Redesign of the International Timetabling Process (TTR)

Business Case

Draft version 3.0

Please, note that this TTR document is a working document and might be subject to changes based on the experience gathered by the pilots and outputs of the TTR working groups.

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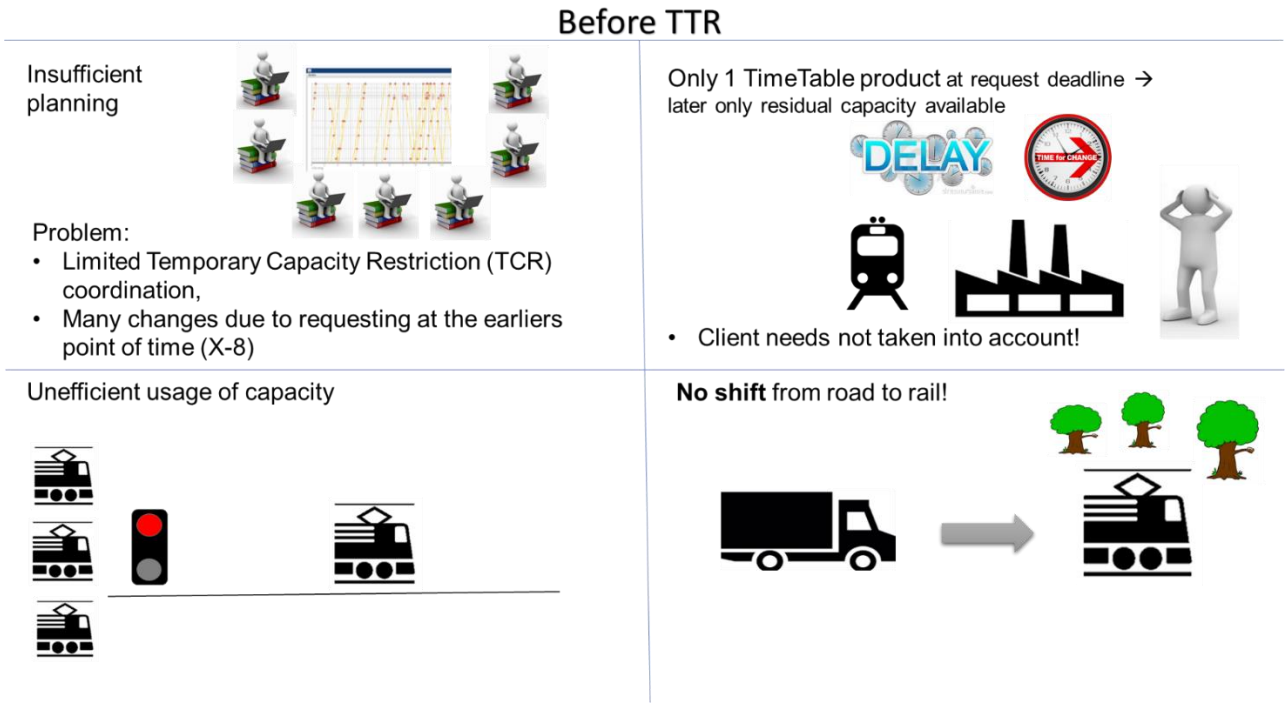
List of Abbreviations

Abbreviation	Explanation
TTR	Time Table Redesign (Project title)
ATT	Annual Time Table
BC	Business Case
BC-S	Business Case Study
BEUR	Billion Euro
DCF	Discounted Cash flow
EC	European Commission
ERFA	European Rail Freight Association
ERIM	European Rail Infrastructure Masterplan
EU	European Union
EUR	Euro
FTE	ForumTrainEurope
HR	Human Ressorces
IM	Infrastructure Manager
IP	Innovation Programme
IT	Information Technology
JIT	Just in time
MEUR	Million Euro
PaP	Pre-arranged paths
pkm	passenger-kilometre
RFC	Rail Freight Corridor
RNE	RailNetEurope
ROI	Return on Investment
RU	Railway Undertaking
TAF/TAP TSI	Telematic Application Freight/Passenger Technical Specifications for Interoperability
TEUR	Thousand Euro
TCR	Temporary Capacity Restriction
TFEU	Treaty on the functioning of the European Union
tkm	tonne-kilometre
TTR	**Time Table Redesign (Project title)**
WP	Work Package

1. Executive Summary

Before TTR



With TTR

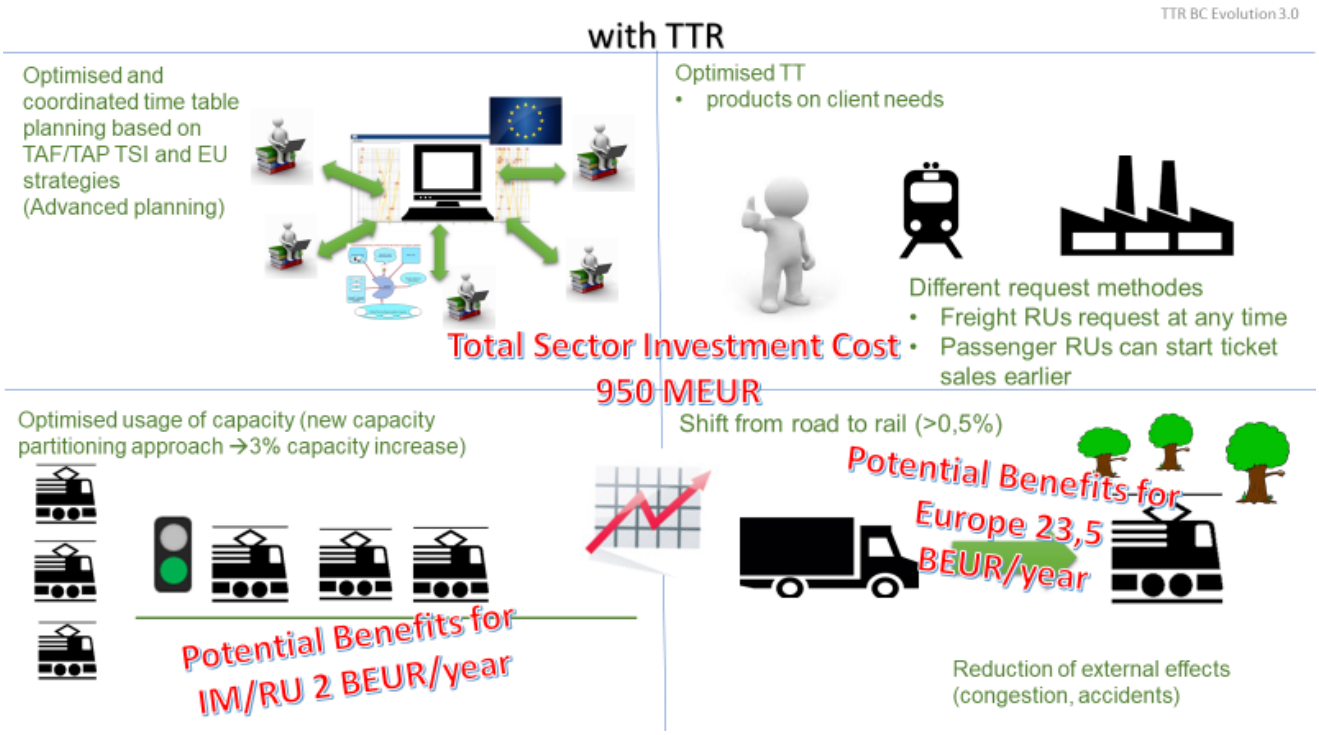


Figure 1 Executive Summary

Note: Explanation for figures changes from Business Case Creation (2017) to Business Case Evolution 2019

Figure	Business Case Creation (2017)	Business Case Evolution 2019	Explanation
Total Sector Investments	1,5 BEUR	0,95 BEUR	More accurate data on system cost from RNE side by definition of IT landscape
Potential Benefits for Europe	32 BEUR/year	23,5 BEUR/year	Introduced increasing capitalisation rate – starting with 10% in 2025 (full benefits will are applied after 2030)
Potential Benefits IM/RU	2,1 BEUR/year	2 BEUR/year	Factor correction and introduced capitalisation rate

Table 1 Deviations Business Case Creation (2017) and Business Case Evolution (2019)

» TTR Scenario BC-Creation (2017)
- Positive Cash flow after 2024 (32 BEUR/year).
- Break-even point after one year in 2025.
- Total investment cost 1,5 BEUR.
- Total benefits 224 BEUR within 15 years.
- Return on Investment = 162 times the investment.

» TTR Scenario BC-Evolution (2019)
- Positive Cash flow after 2025 (Average: BEUR 24/year)
- Break-even point in 2025
- Total investment cost MEUR 950
- Total discounted benefits BEUR 129
- Return on Investment = 346 times the investment

Assumption underlying update BC Evolultion 2019 deviating BC Creation 2017
- Start date 2019
- Investment approach - not budget approach (Financing necessities, etc. shall not taken in consideration)
- Investments includes planning, software development, hardware, maintenance and licences
- Investments in IT-Systems which will be born even TTR will not be implemented (but are a prerequisit for TTR implementation) will not be calculated (e.g. TSI PCS compliant mandatory interfaces)
- Costs are estimated based on low-cost supplier and optimal system and process implementation (no major delays or modifications)
- RNE/FTE HR cost for project management, steering, etc. are included in system cost
- Cost for change management, internal process modification, staff training estimated (is carried forward from Business case 2017 since it could not be further specified)
- Railway-related research and innovation cost (C) are not taken in consideration
- IM/RU investments1: 5 Major RUs invest in respective interfaces, 20 European IMs invest in respective interfaces - Cost are mirrored on centralised system

2. Introduction

RNE and FTE have agreed to jointly reform international timetabling as sponsors of the joint project 'Redesign of the International Timetabling Process' (TTR), together with the European timetabling community and with the support of ERFA (European Rail Freight Association). The objectives are:

[1] a survey in respect to potential implementation/change cost along the members of RNE and FTE did not supply usable indication for cost estimate

- clear market orientation,
- greater reliability (including planning and implementation of possessions),
- improved commitment to the international timetabling process by all parties involved,
- greater efficiency in terms of capacities and resources in order to avoid duplication of planning and/or work, and
- a larger rail market share thanks to a better use of existing track capacity (rather than adding new infrastructure)

The **first phase** of this ambitious project gave a prominent role to Railway Undertakings that expressed their points of view, leading to a market requirements portfolio. The **second phase** worked out innovative answers to the questions raised in an interactive way within the rail community. The **ongoing Phase 3** shall define the framework for the new process incl. the IT system and legal framework and furthermore sets the prerequisites for the endorsement and pilot implementation phase.

The current Business Case takes into account the achieved results and proposals dated end of March. The project is still ongoing and major commercially-oriented issues are in the process of the final specification (e.g. commercial conditions). However, some of the project parts with significant financial impact, especially for the IMs (e.g. IT system requirements), are still under discussion and will not be finalised until delivery of the present Business Case.

The current Business Case is a major basis for the endorsement phase and decision-making process for implementation. It shall be seen as a framework analysis which shall be further detailed as soon as final agreements and specifications are finalised.

Furthermore, according to the results of the Business Case of the previous Phase 2 (TTR project is now in Phase 3), the present Business Case shall not only quantify or qualify potential benefits with respect to micro-economic effects of business process re-engineering – since TTR deals with a key business process heavily influencing the choice of transport mode (rail, road, water), it is obvious that European transport policy requirements and the basic logic of those policies (macro-economic effects) have to be taken into consideration when calculating the business chances. This means in general:

- de-carbonise and reduce emissions → “Save the environment”
- increase in efficiency and utilisation of rail network capacity to avoid bottle necks → Safeguard European investments
- increase in the reliability, lower operating and administrative costs of rail transport → Increase in competitiveness to support shift to rail
- ensure structural change to enable rail to compete effectively and take a significantly greater share of medium and long distance freight and passenger traffic → Change towards market-orientation

3. Disclaimer

The BC-studies refer to the data provided by the stakeholders, expert opinions, and international research studies. BC-Team does not take any liability with respect to the published data.

However, BC-Team tried its best to put the most useful and reliable information together and generate trackable conclusions. All estimations made by the BC-Team were conservative.

The survey on modifications showed different detailing grade on evaluation possibilities which was mainly based on a lack of statistical functionalities of systems in place, which did not allow a tracking of dossier/requests and their status. Additionally, the return of surveys was very limited, only allowing a projection based on estimation.

The approved TTR IT landscape gave to possibility to estimate implementation cost for the central system on an already accurate level. However, data for implementation efforts on RU/IM side are rather limited even

though RNE initiated a survey in this respect. Harmonised commercial conditions concept was still not available during the update of the Business Case. Therefore, these quantitative items could not be analysed.

4. Method

4.1. Methodological approach

The applicable methods for business cases highly depend on the cases themselves. A strategy-oriented business case can only be developed under a high degree of uncertainty. For a concretely- planned project or investment alternative, detailed estimates of economic values are more likely to be predictable. In this way, the business case is more a guiding evaluation: It leads the conception and implementation towards the intended objectives and helps to identify the levers, necessary decisions and risks.

