NeTIRail

Needs Tailored Interoperable Railway Infrastructure

Deliverable 1.1

Report on Selection of Case Studies

Submission date : 30/09/2015

NeTIRail-INFRA is funded by the European Commission under the Horizon 2020 programme - Grant agreement n° 636237

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Executive Summary

Seven case studies have been selected, covering the three business cases considered in the Project: busy routes, underutilized secondary lines, and freight-dominated routes. Slovenia and Turkey provided all three cases, whilst the Romanian case studies were limited to just a secondary line.

All these case studies have in common:

- Routes with distinctive features (context or purpose), so these are not arbitrary line sections;
- A good availability of technical, financial and operational data, pertaining to the infrastructure and operations.

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Abbreviations and acronyms

Abbreviation / Acronym	Description
ASn	Auto stop devices
daN/t	decanewton / ton
GNSS	Global Navigation Satellite System
HŽ	Hrvatske Željeznice, (en) Croatian Railways
SSTC	Signal safety and telecommunication
SŽ, SZ	Slovenske Železnice, (en) Slovenian Railways

1. Task description

Quoting from the NeTIRail-INFRA grant agreement Annex 1 (Part A – section 1.3.3 WT3 Work Package Descriptions pg 11):

> *NeTIRail focuses on infrastructure challenges affecting conventional rail lines. Three line categories have been chosen (busy capacity limited passenger railway; under-utilised rural / secondary line; and a freight dominated route) and each faces different challenges. As noted elsewhere in the proposal, Northern EU networks have been extensively covered by previous EU projects. The aim here is to focus on finding technical solutions with a particular focus on cost reductions, bearing in mind the financial constraints faced by recent accession countries in particular. Case studies will be selected that fit the three line categories from the countries with industry representation (Romania, Turkey and Slovenia). Additional criteria, beyond the need to fit within one of the three line categories, might include, inter alia: good data availability; the existence of substantial government subsidy (showing a particular need for cost reduction); the connection of major population centres (relevant for wider economic effects); and an a priori expectation of important societal benefits.*

2. Methodology for selection

2.1 Sample size

At the project kick-off meeting on15th-16th June 2015, the Consortium found out that each network could provide a sample line in each category. A decision was made to identify nine sample lines (3 categories times 3 networks).

A working document ("Case study selection guidance") was subsequently drafted (UIC, ULEEDS, VTI) and communicated to the concerned partners (AFER, INTADER, RCCF, SŽ). Essential methodology features are summarised below.

2.2 Definition of a "line" or "route"

At the project kick-off meeting, the Consortium agreed to study whole routes, rather than just line segments. However, the term "route" is a soft concept mainly related to actual or possible traffic patterns that will definitely vary from one location to another.

Ultimately, the Consortium agreed a route to be connecting some "important" origins and destinations, and **not just being a short stretch of track**.

The quotes around the word "important" indicate that the notion of importance does not necessarily mean that there is a large amount of traffic currently, given that one of our line categories includes a lightly used line. Rather, the interpretation is that there are other reasons why it is important (perhaps it has important social benefits or has potential for increased traffic flows for example).

2.3 Criteria for selection

2.3.1 Availability of data relative to costs and life cycle

WP 2 to 4 of NeTIRail will be addressing technical improvements with respect to tracks, power supply, and monitoring activities, respectively. In order to be able, in the future, to perform cost and benefit comparisons as part of impact assessments, the following items are deemed necessary. The table illustrates the track case (WP2).

Type of data needed	Availability
Total maintenance cost (annual cost). This must be reported in a way that makes it possible to identify how much is spent today on various subsystems , for instance on switches & crossings (S/C). The important point is that disaggregate cost data is needed in two senses: firstly, information that it is available at the level of the line / route chosen for analysis (national data is not sufficient); second that it is broken down into the relevant type of cost, in the case of the example above, S&C maintenance costs.	
Total replacement (or renewal) costs, for example for S&C on the given route. This should ideally also be expressed as a unit replacement cost, given that volumes of S&C replacements on the line will change from year to year.	
Traffic over each line, including information about number of freight and passenger trains (expressed as passenger and freight train-km, passenger-km and passenger journeys, and freight gross tonne.km), payload and number of passengers, respectively as well as revenue for each.	
Number of failures in total over each line, but in particular failures generating delays that may be linked to each of the four technical components under review. This includes the number of minutes of train disruptions each disturbance generates, including knock-on consequences on subsequent trains.	
The age of S/C and other technical components that may be affected by each type of intervention.	
Potentially other measures relating to the environment (carbon; noise), and also safety if we consider that these will be materially affected by the new technology.	

