on effect on the entire scheduling making the operation especially of freight trains more difficult.

According to RUs, it sometimes happens that in order to keep some capacity available to respond to disruptions to passenger traffic, cargo slots are “sacrificed” over some parts of the transit route, especially during peak hours.

It is worth emphasising that the lack of punctuality across the whole logistics chain leads to service disruptions and operational issues for all stakeholders for the entire shipping. Rail punctuality especially suffers from low departure punctuality of trains entering the network; hence, Infrastructure Managers actually also suffer from the delays caused in terminals, in terms of first-mile operations and so on. Therefore, it is often hard to allocate responsibilities for delays since these are often shared among different actors. Furthermore, the shipping status visibility along the transport chain is also a key factor for logistics planning. Insufficient and/or lack of immediate information on delayed trains may result in interruption of production processes or a lack of supply. This may have a strong impact on the suitability of rail transport for specific commodities which rely on just-in-time production.

5.1 Categories and reasons for delays

In accordance with the definition of Rail Net Europe (RNE), a delay occurs when a train circulates and/or arrives later than planned in the timetable. In particular, a primary delay is a delay that directly affects the train, while a secondary delay (or knock-on delay or cascading delay) is a delay caused by a primary delayed train. The definition of delay as well as the measurement of delay on the RFC RALP is based on a threshold of 30 minutes of deviation from the PTT measured via TIS. More specifically deviations from the PTT are recorded whenever they occur, but are considered as delays only when they exceed the 30-minute threshold.

Not only do train delays cause additional costs to RUs and all involved stakeholders, they also have a significant impact on the whole transport chain in terms of managing the ensuing time schedule changes.

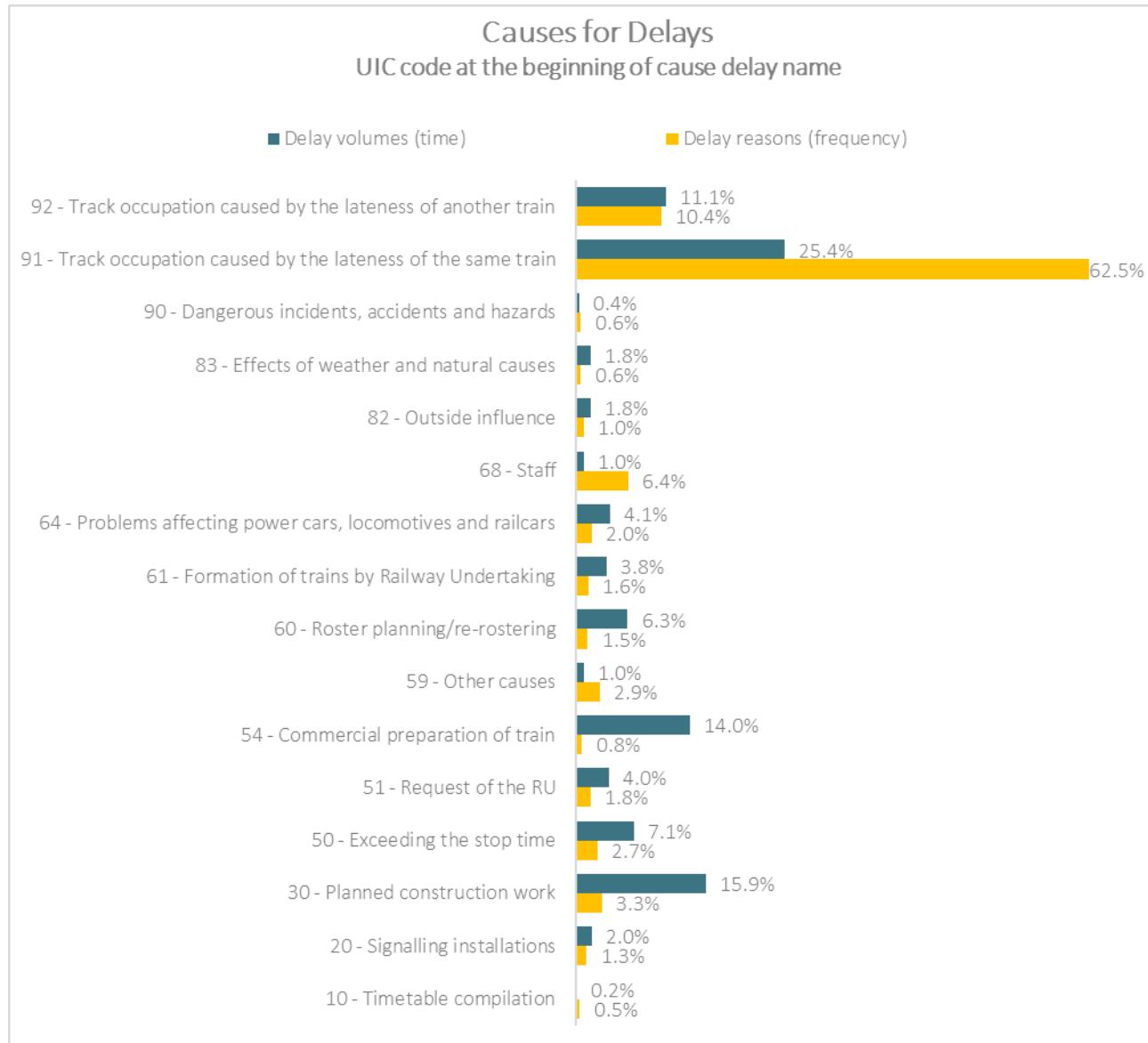
The International Union of Railways (UIC) has defined a list of possible causes for delays and cancelled services in order to harmonise the way the information about delays is collected. UIC codes are used by RUs and IMs within TIS to keep track of delay reasons whenever a delay occurs.