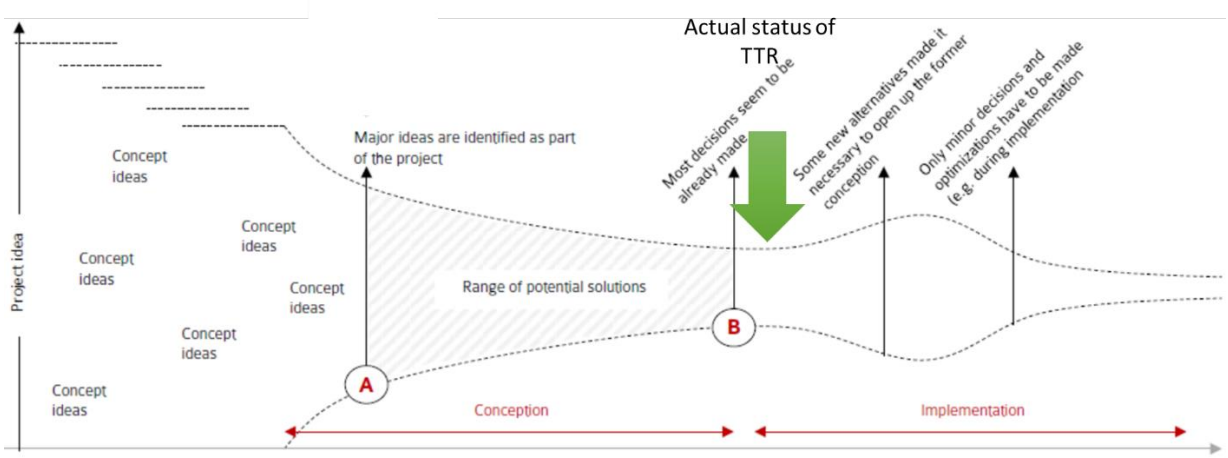


Figure 2 Project conception and implementation[2] - Status of TTR

The following chapter describes the methodological approach.

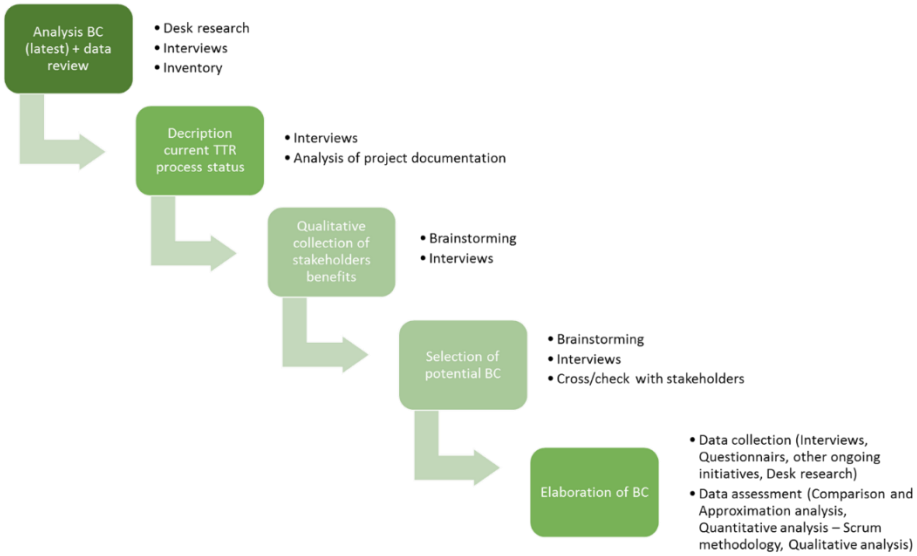


Figure 3 Method

The method follows a step-to-step approach. For the different Business Cases, specific methodologies are applied based on the data availability and estimated outcome.

[2] Development of Business Cases for the Redesign of the International Timetabling Process – Documentation Dr. Götz Volkenandt

4.2. Business Case scope and boundaries

This chapter deals with the analysis of stakeholders to be affected by the new process and their respective benefits.

The Business Case tried to analyse and compile financial benefits and cost for the stakeholders on a European level, based on an extrapolation of data samples provided by the stakeholders.

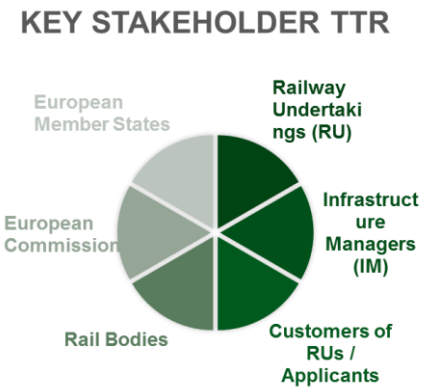
The benefits and cost for single stakeholders such as European IMs or one single IM shall not be analysed since

- Resilient statements require high data-quality;
- Currently comparable statistical data is only available on a high aggregation level since there is a wide range of definitions on which basis the data is compiled;
- Maturity level of IMs and RUs differ – therefore, results may be interpreted differently (positive/negative; e.g. standardised process → shared capacity management based on standard software may be positive for younger underfinanced IMs but not for matured IMs with self-developed IT);

4.2.1. Stakeholders

The intention of stakeholders is documented through the goals of a project. The TTR-project states the following goals:

- Market orientation (different deadlines for the placement of path requests in order to fulfil the requirements of the logistics industry).
- Reliability of the planning and execution of possessions as a basic requirement for higher efficiency, better utilisation and quality products.
- Commitment to the timetabling process, since an optimisation of planning results and effects is only possible if the process is handled deterministically.
- Process efficiency as a result of the minimisation of manual and unnecessary work.
- Improved rail market shares through better use of existing capacity.



It is clear that the last goal is the overall objective since the other goals are (e.g.) requirements and preconditions.

5. Comparison of current and new TTR process

The following Figure shows briefly the main obstacles in the current timetabling process and respective TTR solutions.

Before TTR

- One request method for all traffic
- One hard request deadline in year
- Non harmonized deadlines for path offers and allocation across Europe
- Non harmonized approach to changes and modifications
- Non harmonized capacity restrictions, works and possessions with major impacts to the timetable

After TTR

Long term capacity planning by taking into account TCRs and capacity needs announcements of the applicants

Flexible request methods

Rolling Planning

- 365 Request possibilities in the year
- Multi-year allocation of capacity
- No annual timetable request deadlines
- Quick request process execution:
  - Maximal 4 months ahead of train run
  - Executable in 4 weeks of lead time
- Regular updates of the capacity - overview available daily

Annual Timetable

- Shorter path construction time
- Stable path offer earlier available
  - Consequence for passenger traffic: Ticket sales can start 6 months before the timetable change
- Earlier path allocation
- Even for requests after the deadline, the ticket sales can be opened 2 months earlier than today

Figure 4 New vs. Old TT process

6. Business Case Studies

This chapter serves to legitimise all important financial and non-financial impacts for the Business Case on Business Case Studies (BC-S) and shows how they can be valued.

6.1. Scenario 1: Implement new TTR process

Benefits and cost will be analysed in the following Business Case Study themes:

6.1.1. BC-Study 1 (TTR reduce modifications)

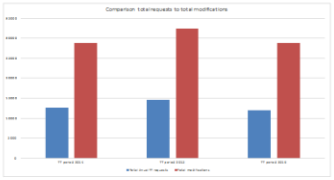
The BC-Team collected data in respect to the changes and modifications on the path requests and respectively allocated paths. The information was collected by means of a survey.

The overview of the results is provided in the tables and graphs below.

Freight applicants

	Figures	TT 2014	TT 2015	TT 2016
Total requests	Total Annual TT requests	**12.616**	**14.514**	**11.964**
Total modifications	Total modifications	**28.887**	**32.420**	**28.893**
	in % of total	229%	223%	241%

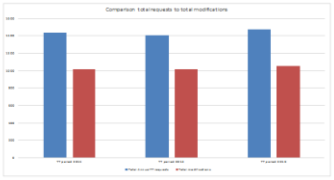
Table 1 Summary of the survey results for the freight applicants (SNCB-Logistic, DB Cargo and BLS Cargo)



Passenger applicants

	Figures	TT 2014	TT 2015	TT 2016
Total requests	Total Annual TT requests	**1438**	**1401**	**1475**
Total modifications	Total modifications	**1012**	**1013**	**1050**
	in % of total	70%	72%	71%

Table 1 Brief overview of survey results for passenger companies (Trenitalia and DB Fernverkehr)



Legend

- Red/orange = number of modifications (X-12 till X-0
- Blue Annual TT requests

Infrastructure Managers

	Figures	TT 2014	TT 2015	TT 2016
Total requests	Total Annual TT requests	**131.254**	**135.449**	**136.889**
Total modifications	Total modifications (X-12 to X-0)	**291.010**	**284.767**	**309.871**
	in % of total path requests	222%	217%	236%

Table 1 Infrastructure Manager survey results – only annual TT requests are taken into account (SBB, ADIF, DB, PKP RFI, SNCF, SZDC)

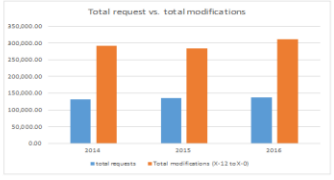


Table 2 Summary of the survey results

The comparison of the figures and tables indicates that the amount of changes and the rate between number of modifications and total number of requests of changes is significantly higher for the freight applicants than for the passenger applicant.

Finally, the survey was applied to the IMs, and the facts / figures were provided by more IMs. As was the case with freight, the IMs also indicated the difficulty to gather the data without having the appropriate IT-tool-support.

In all three cases BC-Team took into account only the figures for annual timetable requests since the ad-hoc request handling varies dramatically from one applicant to the other. For some applicants, all modifications during the running timetable are interpreted as ad-hoc requests. Other applicants only calculate the new traffic during the running timetable period as “ad-hoc”.

As reference are taken the operational research results of the Swedish IM, one of the stakeholder of the TTR project. They show the analogy between lean production and its challenges and timetable planning (see the presentation of Trafikverket in Business Case inventory). The Figure 5, Figure 6 and Figure 7, indicate that the cost of changes applied to the process as well as on the resources involved in the process increase as the degrees of freedom decrease. Trafikverket and SICS institute operatively analysed 8.000 allocated train paths on the dedicated line in Sweden and recorded even 100.000 (!) changes on them.

The BC-Team assumes that the reason for such a high number compared to the result of the survey is related to the fact that Trafikverket / SICS institute has also calculated the servicing and additional ad-hoc traffic.

- Early decisions impacts flexibility and cost.

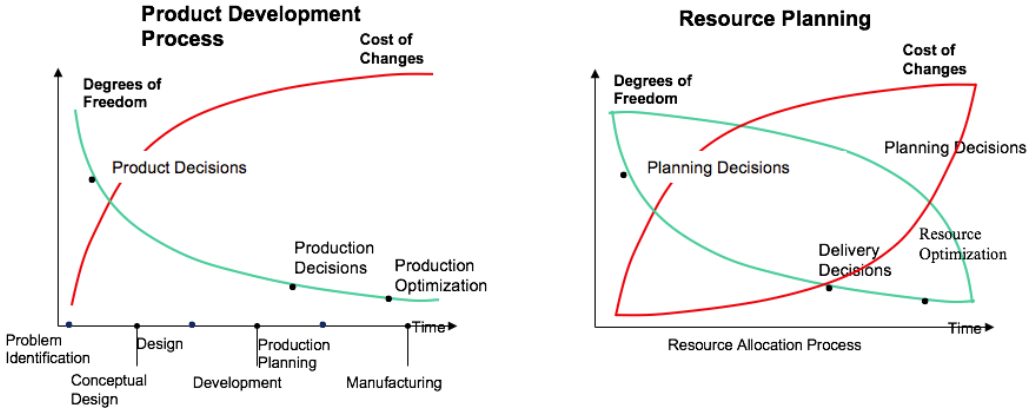


Figure 5 Reference: Trafikverket - SICS presentation

If these findings are applied on the timetabling process, the degrees of freedom would decrease if there was just one day in the year as the request possibility. As the day of operation gets closer, the more changes are applied, as reported in the surveys showed above. According to the rules of “lean production” applied to the timetabling process the costs of each modification increases the day of train operation approaches.

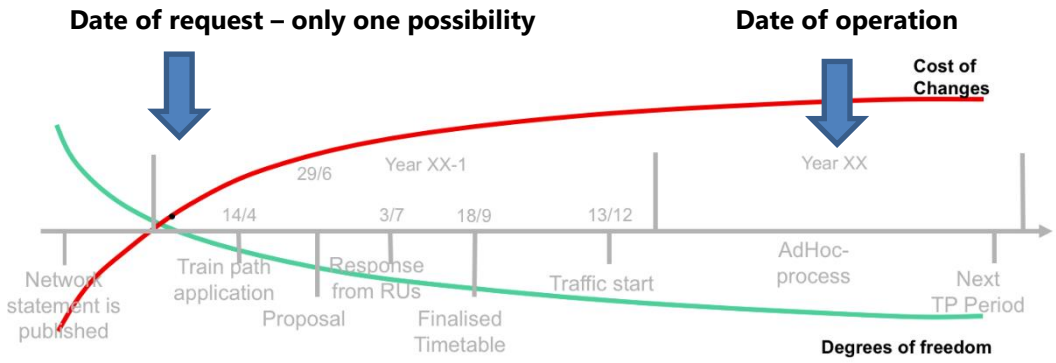


Figure 6 Costs of changes applied to todays' process

Applying any change requires an administrative effort of at least ¼ of the whole amount (this is an experience-based value provided by timetabling experts). By entering the number of requests processed by the applicant, multiplying them with the cost per request (e.g. – 1 applicant and 1 IM with the cost of EUR 550 per request) the costs of additional 25 % are significant, even for one applicant.

According to the survey results the number of changes / modifications registered by IMs and freight companies is more than two times higher than the number of the requests. When applying this cost calculation to the results of the survey (just for TT 2016 for simplicity reasons), the following values are obtained:

Item	Value
Cost per request (1 RU – 1 IM)	EUR 550.00
Cost per change (25% of cost per request)	EUR 137.50
Survey result: total number of requests registered by IMs	136,889.00
Survey result: total number of changes/modifications registered by IMs	309,871.00
Survey result for IMs: 50% of total requests for Passenger applicants (assumption!)	68,444.50
Survey result for IMs: 50% of total requests for Freight applicants (assumption)	68,444.50
Number of changes for passenger applicants multiplied with the factor 71% (see survey results table)	48,723.20
Number of changes for freight applicants multiplied with the factor 241% (see survey results table)	165,293.12
Cost of changes based on the rate for passenger applicants (71%)	EUR 6,699,440.47
Cost of changes for based on the rate for freight applicants (241%)	EUR 22,727,804.58
Cost of changes based on the records of IMs (actually, joint costs for RUs and IMs)	**EUR 42,607,262.50**

Table 3 Cost of changes / modifications

It is obvious that such unnecessary costs should be avoided. The cost calculation was based on the “optimistic” assumptions mentioned before – the readers are free to calculate the costs according to their specific cost and effort estimations.