Table 1 - Selection criteria: cost data availability

The same logic applies to WP 3 and WP4. The need for ultimately getting a sufficient level of cost disaggregation was emphasized.

2.3.2 Availability of data for assessing the effects of innovation

Type of data needed	Is it available (YES/NO)
The investment cost of the new asset(s) as well as any consequences for the future replacement scenario compared to the equipment used under the current scenario (that is, how does the life of the asset, in terms of years or cumulative tonne-km, change as a result of the new techology). This includes the implications of the change in maintenance regime (frequency of inspection, etc.) or other innovations with implications for the life of the asset /frequency of replacement.	
Information relating to the changes in rates of failure and thus implied delays – so that we can estimate the impact on delays and the availability of the network (taking into account also changes to the maintenance regime noted in 1. above).	
To the extent than an intervention has implications for variables other than delays, information about these aspects are also necessary under both “with” and “without” cases. Examples include but are not restricted to speed on the line; ride quality; noise and possibly other environmental consequences as well as accident risk.	

Table 2 - Selection criteria: assessment of innovation effects

The following section shows the result of the selection process. Context information (narrative parts) were not required at the present stage, and will further be developed under WP5.

3. Selected lines

3.1 Overview

The NeTIRail Consortium line selection is displayed in the table below. Lines are characterized by their length and yearly statistics (ST: single track; DT: double track; PT: passenger trains; MP: millions of passengers; FT: freight trains; Mt: millions of freight net tonnes). Data reflect 2014 situation.

Category \ Country	Romania	Slovenia	Turkey
Busy, capacity-limited passenger railway	N/A	Ljubljana – Kamnik 23.6 km ST, diesel 10 276 PT – 0.4 MP 506 FT – 0.08 Mt	Ankara - Sincan 37.0 km 3-4T, 25kV~ 196 599 PT – 16 MP 7 174 FT –
Under-utilised secondary line	Bartolomeu-Zărneşti 23.9 km ST, diesel 10 220 PT – 0.6 MP 192 FT – 0.37 Mt	Pivka – Ilirska Bistrica 24.5 km ST, 3 kV = 4 141 PT – 0.02 MP 1 451 FT – 0.57 Mt	Divriği- Malatya 207 km ST, 25kV~ 5 691 PT – 0.49 MP 22 597 FT –
Freight dominated route	N/A	Divača – Koper 48.0 km ST, 3 kV = 4 420 PT* – 0.1 MP 20 837 FT – 11.04 Mt	Malatya- İskenderun 374 km ST, 25kV~ 3 593 PT – 0.58 MP 38 088 FT –

Table 3 – Summary of selected lines

** Number of passenger trains in 2013. Data from 2013. In 2014 the ice was on the line Ljubljana-Divača, which was reflected in the traffic on the line Divača-Koper, so the number of passenger trains is lower than in previous years.*

We see that “under-utilized secondary line” is an elastic concept, much depending on the line characteristics (defining the potential utilisation) and the local context (yielding the actual utilisation).