Based on the categories of delays defined by UIC, average delays on train runs at selected points were described for nine representative train paths on the RFC RALP belonging to the aforementioned clusters. The distribution of delay reasons and delay volume concerning all three clusters is presented in figure18. The most frequent reason for delay concerns *track occupation caused by the lateness of the same train* with about 63% of cases. Similarly, the *track occupation caused by the lateness of another train* with about 10% of

reported reasons. In terms of delay volume, the same two factors account for about 36% (respectively 25% and 11%) of delay time volume and represent the most critical delay aspects.

Generally, interferences between trains are the main reason causing delays. This is more evident when trains are not homogeneous in terms of type (passenger or freight train) and the respective travel speed. Therefore, relevant interferences occur when passenger and freight trains require the same railway section. Accordingly, night hours are often used to run freight trains and recover delays, as demonstrated for some of the trains analysed in cluster A.

Figure 18 Causes for delays and delay volumes for all selected trains belonging to cluster A, B and C, April-May 2017



Running freight trains during night hours and off-peak hours (early in the morning and late in the evening) significantly simplifies operations even in case of delays thanks to a higher number of available tracks both on the line and within the train stations. Moreover, freight trains have similar characteristics in terms of dynamics and speed and this creates a more homogeneous environment on the railway network. However, there are also some problems with train runs at night, as infrastructure works concerning the railway network are often planned during night time to avoid a disruption of the service during the day.

According to RUs, a relationship exists between delays and length of the journey. In particular, longer routes usually accumulate longer delays. This is mainly due to the difficulties in recovering delays, which normally persist along the trip or even increase having a knock-on effect. The following figure presents the delay distribution for trains running on longer (cluster A), mid-length (cluster B) and short (cluster C) routes. The figure highlights how the time of the relevant delay (more than 1 hour) decreases with the reduction of the travel distance. The longer paths belonging to cluster A report 43% delays longer than 1 hour, while the shorter paths of cluster C have, according to the data provided by the RU, just 25% of trains arriving more than 1 hour late. The sample of train runs and paths considered do not enable us to estimate the level of punctuality on the RFC RALP. However, the figure clearly depicts a situation where always less than 60% (current level of punctuality on the RFC RALP) of trains are punctual. In particular, the selected sample of trains belonging to cluster A and B shows to be frequently delayed.

Figure 19 Percentage distribution of deviation between planned and actual arrival time



The second issue linked to the reliability of rail freight services concerns the promptness in getting informed about delays when they occur. This topic affects all stakeholders in the logistics chain, including RUs and end customers. The first complaint is that in case of delays the Estimated Time of Arrival (ETA) is often not communicated in a timely manner, in sufficient detail or reliably enough for RUs to adapt their production scheme accordingly. Moreover, RUs state that the ETA is often not adequately recalculated as regards the final destination and this causes many management problems, especially for international freight trains which are operated by different RUs through several countries.

On the other hand, the ETA is also the most important information for the end customer to keep track of the shipment status during transport. Indeed, customers want transparency about the status of their shipment (visibility) and generally state that rail freight services fail to meet this requirement compared to road, as the level of information shared among the parties involved is not satisfactory.