Figure 7 Come closer to the day of traffic

The proposal of the TTR project is to apply the new TTR process to avoid or reduce these costs. If the daily request possibility is offered (especially for freight), as specified in the Rolling Planning concept, the cases like Use Case 4,5 and 6 (see Annex 2 of full version TTR BC-V3.0) can be covered, and the cost of the changes can be significantly reduced. The changes after the initial Rolling Planning request may be applied much later than today, the amount of such changes is significantly lower. According to the timetable experts from the stakeholder companies of the TTR project, the requests for the freight traffic in the yearly timetable for the Use Cases 4, 5 and 6 are very often applied 10 times until the train is run in today's process. With the Rolling Planning, such changes may be avoided, and the effort is automatically reduced, due to the customer-oriented, "just-in-time" request method. If no changes are needed by applying the more flexible process, the costs as indicated in the "Table 3 Cost of changes / modifications" for handling of the changes may not appear in that enormous amount any more.

Finally, the quantitative benefits of the new approach are:

- Reducing costs of the resources due to the reduction of modifications (JIT- Just In Time timetable production)
- Increasing the potential offer for the end-customer – with better earnings due to the reduced resources cost, with more reliability on the capacity due to the capacity increase (see Assumption 8)
- Generating additional earnings due to modal shift in a certain percentage area (see BC-study 4), due to the "just-in-time" Rolling Planning customer-friendly approach.

Additionally, taking into account the new capacity concept and real-time capacity calculation, the current available capacity could be extended by 15% (BC Inventory – Studies/Trafikverket "Uncovered capacity in Incremental Allocation" and DB project results NexXt).

Based on the above-mentioned study the BC-Team calculated the capacity gains on following assumptions: 30% of the capacity increase is directly usable, by calculating the product of (3,425,000,000 train km EU (UIC 2014) * (1.10*30%) – 3,425,000,000) *139 SEK (EUR 14.7)/km leading to a potential benefit of up to **BEUR 1.5 /year.**

What does this mean for the shareholders of rail transport?

Beneficiaries of increased capacity

- IM = all service levels (Minimum Access Package, Ancillary services, …)
- Industry = Electritiy/Diesel suppliers
- RUs = railway undertakings, logistics providers, wagon keepers, …

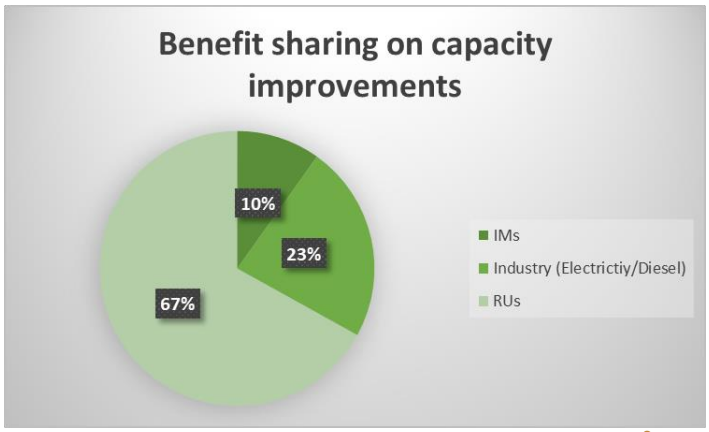


Figure 8 Benefit sharing on capacity improvements[3]

Calculation can be found in Annex 8 of full version of BC Evolution-V3.0.

6.1.2. BC-Study 2 (TTR improve coordination and capacity)

The need for improvement of the coordination about the capacity restrictions, works and possessions has been clearly demonstrated during the TTR project. Additionally, in parallel, the RUs within the UIC working groups for cooperation with RFCs have expressed the needs. Some highlights from the presentation made for the "World Bank Seminar Strategies to deliver opportunities and enhance effectiveness: a response from the sector Sandra Géhénot, UIC Freight Director Vienna, 08 November 2016" are given here.

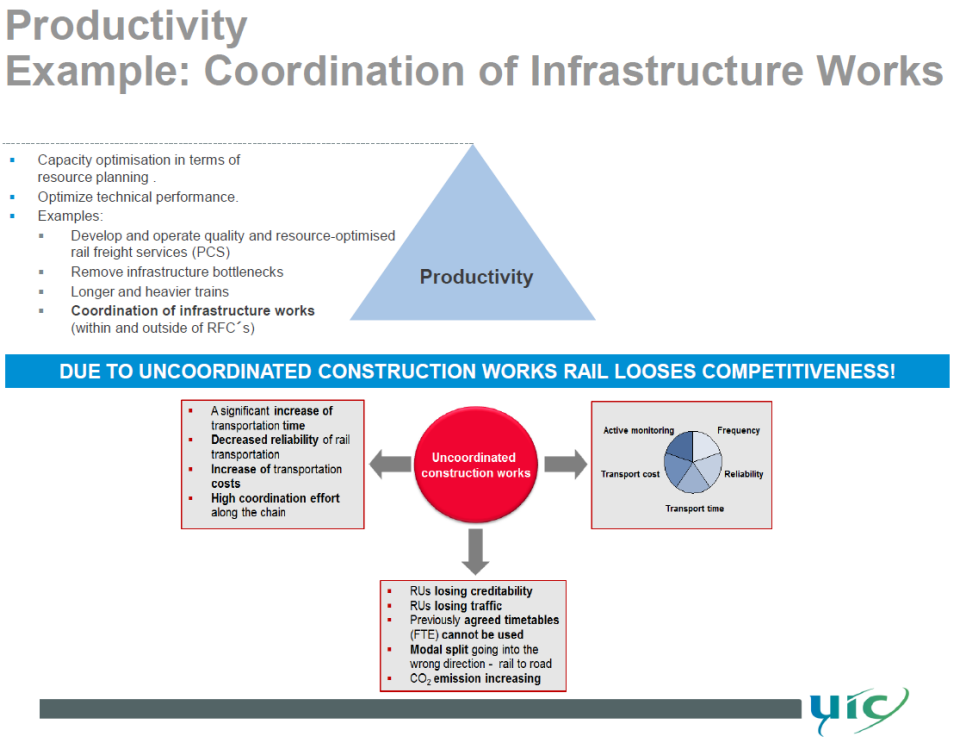


Figure 9 The need for coordination to avoid the loss of competitiveness

The BC-Team gathered the qualitative inputs by means of the survey with the stakeholders of TTR. The survey has shown the numerous examples of insufficient TCR coordination and their consequences to the business. The most drastic example has been indicated by a major German RU on the case of uncoordinated TCRs on the Scandinavian route (see BC-Study 2 inventory).

[3] Calculated based on average transport price of SEK 139 and Swedish Network Statement – see Annex 8 of full version TTR BC-V3.0

Item	Amounts
Number of train paths needed for transport on the route in 2017	275
Number of transports rerouted via sea	87
Total trains cancelled	**188**
Loss according to additional ferry costs (2017)	EUR 133,000.00
The loss according to the cancelled trains	**MEUR 3.8**
Loss for infrastructure manager for cancelled 275 paths	**EUR 415,000**
Total loss of the Group (ferry, missing infrastructure charges, cancelled trains for customers)	**Approx. MEUR 4.3**

Table 4 DB example of the total loss for railways for just one uncoordinated TCR (based on the "real-life" case!)

The analysis of the major German RU brought about the result of around MEUR 4 of loss due to the uncoordinated TCR, which could be avoided if the new TTR process had been implemented. The loss is actually not only registered by the major German RU, but it also affects the IM DB Netze (no access charges can be billed if the capacity is unused).

To calculate the potential benefit, gain on a European basis the BC-Team calculated an average loss per tkm and approximated it to the European level. This approach was highly simplified and did not take into account losses neither for the IM nor for the passenger products which lead also to a loss of client retention since alternatives for long-distance and short-distance passenger traffic are given.

» In the Cost-Benefit calculation provided in the "BC Financial" spreadsheet, the following assumption has been taken in detail: MEUR 4 loss of DB → estimation /74,818,000,000 (UIC Statistics tkm 2014) * tkm Europe EU 261,054,000,000 (UIC Statistics tkm 2014) = approx. **MEUR 14 Mio**

The new approach of the synchronised and coordinated TCRs with the support of an efficient IT is supposed to eliminate (or at least to decrease) the risk of such a loss as described in the study.

The cost-benefit analysis is actually simple and reliable. Investment currently approved by TTR Stakeholder RNE for the TCR IT coordination **web-tool** is approximately **EUR 150,000** for **development** and **EUR 50,000/year** for **maintenance** and improvement. These costs are minor compared to the loss indicated above.

6.1.3. BC-Study 3 (TTR support capacity safeguarding)

Freight traffic

The initial idea of RFC offer of the Pre-Arranged Paths (PaPs) was to support the freight traffic through the structured safeguarding of the dedicated capacity on European corridors. However, the examples provided by the TTR stakeholders showed that without a common approach to capacity safeguarding throughout Europe (i.e. without applying the same synchronised and harmonised procedures by all IMs participating at a corridor), the success would be strongly limited.

In the analysis, the number of offered PaPs on the particular corridor was compared with the number of finally allocated paths (i.e. contracted train-paths used in the operation), according to the original PaP. The analysis contains the information from 3 companies and shows the results for 2017 (the results for previous years also exist – to be found in the BC-Study3 Inventory).

Item	Values
Requested PaPs	175
Allocated PaPs	72
Non-(or partially) harmonised PaP offers	103
Unsuccessful PaP allocation in % (average for 3 companies)	58.9% waste
Best rate (reported by SNCB-Log)	32% wasted
Worst rate (reported by BLS Cargo)	78% wasted
Middle value reported by DB Cargo (but with extreme case of 100% waste on RFC2 and RFC6)	60% wasted

Table 5 PaP wasted statistics

The “best case” examples gathered from the companies BLS Cargo, SNCB-Logistic, DB Cargo and TX Logistic show the highest rate of utilisation of the offered PaPs of 68%.

The “worst case” examples show the 78% wasted, and unfortunately the 100% of unusable PaPs in some cases (see example of DB Cargo on RFC-2/4/6)!

The loss incurred due to unusable PaPs was calculated as follows:

- The loss according to effort of IMs to produce it (40h / IM → in average 3 IMs per corridor/PaP → 120h/PaP. With the resource costs of EUR 50/hit leads to EUR 6,000/PaP → 2,539 PaPs in TT 2017 → EUR 15,234,000.00). This is an optimistic assumption, without taking into account the cost of the RFC organisations! Taking the results from the Table 5 the 59% of wasted capacity generate approximately MEUR 15 that was invested in producing the PaPs. Hence, the “optimistic loss estimation” for the IMs participating at the RFCs is **EUR 8,966,297.14**, a clear indication for alert.
- The loss according to effort for RUs to request it (and waste it) can be calculated as follows:

  Effort per request is given in the table “Assumptions” (row 3) → EUR 200 (wasted effort per non-Usable-PaP). Hence, just for the 3 RUs that contributed to the survey, the 103 * EUR 200 represents already the EUR 206,000 of loss.
- The loss for RUs due to not providing the transport for the final customer (depending on applicant’s pricing policy– each applicant can calculate it individually) can be calculated according to the example of the major German RU from BC Study 2, taking the 188 cancelled trains for the customers reflecting MEUR 3.8 of loss. Hence, the 103 wasted PaPs seen as cancelled trains reflect the loss of approx. **MEUR 2** for the 3 railway companies.
- The loss for IMs by not billing the track access charge for the unused capacity (IMs may get back the capacity, upon the decision by the RFC Managing Board, 30 days before the first operational day and may sell it on demand – therefore the calculation represents the worst case for not using the capacity). Taking the example from DB Group given in BC Study 2, with loss for the IM of not billing the 275 train paths amounts to approximately EUR 415,000. Taking this factor for the 103 wasted PaPs, the loss would amount to approximately **EUR 156,000** for infrastructure charges only.

Therefore, the BC-Team recommends the implementation of the new TTR approach. The new approach should work in the “Just in Time” manner (Rolling Planning) as the Use Cases for freight traffic indicate (provided in the annex of full version TTR BC-V3.0). For this purpose, the new approach envisages a careful investigation in order to form a capacity model, the careful calculation of the capacity partitioning, intelligent management for capacity management at the request time and finally, the harmonisation of the pre-planned products and capacity bands of the IMs on the international / interoperable level.

The following measures offered by the new TTR concept should help avoiding the loss indicated in this study:

- Daily possibility of request (just-in-time): no need for “empty” requests of PaPs on just one day in the year (X-8 – second Monday in April). With this approach, the RU/Applicants come closer to customer needs as indicated in the Annex 2 Use Cases of full version TTR BC-V3.0.
- Daily update of the capacity: less possibility for wasted capacity. According to the assumption 8, the daily capacity management increases the available capacity from 10% to 15% without physical building of the infrastructure.
- The safeguarding of capacity is recommended in the Preparatory Study[34] commissioned by EC for impact assessment of the rail network: securing that the capacity reserved for the purpose of freight should not be jeopardised
- Harmonisation of the capacity bands and slots between the IMs will help avoid the main reason for rejection of the PaP allocation by the RUs/applicants – the low quality and non-harmonised paths.

Applying the measures of the new TTR process would help avoiding the loss indicated in the study.

Passenger traffic

It is not only the rolling planning approach that needs the capacity safeguarding, it is also the Annual Timetable request method. According to the new approach for ATT requests and offers, the draft offer should already be provided at X-6.5. Thus, the sales of the tickets for the passengers can be started 6 months before the timetable change. This would create the competitive advantage to the other modes of passenger transports.

One of the TTR project stakeholders, ÖBB Personenverkehr (Austrian State Railways, Department for Passenger Traffic) has already opened the ticket sales six months before the timetable change date. The train ticket sales significantly increased compared to the period before this processual step had been introduced, according to the report submitted to the management team of the TTR project. Due to the ÖBB corporate data protection guidelines, the quantitative data could not be delivered, but ÖBB is ready to confirm this statement. The current risk, taken into account by ÖBB is that there might be some instabilities of the timetable due to works and possessions. In that case, the customers would be informed, and the refund is offered.