3.2 Details: Romania

3.2.1 Overall map

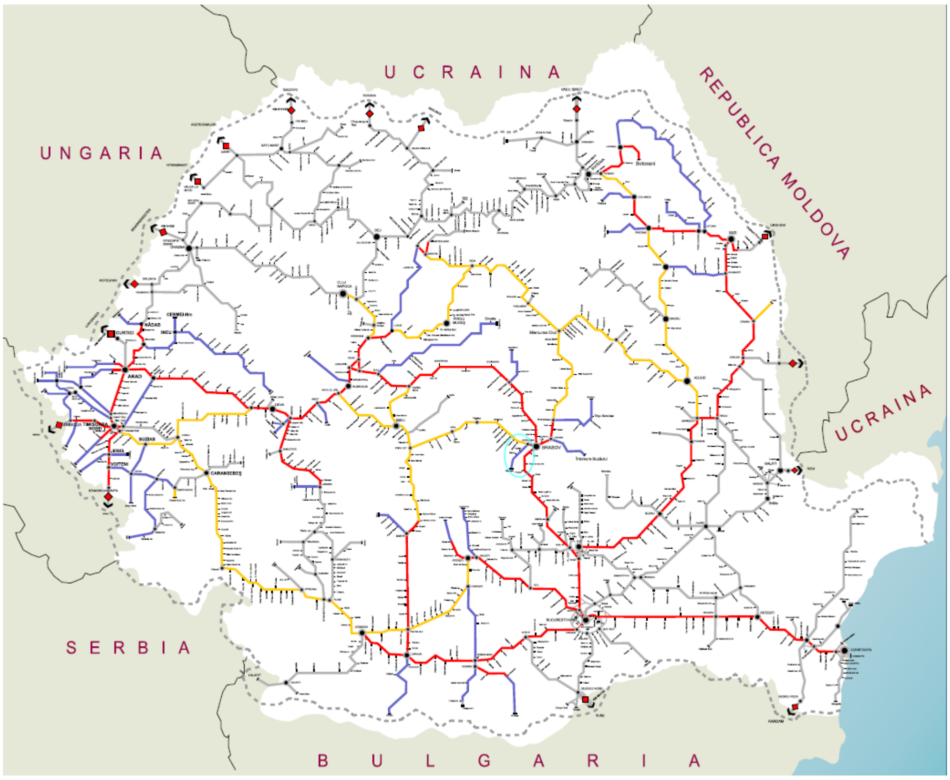

Figure 1- Overall map of Romanian network. Blue circle: Bartolomeu-Zărneşti line

3.2.2 Bartolomeu-Zărneşti line

Descriptive data is easily available for this case study, as this line section was also examined under the SATLOC project.

Bartolomeu-Zărneşti railway, with a length of 23.9 Km, was inaugurated on June 6th, 1891. Opened at the beginning to freight transportation, it became important also for passenger transport because of the numerous factories in the area, and also from a touristic point of view (Rasnov and Bran castles).
In 2005, the railway line was leased to RC-CF TRANS SRL Brasov who saw in this line a great opportunity for development, both in terms of freight and passenger transport. Between 2012 and 2014, the line was included in SATLOC project, with the main objective to prove, by tests and live demonstration, that GNSS[1] is compliant with rail requirements for train control functions on low-density lines. SATLOC remains however compatible with ETCS developments.

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[1] Global Navigation Satellite System

Characteristic	Value
Length	23,9km
Number of tracks	Single track
Clearance gauge	UIC B 505
Axle load category	C (20.0 t/axle, 7,2 t/m)
Traction system	Diesel
Maximum speed	80 km/h
Maximum gradient	14 °/°°
Block section length (level track)	no block section
Block system	no block system