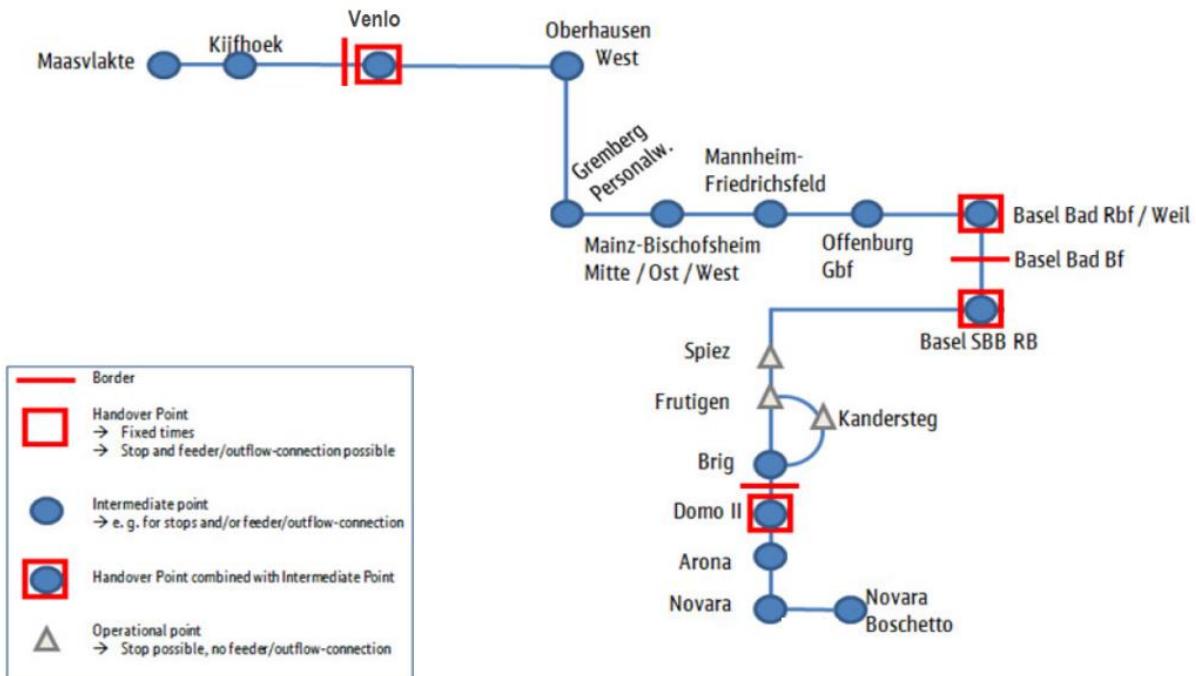
An example of delay analysis related to the train running between Novara and Rotterdam belonging to cluster A follows.

Cluster	Origin	Destination	Period of analysis
A	Novara	Rotterdam	May-June 2017

The runs between Novara and Rotterdam, crossing 4 Corridor countries (cluster A), with a planned running time of 24 hours and loading intermodal freight (containers and semitrailers).

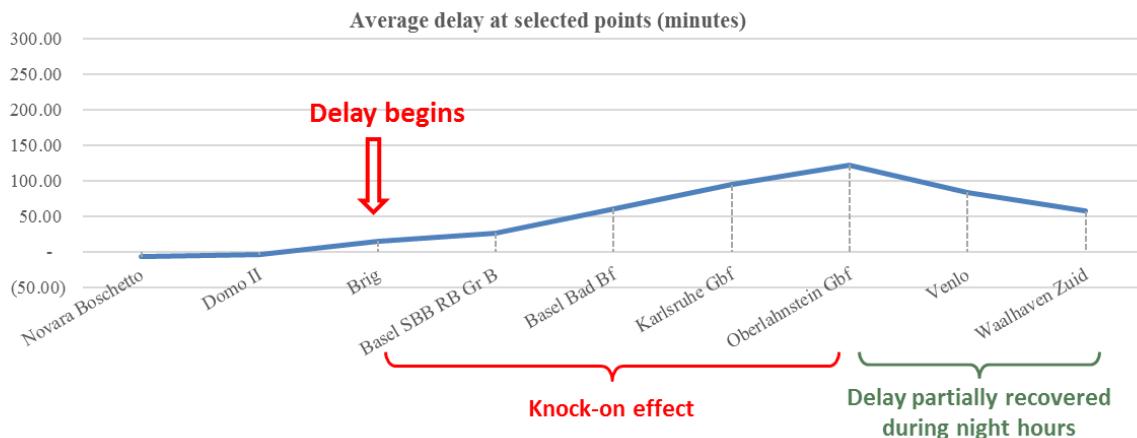
The train departs from Novara Boschetto at 3:00 or 5:00, travels via Domo II during night hours and reaches Basel in 8-9 hours with a slight delay. Further delay is accumulated across Germany during daytime hours and only partially recovered in the last part of the run, during night time, after Oberlahnstein Gbf and in the Netherlands.

The average delay at destination is about 1 hour compared to the CTT. The maximum recorded delay at destination amounts to 4 hours.



How delays are usually recovered?

- by jumping a planned but non-mandatory stop (e.g. stops planned for priority reasons)
- Increasing train speed whenever is possible especially during night hours

