Good practice benchmarking of the rail infrastructure managers

PRIME 2017 data Benchmarking Report – Public Version

Report developed under cooperation between PRIME KPI & Benchmarking Subgroup and European Commission Directorate for Mobility and Transport

Hamburg, 03 May 2019

European Commission

PRIME
Platform of Rail Infrastructure Managers in Europe

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Foreword by PRIME Co-Chairs

The goal of PRIME members is to provide safe, reliable and efficient railway infrastructure for transporting people and goods. The KPI subgroup was set up with the goal to monitor and benchmark performance and by doing so to strive for better results.

We are pleased that we can share with you the second benchmarking report prepared by the PRIME KPI subgroup, covering the years 2012-2017.

For the infrastructure managers, benchmarking helps to understand where each organisation stands and where there is potential for improvement. For the European Commission, there is an invaluable opportunity to receive feedback and to monitor the progress with respect to EU policy priorities. The KPI subgroup has also set up a database and IT tool which can be used for analysing the trends and support management decisions on a daily basis.

The PRIME benchmarking framework is:

• comprehensive – including a selection of indicators covering a broad range of topics and

• has been developed by the industry itself and focussing on what is useful from the infrastructure managers' business perspective.

We believe that these two elements have been key features to ensure its wide support. We promised last year that each next report would be an improvement. And we are proud to confirm that compared to the first report, this edition includes a number of new indicators, more complete dataset, three new participants (in total 15) and is enriched by new analysis. Five infrastructure managers are in the transitional phase to join. We would like to thank the PRIME KPI subgroup chair Rui Coutinho from IP Portugal - as well as the members of this group from 20 organisations and EC for this outstanding achievement.

We believe that PRIME data and definitions can serve the needs of a large range of industry experts and policy makers. By measuring and sharing the results, we aim to demonstrate to wider public that the rail sector is improving its devoted to improve its service provision.

Finally, we invite remaining PRIME members to join the benchmarking framework so that our database and report will gradually become the most renowned source of complete and reliable data!

PRIME co-chairs

Elisabeth Werner	Alain Quinet
European Commission, DG MOVE	*SNCF Réseau*
Director of Land Transport	*Deputy Director General*

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Table of contents

This report provides an overview of KPI data and results – It serves as a starting point for further benchmarking

Purpose of this report (1/4)

What is PRIME?

PRIME was created in 2013 as a cooperation platform between the European Commission and the European Rail Infrastructure Managers, with the view to facilitate the provision of efficient and effective rail services. PRIME has in total 39 member organisations and 15 of them have participated in the preparation of in this report.

OBJECTIVE OF PRIME PERFORMANCE BENCHMARKING

The 4th Railway Package (Article 7f of the Directive 2012/34/EU, as amended by Directive 2016/2370) has formalised and specified the missions of PRIME. In particular, it states that *"[…] the network meets at regular intervals to […] monitor and benchmark performance. For this purpose, the network shall identify common principles and practices for the monitoring and benchmarking of performance in a consistent manner".*

Infrastructure managers are natural monopolies and performance benchmarking is a relevant exercise to assess, manage and improve their performance. Many indicators are already available within the sector but they are not harmonised and are incomplete. Now, for the first time, all Infrastructure Managers are mobilised to provide a coherent framework of performance indicators.

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This report provides an overview of KPI data and results – It serves as a starting point for further benchmarking

Purpose of this report (2/4)

OBJECTIVE OF PRIME PERFORMANCE BENCHMARKING (continued)

Performance Benchmarking covers several dimensions of rail infrastructure management: punctuality, costs, resilience, sustainable development, safety, etc. Our objective is to provide a comprehensive view of the performance of the networks with the opportunity for Infrastructure Managers to identify areas for improvement and the sources of inspiration among their peers.

A **second internal benchmarking report** has been produced based on 2012-2017 data accompanied by assessment of data completeness and robustness, of 49 selected indicators and first assessment of KPI correlations, qualitative relationships between KPIs and potential performance drivers in the different performance dimensions. The purpose of this report was to illustrate the current performance of IMs and identify areas for further analysis. Thus, this is only the beginning of a longer term process.

Compared to PRIME 2016 data Benchmarking report published last year, we have already achieved a significant improvement of the dataset, especially in terms of completeness. Furthermore, we have started to drill down into the subject of punctuality and developed a separate analysis. Our intention is to give information and fruit for thought to stakeholders, researchers, economists and politicians. Above all, **the general objective for the project is to deliver insight and inspiration for better decisions on developing a sustainable and competitive infrastructure management which provides high quality services.**

Thanks to the strong commitment of a large number of Infrastructure Managers, we are confident to be able to progressively improve the participation and the publication with the view to foster accountability, transparency and, ultimately, performance.

This report provides an overview of KPI data and results – It serves as a starting point for further benchmarking

Purpose of this report (3/4)

OPERATIONAL ACHIEVEMENTS

PRIME KPI and its Benchmarking Subgroup has been working actively for the last five years. Through more than 30 meetings, 15 active member organizations and three pilot projects we have achieved the following results:

- An internal **IT tool** developed by the EC IT team in cooperation with civity Management Consultants is now established. Several improvements have been made to increase its usability and functionality.
- The **KPI definitions** are documented in a next version of a PRIME KPI Catalogue that is available on https://webgate.ec.europa.eu/multisite/primeinfrastructure/content/subgroups_en

PRIME 2017 BENCHMARKING REPORT: THE STARTING POINT FOR FURTHER BENCHMARKING

- The present **PRIME 2017 Benchmarking report** shows the results of a selection of indicators which are based on the initial assessment of the internal report were considered mature enough for publishing. **This report with purely factual information** is the second edition, facilitating further data sharing and analysis. As indicated in the document, for some indicators, the data of individual infrastructure managers partially still deviates from agreed definitions, but the members continue their efforts to improve the comparability of data.
- This is PRIME's second Benchmarking report and it shows significant progress compared to the first version of 2016. However, the participating members remain committed that each next report will become an improvement over the previous one.

This report provides an overview of KPI data and results – It serves as a starting point for further benchmarking

Purpose of this report (4/4)

PRIME KPI NEXT STEPS

- **Enhancing participation:** the number of members involved in the benchmarking report, currently 15 will progressively increase
- **Improving the dataset:** The KPI framework will continue to be developed over the coming years, with the KPIs refined, completed, and the quality of the input data and hence output metrics improved
- **In-depth studies**: based on the results achieved, PRIME will work on in-depth analyses which include interpretation of benchmarking results with detailed analyses of contextual factors and identification of root causes for performance differences on selected topics; the topic chosen for 2018 is punctuality
- **Preparing and sharing reports:** PRIME aims to publish annual benchmarking reports. In addition it will prepare 'special reports' presenting the outcome of the in-depth analyses

A number of factors need to be in place to make this benchmarking exercise successful

Context – Key success factors of PRIME KPI

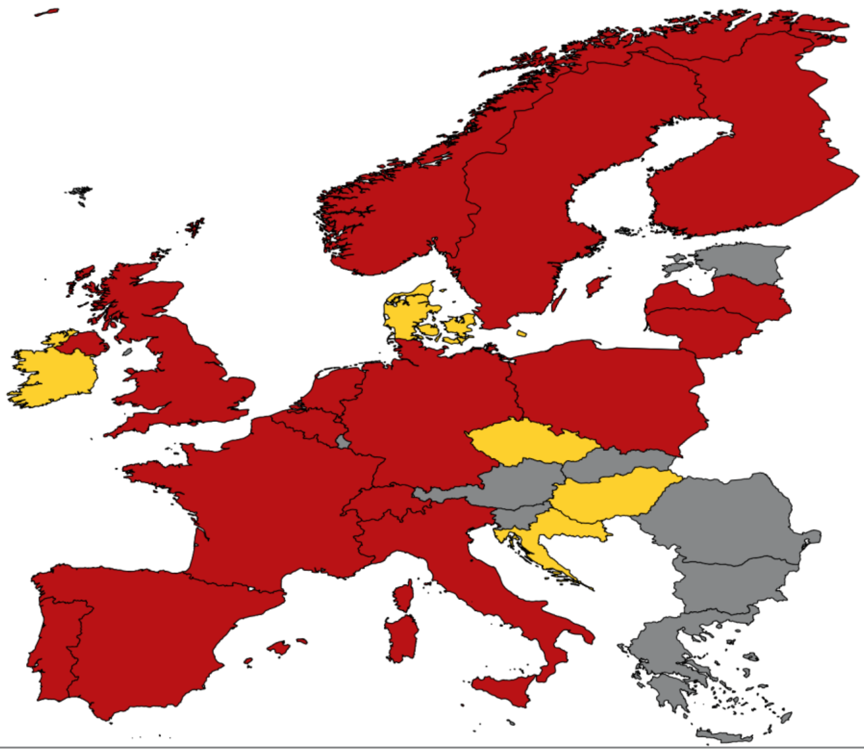
There are a number of factors to be considered for a successful and meaningful benchmarking exercise:

- **Meaningful and supportive KPIs** strongly aligned with the peer group's strategic objectives and providing a good starting point for the identification of good practices
- **Clear and well defined indicators** are essential for reliable and comparable results
- **Reliable and high data quality** through a thorough challenging of the collection and completeness of data including plausibility checks and gap-filling
- **Comparability of results** can be increased by applying adjustments to normalise data based on structural differences between IMs, as well as identifying limitations and caveats very clearly to avoid misinterpretation and misleading conclusions
- **Target group-oriented tools and reporting** should be developed which are flexible, easy-to-use and correspond to the needs of benchmarking experts, team members, and senior managers, etc., using carefully defined requirements.
- A strong **senior management commitment** is essential to support and resource the exercise, and provide confidence to interpret, understand and implement results

15 participants contributed to this report - 7 new members have joined PRIME's KPI benchmarking subgroup

Context – PRIME KPI active members

BANE NOR
banedanmark
ProRail
NetworkRail
Iarnród Éireann Irish Rail
INFRABEL Right On Track
SNCF RÉSEAU
LISEA
SBB CFF FFS
adif
Infraestruturas de Portugal



TRAFIKVERKET
VÄYLÄ
LDZ
LIETUVOS GELEŽINKELIAI
DB NETZE
POLSKIE LINIE KOLEJOWE
SŽDC
MÁV
GYSEV Raaberbahn
HŽ INFRASTRUKTURA
RFI RETE FERROVIARIA ITALIANA

Observers: European Commission; European Union Agency for Railways; CER; RNE RailNetEurope; EIM European Rail Infrastructure Managers; VDV

Participants in PRIME KPI Report | New subgroup members in transition phase | PRIME members

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The 15 participants manage more than 250 thousand main track-kilometres and employ about 200 thousand FTE

Context – PRIME KPI active members

IM name	IM abbreviation	Country	Participation	Main track-km	FTE
Adif	Adif	ES	Benchmarking Report	21.029	12.079
Bane NOR	Bane NOR	NO	Benchmarking Report	4.125	4.420
DB Netz AG	DB	DE	Benchmarking Report	55.311	43.974[1)]
Finnish Transport Infrastructure Agency	FTIA	FI	Benchmarking Report	6.708	639
Infrabel	Infrabel	BE	Benchmarking Report	6.515	11.361[2)]
Infraestruturas de Portugal S.A.	IP	PT	Benchmarking Report	3.244	3.697
Latvijas dzelzceļš	LDZ	LV	Benchmarking Report	2.217	6.494
Lietuvos geležinkeliai	LG	LT	Benchmarking Report	1.911	2.987
Network Rail	NR	GB	Benchmarking Report	31.221	38.594
PKP PLK	PKP PLK	PL	Benchmarking Report	27.120	39.349
ProRail	ProRail	NL	Benchmarking Report	5.409	4.280
RFI	RFI	IT	Benchmarking Report	27.044	25.963
SBB	SBB	CH	Benchmarking Report	6.183	9.450[2)]
SNCF Réseau	SNCF R.	FR	Benchmarking Report	48.992	53.624
Trafikverket	TRV	SE	Benchmarking Report	11.775	7.135
				258.805	**199.261**

1) 2016 data
2) 2015 data

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Currently seven organisations are in transition to becoming a member delivering data

Context – PRIME KPI new members

IM name	IM abbreviation	Country	Participation
Banedanmark	BDK	DK	New member in transition
Győr-Sopron-Ebenfurti Vasút	GySEV	HU/AT	New member in transition
HŽ Infrastruktura d.o.o.	HZ	HR	New member in transition
Iarnród Éireann – Irish Rail	IE	IE	New member in transition
LISEA	LISEA	FR	New member in transition
MÁV Magyar Államvasutak Zrt.	MÁV	HU	New member in transition
Správa železniční dopravní cesty	SZDC	CZ	New member in transition

Eight EU main infrastructure managers do not yet participate

Context – PRIME members, not active in KPI subgroup

IM name	IM abbreviation	Country	Participation
CFR	CFR	RO	PRIME
Eesti Raudtee, AS		EE	PRIME
National Railway Infrastructure Company	NRIC	BG	PRIME
ÖBB Infrastruktur AG	ÖBB	AT	PRIME
OSE.SA - the Hellenic Railways Organisation		EL	PRIME
Slovenske železnice		SI	PRIME
Société Nationale des Chemins de Fer Luxembourgeois	CFL	LU	PRIME
Zeleznice Slovenskej republiky	ZSR	SK	PRIME

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Table of contents

This report provides all high level and benchmarking KPIs of the framework's business dimensions

Introduction (1/2)

- First, the **hierarchy** of all KPIs is illustrated followed by an **example slide** of results explaining contents and meaning of the graphical illustration
- Each business **dimension** is introduced by its **objectives** as described in the PRIME catalogue
- Each **category** is introduced by a description of the current **definitions** of its associated **KPIs**
- This is followed by a **comparison** of these KPIs per IM illustrated in **bar-charts** showing for each IM the **most recent available data** among the years 2012 – 2017. Where KPI values for 2017 are currently not available, KPI values are based on data from the most recent available year. For example, if the latest data provided by an IM is from 2016 then this 2016 data is presented in the bar chart
- Bar-charts also indicate the **weighted average** across all IMs (weighted by the KPI's denominator) based on most recent available data as well as the **individual IM's averages** (over all available years 2012 – 2017)
- The **result** of each comparison is **described** emphasizing the average, the range and individual trends where meaningful
- As requested by the KPI subgroup, benchmarking results are not interpreted and possible reasons for performance differences are not investigated in detail at this stage
- Instead **first questions for further analysis** are raised
- For better readability, bar charts are not labelled with individual values

This report provides all high level and benchmarking KPIs of the framework's business dimensions

Introduction (2/2)

- A comparison of individual **time series** is not illustrated in order to keep up readability; however, time series are available in the **IT-tool**
- Where relevant and helpful to support further analysis, **first correlations** between KPIs are illustrated and commented
- In order to identify exogenous and endogenous drivers of performance differences, each business dimension (except for context) is concluded by
  - A graphical illustration of **examples for underlying drivers** developed by civity compared to the KPIs currently collected in PRIME
  - A summary of possible **guiding questions for further analysis**
- This first root-cause analysis can be used to explain performance differences as well as to **identify** possible **in-depth topics** for the KPI subgroup

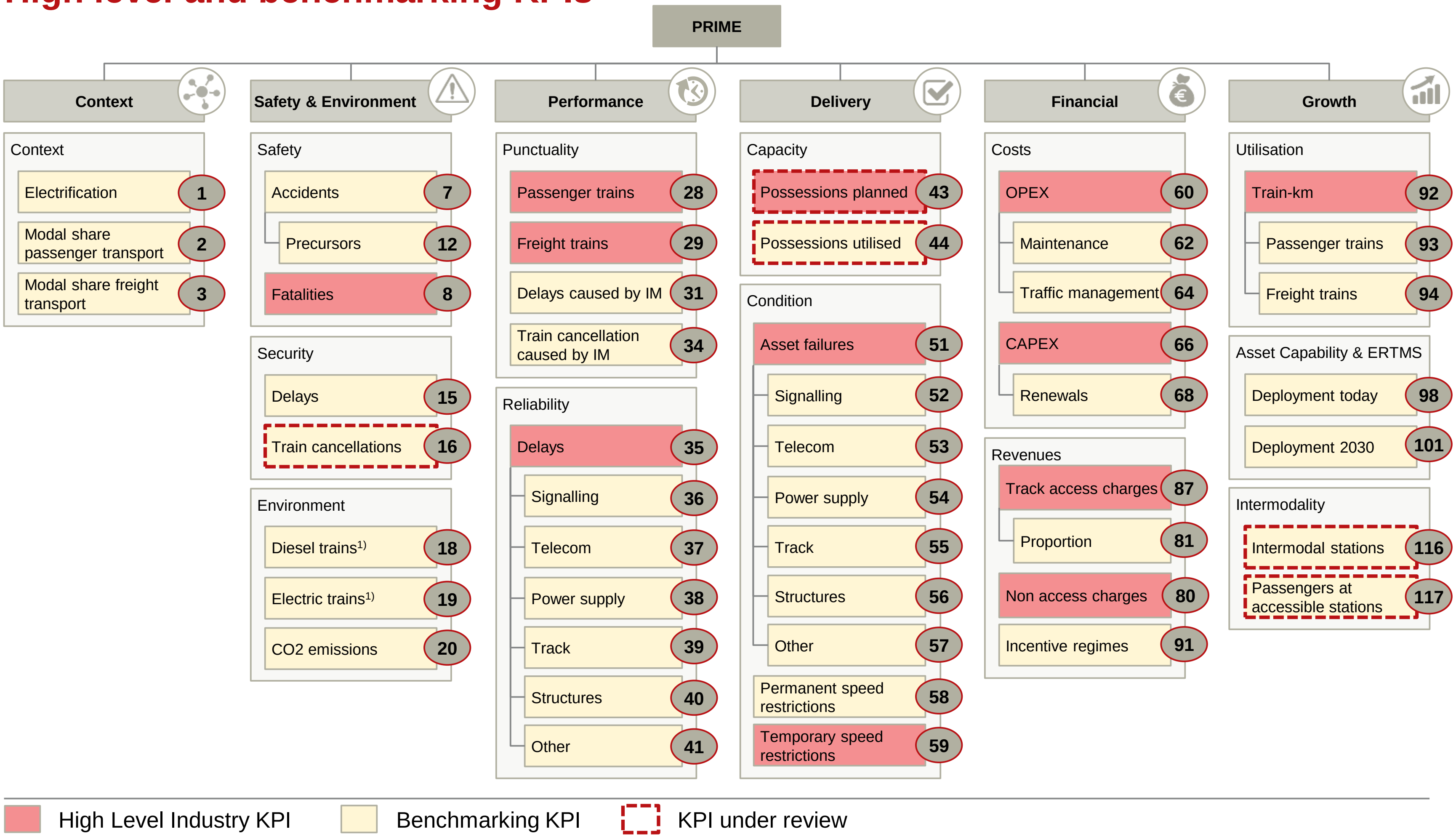
The PRIME performance indicators have been tiered into four levels, with the main KPIs presented in this report

Performance indicator hierarchy

Tier	Indicators	Reporting	
High Level Industry KPIs	Selection of 12 top KPIs	Bench-marking report	Report-ing per indicator in IT tool
Bench-marking KPIs	Additional 32 KPIs covering all categories for core benchmarking		
Additional PIs	All remaining PIs and KPIs under review		
Supporting Indicators & data	Other indicators & data for detail and explanation		

The KPIs presented in this report include 12 high level industry and 32 benchmarking KPIs across six dimensions

High level and benchmarking KPIs



1) For the purpose of this report “Share of train types” (combination of KPI 18 & 19) is considered as a high level KPI

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Example slide of results

The traffic light indicates the overall robustness level (see appendix) of the KPI

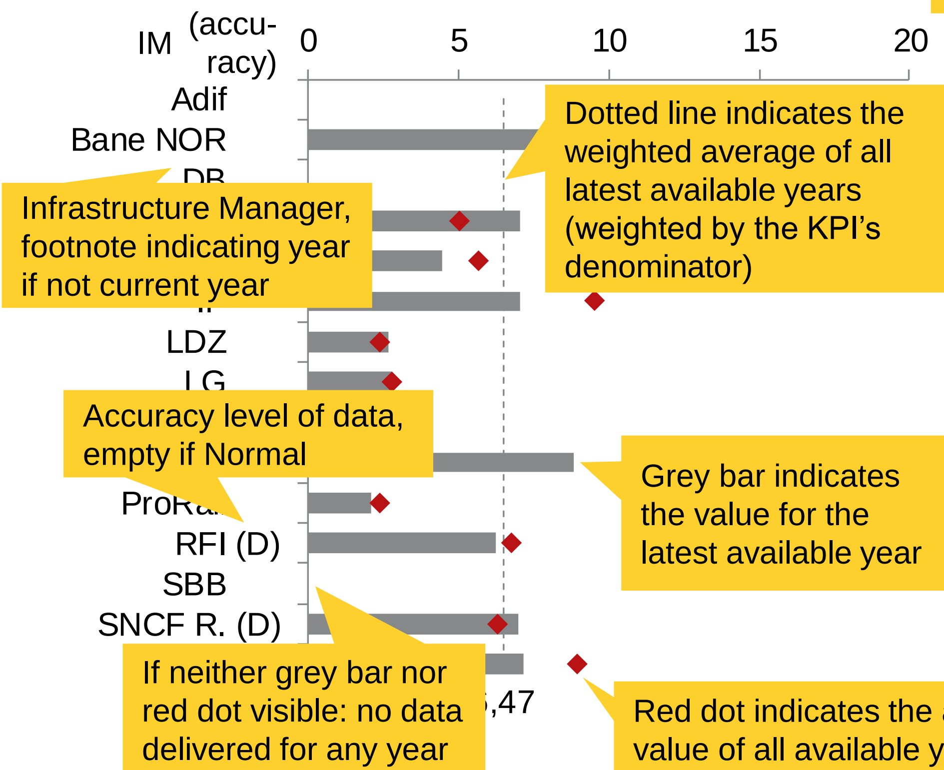
KPI 31

Delay minutes per train-km caused by the IM

Minutes per thousand train-km (2017)

Name, unit and year of most recent data of KPI

Number of KPI, colour coding indicates KPI level (compare High level and benchmarking KPIs overview on previous page)



- Delays vary bet… thousand track-… significantly low… others and this i… overall passeng… punctuality (KPI 2…)
- Several IMs have considerably reduced delays in their responsibility in 2017
- It would be interesting to
  - break down delay minutes by cause to identify main causes, positive trends and thus opportunities for reducing delays
  - understand the reasons and initiatives behind positive trends

Delay causes include: Operat… planning, Infrastructure insta… …ngineering causes, Cause…

Example

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year
Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

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Table of contents

This category provides an overview of the characteristics and configuration of each IM

Context – objectives

- Understanding the size and relative significance of the railway in each country and the market for railway services
- Provision of valuable background information and relevant context when reviewing and assessing other KPIs and additional performance indicators

Source: PRIME Catalogue Version 2.1, 31 May 2018

Context – Overview

PRIME

Context | Safety & Environment | Performance | Delivery | Financial | Growth

Context
- Electrification (1)
- Modal share passenger transport (2)
- Modal share freight transport (3)

This category provides an overview of the characteristics and configuration of each IM. This enables an understanding of the size and relative significance of the railway in each country and the market for railway services, which provides valuable background information and relevant context when reviewing and assessing other KPIs and additional performance indicators.