Table 4 Bartolomeu-Zărneşti line key characteristics

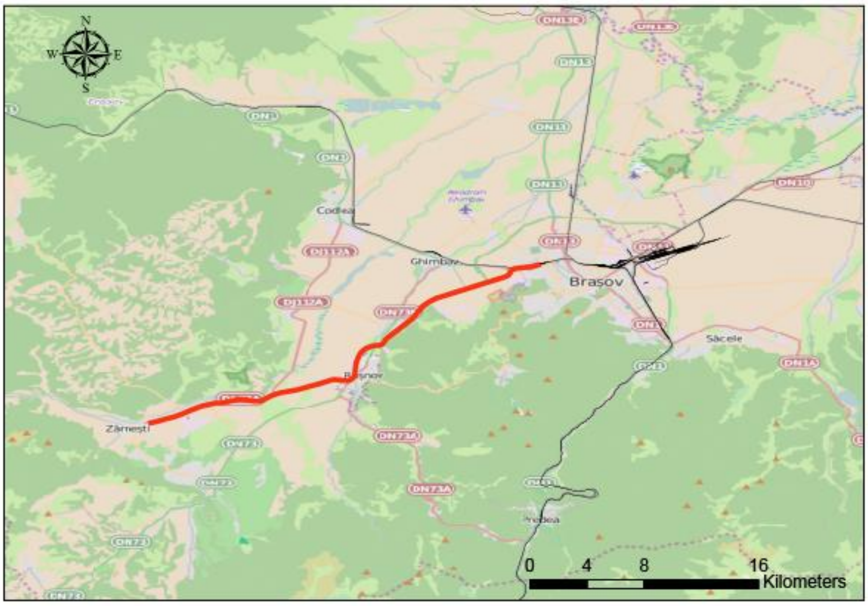

Figure 2- Bartolomeu-Zărneşti line

3.3 Details: Slovenia

3.3.1 Overall Map

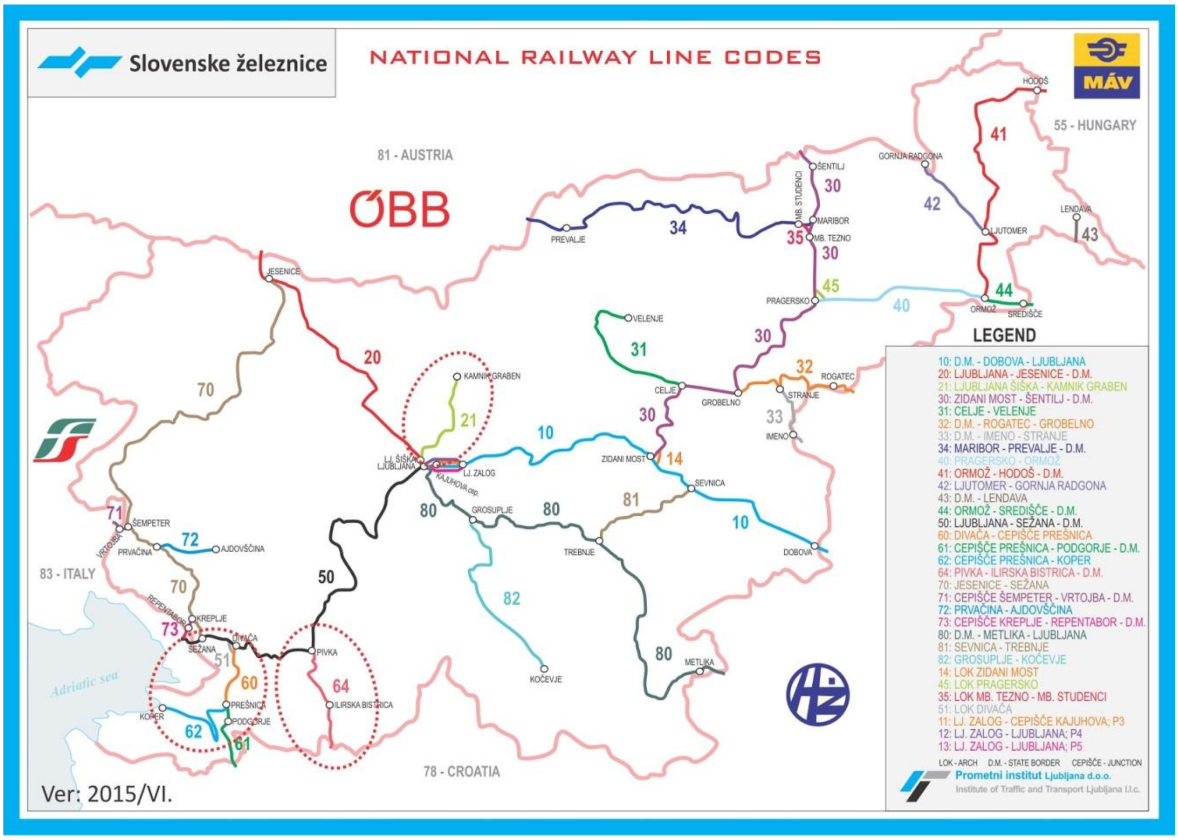

Figure 3- Selected SŽ lines [lines 21, 60 & 62, and 64 on the map]

3.3.2 Ljubljana Šiška – Kamnik Graben

The 23.6 km long railway line between Ljubljana and Kamnik was opened to traffic in early 1891. In addition to numerous factories in the area, an important gunpowder factory was established by the river Kamniška Bistrica, which resulted in the accelerated construction of the Kamnik railway line. At present, the Kamnik railway line is important for both freight and passenger transport.

The line is one of the most important routes supporting suburban commuter traffic. SŽ is constantly endeavoring to provide passengers with high quality of service, both by offering modern and flexible train schedules, as well as with a single ticket for suburban transport of passengers. Following the evolution of transport in particular suburban areas, Kamnik railway line belongs to the main regional lines of SŽ.

The basic information about the line is set out below:

Characteristic	Value
Year of construction	1891
Length	23.6 km
National category	Regional line
Number of line tracks	Single track
Axle load category	C4 (20.0 t/axle, 8.0 t/m)
Traction system	diesel
Maximum speed	100 km/h
Brake distance	700 m
Number of bridges	4
Number of tunnels	1
Number of culverts	28

Table 5 - Kamnik line characteristics - Source: SŽ

The Ljubljana Šiška - Kamnik Graben line exhibits 5 stations and 10 stops, as shown in the figure below.

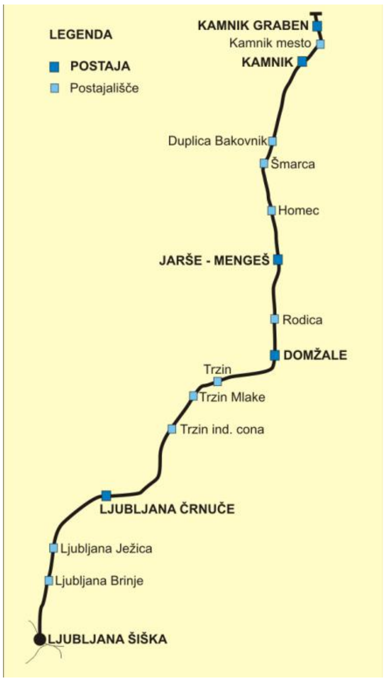

Figure 4 - Kamnik line stations and stops - Source: Prometni institut Ljubljana d.o.o.