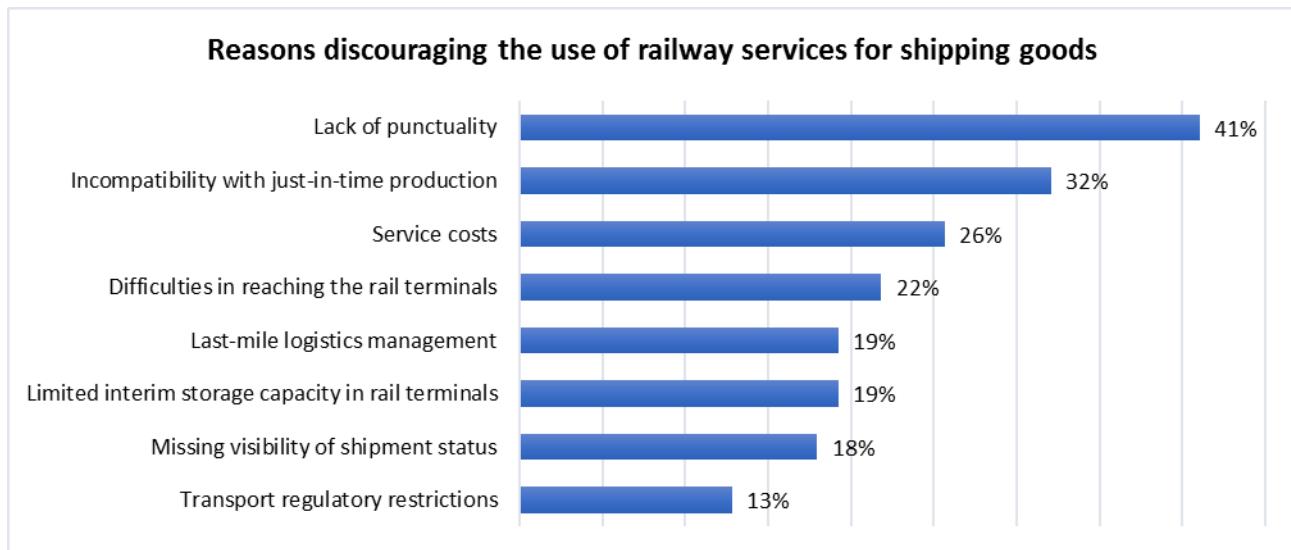


5.2 Market reaction to more reliable trains

Generally speaking, stakeholders are very sensitive to punctuality of the service, which is key to measuring performance and competitiveness of a transport offer. As in the previous topic dealing with faster trains, time losses mean increased costs for RUs as well as for the market as a whole, and a reduction in delays may result in a reduction in transport costs. However, punctuality is not just a matter of costs. Punctuality affects many other issues related to the transport service and, as previously said, can be a crucial factor in determining modal choice.

Within the survey, a pool of industries, logistics operators and freight forwarders were asked to list the reasons discouraging the companies from using railway services, and punctuality is the primary issue for 41% of the market, followed by the incompatibility with just-in-time production (32%).

Figure 20 Reasons discouraging respondents from using railway services (% of companies indicating the reason – multiple replies possible)



The focus on punctuality is demonstrated by the percentage of respondents who indicate their willingness to shift to rail if punctuality increases. Based on the current average punctuality (60%), the companies were asked to provide their intention to shift additional shares of goods from road to rail. In line with the terms of reference, targets of 70% and 80% punctuality were defined. As an expression of their eagerness for a more punctual service, more than 80% of respondents indicated the willingness to increase their rail modal share if punctuality levels reach 70%. Consistently, the share of positive replies increased in relation to the highest punctuality target of 80%.

Intermodal transport is the segment most sensitive to changes in transport reliability as it directly competes with road transport where the logistics chain is simpler due to reduced handling operations and provision of door-to-door services. The main advantages of road transport are related to the reduced number of actors overseeing transport operations and to its flexibility that facilitates better reliability. Consistent with the above considerations, a correlation between type of transport and level of punctuality required shows that commodities that are usually moved as bulk cargo require a cost-efficient but not time-critical transport and do not need to fully match the higher reliability standards of trucks. On the other hand, commodities usually moved via intermodal transport, such as finished and semi-finished products, are linked to efficient production systems and are more time-sensitive. Accordingly, the modal choice criteria basically depend on the category of goods to be shipped. Against this background, a more reliable service would benefit nearly

exclusively intermodal traffic, including automotive, while the impact on other types of goods is deemed negligible. Therefore, in the following the modal shift potential was only quantified for intermodal transport.