KPI Name	KPI Definition
Degree of electrification of total network – all lines	Degree of electrification of total network - all lines
National modal share of rail in passenger transport	Proportion of national rail passenger-kilometre compared to total passenger-kilometre of passenger cars, buses / coaches, and railways (Source: European Commission, Statistical Pocket book)
National modal share of rail in freight transport	Proportion of national rail tonne-kilometre compared to total tonne-kilometre of road, inland waterways and rail freight (Source: European Commission, Statistical Pocket book)

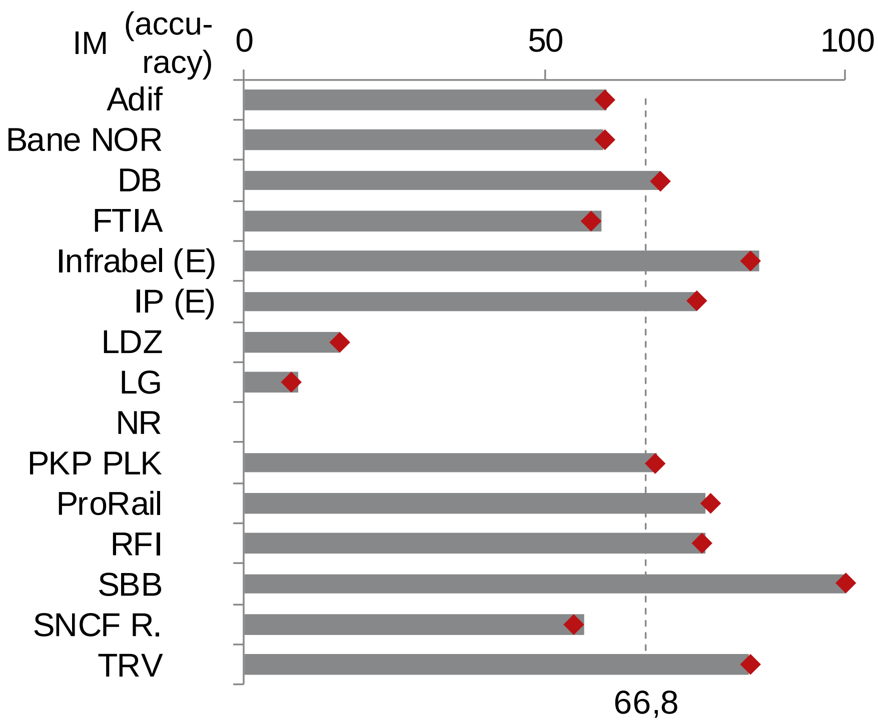
High Level Industry KPI | Benchmarking KPI | KPI under review

67% of the peer group's track-kilometres are electrified

KPI 1

Degree of electrification of total network

% of track-km (2017)



- In Europe railway networks are mostly electrified
- However, the degree of electrification varies strongly from 9% to 100%
- Infrabel, Trafikverket and SBB have the highest degree of electrification
- Overall the degree of electrification has been quite stable in the period considered

NR: currently only report main electrified track-km and is exploring further categorisation into electrified total and main track-km

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year
Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

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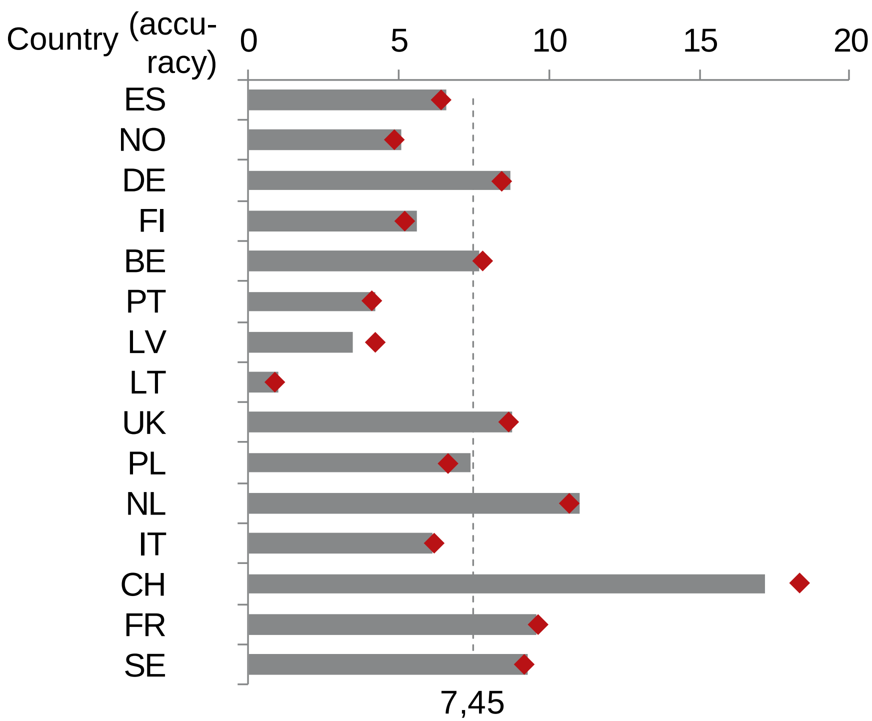
Based on passenger-kilometres, the peer group's average modal share of rail in passenger transport is 7%

National modal share of rail in passenger transport

KPI 2

% of passenger-km (2016)



- The range of national modal shares varies widely between 1% and 17%
- The highest modal share of passenger rail transport can be found in Switzerland (17%)
- With a few slight exceptions, modal shares appear to be relatively constant over time

- Data provided by European Commission
- Source: Eurostat based on data reported by national statistical offices
- 2017 data will only become available during the course of 2019

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year
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Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

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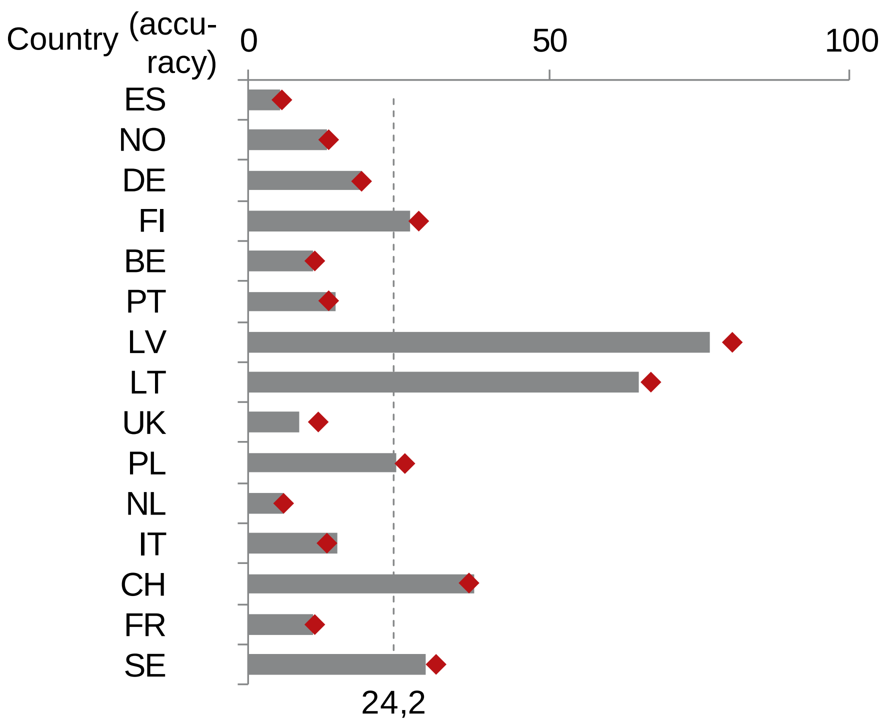
Based on tonne-kilometres, the peer group's average modal share of rail in freight transport is 24%

National modal share of rail in freight transport

KPI 3

% of tonne-km (2016)



- The range of national modal shares varies widely between 5% and 77%
- The highest modal share of freight rail transport can be found in Latvia (77%)
- All modal shares appear to be relatively constant over time except for a slight decrease in a few countries

- Data provided by European Commission
- Source: Eurostat based on data reported by national statistical offices
- 2017 data will only become available during the course of 2019

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year
Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

Table of contents

Aim is to demonstrate the level of safety and security as well as the environmental impact provided by the railway

Safety, Security & Environment – objectives

- Understand and improve the ability of an IM to manage and operate its network and users of its network in such a way as to maximise safety and security (ALARP) for its customers, staff, its partners – operators, contractors and suppliers – and the general public; and
- Demonstrate the ability of an IM to manage its network in such a way as to minimise short term and long term environmental impacts by itself and its staff, its operators, suppliers and customers.

Source: PRIME Catalogue Version 2.1, 31 May 2018

Safety & Environment – Safety – Overview

PRIME

Context | **Safety & Environment** | Performance | Delivery | Financial | Growth

Safety
- Accidents 7
  - Precursors 12
- Fatalities 8

Security
- Delays 15
- Train cancellations 16

Environment
- Diesel trains 18
- Electric trains 19
- CO2 emissions 20

Safety is the primary focus of the management of a railway IM and a prerequisite in any framework of management indicators. It is the most important and essential element in the performance of an IM, and affects customers, stakeholders, the reputation of the IM, the railway and society at large.

KPI Name	KPI Definition
Significant accidents	Relative number of significant accidents including sidings, excluding accidents in workshops, warehouses and depots based on the following types of accidents (primary accidents): • Collision of train with rail vehicle, • Collision of train with obstacle within the clearance gauge, • Derailment of train, • Level crossing accident, including accident involving pedestrians at level crossing, • Accident to persons involving rolling stock in motion, with the exception of suicides and attempted suicides, • Fire on rolling stock, • Other accident The boundary is the point at which the railway vehicle leaving the workshop / warehouse / depot / sidings cannot pass without having an authorization to access the mainline or other similar line. This point is usually identified by a signal. For further guidance, please see ERA Implementation Guidance on CSIs.
IM related precursors to accidents	Relative number of the following types of precursors: • broken rail • track buckle and track misalignment • wrong-side signalling failure
Persons seriously injured and killed	Relative number of persons seriously injured (i.e. hospitalised for more than 24 hours, excluding any attempted suicide) and killed (i.e. killed immediately or dying within 30 days, excluding any suicide) by accidents based upon following categories: • Passenger, • Employee or contractor, • Level crossing user, • Trespasser, • Other person at a platform, • Other person not at a platform

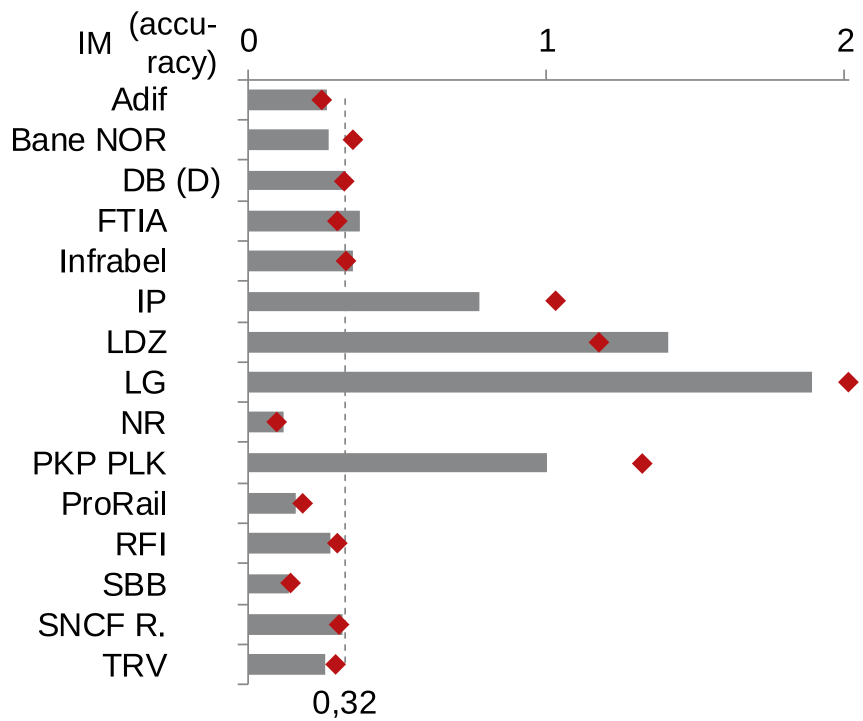
High Level Industry KPI | Benchmarking KPI | KPI under review

On average the peer group's infrastructure networks show 0,3 significant accidents per million train-kilometres

Significant accidents

KPI 7

Number per million train-km (2017)



- Both in recent years and on average over available years ProRail, NR and SBB operate its railways at the lowest accident levels
- In contrast a few IMs significantly exceed the weighted average
- Further analysis should explore the root causes of accidents and possible mitigation measures
- Good practice of IMs to improve their overall safety performance (reduce the number of accidents and accident precursors) could be evaluated further, e.g. programmes to in-crease safety at level crossings, track worker safety or the safety level of signalling systems
- Given that metrics include accidents exclusively due to train operation, a further breakdown and in-depth analysis may be needed

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

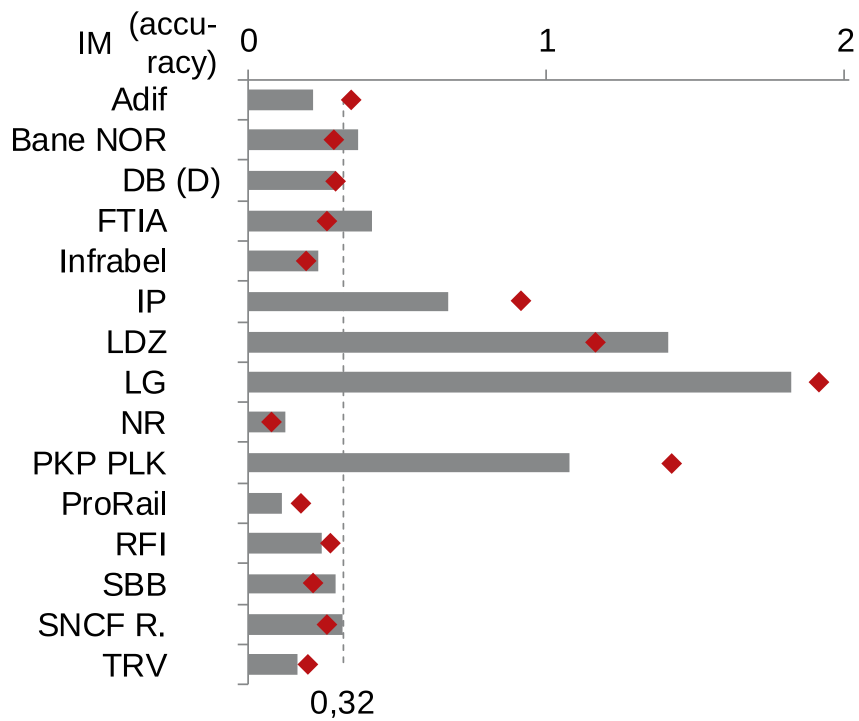
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

The number of persons seriously injured and killed during the reporting period varies widely

KPI 8

Persons seriously injured and killed

Number per million train-km (2017)



- The weighted average of safety related injuries and fatalities in the peer group's railway network is 0,3 per million train-kilometres
- They are lowest at ProRail in 2017 at 0,11; NR maintains the lowest average over time
- The casualty rate on some networks are well above the weighted average
- As safety is the most crucial aspect in delivering railway services it is worth to understand how best practice can be achieved
- Hence further analysis could consider :
  - Which were types of accidents and their underlying causes?
  - What technical measures, regulation or other measures are taken to further increase safety levels?

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year
Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

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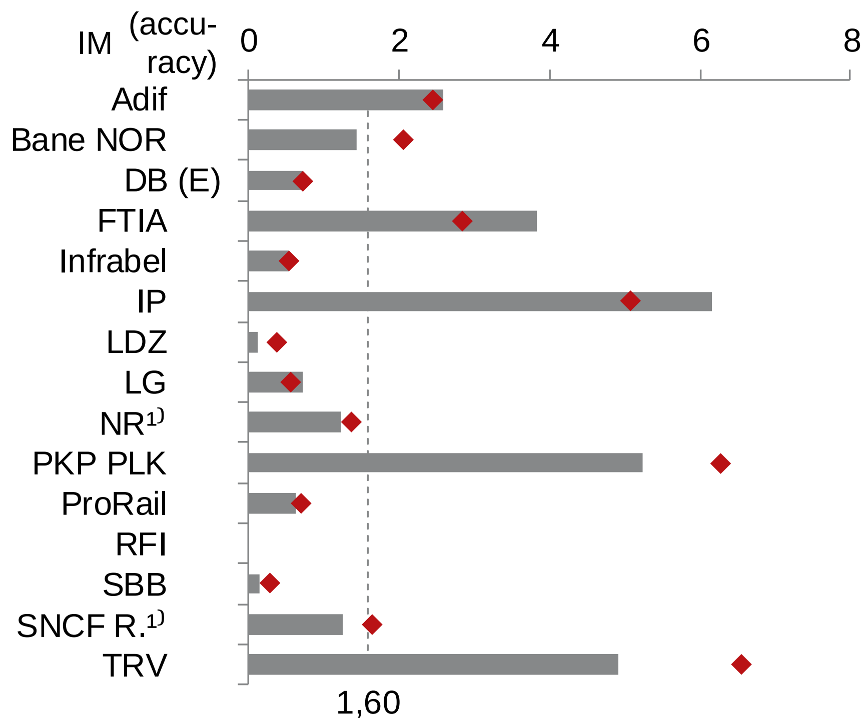
Precursors like broken rails and wrong side signalling failures occur 1,6 times per million train-kilometres

IM related precursors to accidents

KPI 12

Number per million train-km (2017)



- Precursors are a good indicator to understand and mitigate root causes for significant accidents (for example the number of train buckles leading to a risk of train derailments)
- The number of precursors of the peer group varies widely, some showing levels well below the peer group's weighted average while others have significantly higher values
- For a further analysis a breakdown by precursor and the underlying reasons would be valuable; it is also of interest to understand the impact/severity of different precursors

Initial definition was to collect all precursor data. The definition was then narrowed down to a few precursors.

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year
Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019
1) Data of 2016

Safety & Environment – Security – Overview

PRIME

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- Electric trains 19
- CO2 emissions 20

The management of railway security includes activities for the protection of the railway, its users and its staff through monitoring, prevention and preparation of responses to security incidents carried out with malicious intent, which have the potential to harm customers and staff, damage railway assets, or generally to impede and disrupt railway operations.