However, the new TTR approach minimizes this risk. TTR envisages that the draft offer at X-6.5 is already stable and takes into account all major and medium TCRs (Temporary Capacity Restrictions, i.e. works and possessions). The implementation of the complete TTR approach (safeguarding capacity, coordinated TCRs) would guarantee the stability of the timetables provided to the end-customers, i.e. passengers.

6.1.4. BC-Study 4 (TTR support EU policy)

6.1.4.1 Impact assessment

Before launching legislative initiatives, the EC carries out impact assessments that constitute a useful source for the Business Case at hand.

The Preparatory Study for the impact assessment of a freight railway network supposed measures for a "smooth and efficient path allocation process for international freight trains". Together with the possibility for non-RU to apply for train paths, the Study expected a positive influence on commercial speed and line capacity. The activities stipulated to achieve the objective show a remarkable similarity to the TTR project. They include[4]

- **reserve a pre-defined amount of good paths after having carried out a needs assessment by way of a market study;**
  → this corresponds to BC-Study 3 i.e. "Capacity Safeguarding" as proposed by TTR, D4 from Benefits Map
- **set up a catalogue of good ad hoc paths;**
  → this corresponds to BC-Study 3 i.e. "Capacity Safeguarding" as proposed by TTR, D4 from Benefits Map
- **it will not be possible for IM to cancel paths for freight to serve passenger traffic;**
  → this corresponds to BC Study 3, i.e "Capacity Safeguarding" as proposed by TTR, D4 from Benefits Map
- **revise timetabling procedure so that requests for freight paths can be better satisfied;**
  → this corresponds to BC Study 1, D2 and D3 from Benefits Map
- **propose differentiated paths in terms of quality, i.e. in terms of journey time and/or risk of delay and attach commitments, for both contractors (operator and IM), to these different quality levels;**
  → this corresponds to BC Study 2 and 3, D1, D2, D3 and D4 from Benefits Map
- **set up procedures and processes to ensure the consistency of the capacity distributed to freight applicants for cross-border trains composed by paths from different IM.**
  → this corresponds to BC Study 2 and 3, D1, D2 and D4 from Benefits Map

The study expects an increase of freight train paths and therewith, an increase in **freight tkm** of **10 %** as compared to the Baseline Scenario by improved path allocation rules. This equals an increase of freight traffic

[4] PriceWaterhouseCoopers – NEA, Preparatory study for an impact assessment for a rail network giving priority to freight – Final Report (commissioned by European Commission - Directorate General Energy And Transport), 11.11.2008, http://ec.europa.eu/transport/sites/transport/files/modes/rail/studies/doc/2008_11_ia_rapport_final_pwc.pdf, p. 26-27.

on the main corridors and the ERIM network (European Rail Infrastructure Masterplan) of **41,008 million tkm** per year[5].

The study expects benefits between **BEUR 5 and 12** when all measures proposed for the rail freight corridors are implemented[6].

The relation between heavy duty road vehicles and freight trains with electric traction is calculated with the **factor five**. In total, road transport caused 93 % of total EU external cost of transportation (BEUR 314 p.a. in 2008, excluding congestion), **rail transport 2 %** (BEUR 10 p.a. in 2008)[7]. The low and sinking modal share of railways translates directly into higher external cost of transportation in the EU.

The first TTR Business Case used input parameters from a 2016 SCI Verkehr study on the European rail freight transport market. The main parameters taken over are [8]

- 18 % modal share of rail freight
- MEUR 17,500 market volume of rail freight transport
- 440 billion tkm transport performance
- 51 % share of international transport

Mode of transportation	1,000 tkm	Modal share
Road	1,725,000,000	71.9 %
Rail	411,000,000	17.1 %
Inland waterways	151,000,000	6.3 %
Pipelines	113,000,000	4.7 %
Total	2,400,000,000	100.0 %

Table 6 Freight transport in the EU 2014 (land transport only, in 1,000 tkm)

A hypothetical shift of **one percentage point of modal share** on the basis of current EU statistical data, i.e. 24,000,000 x 1,000 tkm, from road freight to freight rail would therefore induce the following changes of external cost of transportation in the EU (prices 2011, see above, excluding congestion cost):

Road freight external cost: 24,000,000 x	EUR 50.5 =	EUR 1,212,000,000
Rail freight external cost: 24,000,000 x	EUR 7.9 =	EUR 189,600,000
Difference:		EUR 1,022,400,000
		i.e. ca. BEUR 1

[5] PriceWaterhouseCoopers – NEA, Preparatory study for an impact assessment for a rail network giving priority to freight – Final Report (commissioned by European Commission - Directorate General Energy And Transport), 11.11.2008, http://ec.europa.eu/transport/sites/transport/files/modes/rail/studies/doc/2008_11_ia_rapport_final_pwc.pdf, p. 85-86.

[6] PriceWaterhouseCoopers – NEA, Preparatory study for an impact assessment for a rail network giving priority to freight – Final Report (commissioned by European Commission - Directorate General Energy And Transport), 11.11.2008, http://ec.europa.eu/transport/sites/transport/files/modes/rail/studies/doc/2008_11_ia_rapport_final_pwc.pdf, p. 123.

[7] Van Esse, Huib et al., External Costs of Transport in Europe – Update Study for 2008, Delft, September 2011, http://ecocalc-test.ecotransit.org/CE_Delft_4215_External_Costs_of_Transport_in_Europe_def.pdf, p. 78.

[8] SCI Verkehr GmbH, European Rail Freight Transport Market - Developments – Volumes – Players, Berlin 2016 https://www.sci.de/uploads/tx_edocuments/Flyer_MC_Rail_Freight_Transport.pdf, p. 5.

The preparatory study for the impact assessment of a freight railway network estimates congestion costs per tkm for a lorry at EUR 2.17; for a freight train at EUR 0.01 (2007)[9]. With the above shift of 24 billion tkm from road to rail, this would result in a reduction of EU congestion costs by **BEUR 53**!

Road freight external cost:	24,000,000 x EUR 50.50 =	EUR 1,212,000,000
	24,000,000,000 x EUR 2.17 =	EUR 52,080,000,000
Rail freight external cost:	24,000,000 x EUR 7.90 =	EUR 189,600,000
	24,000,000,000 x EUR 0.01 =	EUR 240,000,000
Difference:		EUR 52,862,400,000
		i.e. ca. BEUR 53

The marginal cost estimate for freight rail congestion as contained in the Marco Polo calculator is EUR 0.2 per 1000 tkm (average for EU27, in 2011 prices). The average is calculated by assuming equal freight rail congestion costs in most EU countries at the level of EUR 0.1 per 1000 tkm. For Italy, the estimated unit cost is EUR 0.25, for Germany and France EUR 0.4, and for Belgium and the Netherlands EUR 0.5[10].

6.1.4.2 Theoretical European Capacity

The assumed modal shift of 1% means additional 4.4 Billion tkm per year. The question arises; Is the European Rail Capacity sufficient to take over those volumes?

For calculation of network capacity several theoretical approaches have been developed. Commonly used is the so-call Timetable compressing approach according to UIC Leaflet 406. In this approach several parameters (line characteristics – gradients, signals, block lengths, etc. and vehicle characteristics – speed, acceleration, etc.) are taken in consideration to prepare a timetable which is compressed to show the utilisation rate of a current line and express the theoretical capacity.

The capacity calculation is a complex topic and depends on many factors. Therefore, no European Rail Capacity is available.

However, in order to cross-check the possibility of a modal shift of 1% following estimates have been taken into consideration.

Between 2004-2007 the ERIM project carried out a study including a database which covers:

- Current and planned 2020 infrastructure provision (including detailed investment plans).
- Estimations on current and 2020 traffic volumes
- Estimations on current and 2020 capacity utilisation

The working hypothesis has been applied to the entire ERIM network suggesting that 32% (16 000 route km) of the ERIM network will potentially be capacity constrained in 2020, even taken into account the expected productivity gains and the currently planned infrastructure investments increasing theoretical capacity. The results of this approach are shown in the following table.

[9] PriceWaterhouseCoopers – NEA, Preparatory study for an impact assessment for a rail network giving priority to freight – Final Report (commissioned by European Commission - Directorate General Energy And Transport), 11.11.2008, http://ec.europa.eu/transport/sites/transport/files/modes/rail/studies/doc/2008_11_ia_rapport_final_pwc.pdf, p. 113.

[10] Gibson, Gena et al. (2014), Update of the Handbook on External Costs of Transport – Final Report, Ricardo AEA, commissioned by the European Commission: DG MOVE, 08.01.2014, http://ec.europa.eu/transport/sites/transport/files/themes/sustainable/studies/doc/2014-handbook-external-costs-transport.pdf, p. 17.

Degree of utilisation (u)	%	km
u<70%	68	35 330
70% ≤ u < 85%	14	7 089
u ≥ 85%	18	9 254

© UIC 2009, Source: ERIM Database

Table 7 Degree of utilization of ERIM network

Based on these results, an additional working hypothesis to estimate the amount of capacity constrained line sections has been applied in the ERIM Investment Analysis. This additional analysis having very positive assumptions indicates that total route-length of the capacity constrained line sections would be as low as 3,000 km. Probably the plausible projection of the capacity constrained line sections is somewhere between the two Scenarios.

However, taking into account the above-mentioned figures, the estimation may be based on the degree of utilisation of the total European capacity presented in the ERIM database and assuming a direct link between utilisation, network length and transported tkm.

km	Degree of utilisation (u) acc. To UIC 2009	Degree of utilisation (u) acc. To BC-Team	Utilised km
35,330	<70%	60%	21,198
7,089	70% - 85%	80%	5,671
9,254	>85%	95%	8,791
51,673		Total	35,661

Table 8 Calculation of utilised km

Based on conservative assumptions such as a utilisation of 35,661 km (average = 70%) currently used to transport 440 Billion tkm, upscaled to 100% utilisation, the network shall be able to transport approximately 637 Billion tkm.

This approach can be considered as quite hypothetical but it shows that a shift of 4.4 Billion tkm shall be feasible. It also takes into account that the network is able to serve the European passenger transport with 475.3 Billion[11] pkm.

7. The Benefits and Cost Model

The following chapter describes the cost estimates and modelling in more detail.

7.1. Important assumptions and expectations

Assumptions and expectations taken in Business Case calculations are the following:

No.	Item	Effort/Cost/ Benefit	Description	Source
1	Modal share of rail freight	18%		2016 SCI Verkehr study
2	Market volume of rail freight transport	BEUR 17,500		2016 SCI Verkehr study

[11] http://www.uic.org/IMG/pdf/synopsis_2014.pdf - Europe incl. Turkey

3	tkm transport performance 2015	440 billion tkm		2016 SCI Verkehr study
4	tkm transport performance 2014	569.6 billion tkm	Incl. Turkey	http://www.uic.org/IMG/pdf/synopsis_2014.pdf
5	pkm 2014 in Europe	475.3 billion pkm	Incl. Turkey	http://www.uic.org/IMG/pdf/synopsis_2014.pdf
6	congestion costs per tkm for a lorry	EUR 2.17		PriceWaterhouseCoopers – NEA, Preparatory study for an impact assessment for a rail network giving priority to freight – Final Report (commissioned by European Commission - Directorate General Energy And Transport), 11.11.2008,
7	congestion costs per tkm for a freight train	EUR 0.01		PriceWaterhouseCoopers – NEA, Preparatory study for an impact assessment for a rail network giving priority to freight – Final Report (commissioned by European Commission - Directorate General Energy And Transport), 11.11.2008,
8	optimization of the infrastructure capacity	+ 10% Theoretical (Effective 30% of 10 %)	Could be provided if the change from the "one day in the year" based request method for train path to daily request and planning (the idea of "rolling horizon", i.e. the same idea as the concept of Rolling Planning described above) is utilised. This Important assumption is based on the research results of some of the TTR project stakeholders. The research was provided independently from the TTR project with the aim of railway capacity optimisation. The operational research[12] of Trafikverket (Swedish Ministry of Transport, Department for Railway Traffic, Infrastructure Manager) together with the Swedish ICT (SICS – Swedish state research institute of ICT) showed that the change from the "one day in the year" based request method for train path to daily request and planning provides an optimisation[13] of the infrastructure up to 15%. The similar idea of daily optimisation of the infrastructure was investigated by DB Netz (German Infrastructure Manager). The research[14] showed that the railway infrastructure capacity can be optimised around 10% if the daily capacity optimisation process is applied. **Therefore,**	http://link.springer.com/chapter/10.1007%2F978-3-319-28697-6_20. (Research supported by DB Netz) Research Insitutes of Sweden (ICT/SICS): Technical Report T2017:01 http://soda.swedishict.se/5852 (Research supported by Trafikverket

[12] http://soda.swedishict.se/5852 (Gestrelius, Sara and Bohlin, Markus and Aronsson, Martin (2015) On the uniqueness of operation days and delivery commitment generation for train timetables. In: 6th International Conference on Railway Operations Modelling and Analysis (RailTokyo2015), 23-16 March 2015, Tokyo, Japan.)