5.3 Cost savings and modal shift potential for more reliable trains

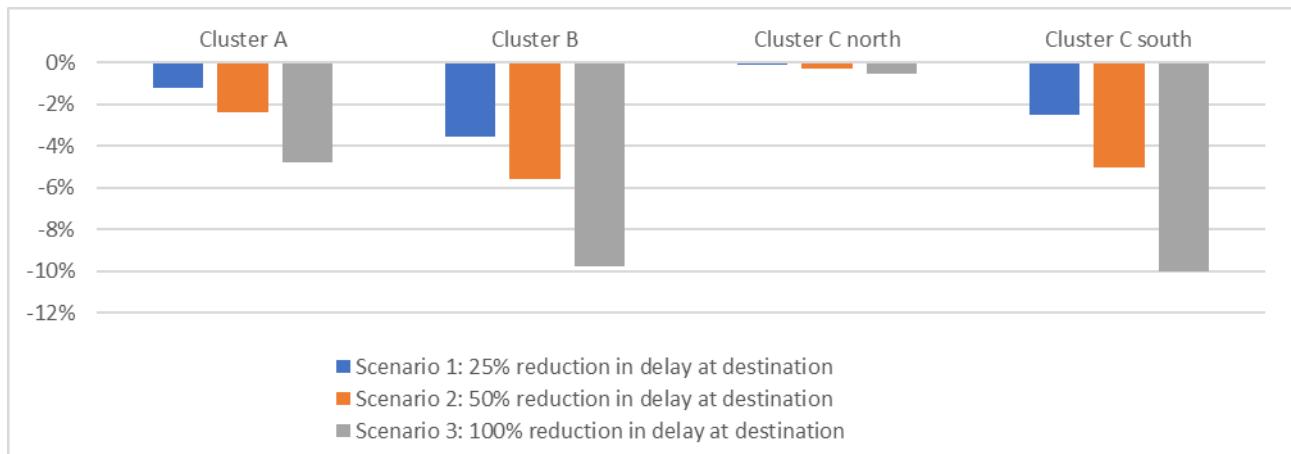
In order to quantify cost savings, three scenarios are compared with the reference scenario. The reference scenario is the situation as it currently stands, with current stops and delays as recorded in the TIS database. The current average delay at destination, according to the information provided by the client, amounts to a punctuality of 60%. Considering a 60% punctuality (within 30 minutes) in the reference scenario, a reduction of 25% of delays would increase punctuality to 70% and reducing 50% of delays to 80%. The main effects are related to high-value, time-sensitive goods such as intermodal and automotive.

The third scenario (100% reduction in delay at destination) serves as an upper benchmark and – although not feasible – is interesting as it shows the full potential related to delay reduction. According to this the third scenario was not included in the modal shift analysis.

The following figure shows the results for the most time-sensitive commodities represented by intermodal trains. If delays decrease, the cost of delays decreases. This element consists of two cost components:

- the costs of reliability; these are the costs of non-optimal use of staff and material and missed opportunities with respect to inventory management, production and distribution systems.
- all hourly costs such as the cost of the locomotive, wagons and driver(s) (hence the associated overheads).

Figure 21 Rail cost variation for intermodal trains related to more reliable trains scenario



As demonstrated by the graph above, the variation of costs caused by reduced delays at destination does not really reflect the market reaction to a better punctuality level. According to RUs, punctuality is in fact more a matter of service performance rather than cost, at least not a direct cost. Therefore, a stated preference survey based on different levels of punctuality rather than cost was considered an effective way to assess the willingness to shift freight traffic to rail in the event of a higher level of punctuality (namely 70% and 80%, corresponding to the first and second scenario of topic 3 where delays are reduced by 25% and 50%, respectively). The survey measured the modal shift potential compared to the % variation of punctuality levels on the RFC RALP. This mean assessing how many companies, moving freight both by rail and road (therefore mainly focused on general cargo and intermodal transport), are sensitive to a variation of 10% and 20% points of punctuality. Furthermore, the study considered the different correlation between type of

transport and level of punctuality required. With respect to this, the analysis confirmed some considerations already reported in the former Transport Market Study:

- commodities that are usually moved via bulk cargo require a cost-efficient but not time-critical transport and do not need to fully match the high reliability standards of trucks;
- commodities usually moved via intermodal transport as finished and semi-finished products are linked to efficient production systems and are more time-sensitive;

According to this, the modal shift potential shows encouraging values for intermodal transport, on average higher than in the case of heavier and faster trains. However, it must be acknowledged that the businesses participating in the survey are keener to use rail transport than it happens for the market average. For this reason, the values estimated have to be treated with caution and considered as an upper limit. Indeed, punctuality is not only a matter of delay but, more generally, it shows the performance of the service in terms of reliability. Improving punctuality levels would mean improving the quality of the rail freight service as a whole. Furthermore, the effect of improved reliability can only be seen in the medium to long term. Stakeholders that are not using the railway or that consider today's performance of the rail services unsatisfactory, are harder to convince. Demonstrating a qualitative improvement of rail transport may take a long time, and results can be expected to be obtained gradually. Events like the accident that occurred in 2017 at Rastatt are a clear threat when considering campaigns targeted at promoting rail transport and its quality.

The stated preference survey result run as part of this study indicated a variation base on a linear correlation between punctuality and modal shift potential, according to which, for each 10% increase in punctuality a 6.1% increase in demand for rail transport could be expected. However, this percentage should not be applied equally to all goods as the analysis demonstrated that different types of commodities result in different outcomes in terms of delay and reliability of service.

According to this, improvements on punctuality will affect intermodal traffic as a whole, while for general cargo and bulk it will only affect a minor part. The latter include the following goods of highest value: textiles (NST 5); chemical products (NST 8); machinery and equipment (NST 11); transport equipment (NST 12); furniture (NST 13).