KPI Name	KPI Definition
Delays caused by security incidents	Number of delay minutes due to security incidents (intentional acts as terrorism, sabotage, cyber-attacks, vandalism, thefts, espionage, unauthorized persons and other acts of aggression or hooliganism) per train-kilometre
National Train cancellations caused by security incidents	Percentage of trains cancelled caused by security incidents (intentional acts as terrorism, sabotage, cyber-attacks, vandalism, thefts, espionage, unauthorized persons and other acts of aggression or hooliganism) per total trains scheduled to be operated

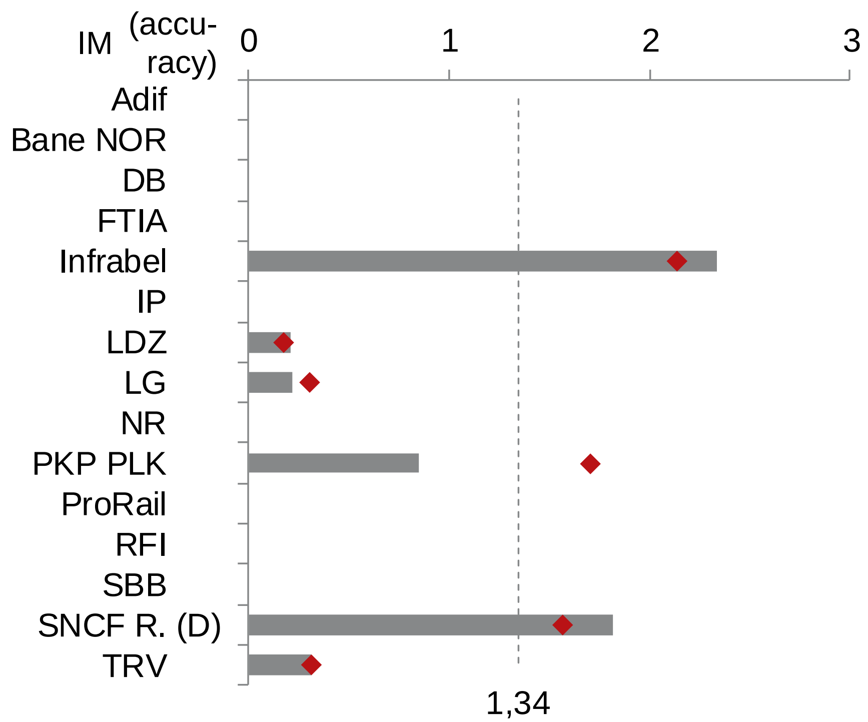
High Level Industry KPI | Benchmarking KPI | KPI under review

On average security incidents cause 1,3 delays minutes per thousand train-kilometres

KPI 15

Delays caused by security incidents

Minutes per thousand train-km (2017)



- The KPI still has a small dataset with an increase in data provision in 2017
- Data shows a range of 0,2 to 2,4 delay minutes per thousand train-kilometres caused by security incidents
- There seem to be some dynamics over the years as average values are quite different compared to values of 2017

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

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Safety & Environment – Environment – Overview

PRIME

Context | **Safety & Environment** | Performance | Delivery | Financial | Growth

Safety
- Accidents 7
  - Precursors 12
- Fatalities 8

Security
- Delays 15
- Train cancellations 16

Environment
- Diesel trains 18
- Electric trains 19
- CO2 emissions 20

Monitoring the environmental impact of the IM focuses on two aspects: the influence of the IM in affecting and improving the environmental impact of the whole integrated railway (e.g. through electrification) and the direct environmental impact of the IM's own activities.

KPI Name	KPI Definition
Share of diesel trains	Diesel train-kilometres compared to train-kilometres both for passenger and freight trains
Share of electric trains	Electric train-kilometres compared to train-kilometres both for passenger and freight trains
Performance against carbon reduction target	CO_2 emission produced from maintenance rolling stock compared to main track-kilometre

High Level Industry KPI | Benchmarking KPI | KPI under review

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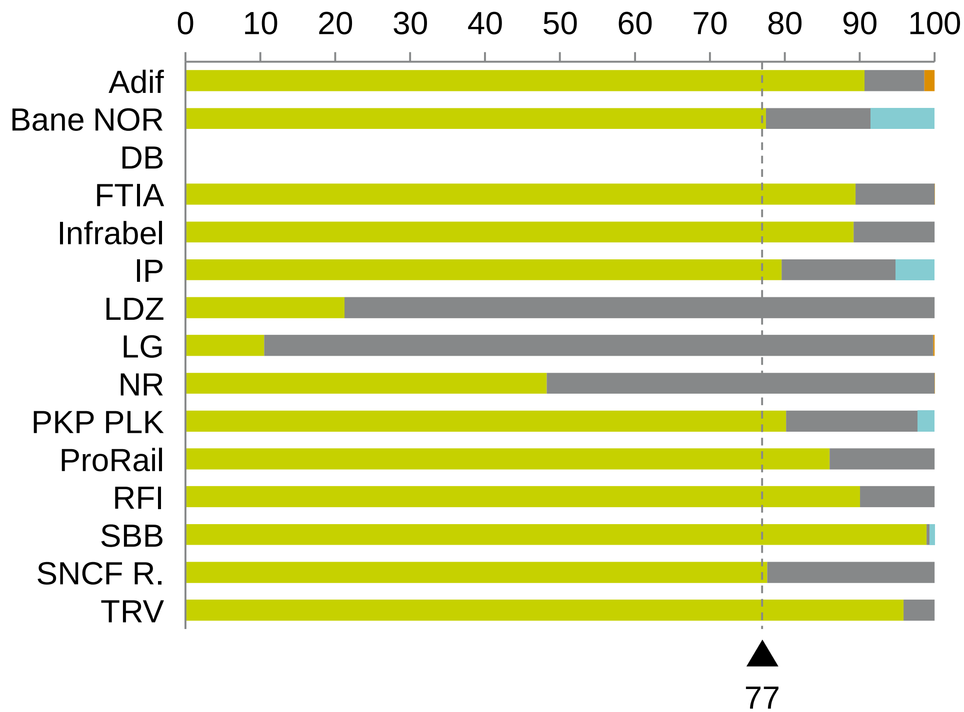
The majority of train-kilometres in the peer group results from electricity-powered trains

KPI 18+19

Share of train types[1)]

% of total train-km (2017)



- Overall the share of electrically produced train-kilometres in the peer group is quite high, reaching 77% of the total
- This reflects the degree of electrification of the network which for most organisations reaches 70% or more (KPI 1)

- The weighted average of the peer group is drawn down particularly by NR's high reliance on Diesel engines
- Unknown share for Adif, FTIA and NR are likely to refer to work trains

Share of electricity-powered trains | Share of diesel-powered trains | Work trains | Unknown

--- Total weighted average of electricity-powered trains

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

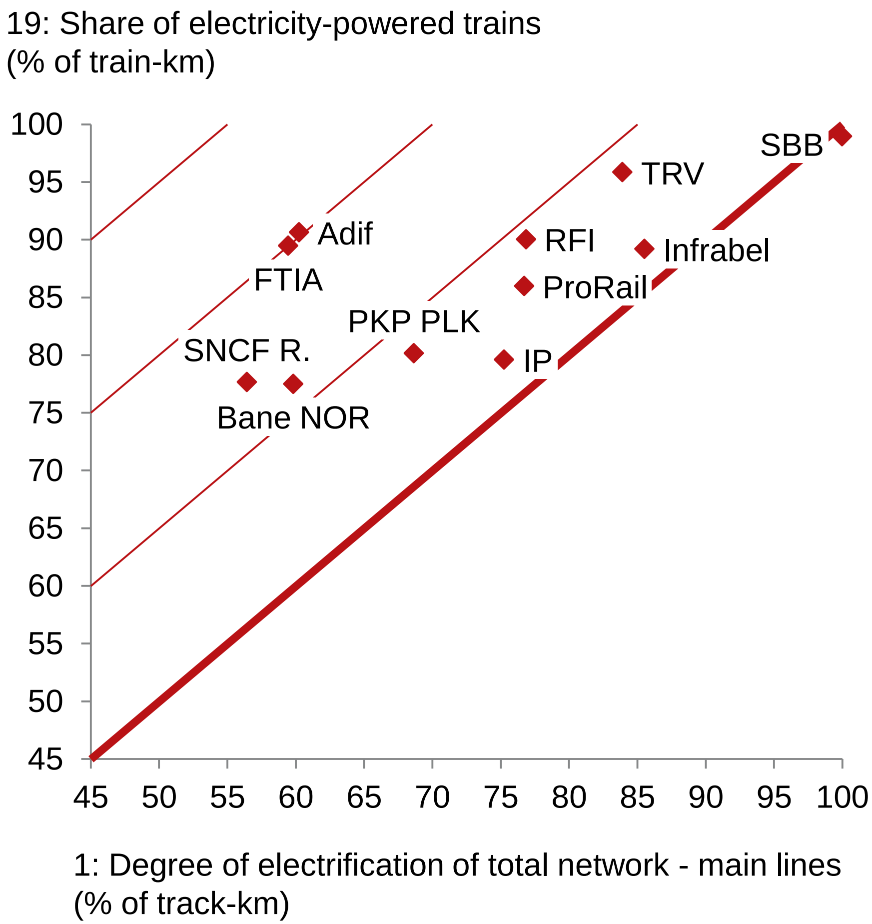
1) For the purpose of this report "Share of train types" (combination of KPI 18 & 19) is considered as a high level KPI

As expected there is a strong correlation between the degree of network electrification and share of electric trains

Share of electricity-powered trains / Electrification

KPI 19 / 1

2017



- In general there is a correlation between the degree of electrification and the share of electric train-kilometre produced in the network
- However it is noticeable that similar degrees of electrification do not lead to similar shares of electrically produced train services
- For instance, SBB reaches a significantly higher share of 99% while other IMs achieve less than 90% although the degree of electrification is higher
- It should be further explored why this is the case and if there are opportunities to more extensively use the electrified infrastructure by reducing the share of diesel trains
- Aspects of further analysis could be: electrification strategy, utilisation of lines, coordination with fleet investments
- LG (10%/9%) and LDZ (21%/16%) were excluded for readability reasons

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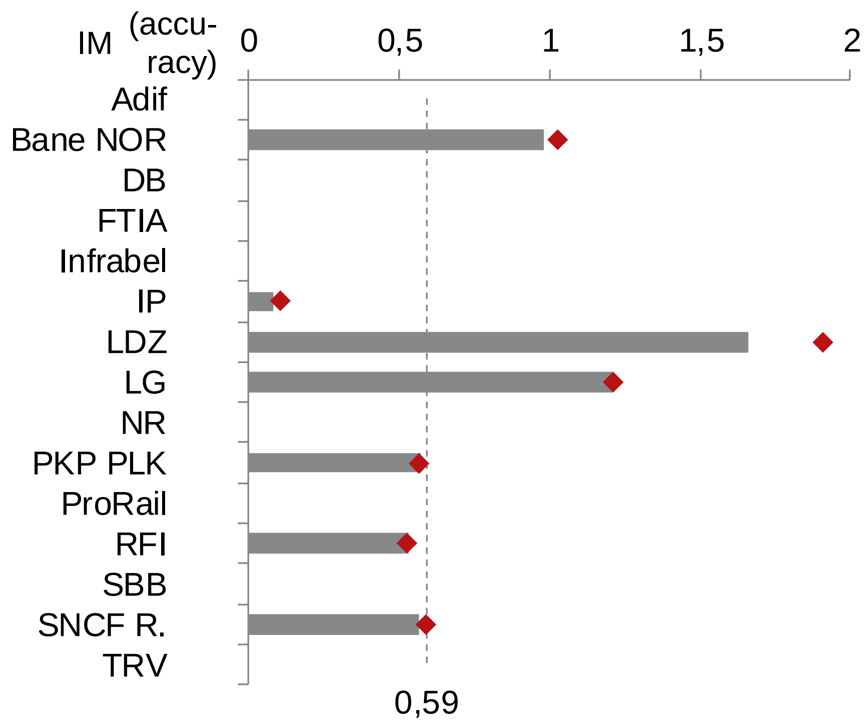
On average IMs' maintenance rolling stock emits 0,6 tonnes of CO_2 per main track-kilometre

KPI 20

CO_2 emission produced from maintenance rolling stock

tCO_2 per main track-km (2017)



- The environmental impact of an IM's maintenance rolling stock is measured by its CO_2 emissions
- On average 0,6 tonnes are annually emitted per main track-kilometre
- However, there are quite large differences between IMs' reporting data which should be further investigated
- Relevant questions are around
  - The intensity of use of this fleet
  - The amount of fleet operated by the IM and considered here (in contrast to fleet operated by contractors)
  - The structure of the fleet in use

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year
Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

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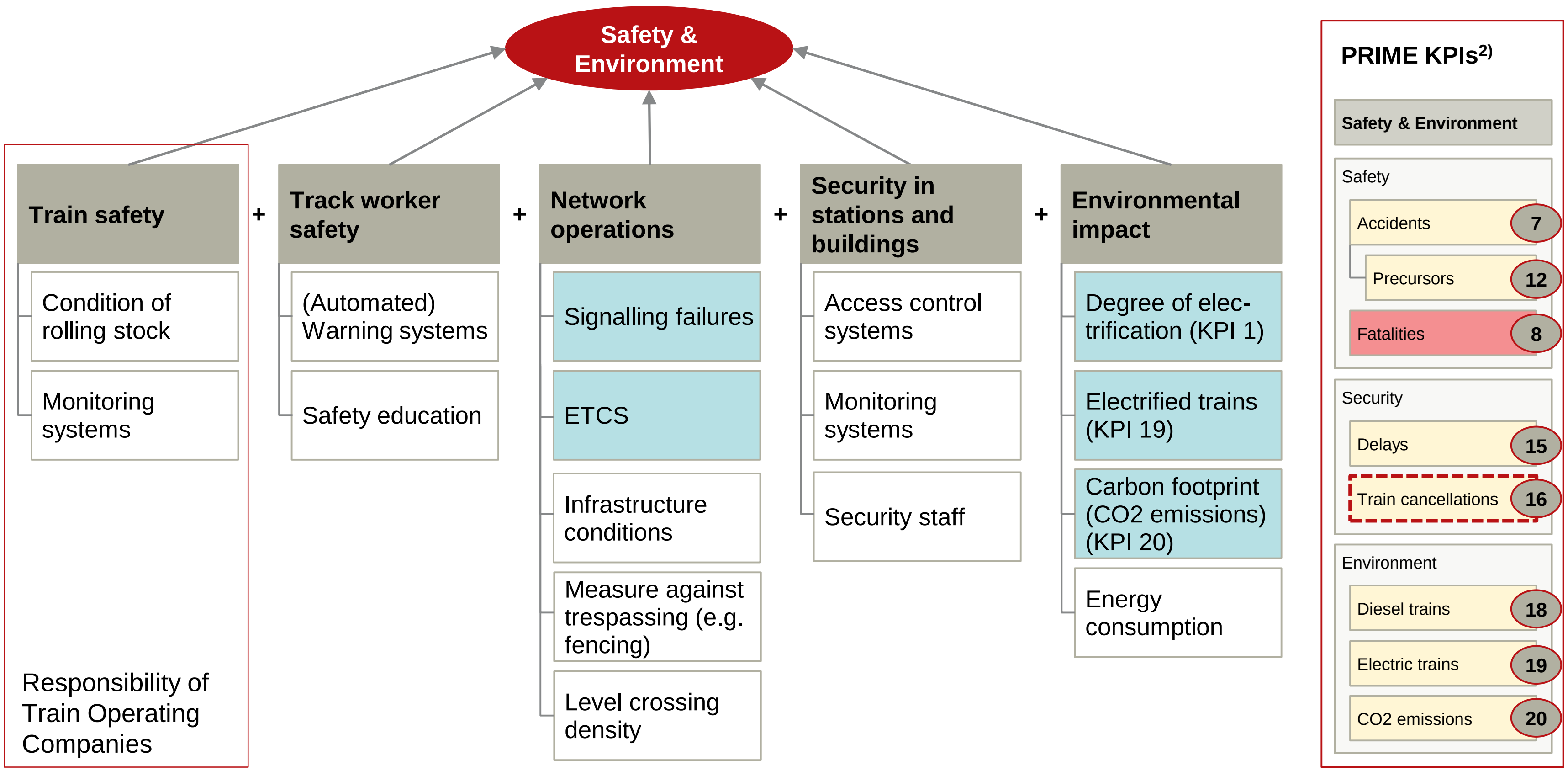
Further analysis on safety and environment could be based on the set of the drivers illustrated below

Safety & Environment – drivers[1)]



1) Drivers which are currently collected in PRIME are coloured light blue
2) As currently collected and evaluated in PRIME

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Further analysis should account for external performance drivers and identify opportunities for improvement

Safety & Environment – Further analysis

- In order to **improve safety performance** (reduce the number of accidents and accident precursors) it would be valuable to investigate the **root causes and the programmes** that IMs initiated to mitigate them
- As precursors to accidents are an important indicator when working on the prevention of critical accidents their impact and severity should be explored more in detail; it would also be valuable to understand how IMs **reduce both the number** of precursors and the resulting number of significant accidents
- In the area of security the **definition of the KPI** “train cancellations caused by safety incidents” needs to be improved and finalised as this KPIs is still critical
- Electrification and the use of electrified trains are important environmental indicators; it should be further explored why **levels of utilisation of electrified track** are different and how electrified track can be exploited better
- The use of **maintenance rolling stock** needs a deeper analysis in order to understand where the differences result from, e.g. considering the volume of maintenance fleet and the intensity of use
- It would be very valuable if well performing IMs and those who improve over time **reported on practices and initiatives** which contribute to their safety and environmental performance

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Table of contents

Aim is to describe the network performance and the resulting impact on operators and customers

Performance – objectives

- Understand the performance of the IM network in relation to other IMs;
- Improve the ability of the IM to enable trains to run on time; and,
- Identify opportunities to improve the management of assets to minimise the number of failures, and the impact of those failures on the operating railway.

Source: PRIME Catalogue Version 2.1, 31 May 2018

Performance – Punctuality – Overview

PRIME

Context | Safety & Environment | **Performance** | Delivery | Financial | Growth

Punctuality
- Passenger trains 28
- Freight trains 29
- Delays caused by IM 31
- Train cancellation caused by IM 34

Reliability
- Delays 35
  - Signalling 36
  - Telecom 37
  - Power supply 38
  - Track 39
  - Structures 40
  - Other 41

Train punctuality is the primary measure of overall railway performance and a key measure of quality of service, driven not only by the IM but also operators and customers. The requirements for punctuality differs between IMs, high-speed routes, core network, customer groups, passenger/freight etc. It is essential to understand both the overall performance of the system through punctuality, as well as the IM's impact on and responsibility for punctuality.

KPI Name	KPI Definition
Passenger trains punctuality	For national and international passenger trains (excluding work trains) the percentage of all trains which arrive at each measuring point with a delay of less than or equal to 5:29 minutes compared to all trains actually operated (i.e. were not cancelled) out of those that were scheduled in the original working timetable, including those timetabled at short notice
Freight trains punctuality	For national and international freight trains (excluding work trains) the percentage of all trains which arrive at each measuring point with a delay of less than or equal to 15:29 minutes compared to all trains actually operated (i.e. were not cancelled) out of those that were scheduled in the original working timetable, including those timetabled at short notice
Delay minutes per train-km caused by the IM	Average delay minutes per train-km caused by incidents that are regarded as IMs responsibility according to UIC leaflet 450-2, Appendix A - Table 1 (columns 1 through 3) and Appendix B.1 through B.3. Train-kms considered are total train-km operated (revenue service + shunting operations to and from depots + IM's work traffic). Delay minutes will be measured at all available measuring points. Of these measured delay minutes the maximum number is counted if it exceeds a threshold of 5:29 minutes for passenger services and 15:29 minutes for freight services. This is in accordance with UIC leaflet 450-2 chapter 4.1 - Rounding rules, number 2. No delay minutes are counted if these thresholds are not exceeded at any measuring point
Percentage of train cancellations caused by the IM	Percentage of fully or partially cancelled national and international passenger trains that are included in the last working timetable issued the day before the service (or the timetable that is valid when the train service takes place) which were caused by incidents that are regarded as IMs responsibility according to UIC leaflet 450-2, Appendix A - Table 1 (columns 1 through 3) and Appendix B.1 through B.3. All four types of cancelled trains are to be included: full cancellation (cancelled at origin), part cancellation en route, part cancellation changed origin, part cancellation diverted

High Level Industry KPI | Benchmarking KPI | KPI under review

PRIME Platform of Rail Infrastructure Managers in Europe

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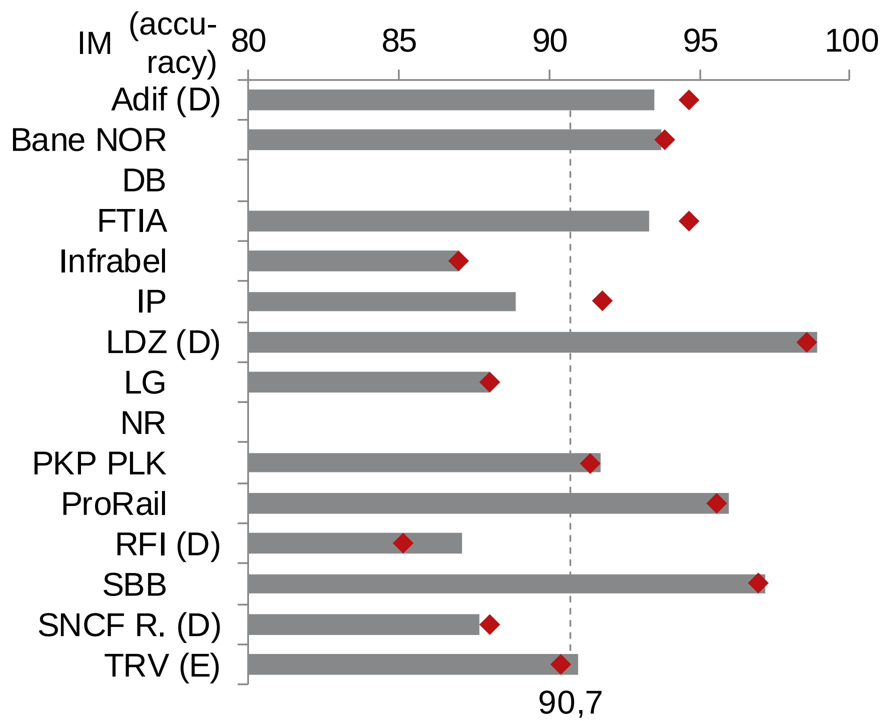
On average 91% of passenger trains are on time

KPI 28

Passenger trains punctuality

% of trains (2017)



- Further work is undertaken by IMs to collect punctuality data according to the PRIME definition, in order to make this measure more comparable across the peer group
- Among IMs with normal data SBB and ProRail show highest levels of punctuality. FTIA and IP have more delays compared to last years' average
- It would be interesting to analyse:
  - reasons behind the good and improving performances of individual IMs
  - external drivers of performance differences such as utilisation or network complexity