3.3.3 Pivka – Ilirska Bistrica – D.M.

The railway line Pivka-Ilirska Bistrica-Šapjane (HŽ – Croatian Railways) is extremely important for the port of Rijeka. It also serves an alternative route that of Rijeka-Zagreb. With the liberalization of the rail transport market in Croatia, this railway line will also became a major force, because it provides the shortest route from the port of Rijeka to Central Europe. On the other hand, the axle load category of line is rather limited (category C, i.e. 20 t / axle). The border station for traffic exchange is Šapjane in Croatia (HŽ), which is fitted with two systems of electrification, namely 3 kV DC (SŽ) and 25 kV 50 Hz (HŽ).

Characteristic	Value
Length	24.5 km
National category	Main line
Number of line tracks	Single track
Axle load category	C2 (20.0 t/axle, 6.4 t/m)
Traction system	3kV DC
Maximum speed	50 - 75 km/h
Maximum gradient	13 ‰
Maximum resistance	15 daN/t
Equipment of line with SSTC devices	electronic relay SS device, the ASn
Permissible capacity	63 trains / day

Table 6 - Pivka - Ilirska Bistrica line characteristics - Source: SŽ

Figure 5 - Pivka - Ilirska Bistrica stations and stops

3.3.4 Divača - Koper

The railway line Divača – Koper is part of the Slovenian railway network, which consists of 1,207 km of lines. Of this, 333 km are double-track lines and 874 km are single-track lines. Within the Slovenian railway network, the line is categorized as a main, single track, electrified line. It is in category D3, the maximal permissible axle load being 22.5 tons with UIC-B loading gauge, which is compatible with intermodal transport. The maximal line speed is between 65 and 75 km/h for freight trains and 90 km/h for passenger trains.

The line consists of two line sections. The line section Divača - Prešnica junction was constructed in 1876 in the scope of "Istrian state railways", when the railway line Divača – Pula was being constructed. The line section from Prešnica junction to Koper was constructed in 1967. Passenger traffic started in 1972 and, in 1979, a new passenger station in Koper was built.

The Divača–Koper line has the characteristics of a mountain railway, with high slopes and small radii. The starting point of the line is in Divača at 431.1 m above sea level. The line reaches sea level at Koper Freight station. The highest altitude station of the line is the station Rodik, at 537.6 m. The maximal gradient is 25.8% over 300 m between Hrastovlje and Rižana, while the minimal radius of the curve is 250 m (in section Črnotiči – Hrastovlje).

The line was electrified in 1976. The catenary is supplied from electrical substations (ESS) at Divača, Črnotiče and Rižana. In the course of modernisation, two electrical substations were set up in Dekani and Hrpelje-Kozina.

The Divača–Koper railway line is particularly important for international rail freight traffic, given the role of the Port of Koper in linking the Slovenian hinterland with the European economy.

Characteristic	Value
Year of construction Divača – Prešnica Prešnica – Koper	 1876 1967
Length Divača – Prešnica Prešnica – Koper	 16.5 km 31.5 km
National category	Main line
Number of line tracks	Single track
Axle load category	D3 (22.5 t/axle 7.2 t/m)
Traction system	Electrified, 3kV =
Maximum speed	90 km/h
Brake distance	1000 m
Maximum slope	26 ‰

Table 7 - Divača - Koper line characteristics - Source: SŽ

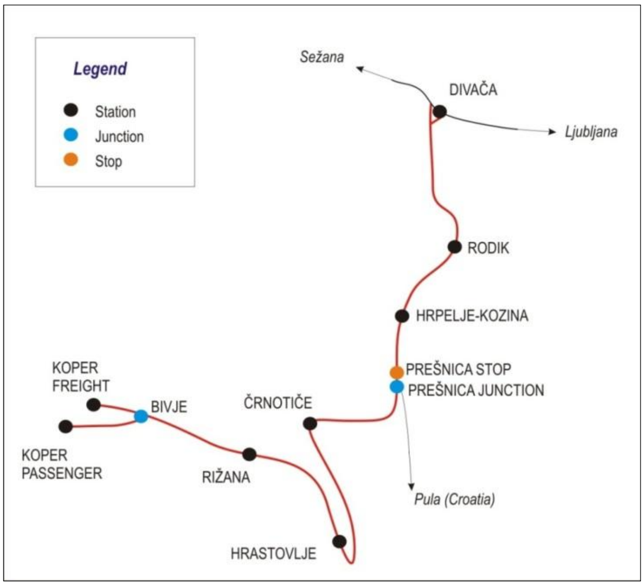

Figure 6 - Divača - Koper stations, stops and junctions - Source: Prometni institut Ljubljana d.o.o.