Table 11 Modal shift potential related to more reliable trains (net 1,000 tonnes)

	Intermodal	General Cargo	Dry Bulk	Wet Bulk	Total
Scenario 1	1,814	90	0	50	1,954
Scenario 2	3,628	180	0	99	3,907

Table 7 Potential RFC volumes compared to current volumes related to more reliable trains scenario (extended corridor rail

Looking at the geographic distribution of the expected modal shift, Germany is the origin or destination of more than 60% of the total additional volumes. Italy, too, plays a significant role with an estimated modal shift exceeding 1 million of net tonnes, mostly concentrated on the trade lanes with Germany, Belgium and the Netherlands, characterised by large volumes of intermodal traffic.

As a whole, the modal shift potential is quantified in the range of 1,954 to 3,907 million net tonnes, depending on the punctuality level achieved (70% and 80%, respectively).

Figure 22 Modal shift potential on RFC RALP related to more reliable trains scenario (net 1,000 tonnes)

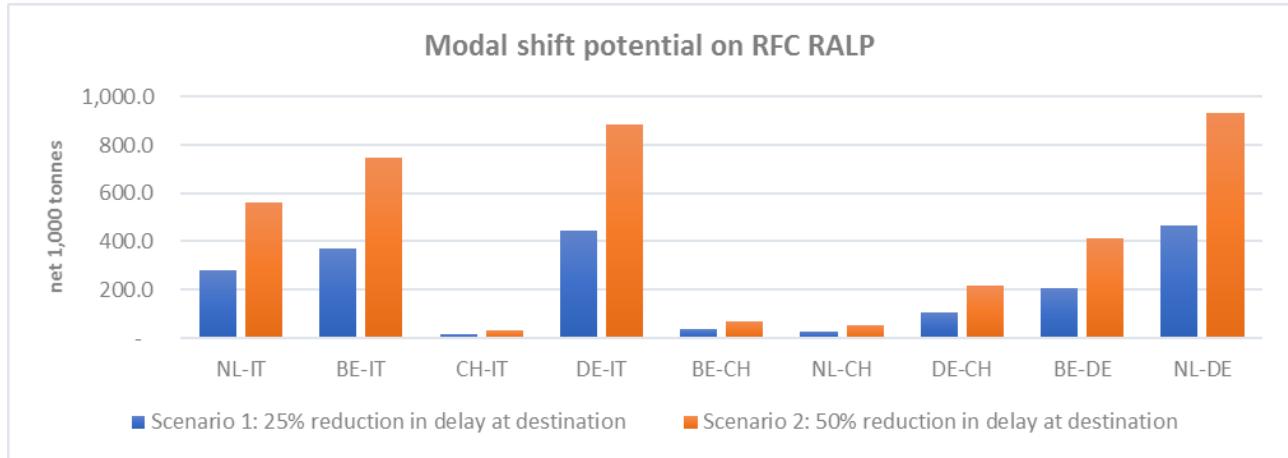


Table 12 Potential RFC volumes compared to current volumes related to more reliable trains scenario (extended corridor rail transport)

	Scenario 1: 25% reduction in delay at destination	Scenario 2: 50% reduction in delay at destination
RFC volumes, 2015 (Million net tonnes)	70.8	70.8
Potential modal shift (Million net tonnes)	2.0	3.9
Potential RFC volumes (Million net tonnes)	72.8	74.7
Potential percentage increment ($\Delta\%$)	2.7%	5.5%

5.4 Recommendations for improving train punctuality and a timely and integrated communication of ETA

In a situation of dense traffic, growing demand and mix of traffic as recorded along the RFC RALP, together with the combination of five different networks, it is not easy to formulate solutions to avoid or reduce delays.

The issues to resolve are the reduction of delays and the timely and integrated communication of the ETA, which is still far from at a satisfactory level.

In order to reduce the frequency of delays, a number of measures could however be proposed:

- Monitor the delays of each train and understand whether there are trains that are delayed more often than others. By reshaping the path offer and negotiating with RUs, these trains could be slowed down by adding buffer stops (while this appears to contradict topic 2, it should be borne in mind that the aims are different) that can be used in case the train is delayed. This is something already applied at the Swiss entrance borders in order to better regulate the traffic transiting through Switzerland.
- Delays are often a knock-on effect of delays at origin, which may be down to either the RU, the MTO or the terminal operator. In this case, too, a “regular” delay can be managed by reshaping the paths and the time threshold for the preparation of the train and by negotiating the path conditions with the stakeholders involved. Since the punctuality rate is key for the quality ranking of the whole corridor, actions could be adopted to penalise those stakeholders that are more frequently responsible for delays. For example, the level of access charges could be linked to a sort of punctuality ranking. A delayed train can be seen as generating externalities (additional costs borne by other users), this could be the rationale of differentiated charges.

- When dealing with delays, a trade-off often occurs between punctuality and average delay. In order to improve the punctuality rate, which is the primary objective considered by topic 3, when a delayed train is likely to have a strong knock-on effect on many other trains, traffic management should prioritise the trains that are running on time. In this way the punctuality rate can be upheld while the delayed trains are further penalised; this could result in a higher average delay, although this will depend on the number of trains running late.