Some IMs use differing observation points and rounding rules for measuring punctuality

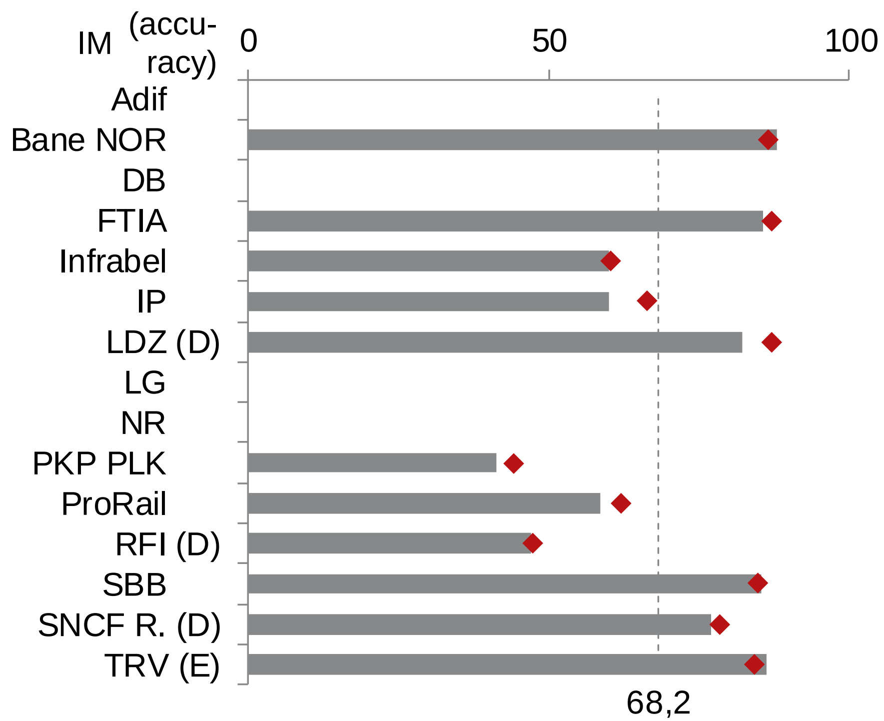
Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year
Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

On average 68% of freight trains are on time

KPI 29

Freight trains punctuality

% of trains (2017)



- Further work is required by IMs to collect punctuality data according to the PRIME definition, in order to make this measure more comparable across the peer group
- Among the IMs with normal data, freight punctuality is highest for Bane NOR, FTIA and SBB. Freight punctuality varies by a factor of 2 and is considerably lower than for passenger traffic, despite its higher delay threshold
- It would be interesting to understand
  - why there is such a wide variation in freight train punctuality
  - the reasons behind the good performances

Some IMs use differing observation points and rounding rules for measuring punctuality

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

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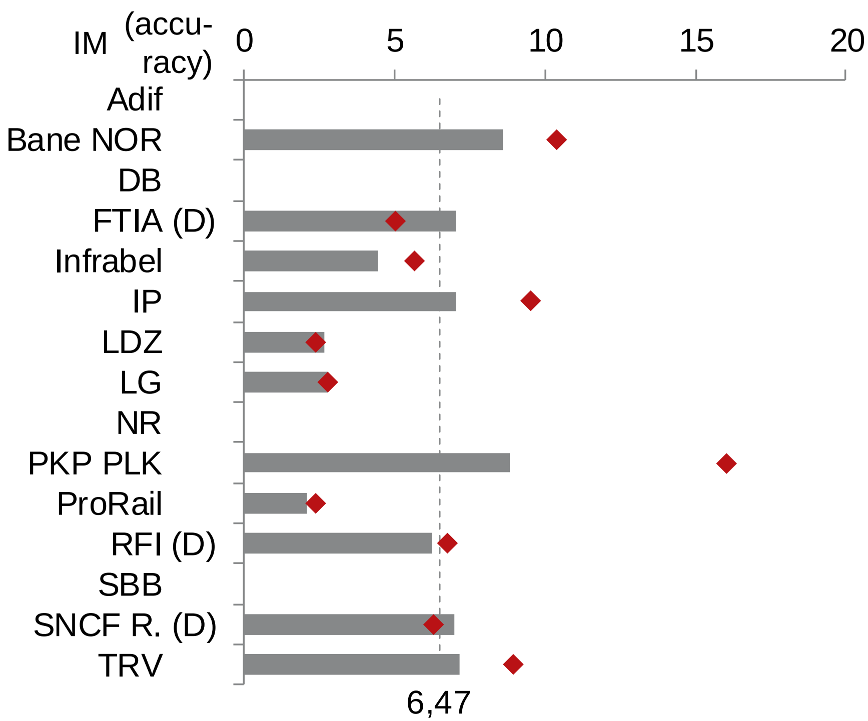
The average of delays caused by IMs is 6 minutes per thousand train-kilometre

Delay minutes per train-km caused by the IM

KPI 31

Minutes per thousand train-km (2017)



- Delays vary between 2 and 9 minutes per thousand train-kilometre. ProRail shows a significantly lower level of delay minutes than others and this is consistent with its good overall passenger punctuality (KPI 28)
- Several IMs have considerably reduced delays in their responsibility in 2017
- It would be interesting to
  - break down delay minutes by cause to identify main causes, positive trends and thus opportunities for reducing delays
  - understand the reasons and initiatives behind positive trends

Delay causes include: Operational planning, Infrastructure installations, Civil engineering causes, Causes of other IM

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year
Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

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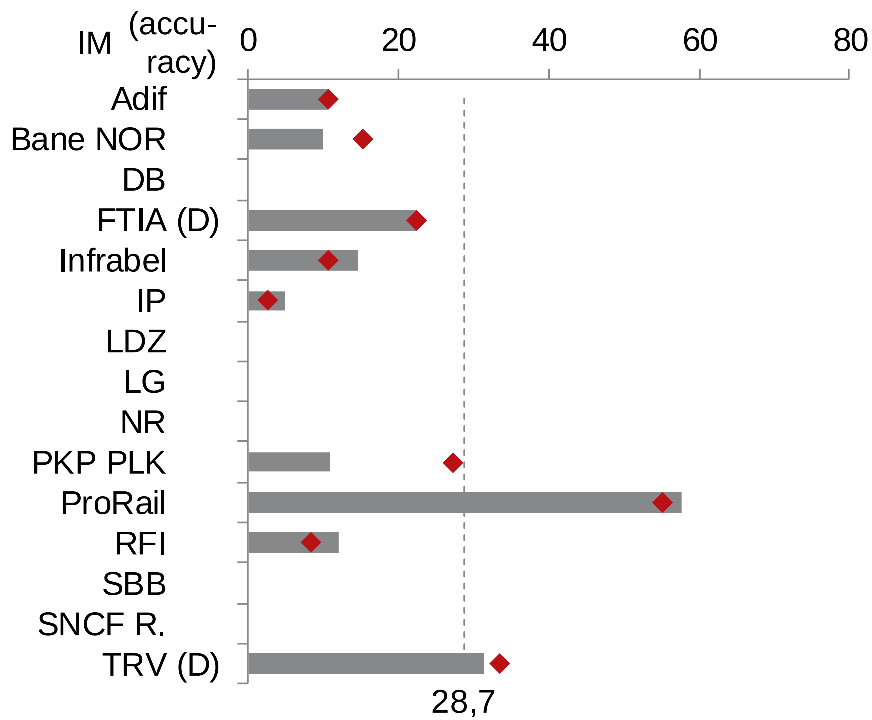
On average IMs cause 29 percent of all passenger train cancellations

KPI 34

Passenger train cancellations caused by the IM

% of scheduled and cancelled passenger trains (2017)



- The percentage of train cancellations caused by IMs varies widely, some showing levels well below the weighted average while others have significantly higher values
- IP stands out as causing no or very few train cancellations. The main reason is that IP had very few infrastructure related works leading to cancellations
- It would be interesting
  - for IP to provide explanations for their outstanding performance
  - to understand the relationship between delays and train cancellations caused by IMs
  - to understand the breakdown of train cancellations by cause (type of incidents within IM's responsibility)

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

Performance – Reliability – Overview

PRIME

Context | Safety & Environment | **Performance** | Delivery | Financial | Growth

Punctuality
- Passenger trains 28
- Freight trains 29
- Delays caused by IM 31
- Train cancellation caused by IM 34

Reliability
- Delays 35
  - Signalling 36
  - Telecom 37
  - Power supply 38
  - Track 39
  - Structures 40
  - Other 41

Reliability of the infrastructure demonstrates the impact of failures. As well as managing its assets in such a way as to minimise the effect of failures on the railway, these indicators also measure the effectiveness and timeliness of the IM in responding to these failures, and returning the network to normal function.

KPI Name	KPI Definition
Average delay minutes per assets failures	Average delay minutes caused by asset failures on main track according to UIC CODE 450-2, numbers 20-25 and 28-29. Delay causes should include both primary causes and secondary causes.
Average delay minutes per … failures	… numbers 20 & 21 including failures related to signalling installations and signalling installations at level crossings.
	… number 22 including failures related to Telecommunications (GSM-R, Radio failure and more).
	… number 23 including failures in the power supply for electric traction, others and variation and drops of voltage.
	… number 24 including failures due to rail breakage, lateral distortion and other track failures.
	… number 25 including failures at bridges and tunnels.
	… number 28 & 29 including failures according to the managing and planning of staff and other failures.

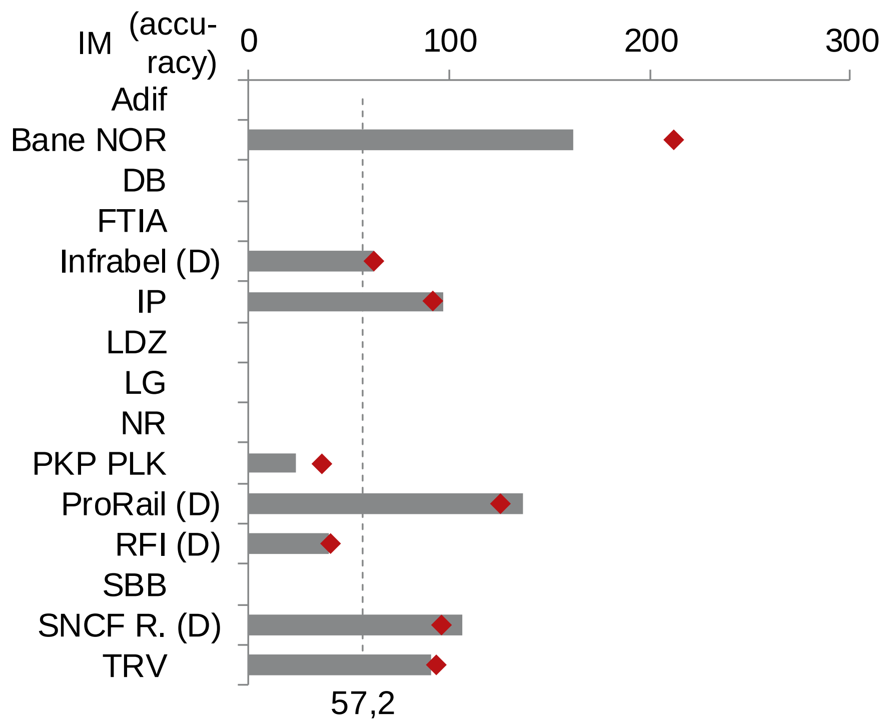
High Level Industry KPI | Benchmarking KPI | KPI under review

On average asset failures cause a delay of 57 minutes

KPI 35

Average delay minutes per asset failure

Minutes per failure (2017)



- The average delay minutes per asset failure varies widely
- Further work is required by IMs to collect data according to the PRIME definition, in order to make this analysis meaningful.

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year
Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

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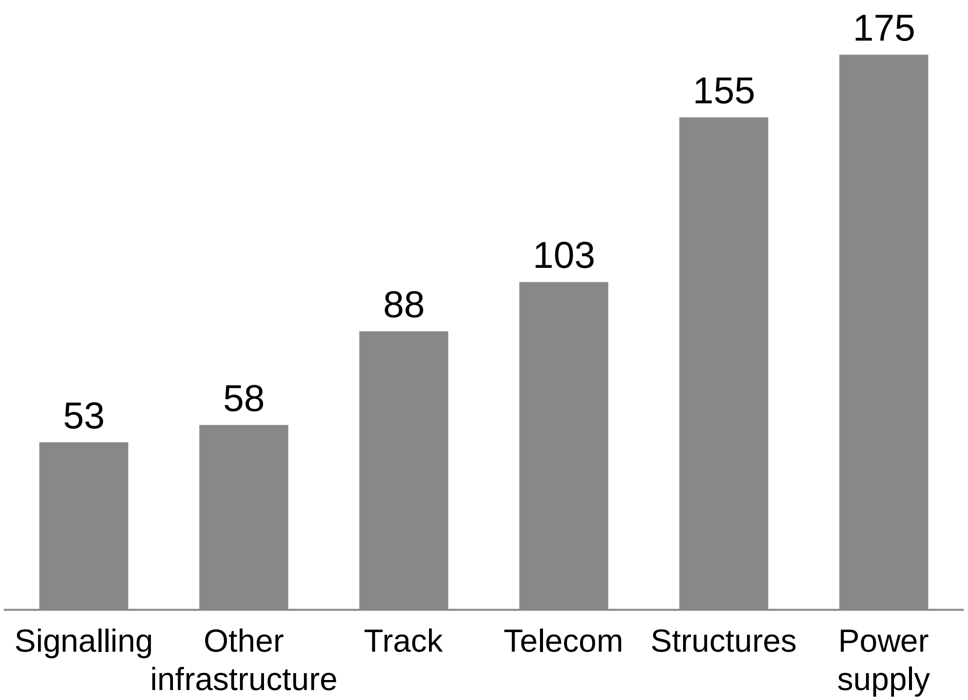
Across the peer group, power supply, structure and telecom failures have particularly large avg. impacts on delays

Average delay minutes per asset failure

KPI 35

Minutes per failure (2017)



- Power supply failures have the largest average impact on delays with 175 minutes per failure followed by structure failures with 155 minutes per failure. However Structure failures have to lowest occurrence by a large margin
- These are followed by average delay minutes per telecommunication failure (103 minutes) and track failure (88 minutes)
- The average impacts of other failures (58 minutes) and signalling failures (53 minutes) are comparatively low, however signalling failures are the most frequent by far
- The frequency of failures in these asset groups needs to be considered in order to determine the overall impact on punctuality

7	7	7	7	7	7	IMs who delivered[1)]
50.611	9.157	9.359	1.871	96	5.711	# of asset failures
66	12	12	2	0	7	% of asset failures

Peer average

1) both asset failures and delay minutes for each asset class

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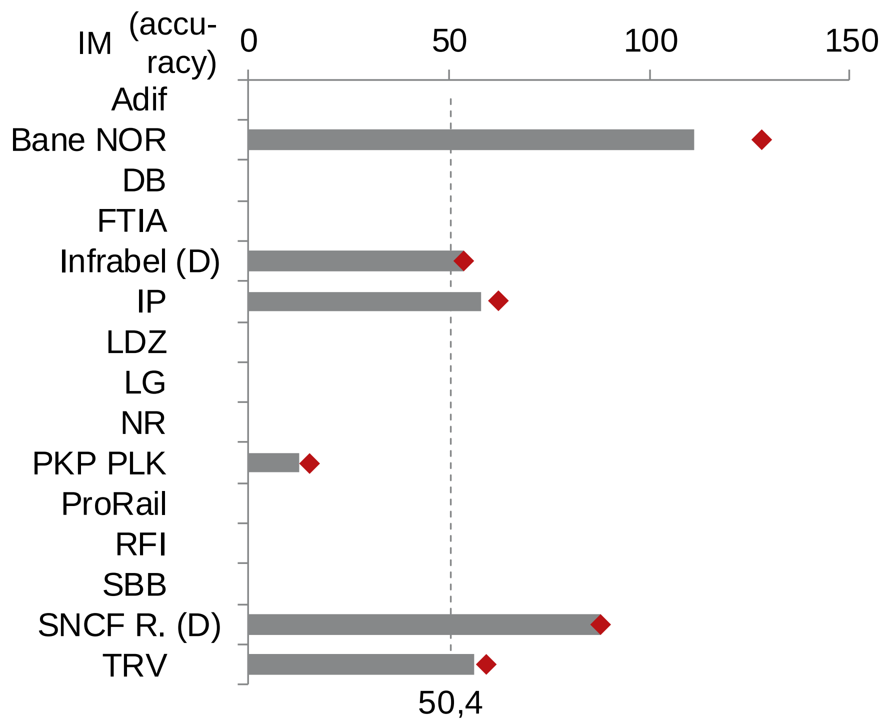
On average a signalling failure causes a delay of 50 minutes

KPI 36

Average delay minutes per signalling failure

Minutes per failure (2017)



- Further work is required by IMs to collect data according to the PRIME definition, in order to make this comparative analysis meaningful
- It may be acknowledged that PKP PLK show levels significantly below the weighted average
- It would therefore be valuable for PKP PLK to provide explanations of the work that they have implemented to achieve low and decreasing levels of average delays
- Signalling failures have a relatively low average impact on delays when compared to other types of failures (KPI 35) but they account for 66% of all asset failures recorded by the peer group (KPI 51)

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

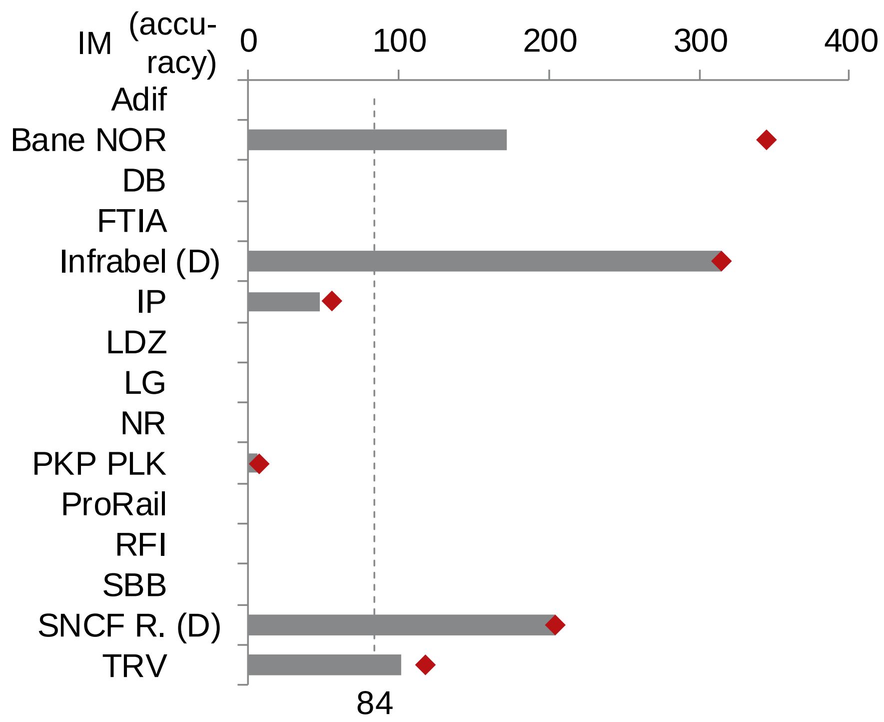
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

On average a telecommunication failure causes a delay of 84 minutes

Average delay minutes per telecommunication failure

KPI 37

Minutes per failure (2017)



- Further work is required by IMs to collect data according to the PRIME definition, in order to make this comparative analysis meaningful
- Nevertheless it may be acknowledged that PKP PLK manage to limit the impact of telecom failures to single digit delays
- While telecom failures account for only 2% of all asset failures recorded by the peer group (KPI 51) the average impact of a telecom failure on delays is high when compared to the impact of other types of failures (KPI 35)

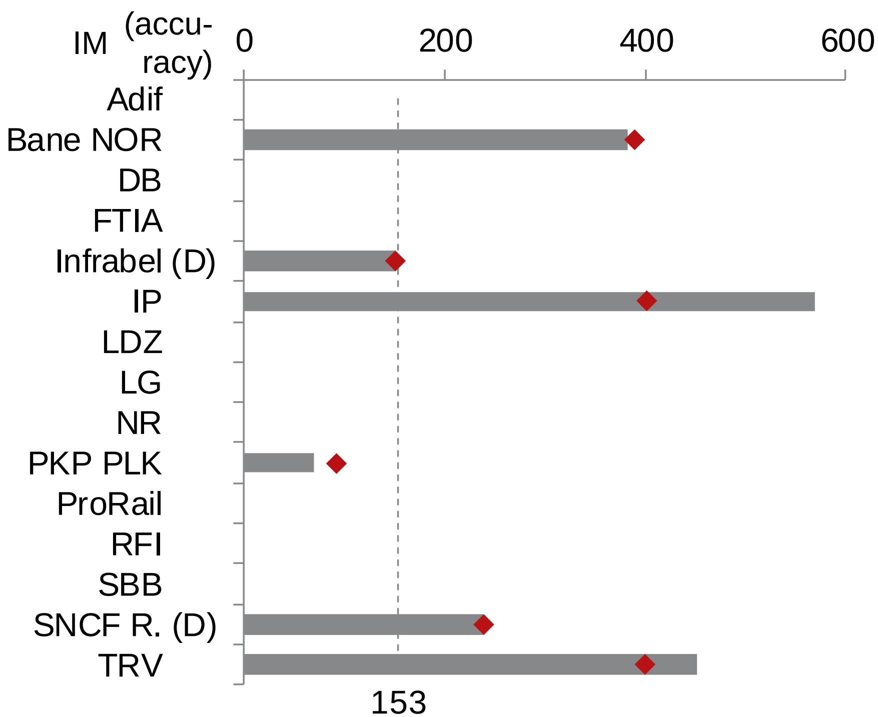
Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year
Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