[13] Research Institutes of Sweden (ICT/SICS): Technical Report T2017:01 (Full paper available in BC Inventory)

[14] http://link.springer.com/chapter/10.1007%2F978-3-319-28697-6_20. (Feil M., Pöhle D. (2016) Why Does a Railway Infrastructure Company Need an Optimized Train Path Assignment for Industrialized Timetabling?. In: Lübbecke M., Koster A., Letmathe P., Madlener R., Peis B., Walther G. (eds) Operations Research Proceedings 2014. Operations Research Proceedings (GOR (Gesellschaft für Operations Research e.V.)). Springer, Cham)

			the assumption is that the introduction of Rolling Planning, due to its daily request / offer / capacity management procedure may provide more available capacity of 10% compared to today's railway capacity availability – without investing in building new infrastructure (!).	
9	Working hour of human resources (RU/IM)	1h		BC-Team estimation
10	Human Resources cost/hour (RU/IM)	EUR 50	The assumption of the average cost of the labour in the TT planning across EU.	BC-Team estimation
11	Path request effort per applicant	4h	Effort of putting the path request data together – minimal optimistic estimation based on experience of TT planners. No communication time with customers or IMs is included here.	BC-Team estimation
12	Effort per application	EUR 200	4hx EUR 50	Calculation
13	Cost for path request processing (1 RU – 1 IM)	EUR 550	4h for request for RU, 4 h for offer for IM, 1.5h for acceptance for RU, 1.5h for allocation for IM (minimal, optimistic estimation)	Calculation
14	Path offer effort for IM	4h	Effort of constructing the path based on "clean" data – minimal optimistic estimation based on experience of TT planners. No communication time with customers is included here.	BC-Team estimation
15	Path offer acceptance for RU	1.5h	Effort of the validation of the offer to the particular request – clean case, minimal optimistic estimation	BC-Team estimation
16	Effort for change of the existing request or path	¼ of the effort for the request (i.e. 25%)	Linear approximation of the effort for the change of the request or the allocated path. The value is chosen based on the combination of the experience values of TT planning experts and the logarithmic formula applied in the operational research (semi-elasticity[15]).	BC-Team estimation combined with operational research findings[36].
17	Cost of change of the existing request or path	EUR 137.50	EUR 550 * 0.25	Calculation
18	Effort for preparation of one PaP by IM	40h	Work of the IM TT planner to produce pre-arranged path	BC-Team estimation
19	Total effort for preparation and publication of one PaP	120h	On average, 3 IMs work on one published PaP for RFC. The value is based on experiences from TT planners, however, they can vary from corridor to corridor, depending on the network complexity and congestions.	BC-Team estimation
20	Cost for PaP production	EUR 6,000	120h* EUR 50	Calculation
21	Number of train runs coordinated through PCS in TT year	1,460,000	The PCS system nowadays carries approximately 4000 x 365 train paths of the cross-border traffic of both passenger and freight (commuter trains excluded).	Calculation
22	Cost of PCS dossier	EUR 111	PCS reports given in the BC Inventory contain in average 4000 dossiers per TT year. The cost calculation is based on the RNE Annual Report (Financials)[16]	Calculation

Table 9 Key Assumptions

[15] Sydsaeter, Knut; Hammond, Peter (1995). *Mathematics for Economic Analysis*. Englewood Cliffs, NJ: Prentice Hall. pp. 173–175. ISBN 013583600X.

[16] Sydsaeter, Knut; Hammond, Peter (1995). *Mathematics for Economic Analysis*. Englewood Cliffs, NJ: Prentice Hall. pp. 173–175. ISBN 013583600X.

7.2. The Cost Benefit Model

Since Scenario 0 (Business as Usual) figures are not available, all benefits and cost are to be defined as additional benefits and cost. The current cost is not taken in consideration.

In other words:

- All Business as Usual cost that cannot be avoided by applying “Implement new TTR process” are not mentioned in none of Scenarios;
- All “Business as Usual” cost that do not arise anymore in Scenario 1 “Implement new TTR process” are calculated as benefits;

For the calculation, the table is structured as a cash flow statement.

- Cash inflows are positive numbers, while
- Cash outflows are negative numbers.

The analysis starts on 1.1.2019 and ends on 31.12.2034.

Discounted Cash Flow (DCF) and Net Present Value (NPV) are based on annual cash flow figures, discounted with end-of-year discounting.

Return on Investment (ROI) is calculated as:

- ROI = (Last_Year_Gain – Last_Year_Cost) / Last_Year_Cost

Payback Period is determined as the time in years at which cumulative cash flow first becomes 0.

The Benefits and Cost model which is used to present benefits and cost, divides benefits in BC-Study areas, and fragmented in Project and Change Management Benefits and Cost, and Operation cost.

<table>
<tr><th rowspan="2"></th><th colspan="2">Project and Change Management Benefits and Costs</th><th colspan="2">Operations cost</th></tr>
<tr><th>Benefits</th><th>Costs</th><th>Benefits</th><th>Costs</th></tr>
<tr><td>BC-Study 1</td><td rowspan="4"></td><td rowspan="4">IT infrastructure cost*
○ Investment (Cloud)
○ Maintenance

Software procurement - Development
○ D1: Capacity Needs Announcements
○ D2: Train Harmonization
○ D3: Path Request Management
○ D4: Messaging Module
○ D5: TCR
○ D6: Capacity Broker</td><td>• Better resource utilisation for req. Process
• capacity increase</td><td rowspan="4">• Central System: IT maintenance& development
• Stakeholder Internal Cost: IT change management, internal process modification, staff training</td></tr>
<tr><td>BC-Study 2</td><td>• Decreased loss due to uncoordinated TCRs</td></tr>
<tr><td>BC-Study 3</td><td>• Loss on effort of IMs to produce PAPs</td></tr>
<tr><td>BC-Study 4</td><td>• One percentage point of modal share (50%)
• Reduction of EU</td></tr>
</table>

		○ D7: Capacity Hub ○ D8: Path Management ○ Other software (GUI, BigData, Sales Module,etc)*	congestion costs (50%) • Creation of additional EU GDP of BEUR 49 (2015-2030) • Additional exports of up to BEUR 20 (2015-2030)	

Table 10 Timely overview of Benefits and Cost

7.3. Methods for Estimating Benefits and Costs values

The following tables present the calculation of benefit and cost items.

7.3.1. Benefits

Item	Calculation
BC-S1: Better resource utilisation for request process	Cost of changes / modifications based on the records of IMs given in the survey (actually, joint costs for RUs and IMs)
BC-S1: Capacity increase of 10% (Effective=30% of 10%)	10% capacity increase possible, 30% thereof usable, 3.425.000.000 train km EU x 139 SEK (= EUR 14.7)/km
BC-S2: Decreased loss due to uncoordinated TCRs	MEUR 4 losses DB → estimation 74,818,000,000 DB tkm x tkm Europe EU 261,054,000,000
BC-S3: Loss on effort of IMs to produce PAPs	40h/IM → in average 3 IMs per corridor/PaP → 120h/PaP x Resource costs EUR 50/h = EUR 6,000/PaP → 2,539 PaPs in TT 2017
BC-S4: One percentage point of modal share (50%)	(24,000,000,000 tkm x EUR 50.5/1,000 tkm Road External Cost) – (24,000,000,000 tkm x EUR 7.9 /1,000 tkm Rail External Cost) x 50%
BC-S4: Reduction of EU congestion costs (50%)	(24,000,000,000 tkm x EUR 2.17 Road Congestion cost) – (24,000,000,000 tkm x EUR 0.01 Rail Congestion cost) x 50%
BC-S4: Creation of additional EU GDP of 49 BEUR 2019-2034	BEUR 49 /16 years → only calculated after 2025
BC-S4: Additional exports of up to 20 BEUR 2019-2034	BEUR 20 /16 years → only calculated after 2025

Table 11 Benefits calculation

7.3.2. Cost

General Assumption for Cost Category A, B and C:

[A] Start date 2019
[A] Investment approach - not budget approach (Financing necessities, etc. shall not taken in consideration)
[A] Investments includes planning, software development, hardware, maintenance and licences
[A] Investments in IT-Systems which will be born even TTR will not be implemented (but are a prerequisit for TTR implementation) will not be calculated (e.g. TSI PCS compliant mandatory interfaces)

[A] Costs are estimated based on low-cost supplier and optimal system and process implementation (no major delays or modifications)
[A] RNE/FTE HR cost for project management, steering, etc. are included in system cost
[B] Cost for change management, internal process modification, staff training estimated (is carried forward from Business case 2017 since it could not be further specified)
[C] Railway-related research and innovation cost (C) are not taken in consideration

Specific Assumptions for Cost Category A

IT Hardware

Use of Cloud Services

1000€ per Virtual Machine (VM) for creation and later for maintenance + 5 % price increase/anno

Hardware, licences and utilities are included in the service price. The service price include:

- Hardware (50% of IT Infrastructure cost)
- Licences (25% of IT Infrastructure cost)
- Utilities (25% of IT Infrastructure cost)

After the deliveries of the second phase, 2 new VMs per year are estimates (means one application environment)

Software

Investment cost	35% for planning and requirements engineering 65% for development and testing
Maintanance	20% of total implementation costs per year + progressive 5% adding to the further yearly investment for the new functions and adaptations to the additional requirements to come.

	Planning	Development	Total Investment	Maintenance
D1: Capacity Needs Announcements	(70,0)	(130,0)	(200,0)	(40,0)
D2: Train Harmonization	(175,0)	(325,0)	(500,0)	(100,0)
D3: Path Request Management	(175,0)	(325,0)	(500,0)	(100,0)
D4: Messaging Module	(70,0)	(130,0)	(200,0)	(40,0)
D5: TCR	(91,0)	(169,0)	(260,0)	(52,0)
D6: Capacity Broker	(105,0)	(195,0)	(300,0)	(60,0)
D7: Capacity Hub	(101,5)	(188,5)	(290,0)	(58,0)
D8: Path Management	(770,0)	(1.430,0)	(2.200,0)	(440,0)
Other software (GUI, BigData, Sales Module,etc)*	(192,5)	(357,5)	(550,0)	(110,0)

Investment allocation between FTE and RNE

Costs (in 1.000€) for RUs (via FTE) for the central system including maintenance until 2030

Hardware and licences (assumption is 50% of total costs)	
Capacity Needs Announcements	
Train Harmonization	(1.452,6)

Path Request Management	(1.452,6)
Messaging module (assumption is 50% of total costs)	(283,1)
Total cost of central system until 2030	**(3.188,3)**

Costs (in 1.000€) for IMs (via RNE) for the central system including maintenance until 2030	
Hardware and licences (assumption is 50% of total costs)	(24,2)
TCR	(695,3)
Capacity Broker	(798,6)
Capacity Hub	(732,0)
Path Management	(5.406,5)
Other	(1.464,1)
Messaging module (assumption is 50% of total costs)	(283,1)
Total cost of central system until 2030	**(9.403,8)**

Specific Assumptions for Cost Category B
5 Major RUs invest in respective interfaces
20 European IMs invest in respective interfaces
Cost are mirrored on centralised system

*a survey in respect to potential implementation cost along the members of RNE and FTE did not supply usable indication for cost estimate

8. Business Impact

8.1. Financial impact TTR Scenario

Based on assumptions provided under Chapter 8 and the Cost Benefit Model described in Chapter 10 the following financial impacts can be calculated.

For analysing the following financial impact calculation table, the following notes are taken into consideration:

- The analysis started on 1.1.2019 and shall end on 31.12.2034.
- The analysis focuses on the European rail sector and the long-term strategic outcome.

Since developments towards TAF/TAP TSI for better coordination and harmonisation are already under way (RNE projects since 2008 – PCS, TCR Excel, TIS, …) the potential benefits shall start earlier than calculated. However, to be on a conservative side the BC-Team estimated the full roll-out of the TTR system including connections to national systems in 2025 which shall give the full potential benefits but additionally the study team included an increasing capitalisation rate of those benefits start with 10% in 2025 and reaching 100% in 2030.

- Additionally, the BC-Team took only 50% of the external benefits into consideration.
- Cost for change process (HR) and national adjustment on IM and RU side can hardly be estimated but was included based on TTR Business Case 2017, with a relatively high amount (96Mio/year 2021-2026).

» Railway-related research and innovation cost (C) are not taken in consideration since they will be issued anyway with our without TTR project

Analysis

- Negative Cash flow from 2019-2024 (between MEUR 0,6 and MEUR 16/year)
- Positive Cash flow after 2025 (Average: BEUR 24/year)
- **Break-even point in 2025**
- Total investment cost MEUR 949
- Total discounted benefits BEUR 128
- **Return on Investment = 346,7 times the investment**