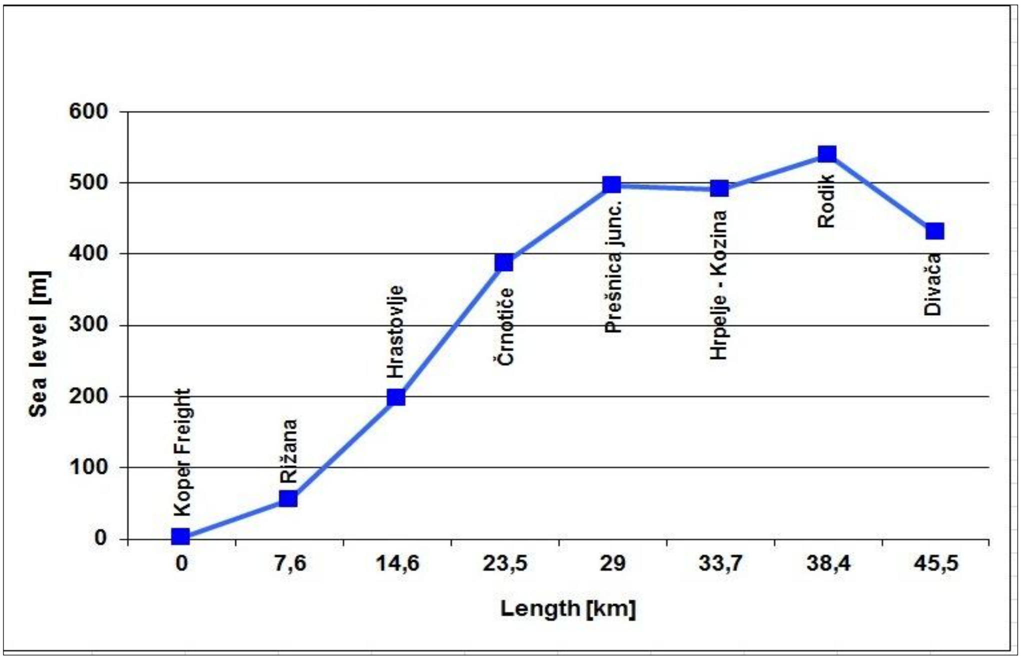

Figure 7 - Longitudinal profile of Divača-Koper line - **Source: Prometni institut Ljubljana d.o.o.**

3.4 Details: Turkey

3.4.1 Overall map

3.4.2 Ankara- Kayaş

This line is an electrified line with automatic block system. The length of the line is 37km, passenger train.km/year for Ankara-Marşandiz is 190915, for Marşandiz-Sincan is 2347975 and for Ankara-Kayaş 318017. Freight train.km/year for Ankara-Marşandiz is 20061, for Marşandiz-Sincan 42620 and for Ankara-Kayaş is 27507. Gross-Tonnage.km are 16222000 for Ankara-Marşandiz, 30968000 for Marşandiz-Sincan and 22014000 for Ankara-Kayaş. The Sincan-Kayaş railway line comes second for passenger transportation amongst TCDD lines.

The number of tracks between Kayaş and Ankara is three, between Ankara and Marşandiz it increases to four, and between Marşandiz and Sincan, it is again three. The gauge of the line is standard (clearance gauge UIC B 505, track gauge 1435mm). The traction system is 25kV 50 Hz. The maximum speed of the line is uniformly set at 120 km/h, and the maximum gradient on the line is 17.8 °/°°. A block system with 3-aspect signals is used; block section length is the same for all lines, namely 700 meters.

Characteristic	Value
Length	37 km
Number of tracks	Kayaş-Ankara: 3 lines Ankara-Marşandiz:4 lines Marşandiz-Sincan:3 lines
Clearance gauge	UIC B 505; 1435mm track gauge
Axle load category	D4 (22.5 t/axle, 8.0 t/m)
Traction system	25 kV 50 Hz
Maximum speed	120 km/h
Maximum gradient	17,8 °/°°
Block section length (level track)	700 m
Block system	3-aspect signals

Table 8 - 3.4.2 Sincan- Kayaş

3.4.3 Divriği- Malatya

It is a 207,4 km long, electrified and signalled single-track line. The passenger-train-km annually between Divriği and Çetinkaya amount to 164518; between Çetinkaya and Hekimhan, to 103494, and between Hekimhan and Malatya to 121709. The gross freight ton.km between Divriği and Çetinkaya amount to 407683000; between Çetinkaya and Hekimhan, to 438379000, and between Hekimhan and Malatya to 561806000.