On average a power supply failure cause a delay of 153 minutes

KPI 38

Average delay minutes per power supply failure

Minutes per failure (2017)



- Further work is required by IMs to collect data according to the PRIME definition, in order to make this comparative analysis meaningful
- It may be acknowledged that PKP PLK manage a significantly lower level of delays per failure
- While power supply failures account for only 7% of all asset failures recorded by the peer group (KPI 51) a power supply failure causes one of the largest average impacts on delays among all types of asset failures, according to this sample

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year
Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

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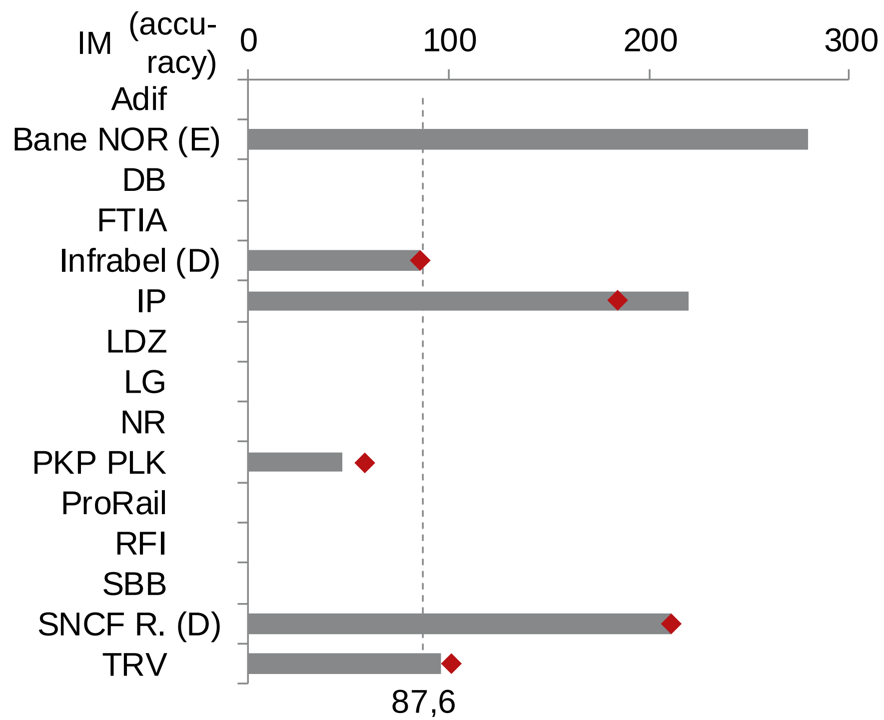
On average a track failure causes a delay of 88 minutes

KPI 39

Average delay minutes per track failure

Minutes per failure (2017)



- Further work is required by IMs to collect data according to the PRIME definition, in order to make this comparative analysis meaningful
- The track system accounts for 12% of all asset failures recorded by the peer group making it the second least reliable asset group behind the signalling system (KPI 51)

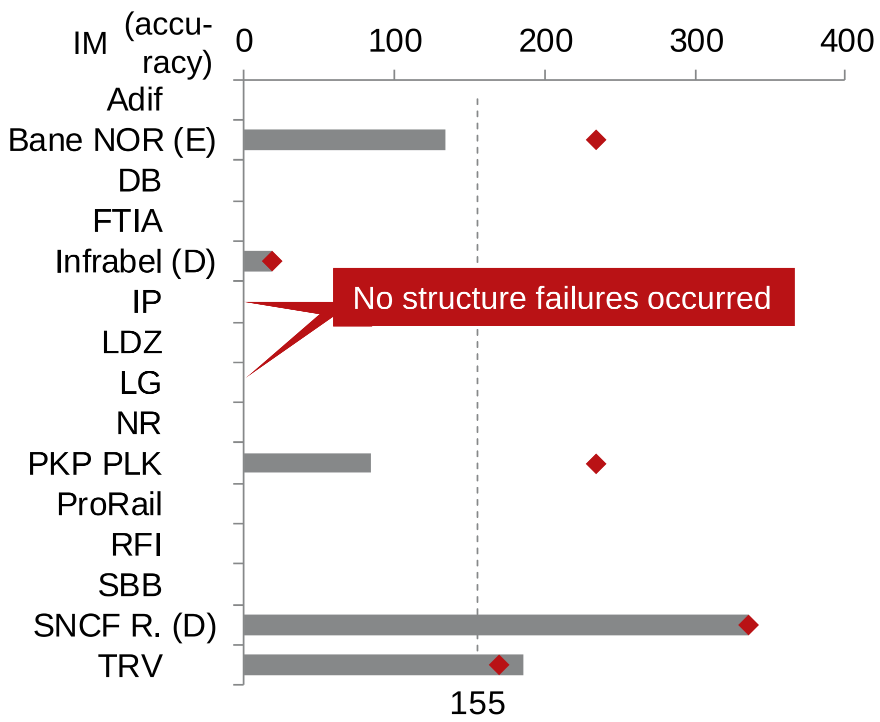
Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year
Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

On average a structure failure causes a delay of 155 minutes

KPI 40

Average delay minutes per structure failure

Minutes per failure (2017)



- Further work is required by IMs to collect data according to the PRIME definition, in order to make this comparative analysis meaningful
- IP and LG did not record any structure failures in 2017

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

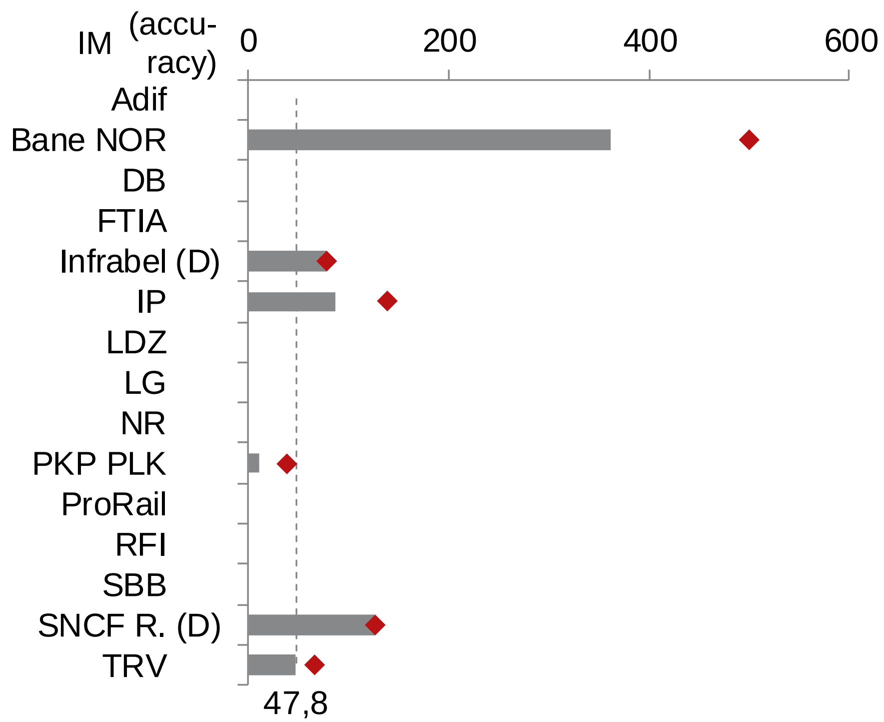
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

On average any other failure causes a delay of 48 minutes

KPI 41

Average delay minutes per other failure

Minutes per failure (2017)

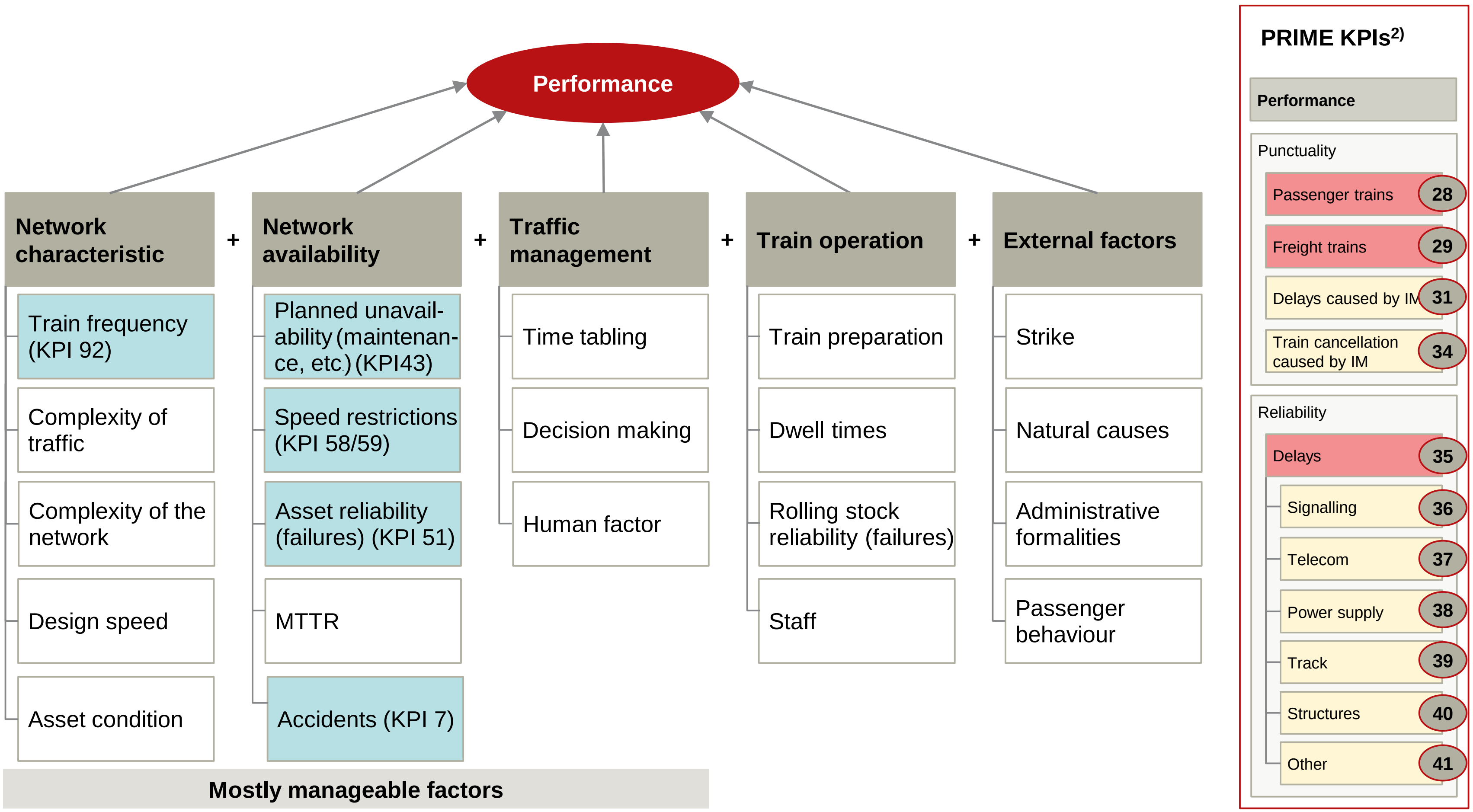


- Further work is required by IMs to collect data according to the PRIME definition, in order to make this comparative analysis meaningful
- Nevertheless it may be acknowledged that PKP PLK manage a significantly lower level of delays per failure
- It would then be valuable for PKP PLK to provide explanations of the work that they have implemented to achieve their outcomes

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year
Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

IMs are encouraged to use civity's first draft of a root-cause analysis as basis for discussing performance differences

Performance – drivers[1)]



1) Drivers which are currently collected in PRIME are coloured light blue
2) As currently collected and evaluated in PRIME

Further analysis should account for external performance drivers and identify opportunities for improvement

Performance – Further analysis

- In order **to understand performances and performance differences** between IM networks it would be good to identify, analyse and account for external drivers of these differences.
- civity's first draft of a root cause analysis for performance indicates what these external factors are. For example, it would be helpful to understand the impact of utilisation and network complexity on punctuality levels
- In order to then **identify** and assess room and **opportunities for improvement**, it is recommended to break down delays (and train cancellations) by cause as well as to analyse the evolution of this over time. This would allow to identify main delay causes, positive trends and thus opportunities for reducing delays
- The **coverage of delay causes should be improved**. Further work is required by IMs to collect data on average delays per type of failure (KPIs 35-41), construction work (KPIs 43-44) and speed restrictions (KPIs 58-59) as this data is currently less complete and robust than the majority of other KPIs
- Having identified potential areas for improvement, it needs to be analysed **how performance can be improved** in these areas. A first root cause analysis for performance indicates drivers which are internally manageable by IMs
- It would be very valuable if well performing IMs and those who improve over time **reported on practices and initiatives** which contribute to their performance.

Table of contents

Aim is to describe the effectiveness of the IM's internal processes and management of the assets

Delivery – objectives

- Deliver an available, operable and fully functional network, to the required level of capacity;
- Carry out its asset management functions effectively and in a timely manner; and
- Maintain and improve asset condition in line with its strategy.

Source: PRIME Catalogue Version 2.1, 31 May 2018

Delivery – Capacity – Overview

PRIME

Context | Safety & Environment | Performance | **Delivery** | Financial | Growth

Capacity
- Possessions planned 43
- Possessions utilised 44

Condition
- Asset failures 51
  - Signalling 52
  - Telecom 53
  - Power supply 54
  - Track 55
  - Structures 56
  - Other 57
- Permanent speed restrictions 58
- Temporary speed restrictions 59

The Capacity category measures the overall constraints on capacity of the IM's network. It includes the impact on capacity from the condition of the IM's infrastructure and the impact of activities undertaken to maintain or improve overall condition.

KPI Name	KPI Definition
Possessions planned	Share of main track planned for IMs activities, including maintenance, enhancement and renewals on main tracks. Planned work in the yearly timetable. This is calculated as the number of main track-km planned for IMs activities weighted by duration and divided by the total network length
Possessions utilised	Ratio of executed to planned possessions for IMs activities included in the yearly timetable, including maintenance, enhancement and renewals on main tracks. This is calculated as the sum of main track-km-days divided by sum of main track-km-days planned

High Level Industry KPI | Benchmarking KPI | KPI under review

Delivery – Condition – Overview

PRIME

Context | Safety & Environment | Performance | **Delivery** | Financial | Growth

Capacity
- Possessions planned (43)
- Possessions utilised (44)

Condition
- Asset failures (51)
  - Signalling (52)
  - Telecom (53)
  - Power supply (54)
  - Track (55)
  - Structures (56)
  - Other (57)
- Permanent speed restrictions (58)
- Temporary speed restrictions (59)

The measurement of asset condition is complex, and not always straight forward for a single IM, never mind as a comparative metric for use in bench-marking. Therefore the PRIME condition category describes the condition of the asset primarily in terms of how well it functions (i.e. number of failures) and in terms of the impact of condition of the assets on the expected delivery of the network, in terms of temporary and permanent speed restrictions.

KPI Name	KPI Definition
Assets failures per thousand main track-km	Number of asset failures on main track according to UIC CODE 450-2, numbers 20-25 and 28-29 per thousand main track-km.
… failures per thousand main track-km	… numbers 20 & 21 … . Including failures related to signalling installations and signalling installations at level crossings.
	… number 22… . Including failures related to Telecommunications (GSM-R, Radio failure and more).
	… number 23 … . Including failures in the power supply for electric traction, others and variation and drops of voltage.
	… number 24 … . Including failures due to rail breakage, lateral distortion and other track failures.
	… number 25 … . Including failures at bridges and tunnels.
	… numbers 28 & 29 … . Failures according to the managing and planning of staff and other failures.
Tracks with permanent speed restrictions	Percentage of tracks with permanent speed restriction due to deteriorating asset condition weighted by the time the restrictions are in place (included in the yearly timetable), related to total main track-km
Tracks with temporary speed restrictions	Percentage of tracks with temporary speed restriction due to deteriorating asset condition weighted by the time the restrictions are in place (not included in the yearly timetable), related to total main track-km

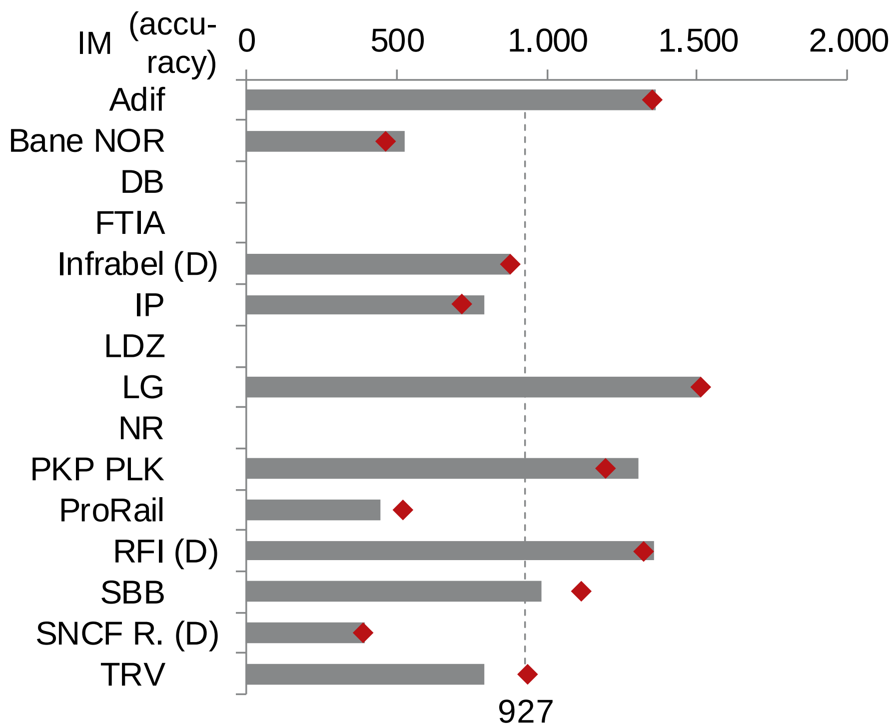
High Level Industry KPI | Benchmarking KPI | KPI under review

On average 900 assets are failing per thousand main track-kilometre and year

Asset failures in relation to network size

KPI 51

Number per thousand main track-km (2017)



- Asset failure frequency in the peer groups' railway networks varies between 400 and 1.500 failures per thousand main track-kilometre and year
- Three IMs (BaneNOR, ProRail and SNCF-Réseau) achieve a failure rate well below the weighted average
- All failure rates appear to be relatively constant over time
- Balance between preventive and corrective maintenance regimes need to be taken into account
- Extent of use of different failure registration tools might have an impact on this comparative analysis

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

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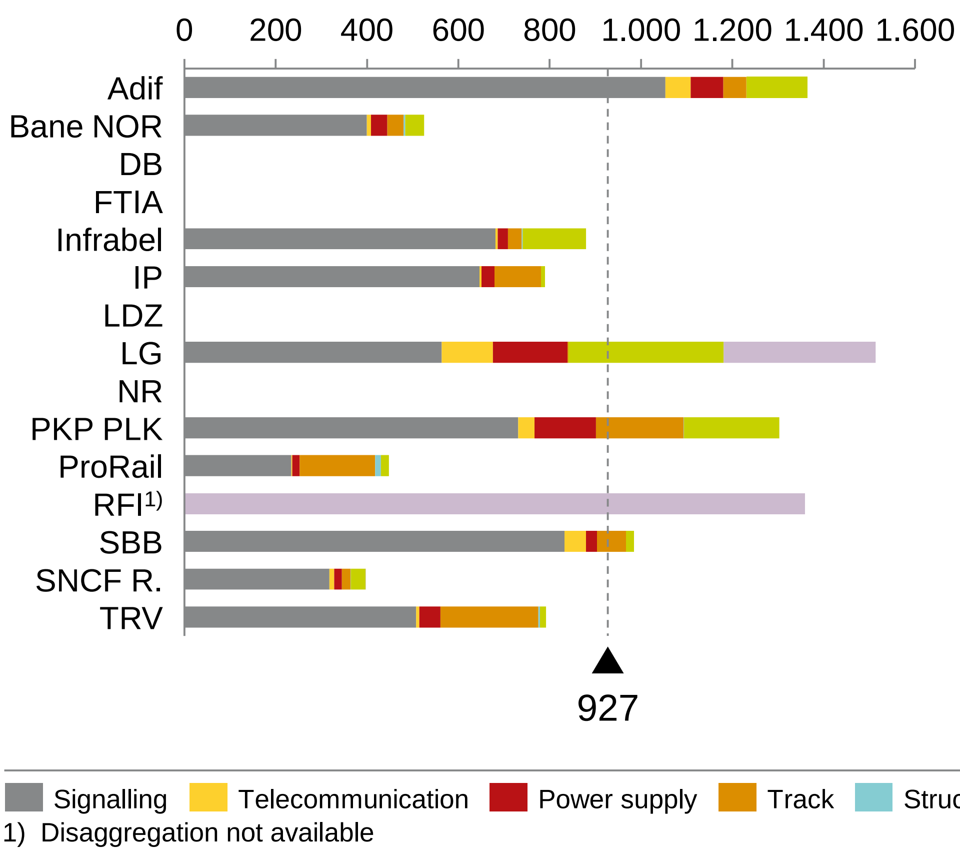
The majority of asset failures occurs in the signalling system