Table 12 Financial impact calculation table – TTR Scenario

€ in 1000s	YTD 31 Dez 2019	Yr 2 ending 31 Dez 2020	Yr 3 ending 31 Dez 2021	Yr 4 ending 31 Dez 2022	Yr 5 ending 31 Dez 2023	Yr 6 ending 31 Dez 2024	Yr 7 ending 31 Dez 2025	Yr 8 ending 31 Dez 2026	Yr 9 ending 31 Dez 2027	Yr 10 ending 31 Dez 2028	Yr 11 ending 31 Dez 2029	Yr 12 ending 31 Dez 2030	Yr 13 ending 31 Dez 2031	Yr 14 ending 31 Dez 2032	Yr 15 ending 31 Dez 2033	Yr 16 ending 31 Dez 2034	TOTAL
BENEFITS / GAINS																	
Cash inflows																	
BC-S1: Better resource utilization for req. process	0	0	0	0	0	0	42.607	42.607	42.607	42.607	42.607	42.607	42.607	42.607	42.607	42.607	426.070
BC-S1: Capacity increase of 15% (Effective=30% of 15%)	0	0	0	0	0	0	2.265.637	2.265.637	2.265.637	2.265.637	2.265.637	2.265.637	2.265.637	2.265.637	2.265.637	2.265.637	22.656.375
BC-S2: Decreased loss due to uncoordinated TCRs	0	0	0	0	0	0	13.957	13.957	13.957	13.957	13.957	13.957	13.957	13.957	13.957	13.957	139.567
BC-S3: Loss on effort of IMs to produce PAPs	0	0	0	0	0	0	15.234	15.234	15.234	15.234	15.234	15.234	15.234	15.234	15.234	15.234	152.340
BC-S4: One percentage point of modal share (50%)	0	0	0	0	0	0	511.200	511.200	511.200	511.200	511.200	511.200	511.200	511.200	511.200	511.200	5.112.000
BC-S4: Reduction of EU congestion costs (50%)	0	0	0	0	0	0	25.920.000	25.920.000	25.920.000	25.920.000	25.920.000	25.920.000	25.920.000	25.920.000	25.920.000	25.920.000	259.200.000
BC-S4: Creation of additional EU GDP of 49 BEUR 2015-2030	0	0	0	0	0	0	3.062.500	3.062.500	3.062.500	3.062.500	3.062.500	3.062.500	3.062.500	3.062.500	3.062.500	3.062.500	30.625.000
BC-S4: Additional exports of up to 20 BEUR 2015-2030	0	0	0	0	0	0	1.250.000	1.250.000	1.250.000	1.250.000	1.250.000	1.250.000	1.250.000	1.250.000	1.250.000	1.250.000	12.500.000
Total Benefits/Gains	0	0	0	0	0	0	33.081.135	33.081.135	33.081.135	33.081.135	33.081.135	33.081.135	33.081.135	33.081.135	33.081.135	33.081.135	330.811.352
Capitalisation rate							**10%**	**20%**	**40%**	**60%**	**80%**	**100%**	**100%**	**100%**	**100%**	**100%**	
COSTS																	
Cash outflows																	
IT infrastructure cost*																	
Investment (Cloud)			-6	-15	-9	-2	-2	-3	-3	-3	-3	-3					-48
Maintenance			0	-6	-21	-30	-32	-35	-37	-40	-43	-46	-48	-50	-53	-55	-495
Software procurement - Development																	0
D1: Capacity Needs Announcements	0	-100	-100	-40	-40	-40	-40	-40	-42	-44	-46	-49	-51	-54	-56	-59	-801
D2: Train Harmonization	0	-250	-250	-100	-100	-100	-100	-100	-105	-110	-116	-122	-128	-134	-141	-148	-2.003
D3: Path Request Management	0	-250	-250	-100	-100	-100	-100	-100	-105	-110	-116	-122	-128	-134	-141	-148	-2.003
D4: Messaging Module	-100	-50	-50	-40	-50	-50	-50	-50	-53	-55	-58	-61	-64	-67	-70	-74	-941
D5: TCR	-60	-100	-100	-52	-52	-52	-52	-52	-55	-57	-60	-63	-66	-70	-73	-77	-1.041
D6: Capacity Broker	0	0	-100	-200	-60	-60	-60	-60	-60	-63	-66	-69	-73	-77	-80	-84	-1.113
D7: Capacity Hub	-40	-50	-100	-100	-58	-58	-58	-58	-58	-61	-64	-67	-70	-74	-78	-82	-1.076
D8: Path Management	-450	-450	-650	-650	-440	-440	-440	-440	-440	-462	-485	-509	-535	-562	-590	-619	-8.162
Other software (GUI, BigData, Sales Module,etc)*	0	-150	-200	-200	-110	-110	-110	-110	-110	-116	-121	-127	-134	-140	-147	-155	-2.040
																	0
																	0
Total Cost Category A	-650	-1.400	-1.806	-1.503	-1.040	-1.042	-1.045	-1.047	-1.067	-1.121	-1.178	-1.238	-1.296	-1.361	-1.429	-1.501	-19.723
Stakeholder internal Costs [B]																	
RU - Implementation (5 RUs)		-250	-3.125	-3.125	-1.300	-1.325	-1.325	-1.325	-1.325	-1.391	-1.461	-1.534	-1.611	-1.691	-1.776	-1.864	-24.428
IM - Implementation (20 IMs)		-12.000	-15.500	-23.500	-24.440	-14.900	-14.900	-14.900	-14.900	-14.977	-15.726	-16.512	-17.338	-18.205	-19.115	-20.071	-256.983
Costs Item HR RU (estimates) --> Training/Process changes .....€	0	0	-42.000	-42.000	-42.000	-42.000	-42.000	-42.000	-42.000								-294.000
Cost item HR IM (estimates) --> Training/Process changes .....€	0	0	-54.000	-54.000	-54.000	-54.000	-54.000	-54.000	-54.000								-378.000
Total Cost Category B	0	-12.000	-111.500	-119.500	-120.440	-110.900	-110.900	-110.900	-110.900	-14.977	-15.726	-16.512	-17.338	-18.205	-19.115	-20.071	-928.983
Railway-related research and innovation cost [C]																	
							0	0	0	0	0	0	0	0	0	0	0
Total Cost Category C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Costs	-650	-13.400	-113.306	-121.003	-121.480	-111.942	-111.945	-111.947	-111.967	-16.098	-16.904	-17.750	-18.634	-19.566	-20.544	-21.571	-948.706
CASH FLOW SUMMARY																	
Cash inflows (outflows)																	
Benefits.....	0	0	0	0	0	0	3.374.276	6.748.552	13.497.103	20.245.655	26.994.206	33.742.758	33.742.758	33.742.758	33.742.758	33.742.758	330.811.352
Costs.....	-650	-13.400	-113.306	-121.003	-121.480	-111.942	-111.945	-111.947	-111.967	-16.098	-16.904	-17.750	-18.634	-19.566	-20.544	-21.571	-948.706
NET CASH FLOW.....	**-650**	**-13.400**	**-113.306**	**-121.003**	**-121.480**	**-111.942**	**3.262.331**	**6.636.604**	**13.385.136**	**20.229.557**	**26.977.303**	**33.725.008**	**33.724.124**	**33.723.192**	**33.722.214**	**33.721.187**	**329.862.646**
Cumulative net cash flow.....	-650	-14.050	-127.356	-248.359	-369.839	-481.781	2.780.550	9.417.155	22.802.291	43.031.848	70.009.150	103.734.158	137.458.282	171.181.475	204.903.688	238.624.875	
Discounted cash flow at 5,0%.....	-619	-12.154	-97.878	-99.549	-95.183	-83.533	2.318.478	4.491.915	8.628.178	12.419.193	15.773.070	18.779.346	17.884.623	17.032.504	16.220.961	15.448.064	128.607.417

*Experts estimation - RNE CIO, RNE IT Working Group

ROI= 346,7

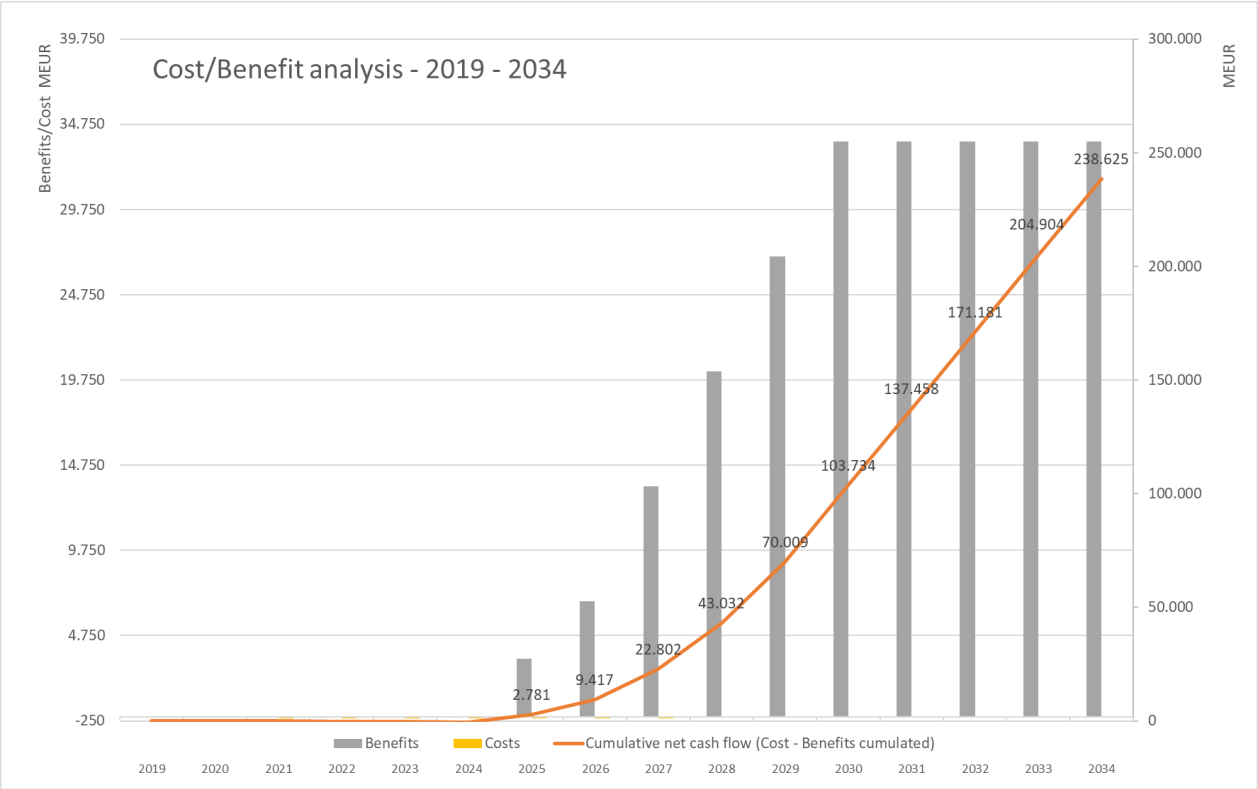


Figure 10 Graph Cashflow – Financial calculation – TTR Scenario

8.2. Financial impact IM/RU TTR Sub Scenario

The IM/RU TTR Sub Scenario focus only on direct benefits of the IM/RU and does not consider the European perspective. This means the benefits of chapter 11.1 were reduced by:

» Reduction of EU congestion cost (BEUR 0)
» Additional EU DGP (BEUR 0)
» Additional exports (BEUR 0)

Analysis

- Negative Cash flow from 2019-2024
- Positive Cash flow after 2026 (MEUR 166)
- **Break-even point in 2025**
- Total investment cost MEUR 949
- Total discounted benefits BEUR 10,5
- **Return on Investment = 28 times the investment**

€ in 1000s	YTD 31 Dez 2019	Yr 2 ending 31 Dez 2020	Yr 3 ending 31 Dez 2021	Yr 4 ending 31 Dez 2022	Yr 5 ending 31 Dez 2023	Yr 6 ending 31 Dez 2024	Yr 7 ending 31 Dez 2025	Yr 8 ending 31 Dez 2026	Yr 9 ending 31 Dez 2027	Yr 10 ending 31 Dez 2028	Yr 11 ending 31 Dez 2029	Yr 12 ending 31 Dez 2030	Yr 13 ending 31 Dez 2031	Yr 14 ending 31 Dez 2032	Yr 15 ending 31 Dez 2033	Yr 16 ending 31 Dez 2034	TOTAL
BENEFITS / GAINS																	
Cash inflows																	
BC-S1: Better resource utilization for req. process	0	0	0	0	0	0	42.607	42.607	42.607	42.607	42.607	42.607	42.607	42.607	42.607	42.607	426.070
BC-S1: Capacity increase of 15% (Effective=30% of 15%)	0	0	0	0	0	0	2.265.637	2.265.637	2.265.637	2.265.637	2.265.637	2.265.637	2.265.637	2.265.637	2.265.637	2.265.637	22.656.375
BC-S2: Decreased loss due to uncoordinated TCRs	0	0	0	0	0	0	13.957	13.957	13.957	13.957	13.957	13.957	13.957	13.957	13.957	13.957	139.567
BC-S3: Loss on effort of IMs to produce PAPs	0	0	0	0	0	0	15.234	15.234	15.234	15.234	15.234	15.234	15.234	15.234	15.234	15.234	152.340
BC-S4: One percentage point of modal share (50%)	0	0	0	0	0	0	511.200	511.200	511.200	511.200	511.200	511.200	511.200	511.200	511.200	511.200	5.112.000
BC-S4: Reduction of EU congestion costs (50%)	0	0	0	0	0	0											0
BC-S4: Creation of additional EU GDP of 49 BEUR 2015-2030	0	0	0	0	0	0											0
BC-S4: Additional exports of up to 20 BEUR 2015-2030	0	0	0	0	0	0											0
Total Benefits/Gains	0	0	0	0	0	0	2.848.635	2.848.635	2.848.635	2.848.635	2.848.635	2.848.635	2.848.635	2.848.635	2.848.635	2.848.635	28.486.352
Capitalisation rate							**10%**	**20%**	**40%**	**60%**	**80%**	**100%**	**100%**	**100%**	**100%**	**100%**	
COSTS																	
Cash outflows																	
IT infrastructure cost*																	
Investment (Cloud)			-6	-15	-9	-2	-2	-3	-3	-3	-3	-3					-48
Maintenance			0	-6	-21	-30	-32	-35	-37	-40	-43	-46	-48	-50	-53	-55	-495
Software procurement - Development																	0
D1: Capacity Needs Announcements	0	-100	-100	-40	-40	-40	-40	-40	-42	-44	-46	-49	-51	-54	-56	-59	-801
D2: Train Harmonization	0	-250	-250	-100	-100	-100	-100	-100	-105	-110	-116	-122	-128	-134	-141	-148	-2.003
D3: Path Request Management	0	-250	-250	-100	-100	-100	-100	-100	-105	-110	-116	-122	-128	-134	-141	-148	-2.003
D4: Messaging Module	-100	-50	-50	-40	-50	-50	-50	-50	-53	-55	-58	-61	-64	-67	-70	-74	-941
D5: TCR	-60	-100	-100	-52	-52	-52	-52	-52	-55	-57	-60	-63	-66	-70	-73	-77	-1.041
D6: Capacity Broker	0	0	-100	-200	-60	-60	-60	-60	-60	-63	-66	-69	-73	-77	-80	-84	-1.113
D7: Capacity Hub	-40	-50	-100	-100	-58	-58	-58	-58	-58	-61	-64	-67	-70	-74	-78	-82	-1.076
D8: Path Management	-450	-450	-650	-650	-440	-440	-440	-440	-440	-462	-485	-509	-535	-562	-590	-619	-8.162
Other software (GUI, BigData, Sales Module,etc)*	0	-150	-200	-200	-110	-110	-110	-110	-110	-116	-121	-127	-134	-140	-147	-155	-2.040
																	0
																	0
Total Cost Category A	-650	-1.400	-1.806	-1.503	-1.040	-1.042	-1.045	-1.047	-1.067	-1.121	-1.178	-1.238	-1.296	-1.361	-1.429	-1.501	-19.723
Stakeholder internal Costs [B]																	
RU - Implementation (5 RUs)		-250	-3.125	-3.125	-1.300	-1.325	-1.325	-1.325	-1.325	-1.391	-1.461	-1.534	-1.611	-1.691	-1.776	-1.864	-24.428
IM - Implementation (20 IMs)		-12.000	-15.500	-23.500	-24.440	-14.900	-14.900	-14.900	-14.900	-14.977	-15.726	-16.512	-17.338	-18.205	-19.115	-20.071	-256.983
Costs Item HR RU (estimates) --> Training/Process changes .....€	0	0	-42.000	-42.000	-42.000	-42.000	-42.000	-42.000	-42.000								-294.000
Cost item HR IM (estimates) --> Training/Process changes .....€	0	0	-54.000	-54.000	-54.000	-54.000	-54.000	-54.000	-54.000								-378.000
Total Cost Category B	0	-12.000	-111.500	-119.500	-120.440	-110.900	-110.900	-110.900	-110.900	-14.977	-15.726	-16.512	-17.338	-18.205	-19.115	-20.071	-928.983
Railway-related research and innovation cost [C]																	
							0	0	0	0	0	0	0	0	0	0	0
Total Cost Category C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Costs	-650	-13.400	-113.306	-121.003	-121.480	-111.942	-111.945	-111.947	-111.967	-16.098	-16.904	-17.750	-18.634	-19.566	-20.544	-21.571	-948.706
CASH FLOW SUMMARY																	
Cash inflows (outflows)																	
Benefits.....	0	0	0	0	0	0	290.561	581.122	1.162.243	1.743.365	2.324.486	2.905.608	2.905.608	2.905.608	2.905.608	2.905.608	28.486.352
Costs.....	-650	-13.400	-113.306	-121.003	-121.480	-111.942	-111.945	-111.947	-111.967	-16.098	-16.904	-17.750	-18.634	-19.566	-20.544	-21.571	-948.706
**NET CASH FLOW.....	**-650**	**-13.400**	**-113.306**	**-121.003**	**-121.480**	**-111.942**	**178.616**	**469.174**	**1.050.276**	**1.727.267**	**2.307.583**	**2.887.858**	**2.886.974**	**2.886.042**	**2.885.064**	**2.884.037**	**27.537.646**
Cumulative net cash flow.....	-650	-14.050	-127.356	-248.359	-369.839	-481.781	-303.165	166.010	1.216.286	2.943.553	5.251.135	8.138.993	11.025.967	13.912.010	16.797.073	19.681.110	
Discounted cash flow at 5,0%.....	-619	-12.154	-97.878	-99.549	-95.183	-83.533	126.939	317.556	677.017	1.060.392	1.349.196	1.608.067	1.531.024	1.457.647	1.387.765	1.321.210	10.447.898