The gauge of the lines is standard (UIC B 505, 1435mm track gauge). Traction system is 25kV 50 Hz. The maximum speed of the line is 120 km/h, and the maximum gradient of the lines is 24.12 °/°°. A block system with 3 aspect signals is used, and block section length is 700 m for all lines.

Characteristic	Value
Length	209 km
Number of tracks	Single
Clearance gauge	UIC B 505
Axle load category	D4 (22.5 t/axle, 8.0 t/m)
Traction system	25 kV 50 Hz
Maximum speed	120 km/h
Maximum gradient	24,12°/°°
Block section length (level track)	700 m
Block system	3-aspect signals

3.4.4 Malatya- İskenderun

The length of the line is 373,7km and it is electrified and signalled line. The number of Passenger Train-km / year is 129875 between Malatya and Narlı, 41790 between Toprakkale-İskenderun, 91840 between Toprakkale-Fevzipaşa, 50076 between Fevzipaşa-Narlı.

The number of Freight Train - Km / Year is 1530555 between Malatya and Narlı, 548800 between Toprakkale-İskenderun, 639840 between Toprakkale-Fevzipaşa, 715615 between Fevzipaşa-Narlı. The Gross-Tonnage-Km are between Malatya and Narlı is 1,522,527,000 between Narlı and Fevzipaşa is 675174000 between Fevzipaşa and Toprakkale is 613954000 and between Toprakkale and İskenderun is 425459000. The gauge of the lines is standard and UIC B 505, 1435mm. Traction system is 25kV 50 Hz. Also, the maximum speed of the line is 120 km/h, and the maximum gradient of the lines is 21 °/°°. For the block system, 3 aspect signals are used and block section length is 700 meters.

This line is of significant importance, due to the connection with İskenderun Port and İskenderun Iron and Steel Plant. As per 2011 statistics, the number of loaded goods is 489,000 t and unloaded goods, 1,044,000 t at the port. The revenue of the İskenderun Port is over 12.5 million TL annually. Line capacity enhancement is expected to increase the revenue of the port by increasing the capacity of usage of the hinterland, by means of decreasing the downtime related to maintenance. The connection to the iron and steel plant is also of significant importance for freight transportation. In particular, iron ore is mined from Divriği and transported to İskenderun by rail.

Characteristic	Value
Length	373,7 km
Number of tracks	Single
Clearance gauge	UIC B 505
Axle load category	D4 (22.5 t/axle, 8.0 t/m)
Traction system	25 kV 50 Hz
Maximum speed	120 km/h
Maximum gradient	21 °/°°
Block section length (level track)	700 m
Block system	3-aspect signals

4. Conclusion

The proposed selection of routes fulfils the initial intentions. The relevant partners in each country have confirmed, for each item in the tables set out in Annex 1, that the data is available at the required level of disaggregation and detail. Some basic data for the lines has already been provided as set out above.

Since each line category is actually illustrated by two to three sample lines, the technical risk of getting inadequate data, and the strategic risk of having picked an “uninteresting” case with respect to future development, are mitigated.

5. Next steps

The Consortium will proceed with data collection under Task 1.2, and will cast the data into the data structure under development (T2.1). The context information will further be provided and analysed under WP5. To the extent that, during this next phase, major data gaps appear, there will be an opportunity to iterate around the choice of case study lines. However, the discussions to date indicate that the data required should be available for the lines chosen.

ANNEX 1 : Data checklist document

Introduction

As noted in the guidance document, WP 2-4 of Netirail will be addressing technical improvements with respect to tracks, electricity supply and monitoring activities, respectively. Here we will be using WP 2 as an example of the type of reasoning used for identifying relevant data. Within WP 2, four different technical interventions are being considered:

1. Increasing the life-length of switches/crossings (S/C) by way of new principles for lubrication.
2. Interventions to reduce corrugation of tracks; this will in turn reduce the volume of some maintenance activity.
3. Alternative means for lubrication (that will also reduce the volume of some maintenance activity; also of rolling stock maintenance?).
4. Alternative techniques for reducing the wear in transition zones, i.e. where the substructure changes due to the track passing from the line with a macadam bearing to the concrete of a bridge.