Asset failures in relation to network size

KPI 51

Number per thousand main track-km (2017)



- Based on current data, signalling accounts for 66% of all asset failures
- The track system with 12% is the second highest failing asset group
- Power supply (7%) and telecommunication assets (2%) appear to be more reliable
- Structure failure frequency is negligible (0,1%)
- Of course the impact of failures on train operations is expected to show a different distribution among the asset groups
- The distribution of other asset failures is very heterogeneous. Where it is reported, its impact should not be neglected

1) Disaggregation not available

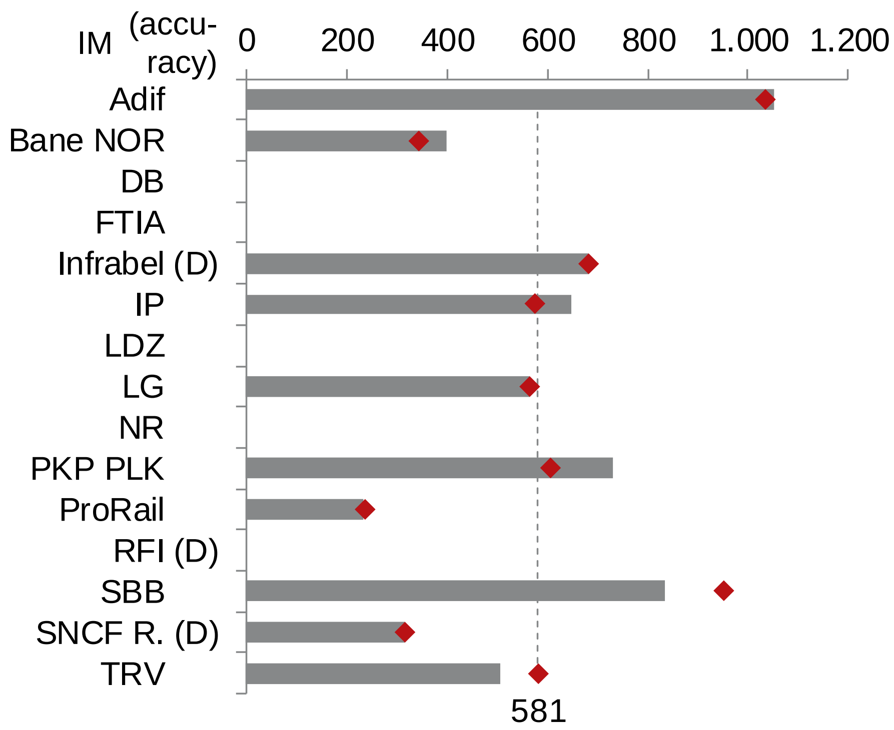
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

Average failure frequency for signalling assets is 580 per thousand main track-kilometre and year

Signalling failures in relation to network size

KPI 52

Number per thousand main track-km (2017)



- The failure frequency varies widely between 230 and 1.050 failures per thousand main track-kilometre and year
- Signalling failure rates appear to be relatively constant over time
- As signalling accounts for the majority of all asset failures (66%) it would be useful to identify the most critical components among all signalling assets
- Also different signalling technologies should be taken into account

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

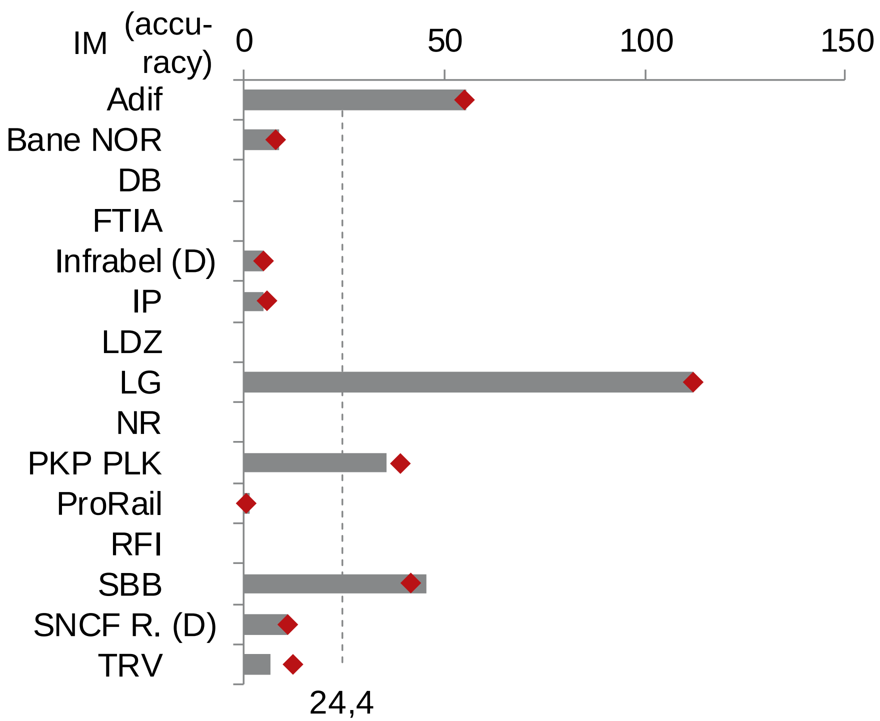
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

Average failure frequency for telecommunication assets is 24 per thousand main track-kilometre and year

Telecommunication failures in relation to network size

KPI 53

Number per thousand main track-km (2017)



- The failure frequency varies widely between 2 and nearly 110 failures per thousand main track-kilometre and year
- Six out of ten IMs (BaneNOR, Infrabel, IP, ProRail, SNCF R. and TRV) appear to have quite reliable systems
- Failure rates appear to be relatively constant over time except for TRV, that shows a decrease in 2017 compared to the average of 2012-2017
- Even if telecommunication plays a minor role (2%) in all asset failures, it would be worth to understand
  - The main reasons for failing telecommunication assets
  - What different telecommunication technologies are in place
  - How some IMs achieve such a low failure frequency

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

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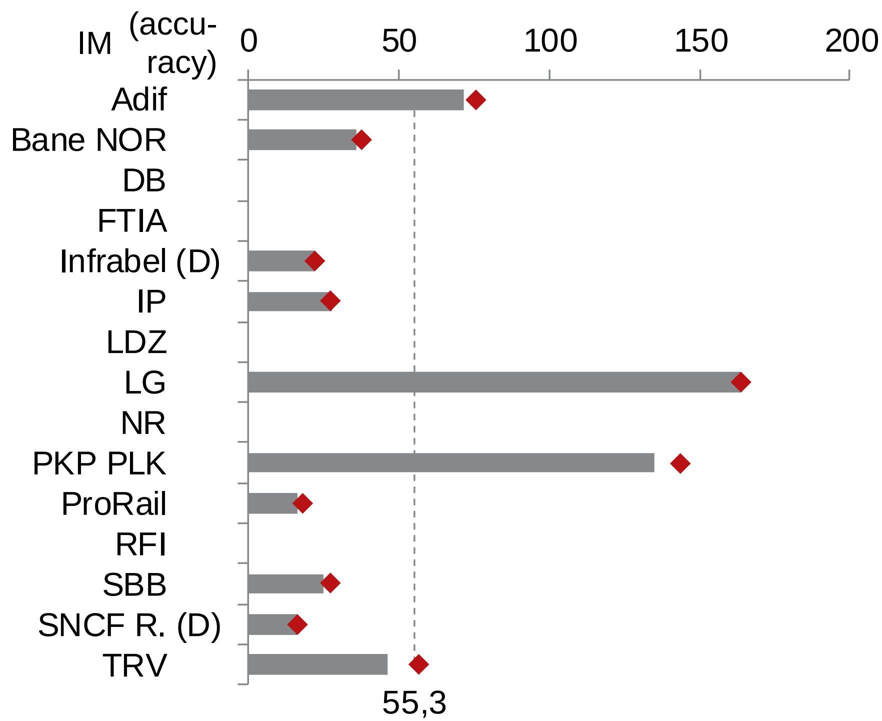
Average failure frequency for power supply assets is 55 per thousand main track-kilometre and year

Power supply failures in relation to network size

KPI 54

Number per thousand main track-km (2017)



- The failure frequency varies widely between 16 and 630 failures per thousand main track-kilometre and year
- Power supply failure frequency plays a minor role (7%) compared to the entire asset failure rate in the network
- A more precise comparison would have to take the degree of electrification into account, i.e. the power supply failure rate should refer to the length of electrified main track
- Especially in the power supply system, the impact of asset failures on train operations is essential (as already identified in the dimension "Reliability")

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year
Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

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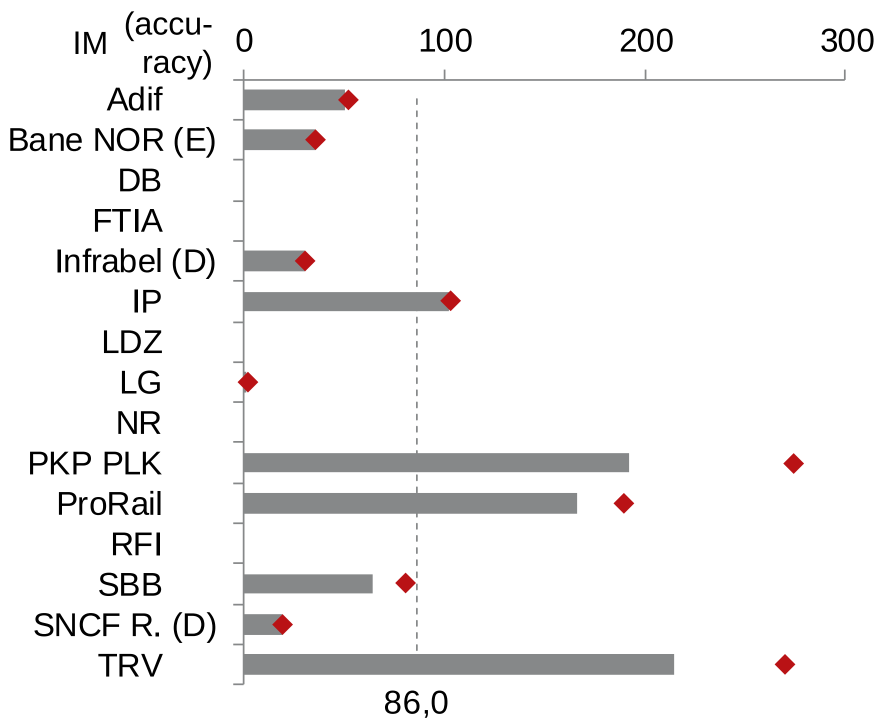
Average failure frequency for track assets is 86 per thousand main track-kilometre and year

Track failures in relation to network size

KPI 55

Number per thousand main track-km (2017)



- The failure frequency varies widely between 2 and 200 failures per thousand main track-kilometre and year
- Five out of ten IMs (Adif, BaneNOR, Infrabel, LG and SCNF R.) achieve a track failure rate well below the weighted average
- PKP PLK, ProRail, SBB and TRV show a decrease in 2017 compared to the average of 2012-2017
- As the track system is the second highest failing asset group (12% of all asset failures), an in-depth analysis could identify
  - The main reasons for track failures
  - How track quality is measured at the IMs
  - If there is a correlation between track failures and age of track (in terms of years and/or accumulated gross tonnage)

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

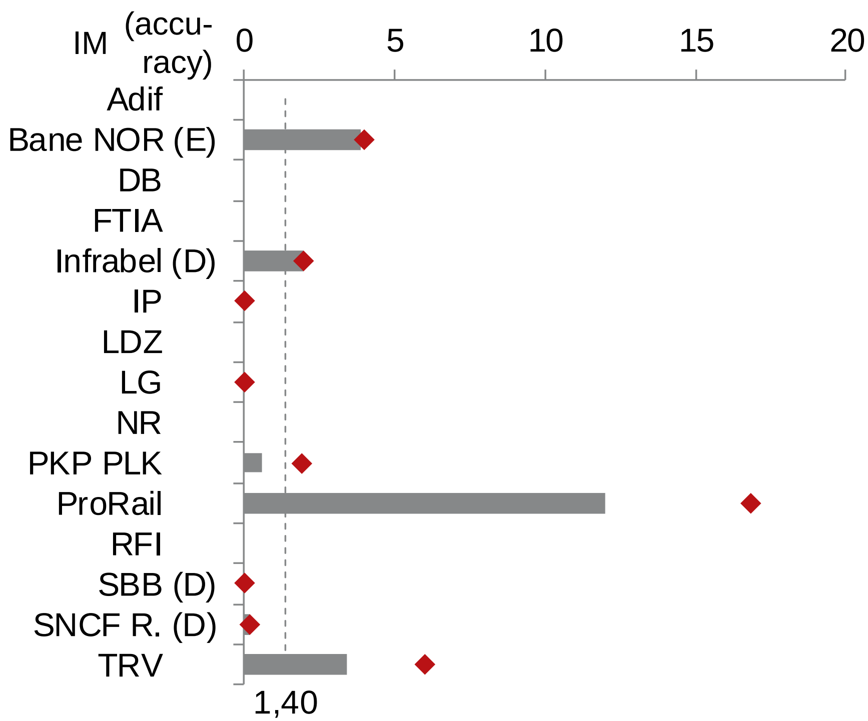
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

Average failure frequency for structures is 1 per thousand main track-kilometre and year

KPI 56

Structure failures in relation to network size

Number per thousand main track-km (2017)



- The failure frequency varies between 0 and 12 failures per thousand main track-kilometre and year
- The higher number of failures at ProRail results from the large number of bridges and collisions by boats
- A few IMs show a slight decrease in 2017 compared to the average of 2012-2017
- Compared to the average asset failure frequency in the peer groups' network, structure failure rates are negligible (0,1%)
- Similar to the power supply system, a more precise comparison would have to take the share of structures into account, i.e. the structure failure rate should refer to the length main track on bridges/ in tunnels
- Also for structures, the impact of asset failures on train operations is essential

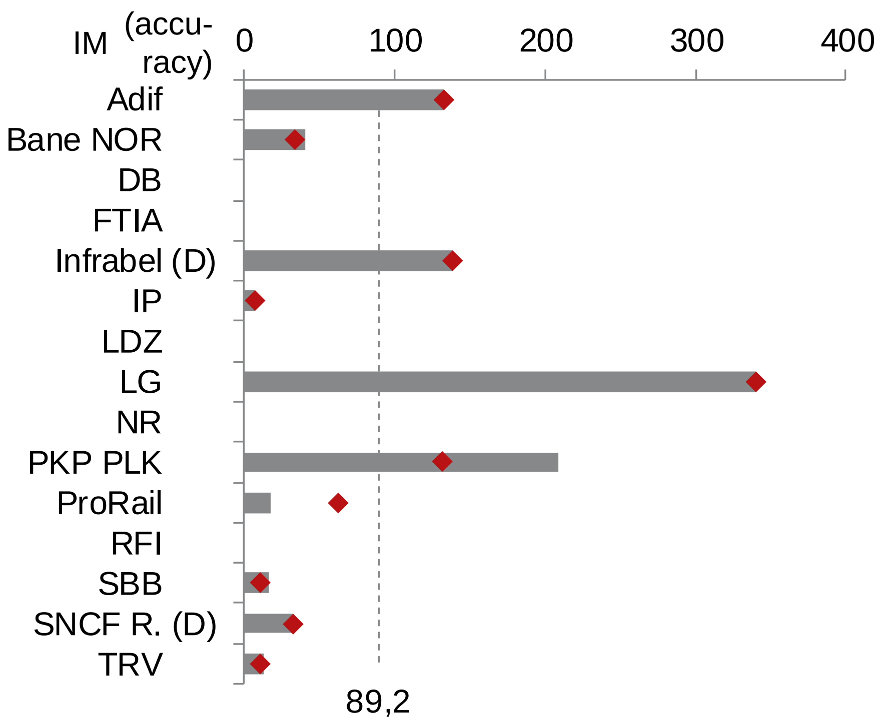
Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year
Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

Average failure frequency for other assets is 89 per thousand main track-kilometre and year

Other infrastructure failures in relation to network size

KPI 57

Number per thousand main track-km (2017)



- The failure frequency varies between 7 and 340 failures per thousand main track-kilometre and year
- Some IMs appear to have a significant share of other asset failures
- Compared to the average of 2012-2017, the failure frequency for other assets was increasing at PKP PLK
- For a meaningful interpretation, it needs to be analysed further
  - What is behind the other asset failures
  - What are the reasons for the high failure rates

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

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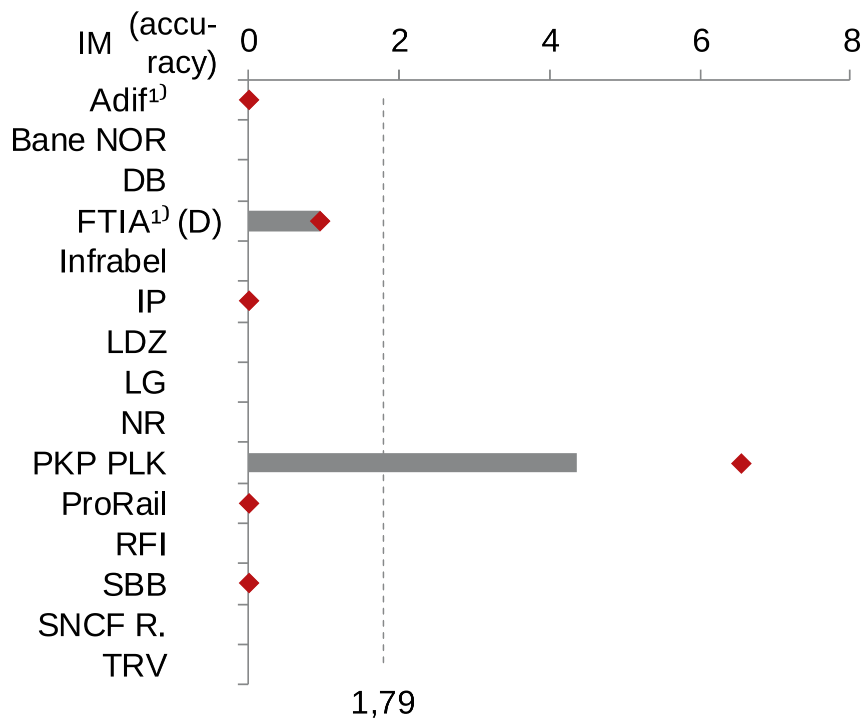
The peer group's weighted average for tracks with permanent speed restrictions is 2% of main track-kilometre

Tracks with permanent speed restrictions

KPI 58

% of main track-km (2017)



- Based on the definition, all permanent speed restrictions that are already included in the annual timetable should be provided
- Some IMs do not count permanent speed restrictions at all, as these are included in the working timetable
- It would be interesting to understand why some IMs do not count PSR
- Additional value would be provided by a root-cause analysis for PSR (e.g. postponed renewals, lack of resources …)
- Furthermore, it would be interesting to understand the difference between average track design speed (in terms of track standard) and average operated train speed
- It could be worth testing a new indicator measuring this difference

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

1) Data years: Adif 2016, FTIA 2015

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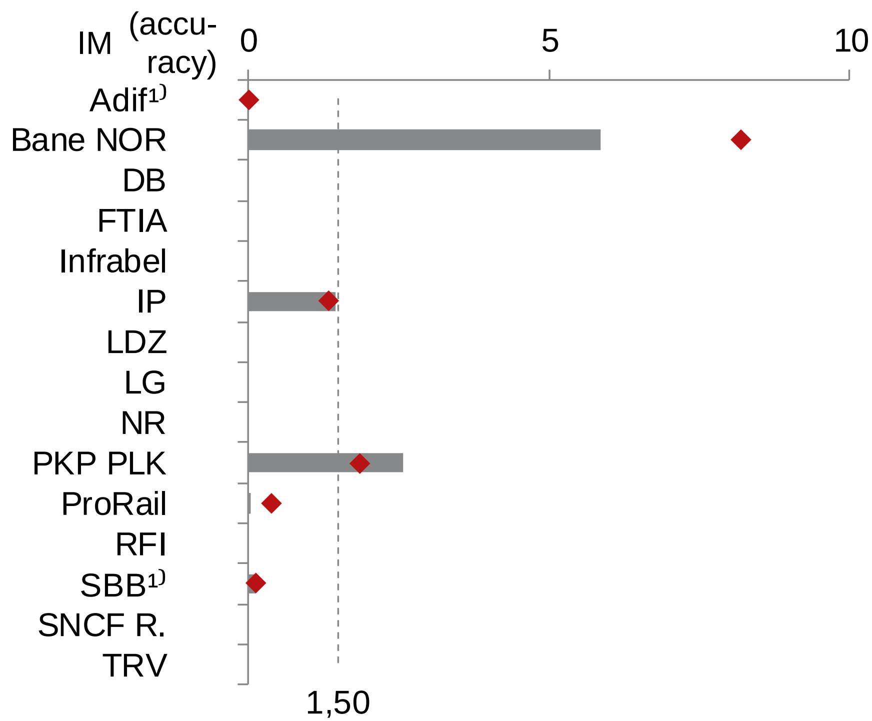
On average, about 1,5% of the main track has temporary speed restrictions due to deteriorating condition

Tracks with temporary speed restrictions

KPI 59

% of main track-km (2017)