The ETA, and its timely communication, in particular in cases of delay, has been indicated as a key measure to improve the competitiveness of the rail freight industry. Efforts are being made and projects are being implemented with the objective of improving the management of this kind of information.

The actions that are deemed crucial to progress on this are:

- Involve all stakeholders in information sharing. TIS currently provides information on delayed trains, but for example terminal operators do not have access to this information.
- The ELETA project is carrying out pilot projects involving many stakeholders of the RFC RALP (RUs, IMs, Terminal operators, MTO). According to the approach proposed, all partners involved in a train run should have access to tracking and ETA data, but they should also share train tracking data and ETA data as well as feed their ETA into TIS.
- Ministries / the EU should change the legal framework to enable open access to train running information (TIS data) for all stakeholders in the logistics chain or even for the general public, as is already possible in a few European countries (e.g. Norway, France, UK) and as is possible in many other modes (IWW, Maritime, Air)
- With these enhancements the leading RU, terminal operators and MTOs would have a complete view of the train status, and would be able to foresee the ETA and communicate the status almost in real time to the end customers.

6 Summary of the results

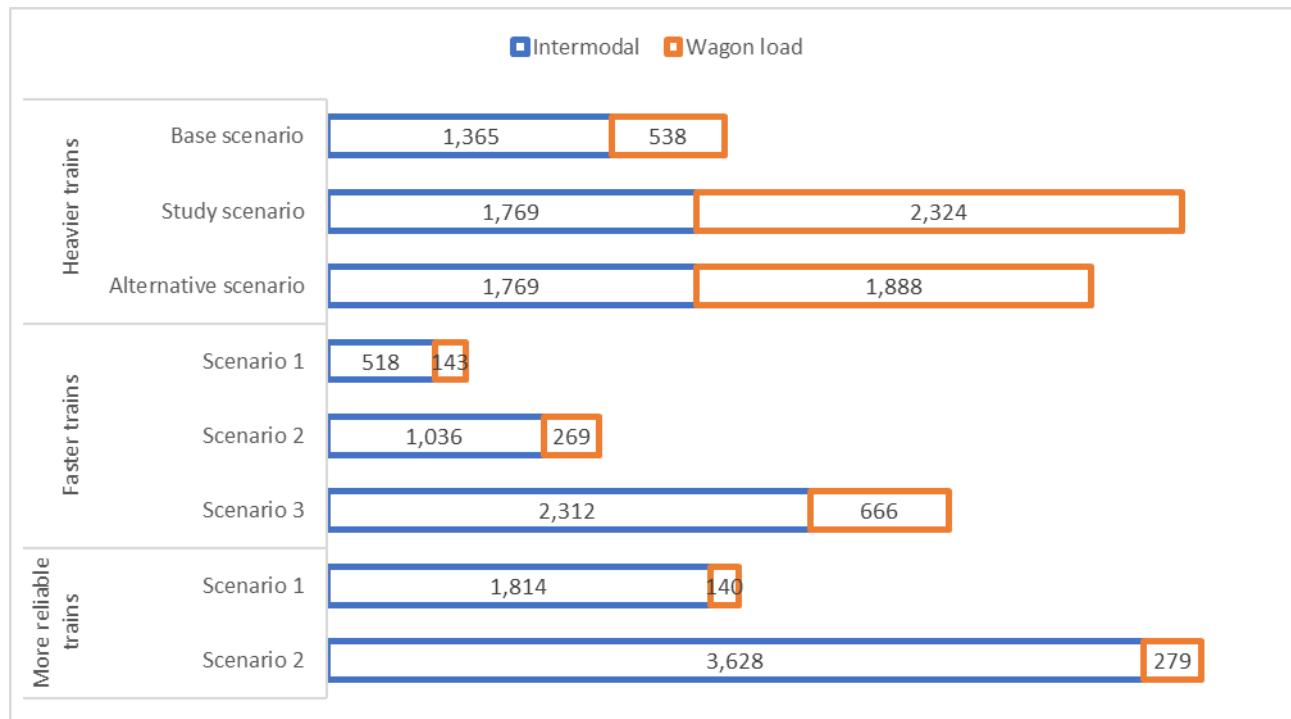
Introducing heavier and longer trains, as well as reducing stops and delays would actually encourage the freight market towards a modal shift to rail. In terms of modal shift potential, the study estimated an additional freight demand of a minimum of 662,000 net tonnes to a maximum of 4.1 million net tonnes, depending on the scenario considered. As expected, wagon loads (including bulk and general cargo) would benefit more in terms of cost savings by the introduction of heavier and longer trains and thus induce changes in the modal split between IWW and rail, which compete on these commodity types.