It is yet unclear precisely which improvement(s) is to be suggested under each of the above bullets. But since the economic analysis compares:

- the current situation (or scenario)

  with;

- the situation after that an intervention has been implemented,

It is possible already at the outset to start collecting the types of data that will constitute our “without” or comparison alternative – in other words, what does the current situation look like? A valuable input for generating this information will probably be provided by the reviews included in WP 2, 3 and 4. These should include, amongst other things, a description of the current maintenance regime, including also the frequency of inspections.

Table to complete to check data availability

With this as a starting point, below we have summarized in a table the information that we consider to be necessary for each of the three types of lines in all three countries for the current situation. Please could you confirm for each item below that such data will be available for the case study lines that you have selected. In this respect it would be useful, if possible at this stage, if you could provide a small amount of sample data, or an indication about the structure of the data (and its source).

Type of data needed	**Is it available (YES/NO)**
Total maintenance cost (annual cost). This must be reported in a way that makes it possible to identify how much is spent on, for example, each of the four above bullet points (WP2-4 technical innovations – and of course for the other innovations envisaged in the other work packages). For example the first bullet, this means costs spent today on S/C. The important point is that disaggregate cost data is needed in two senses: firstly, information that it is available at the level of the line / route chosen for analysis (national data is not sufficient); second that it is broken down into the relevant type of cost, in the case of the example above, S&C maintenance costs.	
Total replacement (or renewal) costs, for example for S&C on the given route. This should ideally also be expressed as a unit replacement cost, given that volumes of S&C replacements on the line will change from year to year[2].	
Traffic over each line, including information both about number of freight and passenger trains (expressed as passenger and freight train-km, passenger-km and passenger journeys, and freight gross tonne-km), payload and number of passengers, respectively as well as revenue for each.	
Number of failures in total over each line, but in particular failures generating delays that may be linked to each of the four technical components under review. This includes the number of minutes of train disruptions each disturbance generates, including knock-on consequences on subsequent trains.	
The age of S/C and other technical components that may be affected by each type of intervention.	
Potentially other measures relating to the environment (carbon; noise) and also safety if we consider that these will be materially affected by the new technology.	

As noted, and to emphasise, a crucial aspect of the analyses is the need for disaggregate information. Costs etc. for the national network as a whole is therefore of secondary relevance. Rather, the unit of observation should be as detailed as possible.

In order to compare these costs with what happens after the innovations are applied, the following additional information is required:

Type of data needed	**Is it available (YES/NO)**
The investment cost of the new asset(s) as well as any consequences for the future replacement scenario compared to the equipment used under the current scenario (that is, how does the life of the asset, in terms of years or cumulative tonne-km, change as a result of the new techology). This includes the implications of the change in maintenance regime (frequency of inspection, etc.) or other innovations with implications for the life of the asset /frequency of replacement.	
Information relating to the changes in rates of failure and thus implied delays – so that we can estimate the impact on delays and the availability of the network (taking into account also changes to the maintenance regime noted in 1. above).	
To the extent than an intervention has implications for	

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[2] “Unit cost * quantity » will **only work with an appropriate level of disaggregation**. In this particular case, it will probably be necessary to break down the cost: cost of replacement = cost of track possession + cost of logistics + material + workmanship + testing & commissioning, etc., where cost of track possession = organization cost + cost of traffic diversion or slowdowns + cost of lost traffic. Each of these cost elements may strongly vary according to local circumstances, hence the need to perform a **reasonable breakdown** in order to be able to extrapolate the costs to other situations, and to compare the consistency of cost indications.

	variables other than delays, information about these aspects are also necessary under both “with” and “without” cases. Examples include but are not restricted to speed on the line; ride quality; noise and possibly other environmental consequences as well as accident risk.	

Commentary on the line

As noted above, other factors that may be taken into account include:

- Is there a reasonable potential that the innovation could make a real difference to the economic case for the line – of course this is hard to judge. We need cases that are perhaps struggling from a viability perspective, but have some hope (so not a totally hopeless case) and where the technical innovation is likely to make a difference to the case for keeping the line open
- Is there the likely possibility of significant wider economic effects (e.g. connection of major population centres / importance from an employment perspective)
- Is there the likely possibility of significant societal effects – so is the line socially important in terms of, for example, how it provides mobility for particular groups / regions
- Will the route support all of the technical innovations in WP2-WP4 (this may not be a hard and fast rule but it would seem to be desirable)

Please could you provide some further information about the lines selected – based on your local knowledge – so that we can gain an impression as to the economic issues applying to those lines, their viability and potential viability, and their potential to generate some of the wider economic and societal benefits following implementation of our proposed technological solutions.