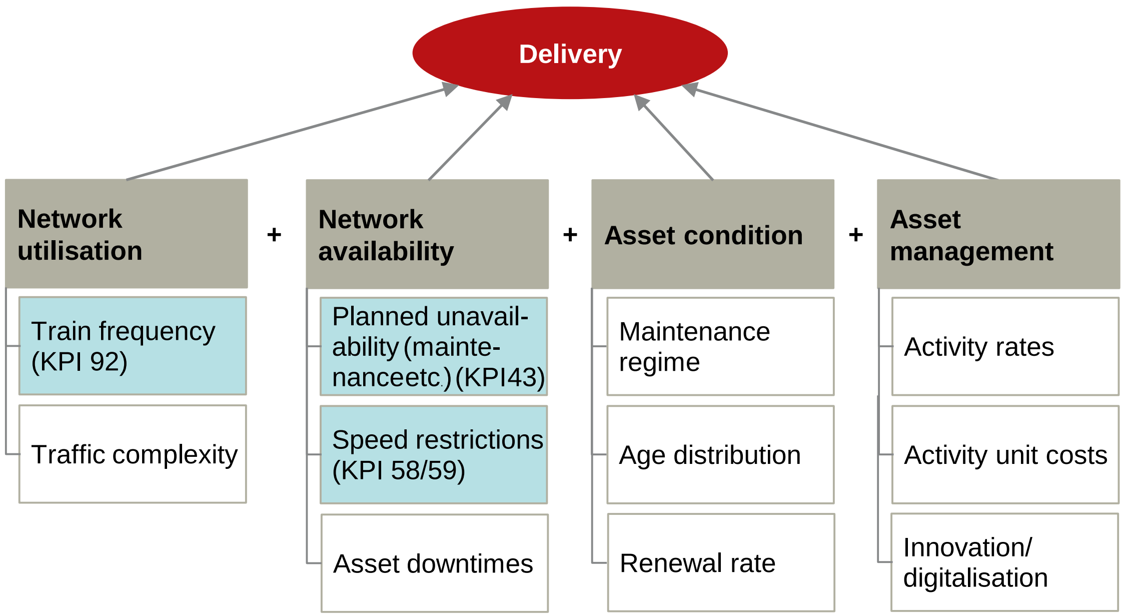


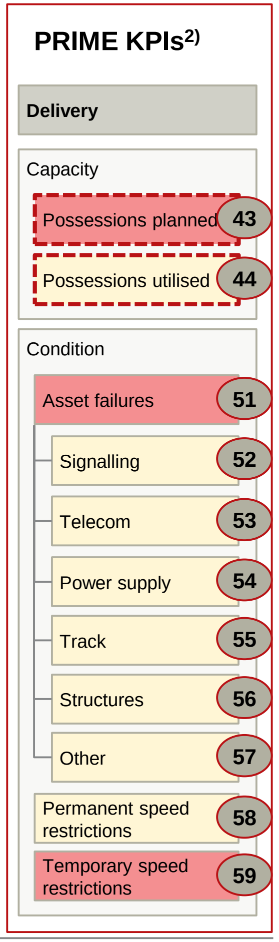
- While some IMs have hardly any TSRs, others temporarily restrict speed on 6% of their network
- An in-depth analysis could identify
  - The statistical distribution of length and duration of TSRs
  - The reasons for temporary speed restrictions (e.g. bad track geometry …)
- It would be also interesting to understand the impact of TSRs on train operations

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year
Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019
1) Data of 2016

IMs are encouraged to use civity's first draft of a root-cause analysis as basis for discussing performance differences

Delivery – drivers[1)]





1) Drivers which are currently collected in PRIME are coloured light blue
2) As currently collected and evaluated in PRIME

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Further analysis should focus on the concepts and the impact of capacity constraints on train operations

Delivery – Further analysis

- Information on **possession management** is relatively **sparse** so far
- It would be worth **understanding** the **different concepts** of possession management in general
- Furthermore, a good practice exchange should focus on how IMs intend to **optimise their utilisation** of possessions for maintenance, renewals and enhancements
- Concerning **asset failure frequencies**, it would be interesting to **understand the reasons**/ the background for the wide range of frequencies among the peers, such as asset condition, maintenance regimes, different failure recording technologies etc.
- The **signalling** system accounts for approximately two thirds of all asset failures
- Even if failure frequency is much lower, the impact of failing **power supply, structure and telecommunication** assets on train delays is significant as already identified in the performance chapter
- In order to identify the consequences of asset failures, their **impact on train operations** (i.e. train operations as well as passengers or freight customers) would need to be analysed further
- Current available data on **speed restrictions** is improving but still **sparse**
- It would be beneficial to **understand** the **different concepts**, the drivers or main causes when to set up either a temporary or a permanent speed restriction
- Similar to asset failures, also the **impact** of restricted network availability (by speed restrictions) **on train operations** would need to be analysed further

Table of contents

Financial dimension is intended to provide understanding of the structure and the level of costs and revenues

Financial – objectives

- Support delivery of a cost-effective railway, through identification and implementation of good practices and processes;
- Identify and encourage opportunities to increase revenues from all sources;
- Understand the impact of charging and charges on IM and the whole railway industry; and
- Support making the case for appropriate and effective investment in the railway.

Source: PRIME Catalogue Version 2.1, 31 May 2018

All financial data have been adjusted for purchasing power and converted into Euro using purchasing power parities

PPPs[1)]

		Purchasing power parity (LCU/EUR)					
Country	**Currency**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Belgium	EUR	1,10	1,11	1,10	1,08	1,10	1,10
Finland	EUR	1,21	1,24	1,24	1,22	1,24	1,24
France	EUR	1,12	1,11	1,10	1,08	1,10	1,10
Germany	EUR	1,04	1,05	1,04	1,03	1,06	1,07
Great Britain	GBP	0,92	0,94	0,94	0,91	0,95	0,98
Italy	EUR	1,00	1,01	1,01	0,98	0,99	0,99
Latvia	EUR	0,67	0,68	0,68	0,67	0,67	0,69
Lithuania	EUR	0,60	0,60	0,60	0,60	0,62	0,63
Netherlands	EUR	1,10	1,09	1,09	1,09	1,10	1,12
Norway	NOK	11,95	12,26	12,56	12,86	13,71	13,98
Poland	PLN	2,40	2,41	2,41	2,36	2,40	2,47
Portugal	EUR	0,78	0,79	0,78	0,78	0,80	0,81
Spain	EUR	0,91	0,91	0,90	0,89	0,90	0,90
Sweden	SEK	11,52	11,81	11,99	11,99	12,28	12,51
Switzerland	CHF	1,79	1,79	1,75	1,67	1,69	1,68

1) Data provided by European Commission

Financial – Costs – Overview

PRIME

- Context
- Safety & Environment
- Performance
- Delivery
- **Financial**
- Growth

Costs

- OPEX 60
  - Maintenance 62
  - Traffic managemer 64
- CAPEX 66
  - Renewals 68

Revenues

- Track access charge 87
  - Proportion 81
- Non access charges 80
- Incentive regimes 91

The Costs category includes all the costs incurred by the IM, broken down into useful and comparable sub-categories. It includes all Operating, Capital and Investment costs. For purposes of comparison, costs will be adjusted where appropriate to reflect local costs using purchasing power parities (PPPs). The costs incurred by an IM will be dependent on a number of factors: some within and some outside the management responsibility of the IM.

KPI Name	KPI Definition
OPEX – operational expenditures in relation to network size	Total IMs annual operational expenditures per main track-km
Maintenance expenditures in relation to network size	Total IMs annual maintenance expenditures per main track-km
Traffic management expenditures in relation to network size	Total IMs annual traffic management expenditures per main track-km
CAPEX – capital expenditures in relation to network size	Total IMs annual capital expenditures per main track-km
Renewal expenditures in relation to network size	Total IMs annual renewal expenditures per main track-km

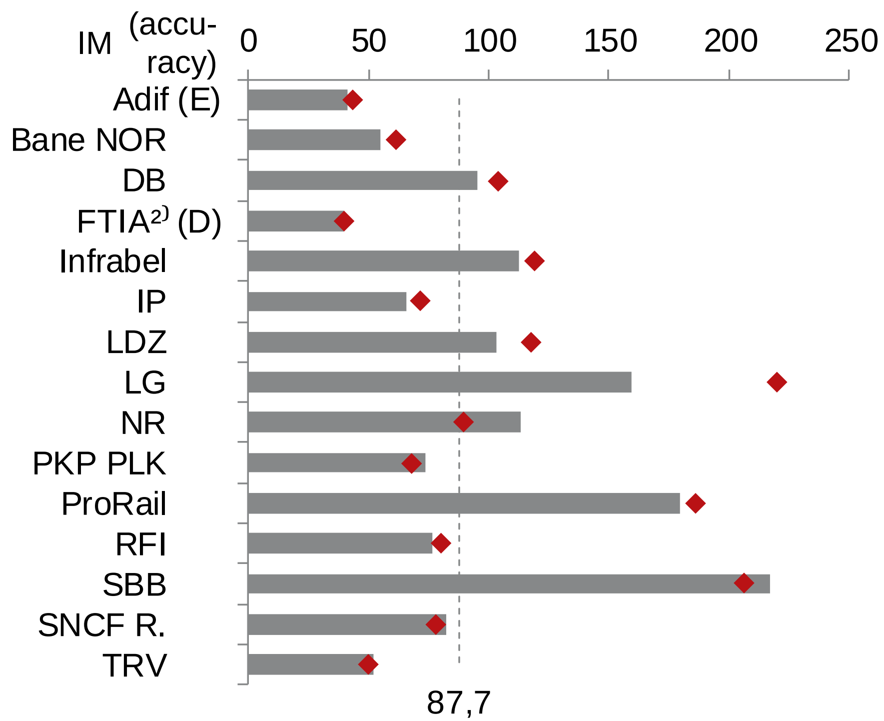
High Level Industry KPI | Benchmarking KPI | KPI under review

Average annual operational expenditures are 88 thousand Euros per main track-kilometre

KPI 60

OPEX – operational expenditures in relation to network size[1)]

1.000 Euro per main track-km (2017)



- Operational expenditures vary between 41 and 217 thousand Euros per main track-kilometre and year
- OPEX appear to be relatively constant over time except for LG, showing a decrease in 2017 compared to the average of 2012-2017
- This comparison provides an overview about annual expenditure levels independent of different operational conditions, representing major cost drivers
- For a meaningful gap analysis, these cost drivers should be taken into account, e.g.
  - Network characteristics (i.e. asset densities)
  - Network utilisation (i.e. train frequencies, gross tonnage)
  - Traffic management technologies and degree of centralisation

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

1) Results are normalised for purchasing power parity

2) Data of 2015

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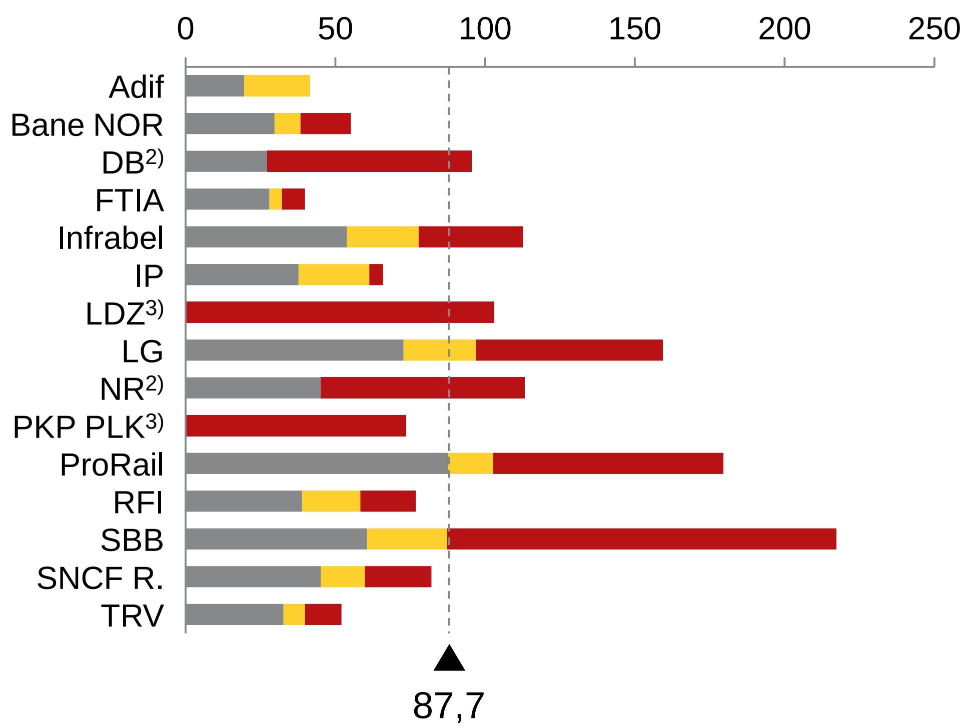
Maintenance and traffic management cover a significant share in total operational expenditures

OPEX – operational expenditures in relation to network size[1)]

KPI 60

1.000 Euro per main track-km (2017)



- All 15 IMs provided total annual operational expenditures
- 13 IMs provided annual maintenance expenditures
- 11 IMs also provided annual expenditures for traffic management
- Based on these 11 IMs, maintenance accounts for 50% and traffic management accounts for 20% of total operational expenditures on average
- As the residual OPEX are about a third of total OPEX, it would be worth analysing these more in detail
- The weighted average of OPEX is 88 thousand Euros per main track-kilometre

Maintenance Traffic Management Residual OPEX such as power consumption and other OPEX

1) Results are normalised for purchasing power parity

----- Total weighted average of total OPEX

2) Traffic Management not available, therefore included in residual OPEX

3) Disaggregation not available

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

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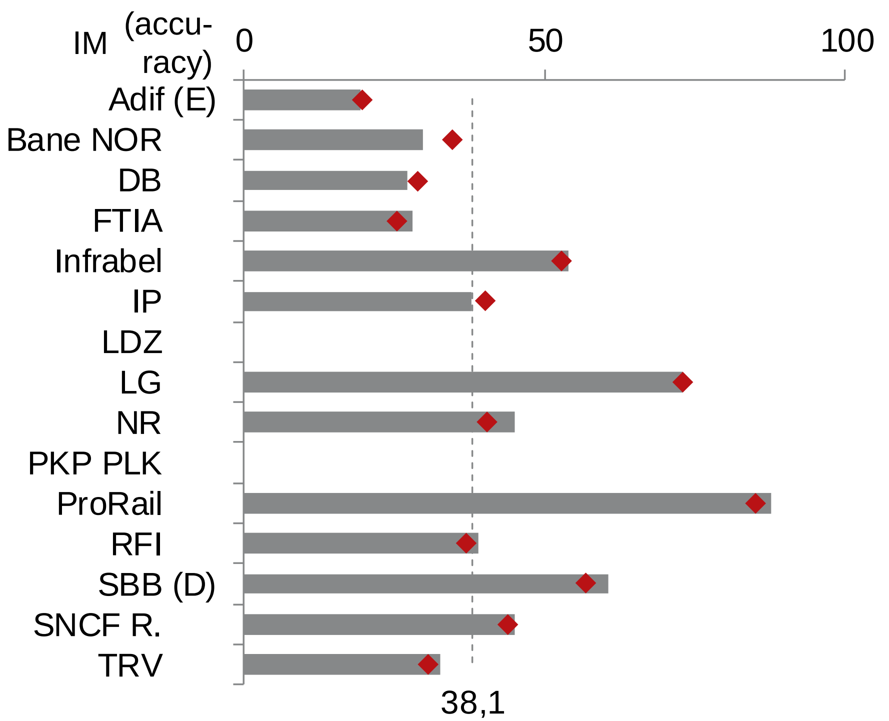
Average annual maintenance expenditures are 38 thousand Euros per main track-kilometre

Maintenance expenditures in relation to network size[1)]

KPI 62

1.000 Euro per main track-km (2017)



- The range of maintenance expenditures varies between 20 and 87 thousand Euros per main track-kilometre and year
- With one major exception (LG), maintenance expenditures appear to be relatively constant over time
- Similar to the total expenditure level, the comparative analysis of maintenance expenditures should also take into account major cost drivers such as network characteristics and utilisation
- An in-depth analysis should further differentiate
  - Asset groups (track, signalling …)
  - Preventive and corrective activities

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

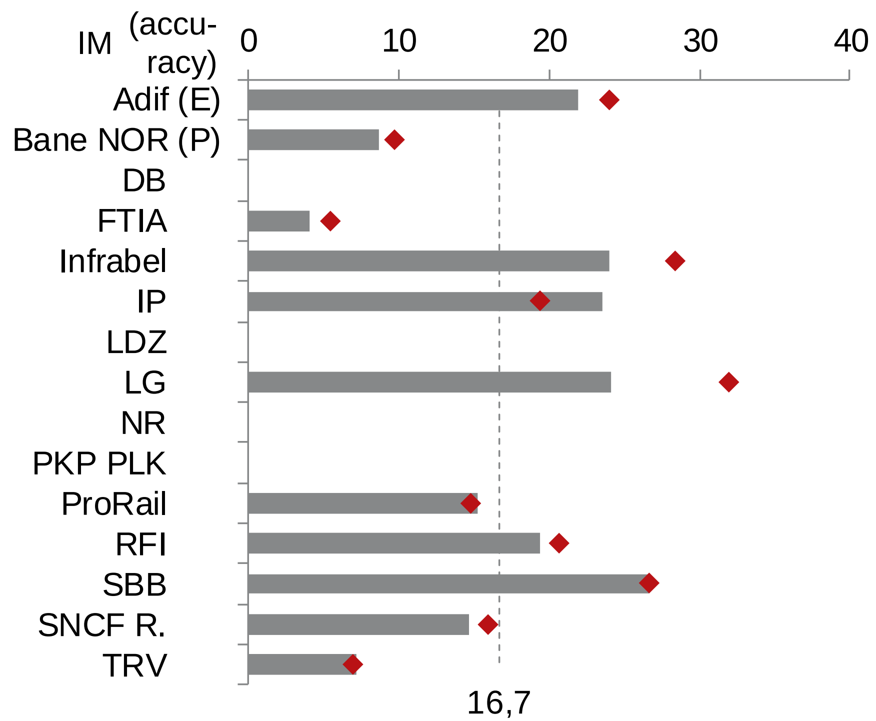
1) Results are normalised for purchasing power parity

Average annual expenditures for traffic management are 17 thousand Euros per main track-kilometre

KPI 64

Traffic management expenditures in relation to network size[1)]

1.000 Euro per main track-km (2017)



- The range of expenditures for traffic management varies between 4 and 27 thousand Euros per main track-kilometre and year
- Similar to maintenance, also traffic management expenditures appear to be relatively constant over time except for Infrabel and LG, showing a decrease in 2017 compared to the average of 2012-2017
- Operational expenditures for traffic management are assumed to be driven mainly by labour costs (as expenditures for signalling assets are covered in maintenance or CAPEX)
- An in-depth analysis should consider different signalling technologies currently in use and the varying degrees of centralisation

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

1) Results are normalised for purchasing power parity

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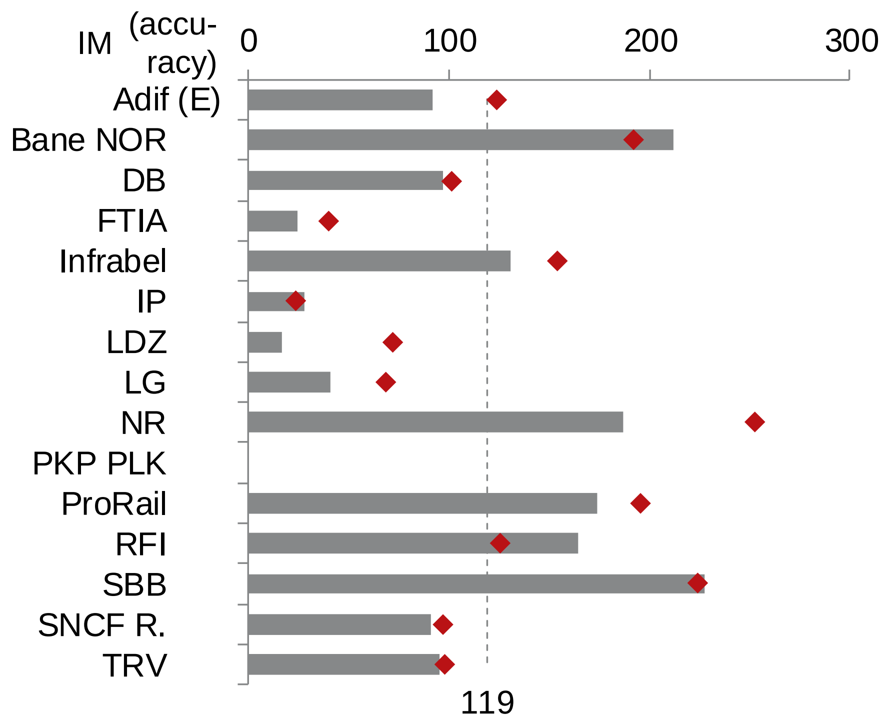
On average 119 thousand Euros per main track-kilometre and year are spent on capital expenditures

CAPEX – capital expenditures in relation to network size[1)]

KPI 66

1.000 Euro per main track-km (2017)



- The range of annual capital expenditures varies between 17 and 227 thousand Euros per main track-kilometre and year
- In many cases, capital expenditures are linked to major (re-) investment programs
- Thus it is not surprising that some IMs show high fluctuations in expenditure levels over time
- For an in-depth analysis, major cost drivers should be taken into account such as
  - Age and condition of the infrastructure assets
  - Technological migration strategies (such as ERTMS)
  - Available budgets and funding agreements
  - Supplier market, prices and resources