*Experts estimation - RNE CIO, RNE IT Working Group

ROI= 28,0

Table 13 Financial impact calculation table – IM/RU Scenario

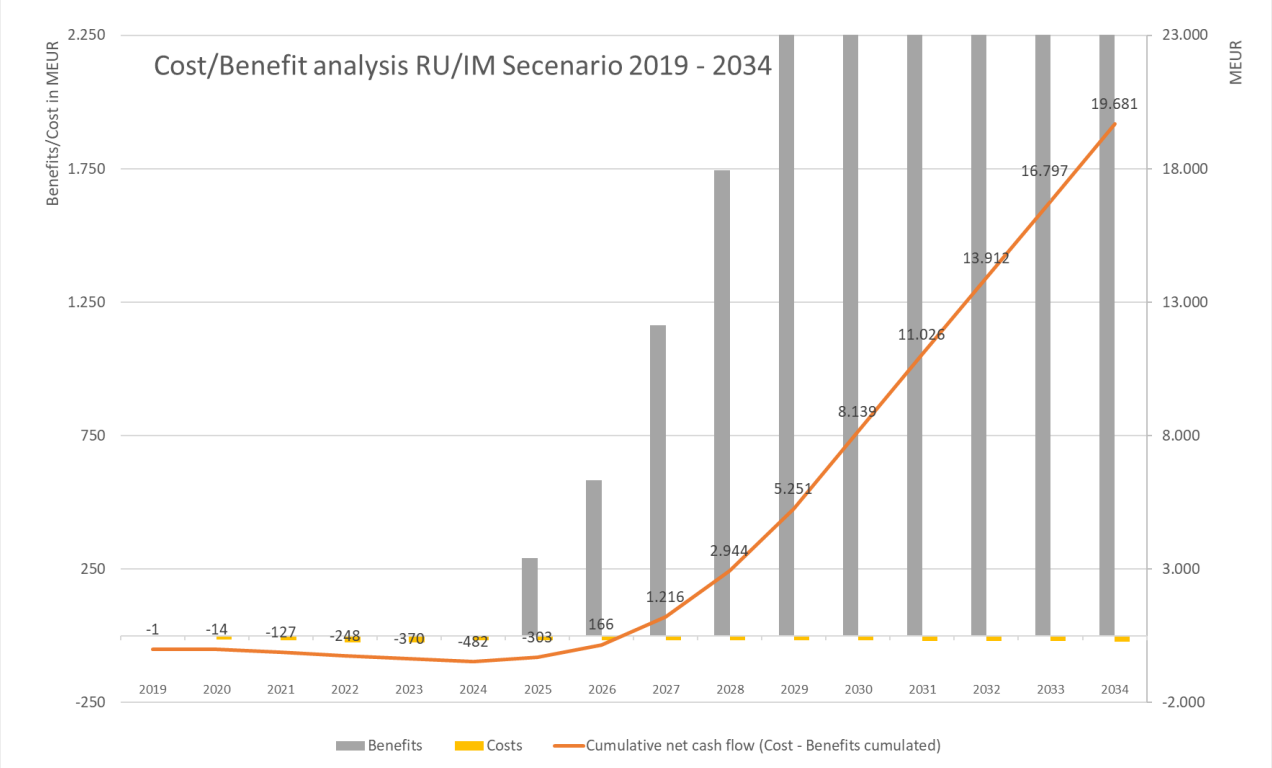


Figure 11 Graph Cashflow – Financial calculation IM/RU Scenario

8.3. Non-financial measurable impact

Business impacts that cannot be acceptably quantified in monetary terms may still represent major objectives for stakeholders. They should ultimately be translated into lower costs and increased revenues. The non-financial results will not enter into the financial model, cash flow results, or the financial metrics from the previous chapter, yet they may still be considered in the proposal—especially if they represent contributions to important business objectives.

Non-financial measurable impacts	Potential impact
» **Less coordination effort for human resources by enabling the advanced and standardised IT systems** » **Efficient harmonisation and train and path management effort for human resources by enabling the advanced and standardised IT systems**	Advanced systems such as TCR – Webtool - (currently under tendering – providing a web-based coordination platform for TCR harmonisation, in a further step including business intelligence and having a broader basis on timetables and capacity data, the harmonisation can be automated) is the first step towards intelligent IT systems supporting the coordination in the first instance in two ways: » Less effort for staff to identify potential conflicts. » Direct communication including action management shorten the coordination process and decrease the necessary staff resources. A central system including respective IT- based intelligent business process having access to European network capacity data, real-time timetables and TCRs may benefit in reducing staff for timetabling and coordination, increasing time to market, supporting capacity utilisation which shall led to cost reductions and increase revenues for RUs and IMs

» **Limited number of complaints to regulatory bodies**	Regulatory bodies shall benefit from the limited number of complaints with respect to path allocation, commercial conditions etc. since the allocation rules, etc. are standardised and transparent. This shall lead to internal savings and fairness for IMs and RUs which have to deal with such cases
» **Request methods that support "harmonised and transparent market" approach and cross-border-cooperation as well as efficient use of the cost-intensive infrastructure.** » **Supported interoperability through the intensive utilisation of TAF / TAP framework**	The whole European rail system shall benefit from an easy, transparent, less discrimination, and harmonised access which shall lead to client retention, higher utilisation of capacity, quicker ROI of infrastructure developments, more competition in the rail sector and better prices for the final customers.
» **Improvement of Timetable robustness for specific segments according to market needs (passenger traffic early ticket sales, freight traffic UC 1-3)**	Long distance passenger traffic is in heavy competition with the low-budget airlines as well as the long-distance bus services. Early ticket sales shall support passenger railway undertakings to win back market share and increase their competitive situation. This shall lead to more business for railway undertakings and thereof for IMs.
» **Time to market – industrial customers can get a stable and continuous offer for several years with the guaranteed (safeguarded) capacity**	In many cases customers have alternatives to rail transport, especially since more and more goods are containerised (even bulk goods). All aspects decreasing the time to market shall lead to winning back market shares and increase customer retention, thus leading to more business for RUs and thereof for IMs.

Table 14 Non-financial measurable impact

8.4. Sensitivity Analysis

The Sensitivity Analysis tries to identify key benefits and "operating levers" for the modification of the process. However, when analysing the financial implication, it is clear that the external effects (congestion, accidents, etc.) are key benefits for the society – but not the key aspects for IM and RUs.

Therefore, the following adjustments to the TTR Scenario have been made:

- Reduction of EU congestion cost (BEUR 0)
- Additional EU DGP (BEUR 0)
- Additional exports (BEUR 0)
- Increasing capacity by 1.0% (10% increase but thereof 10% effective)
- [A] Cost for centralised system +10%
- [B] 30 RU and 30 IM need to implement the system to generate the benefits

Table 15 Sensitivity Analysis

€ in 1000s		YTD 31 Dez 2019	Yr 2 ending 31 Dez 2020	Yr 3 ending 31 Dez 2021	Yr 4 ending 31 Dez 2022	Yr 5 ending 31 Dez 2023	Yr 6 ending 31 Dez 2024	Yr 7 ending 31 Dez 2025	Yr 8 ending 31 Dez 2026	Yr 9 ending 31 Dez 2027	Yr 10 ending 31 Dez 2028	Yr 11 ending 31 Dez 2029	Yr 12 ending 31 Dez 2030	Yr 13 ending 31 Dez 2031	Yr 14 ending 31 Dez 2032	Yr 15 ending 31 Dez 2033	Yr 16 ending 31 Dez 2034	TOTAL
BENEFITS / GAINS																		
Cash inflows																		
BC-S1: Better resource utilization for req. process		0	0	0	0	0	0	42.607	42.607	42.607	42.607	42.607	42.607	42.607	42.607	42.607	42.607	426.070
BC-S1: Capacity increase of 1% (Effective=10% of 10%)		0	0	0	0	0	0	503.475	503.475	503.475	503.475	503.475	503.475	503.475	503.475	503.475	503.475	5.034.750
BC-S2: Decreased loss due to uncoordinated TCRs		0	0	0	0	0	0	13.957	13.957	13.957	13.957	13.957	13.957	13.957	13.957	13.957	13.957	139.567
BC-S3: Loss on effort of IMs to produce PAPs		0	0	0	0	0	0	15.234	15.234	15.234	15.234	15.234	15.234	15.234	15.234	15.234	15.234	152.340
BC-S4: One percentage point of modal share (50%)		0	0	0	0	0	0	255.600	255.600	255.600	255.600	255.600	255.600	255.600	255.600	255.600	255.600	2.556.000
BC-S4: Reduction of EU congestion costs (50%)		0	0	0	0	0	0											0
BC-S4: Creation of additional EU GDP of 49 BEUR 2015-2030		0	0	0	0	0	0											0
BC-S4: Additional exports of up to 20 BEUR 2015-2030		0	0	0	0	0	0											0
Total Benefits/Gains		0	0	0	0	0	0	830.873	830.873	830.873	830.873	830.873	830.873	830.873	830.873	830.873	830.873	8.308.727
Capitalisation rate								10%	20%	40%	60%	80%	100%	100%	100%	100%	100%	
COSTS																		
Cash outflows																		
IT infrastructure cost*																		
Investment (Cloud)	0,0	0,0	0,0	-6,6	-16,2	-9,7	-2,5	-2,7	-2,8	-2,9	-3,1	-3,3	-3,4	0,0	0,0	0,0	0,0	-53
Maintenance	0,0	0,0	0,0	0,0	-6,9	-23,1	-32,8	-35,3	-38,0	-40,8	-43,8	-46,9	-50,1	-52,6	-55,3	-58,0	-60,9	-545
Software procurement - Development	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0
D1: Capacity Needs Announcements	0,0	0,0	-110,0	-110,0	-44,0	-44,0	-44,0	-44,0	-44,0	-46,2	-48,5	-50,9	-53,5	-56,2	-59,0	-61,9	-65,0	-881
D2: Train Harmonization	0,0	0,0	-275,0	-275,0	-110,0	-110,0	-110,0	-110,0	-110,0	-115,5	-121,3	-127,3	-133,7	-140,4	-147,4	-154,8	-162,5	-2.203
D3: Path Request Management	0,0	0,0	-275,0	-275,0	-110,0	-110,0	-110,0	-110,0	-110,0	-115,5	-121,3	-127,3	-133,7	-140,4	-147,4	-154,8	-162,5	-2.203
D4: Messaging Module	0,0	-110,0	-55,0	-55,0	-44,0	-55,0	-55,0	-55,0	-55,0	-57,8	-60,6	-63,7	-66,9	-70,2	-73,7	-77,4	-81,3	-1.035
D5: TCR	0,0	-66,0	-110,0	-110,0	-57,2	-57,2	-57,2	-57,2	-57,2	-60,1	-63,1	-66,2	-69,5	-73,0	-76,7	-80,5	-84,5	-1.146
D6: Capacity Broker	0,0	0,0	0,0	-110,0	-220,0	-66,0	-66,0	-66,0	-66,0	-66,0	-69,3	-72,8	-76,4	-80,2	-84,2	-88,4	-92,9	-1.224
D7: Capacity Hub	0,0	-44,0	-55,0	-110,0	-110,0	-63,8	-63,8	-63,8	-63,8	-63,8	-67,0	-70,3	-73,9	-77,5	-81,4	-85,5	-89,8	-1.183
D8: Path Management	0,0	-495,0	-495,0	-715,0	-715,0	-484,0	-484,0	-484,0	-484,0	-484,0	-508,2	-533,6	-560,3	-588,3	-617,7	-648,6	-681,0	-8.978
Other software (GUI, BigData, Sales Module,etc)*	0,0	0,0	-165,0	-220,0	-220,0	-121,0	-121,0	-121,0	-121,0	-121,0	-127,1	-133,4	-140,1	-147,1	-154,4	-162,2	-170,3	-2.244
																		0
																		0
Total Cost Category A		-715	-1.540	-1.987	-1.653	-1.144	-1.146	-1.149	-1.152	-1.174	-1.233	-1.296	-1.361	-1.426	-1.497	-1.572	-1.651	-21.696
Stakeholder internal Costs [B]																		
RU - Implementation (30 RUs)			-1.650	-20.625	-20.625	-8.580	-8.745	-8.745	-8.745	-8.745	-9.182	-9.641	-10.123	-10.630	-11.161	-11.719	-12.305	-161.222
IM - Implementation (30 IMs)			-19.800	-25.575	-38.775	-40.326	-24.585	-24.585	-24.585	-24.585	-24.712	-25.948	-27.245	-28.607	-30.038	-31.540	-33.117	-424.022
Costs Item HR RU (estimates) --> Training/Process changes.....€		0	0	-42.000	-42.000	-42.000	-42.000	-42.000	-42.000	-42.000								-294.000
Cost item HR IM (estimates) --> Training/Process changes .....€		0	0	-54.000	-54.000	-54.000	-54.000	-54.000	-54.000	-54.000								-378.000
Total Cost Category B		0	-19.800	-121.575	-134.775	-136.326	-120.585	-120.585	-120.585	-120.585	-24.712	-25.948	-27.245	-28.607	-30.038	-31.540	-33.117	-1.096.022
Railway-related research and innovation cost [C]																		
								0	0	0	0	0	0	0	0	0	0	0
Total Cost Category C		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Costs		-715	-21.340	-123.562	-136.428	-137.470	-121.731	-121.734	-121.737	-121.759	-25.945	-27.243	-28.606	-30.033	-31.535	-33.112	-34.767	-1.117.717
CASH FLOW SUMMARY																		
Cash inflows (outflows)																		
Benefits.....		0	0	0	0	0	0	84.749	169.498	338.996	508.494	677.992	847.490	847.490	847.490	847.490	847.490	8.308.727
Costs.....		-715	-21.340	-123.562	-136.428	-137.470	-121.731	-121.734	-121.737	-121.759	-25.945	-27.243	-28.606	-30.033	-31.535	-33.112	-34.767	-1.117.717
NET CASH FLOW.....		**-715**	**-21.340**	**-123.562**	**-136.428**	**-137.470**	**-121.731**	**-36.985**	**47.761**	**217.237**	**482.549**	**650.749**	**818.884**	**817.457**	**815.955**	**814.379**	**812.723**	**7.191.010**
Cumulative net cash flow.....		-715	-22.055	-145.617	-282.045	-419.515	-541.246	-578.231	-530.470	-313.232	169.317	820.065	1.638.949	2.456.406	3.272.361	4.086.740	4.899.463	
Discounted cash flow at 5,0%.....		-681	-19.356	-106.737	-112.240	-107.711	-90.838	-26.285	32.327	140.033	296.243	380.479	455.985	433.515	412.113	391.730	372.318	2.450.896