Table 13 Comparison of modal shift potential among the three study topics (net 1,000 tonnes)

		Intermodal	General cargo	Dry bulk	Wet bulk	Total	Potential effect
Topic 1	Base scenario	1,365	463	0	75	1,903	+2.6%
	Study scenario	1,769	1,511	495	318	4,094	+5.7%
	Alternative scenario	1,769	1,511	248	129	3,658	+5.1%
Topic 2	Scenario 1	518	73	56	14	662	+0.9%
	Scenario 2	1,036	128	112	29	1,306	+1.8%
	Scenario 3	2,312	289	301	76	2,978	+4.2%
Topic 3	Scenario 1	1,814	90	-	50	1,954	+2.7%
	Scenario 2	3,628	180	-	99	3,907	+5.5%

Among the three study topics, an increase of punctuality emerged as the most effective measure, considering the low boundary scenarios of each topic, to shift the modal choice in favour of rail, although its potential almost exclusively pertains to intermodal transport. This was confirmed by the representative sample of businesses operating along the RFC RALP that were involved in the study. Punctuality is a key indicator for assessing the overall quality and reliability of a transport service. The study demonstrated that losing time would increase costs for RUs as well as for the market as a whole, and a reduction in delays may also result in a reduction of transport costs.

Figure 23 Modal shift potential on RFC RALP per type of cargo (net 1,000 tonnes)



7 Conclusions

The study indicated the potential for a favourable outlook for rail traffic by exploring possible enhancements of rail services in terms of heavier, faster and more reliable trains along the RFC RALP. The three enhancements were selected among the topics that are under direct influence of IMs. Other transport policy measures that may strongly favour the modal shift were out of scope; this is the case of charging schemes like those applied in Switzerland or incentives like those adopted in Italy to support the shift from road to rail.

Heavier trains would make rail freight services more competitive. The main challenge here is the topographical limitation in Switzerland, in Aachen and the 1,600 tonnes weight limitation in Italy. At the same time, permitting 740m-long trains on the whole corridor is another necessary condition for the competitiveness of rail in the short term.

Despite the improvement linked to the base tunnels built along the corridor (in Switzerland) the topography poses some limitations given that slopes on Alpine sections limit the maximum train weight (limits on train weight are a function of speed, gradient and traction power of the locomotives). A workaround that is already in use is the deployment of additional locomotive(s) when needed; however, this requires additional shunting operations for adding/removing locomotives and extra costs which may compromise the competitiveness of rail services when compared with the road.

While introducing heavier and longer trains would require a check of the railway network infrastructure (e.g. bridges) and changes to national regulations in Italy, running faster trains is essentially a result of the timetable-planning process. Actually, the corridor timetable does not show many margins for changes. The allocation of capacity between passenger and freight transport is also a challenge. This is relevant in the proximity of urban nodes and in some congested sections such as at the Gotthard base tunnel, which requires strict adherence to the timetable, including planned stops to avoid delays.

Additional constraints in reaching the faster train target can be found in operational issues. During the analysis, the RUs pointed out that stops due to the change of locomotives and traction reinforcement are a result of infrastructure constraints and interoperability conditions. The latter are particularly relevant as stops at handover points due to lack of interoperability among the national rail networks are quite frequent along the RFC RALP. Conversely, positive examples exist as well, such as between Zevenaar and Emmerich where no stop is needed to cross the border section between Germany and the Netherlands and freight trains run faster than elsewhere.

One of the main aspects that emerged from the study concerns the relationship between reliability and attractiveness of the rail freight service. During the interviews, most of the stakeholders warned that the current low level of reliability discourages part of the market to use this mode of transport not only on the RFC RALP but also on all those routes where road transport offers faster and more reliable connections. Reliability could be improved with better management of operational issues (optimisation of driver shifts, availability of support locomotives, handover stations, entering/exiting trains into/from the rail network, etc.). This requires cooperation between different IMs and RUs, improved interoperability and a clear allocation of traffic priorities (between intercities, regional and freight trains). As an example for the reduction of the frequency and the extent of delays, if a train fails to keep its assigned route for any reason, it should be able to use the first one that becomes available.

The second issue linked to the reliability of rail freight services concerns the promptness in getting information about delays when they occur. This topic affects both RUs and end customers and is related to the availability of reliable information on ETA during the journey. During the interviews, RUs complained that

in case of delays on the RFC RALP the ETA is often not communicated promptly, does not have sufficient detail or is not reliable enough. However, this is most likely to be attributed to the RUs' reluctance to share the information. Importantly, a lack of information about ETA strongly affects train service management and could generate extra delays when a service disruption occurs along the path.

Apart from providing information on ETA as soon as possible, what is actually missing is general coordination with all stakeholders involved whenever a delay occurs and the timely updating of the ETA. The leading RU should be always able and willing to inform its partner RU and customers about the status of the shipment to guarantee the reliability of the service and to manage possible deviations. Moreover, first and last mile operations also need to be included in the information loop, as final customers need to calculate the estimated time of arrival of their goods. Currently, partners outside the railway network do not have guaranteed access to this information as it is legally required to maintain data confidentiality and also due to the fact that the interfaces needed in order to receive this data are not yet available to all partners along the logistics chain. Overall, the positive effects of providing an ETA within a reasonable time would be: an increase of customer satisfaction, better planning in terminals, improvement of process scheduling and of the quality of the service provided by the IMs and the RUs.