*Experts estimation - RNE CIO, RNE IT Working Group

ROI= 6,4

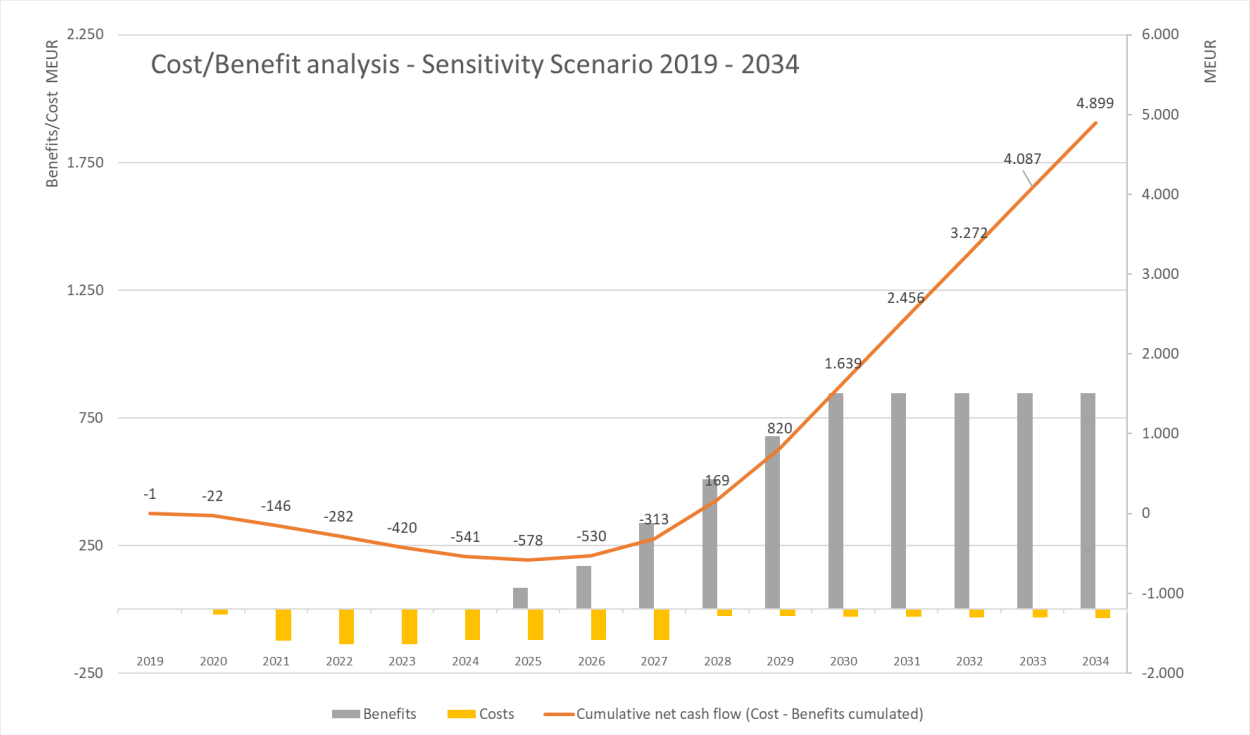


Figure 12 Graph Cash flow – Financial calculation – Sensitivity

Analysis

- Negative Cash flow from 2015-2023 (between MEUR 143 and MEUR 240/year).
- Positive Cash flow after 2026
- **Break-even point in 2028**.
- Total investment cost BEUR 1,1.
- Total benefits BEUR 2.4
- **Return on Investment = 6,4 times the investment.**

The Sensitivity Scenario with radical reduction of benefits still shows a positive cash flow and ROI being a sufficient buffer for cost of IT infrastructure and maintenance.

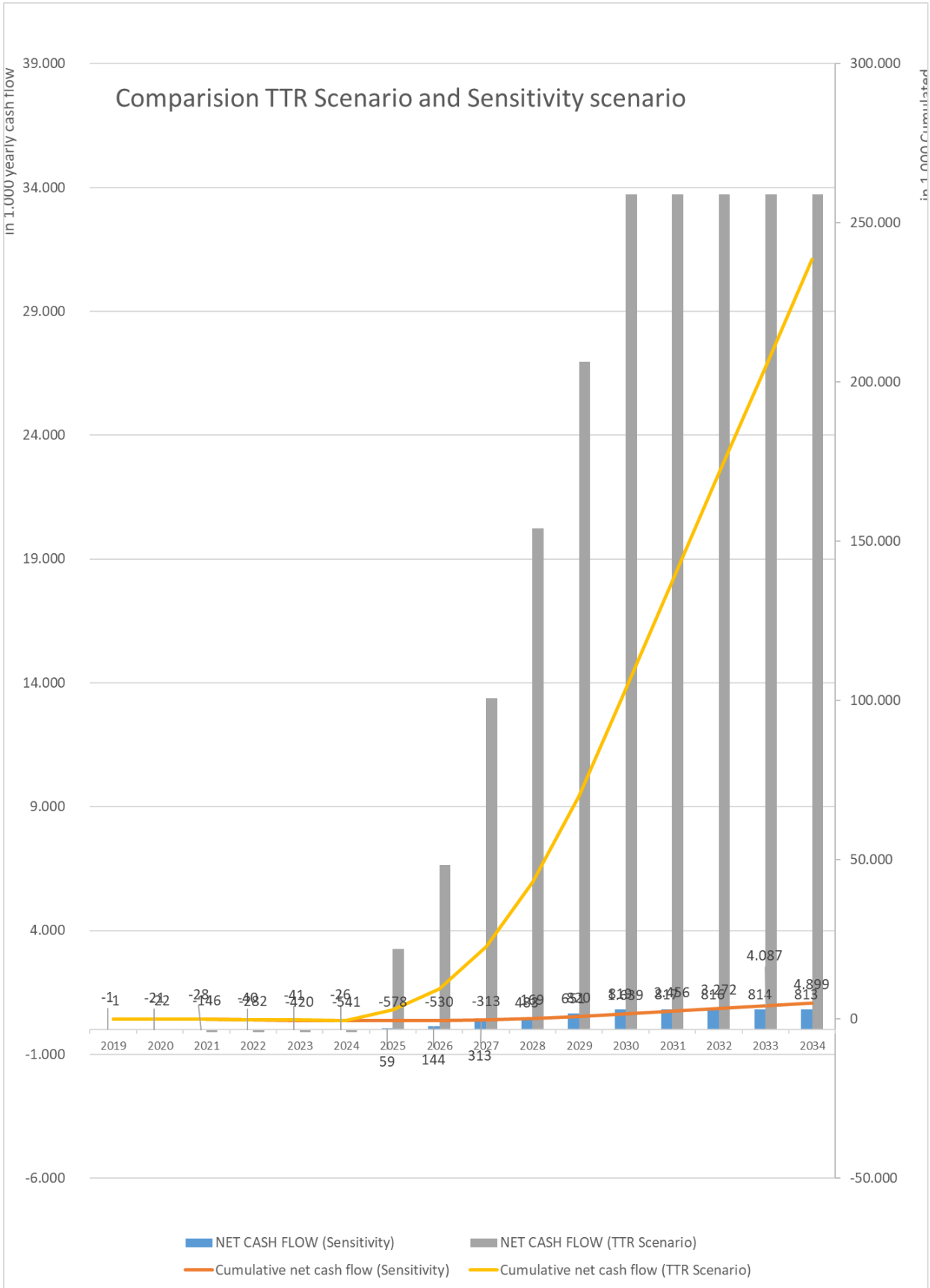


Figure 13 Graph Cash flow – Financial calculation – Comparison TTR Scenario and Sensitivity Scenario

9. Conclusion and Recommendation

9.1. Conclusion

Summarising the results of the Business Case: There are many good reasons to continue the way forward – in particular the potential mode shift towards rail seems to be of a magnitude justifying the costs of the TTR project. As many aspects of the project are still not finally decided (commercial conditions) there is sufficient space for additional ideas to influence the project during its further conception.

Business as Usual Scenario has shown that the current system does not reflect the market needs any longer. Reviewing the European policies and analysing customer surveys as well as combining them with independent research of market participants under competition clearly show the need for change in the European time tabling and capacity allocation process. Furthermore, it is obvious that efficient IT-system support shall improve the capacity management and European-wide coordination.

The analysis of TTR Scenario ("New TTR process") clearly shows that the capacity modelling, partitioning and safeguarding combined with coordinated TCRs is necessary to support the market needs. However, it requires to implement the whole concept including rolling planning, optimised annual-timetable request method in order to meet the market demands and to push forward the modal-shift. A further aspect is that the system (fully integrated) shall highly increase the European railway capacity without additional physical (costly) interventions on railway infrastructure.

Main conclusions:

- In order to achieve an impact on the mode shift towards rail in cross-border transport innovative concepts are required.
- The major ideas of the TTR project are a collection of process and systems innovations which might be able to tap a high share of the full market potential.
- Standardisation, optimisation and efficiency are urgently required in order to shift some more transport volume to the rail sector. One of the few levers to make rail more attractive is the cross-border transport because about 50% of the rail freight is cross-border transport.
- The financial benefits and support for the sector are enormous:
  - Negative Cash flow from 2019-2024 (between MEUR 0,6 and MEUR 121/year)
  - Positive Cash flow after 2025 (Average: BEUR 24/year)
  - Break-even point in 2025
  - Total investment cost MEUR 950
  - Total discounted benefits BEUR 129
  - Return on Investment = 346 times the investment

The view on benefits depends on the views of the stakeholders. Seen from the point of view of the rail-sector, the potential benefits of the TTR project significantly outweigh the costs.

9.2. Recommendation

The BC-Team recommends the following:

1.) Not to keep the status-quo since it does not fulfil client requirements.
2.) Total roll-out of the TTR concept to ensure maximum benefits.
3.) Introduction of pilots for fine-tuning the functions and process steps.
4.) Introduction of a process measurement system for continual tracking and quality improvement of the process (Setting up of KPIs).
5.) Utilisation of standard IT-frameworks such as TAF/TAP TSI to ensure harmonised IT-systems.
6.) Improving Business Case by continuously updating the results of the project progress (Conduct mandatory survey on cost for implementation on RU/IM side – Detailed calculation by each member of RNE/FTE).
7.) Since IT requirements and effort estimations are only included in a raff estimate they should be incorporated into the Business Case at a later stage.

8.) Since commercial conditions have not finally been agreed on they should be incorporated into the Business Case at a later stage.

9.) The Business Case should be used as core evaluation document with regular updates based on project progress in order to consciously track benefits, KPIs and support process optimisation.