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

1) Results are normalised for purchasing power parity

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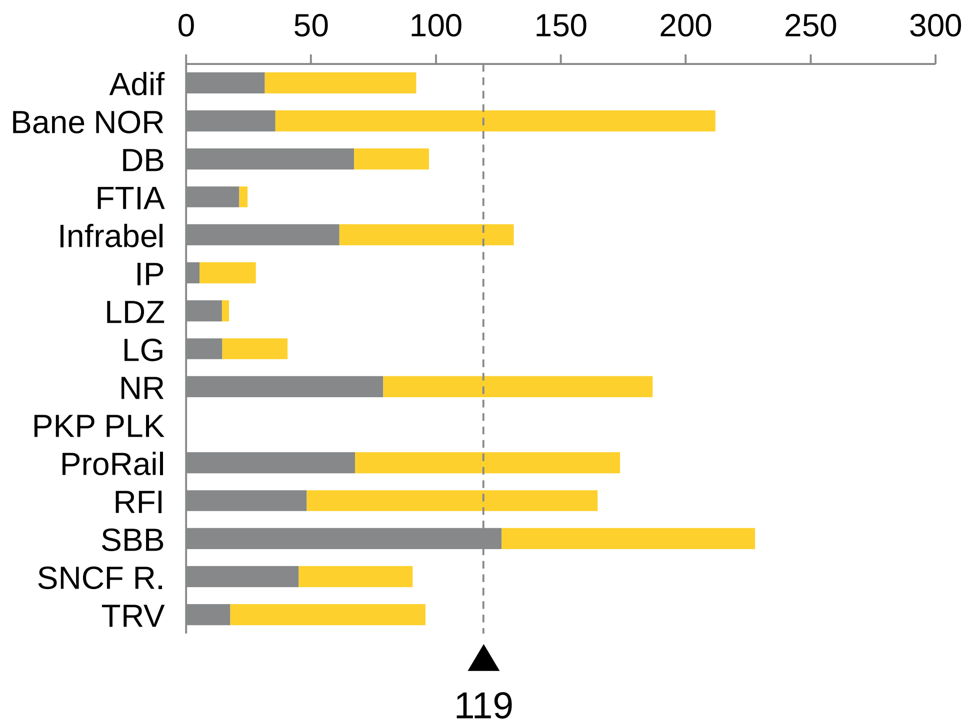
Renewal expenditures cover nearly 50% of the total capital expenditures

CAPEX – capital expenditures in relation to network size[1)]

KPI 66

1.000 Euro per main track-km (2017)



- 14 IMs provided both total annual capital expenditures and renewal expenditures
- Based on these 14 IMs, renewal expenditures accounts for 45% of total capital expenditures
- As the remaining expenditures, such as enhancements and investments, are more than half the total CAPEX, it would be worth analysing these more in detail

Renewal | Enhancements, Investments & Other CAPEX | ----- Total weighted average of total CAPEX

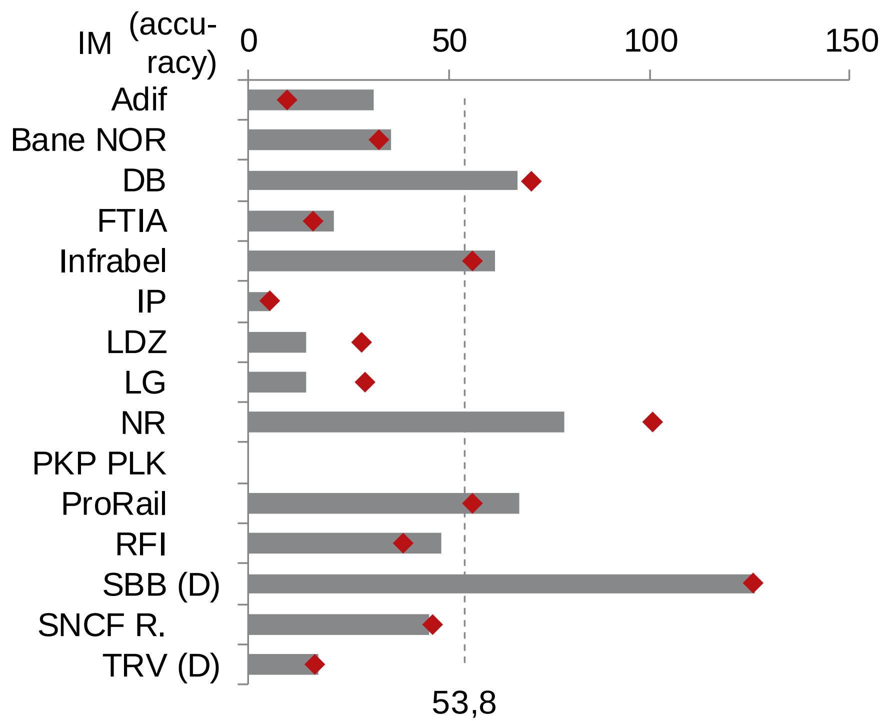
1) Results are normalised for purchasing power parity
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

Average annual renewal expenditures are 54 thousand Euros per main track-kilometre

KPI 68

Renewal expenditures in relation to network size[1)]

1.000 Euro per main track-km (2017)



- The range of renewal expenditures varies between 5 and 126 thousand Euros per main track-kilometre and year
- Similar to the total CAPEX it is not surprising that some IMs show high fluctuations in renewal expenditure levels over time
- A constantly low renewal expenditure level bears the risk of creating a reinvestment backlog
- A high renewal expenditure level does not necessarily mean inefficient renewal activities
- For a meaningful interpretation of results, the varying stages within the entire life cycle of the different asset groups need to be taken into account

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

1) Results are normalised for purchasing power parity

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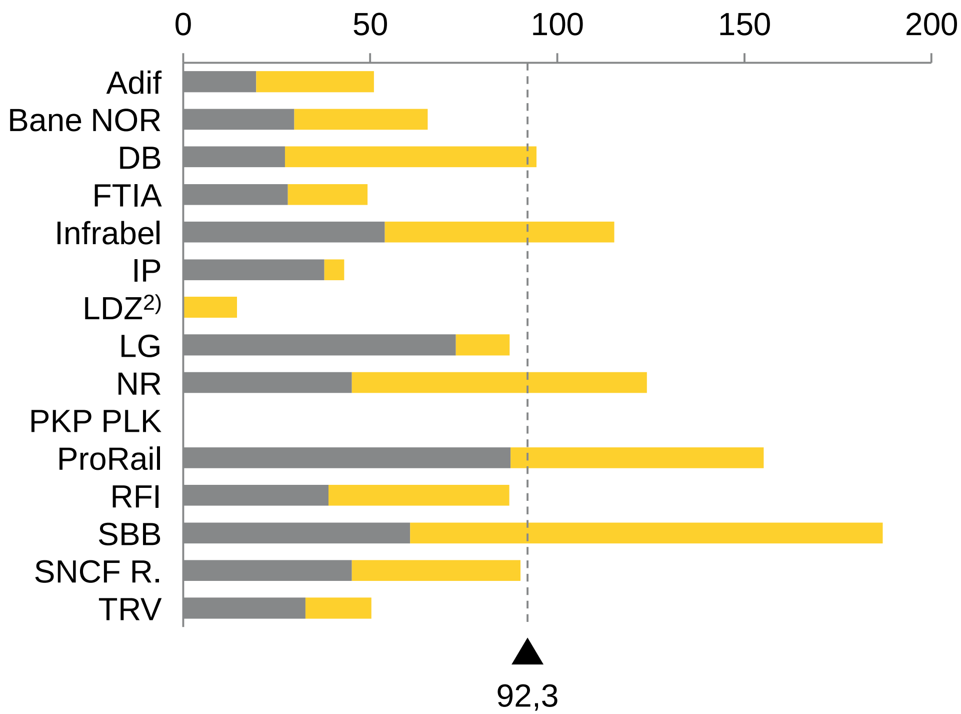
Average annual expenditures for maintenance and renewal are 92 thousand Euros per main track-kilometre

Maintenance and renewal expenditures in relation to network size[1)]

KPI 62+68

1.000 Euro per main track-km (2017)



- The sum of annual maintenance and renewal expenditures provide a snapshot of current expenditures into the existing network
- As especially renewals are considerably fluctuating over time, future analysis should consider comparing multi-annual averages
- An individual gap analysis should further take into account different operational conditions and cost drivers that are outside or hardly in control of IMs, such as
  - Network complexity/ asset densities e.g. switches, bridges, tunnels …
  - Network utilisation e.g. train frequency, gross tonnage
  - Current stage of key assets/ asset groups within the entire life cycle e.g. current renewal rates compared to steady state renewal rates

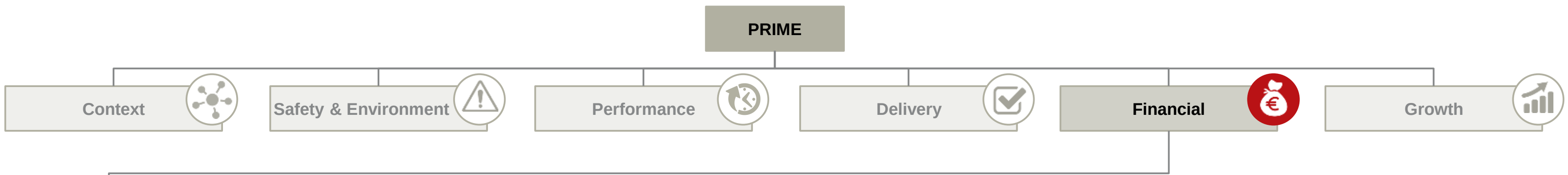
Maintenance expenditures relative to network size | Renewal expenditures relative to network size

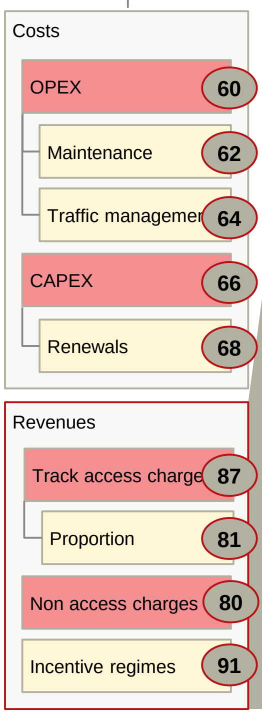
1) Results are normalised for purchasing power parity | ----- Total weighted average of sum of maintenance and renewal expenditures

2) Maintenance expenditures not available

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

Financial – Revenues – Overview





The Revenue category provides a summary of the total non-track access revenue 'earned' by an IM, excluding subsidies and property development. Furthermore, it measures and compares that element of an IM's revenue that comes from charges from operators using its network and service facilities.

KPI Name	KPI Definition
TAC revenue in relation to network size	Total IMs annual TAC revenues (including freight, passenger and touristic trains) compared to total main track-km
Proportion of TAC in total revenue	Percentage of IMs annual TAC revenues (including freight, passenger and touristic trains) compared to total revenues
Total revenues from non-access charges in relation to network size	Total IMs annual revenues from non-access charges (e.g. commercial letting, advertising, telecoms but excluding grants or subsidies) related to total main track-km
Income from incentive regimes in relation to network size	Total IMs annual income from incentive/performance regimes with customers (if applicable, no public grants or state subsidies) per main track-km

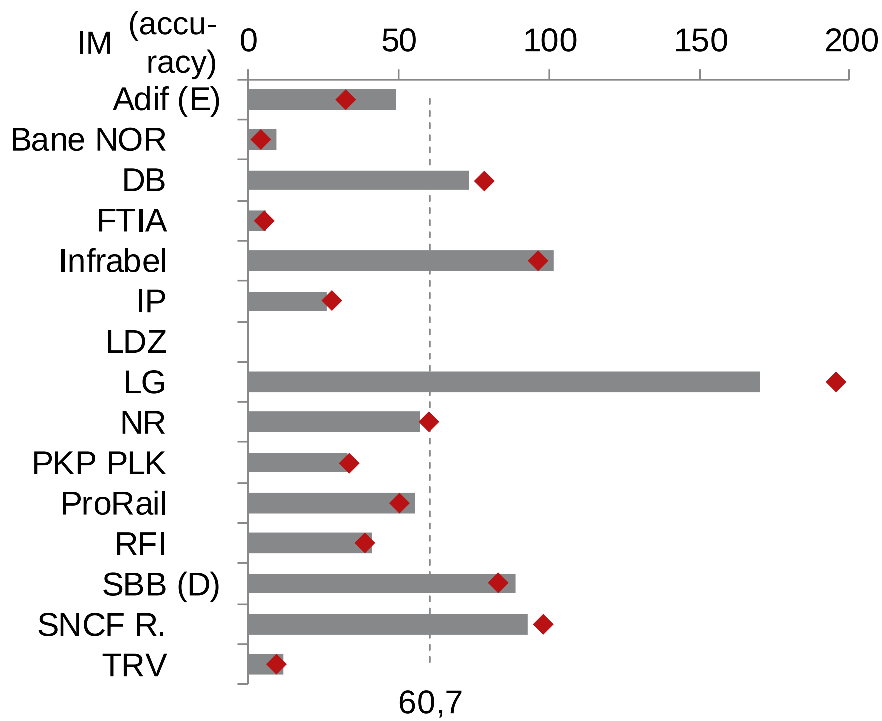
High Level Industry KPI | Benchmarking KPI | KPI under review

Average annual revenues from track access charges are 61 thousand Euros per main track-kilometre

TAC revenue in relation to network size[1)]

KPI 87

1.000 Euro per main track-km (2017)



- The range of TAC revenues in relation to network size varies between 6 and 170 thou-sand Euros per main track-kilometre and year
- TAC revenues appear to be relatively constant over time
- This KPI illustrates the degree to which IMs manage to generate user revenues to cover the cost of the network. The degree to which IMs generate revenues from the utilisation of the network by operators is provided by relating TAC revenue to the traffic volume (additional KPI 82)
- An in-depth analysis could focus on
  - Track access charge regimes
  - Differentiation into/ share of train types
- A more precise definition of TAC revenue and its constituents will be provided in the future

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year
Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019
1) Results are normalised for purchasing power parity

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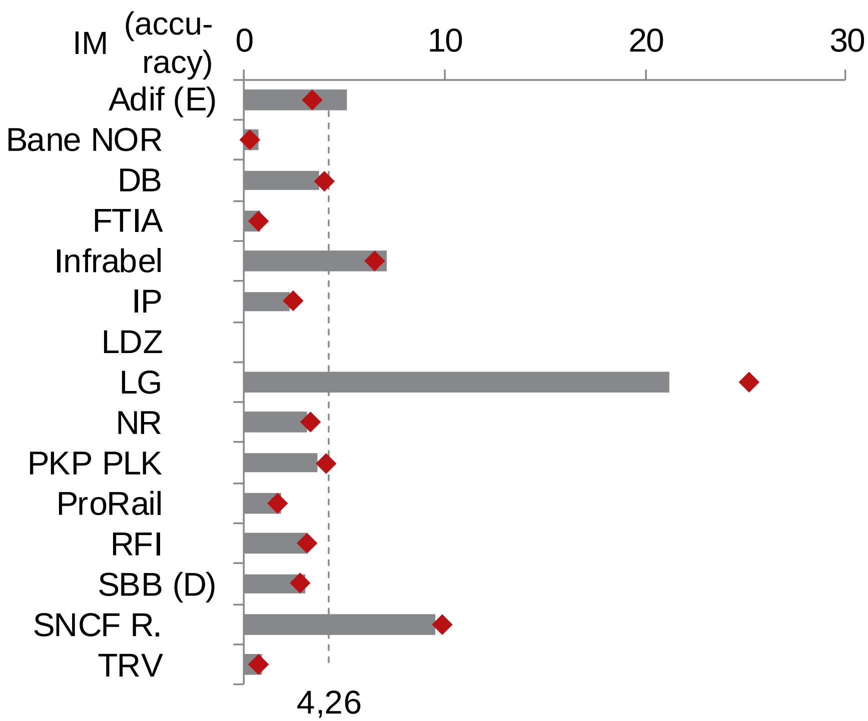
Average annual revenues from track access charges are 4 Euros per train-kilometre

KPI 82

TAC revenue in relation to traffic volume[1)]

Euro per train-km (2017)



- TAC revenue in relation to traffic volume appears to be more homogeneous among the peer group than TAC revenue in relation to network size (c.f. KPI 87)
- The range of TAC revenues in relation to traffic volume varies between below 1 and more than 20 Euros per train-kilometre and year
- TAC revenues appear to be relatively constant over time

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

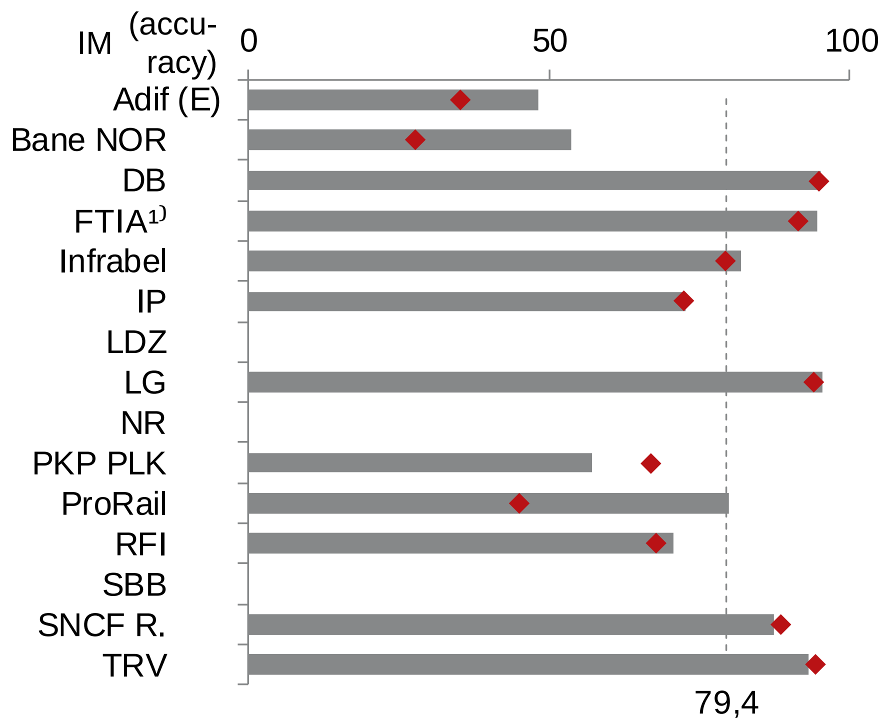
1) Results are normalised for purchasing power parity

Track access charges account for 79% of the total revenues on average

KPI 81

Proportion of TAC in total revenue

% of monetary value (2017)



- Five out of twelve IMs generate a proportion of total revenue from track access charges above the weighted average
- Three IMs realize about 50% of their revenues by track access charges
- Adif, Bane NOR and RFI have increased their proportion in 2017 compared to the average of 2012-2017
- Total revenues excluding grants and subsidies

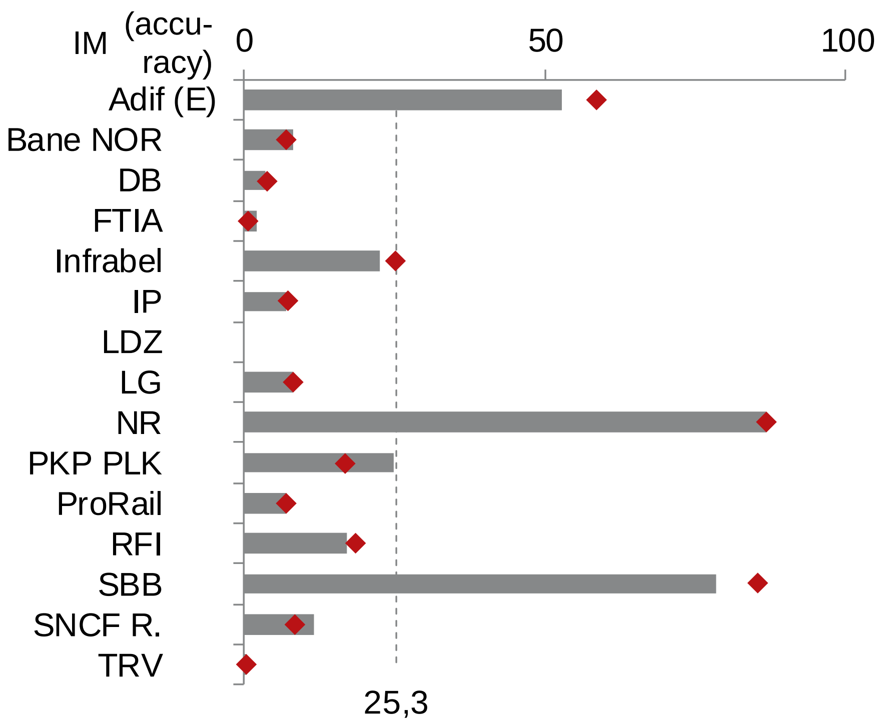
Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year
Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019
1) Data of 2016

Average annual revenues from non-access charges are 25 thousand Euros per main track-kilometre

Total revenues from non-access charges in relation to network size[1)]

KPI 80

1.000 Euro per main track-km (2017)



- Three out of 14 IMs manage to generate above average revenues from non-access charges (Adif, NR and SBB)
- Thus it would be interesting to understand in detail, how IMs achieve these revenues and what they are based on
- SBB's above avg. revenues stem from providing goods (e.g. switches, rails, sleepers) and services (e.g. use of IT tools) to other IMs and RUs in Switzerland
- Total IMs annual revenues from non-access charges include commercial letting, advertising, telecoms but exclude station access charges, income from energy supply, grants and subsidies

Concerning the definition it should be ensured that income from energy supply is not included

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

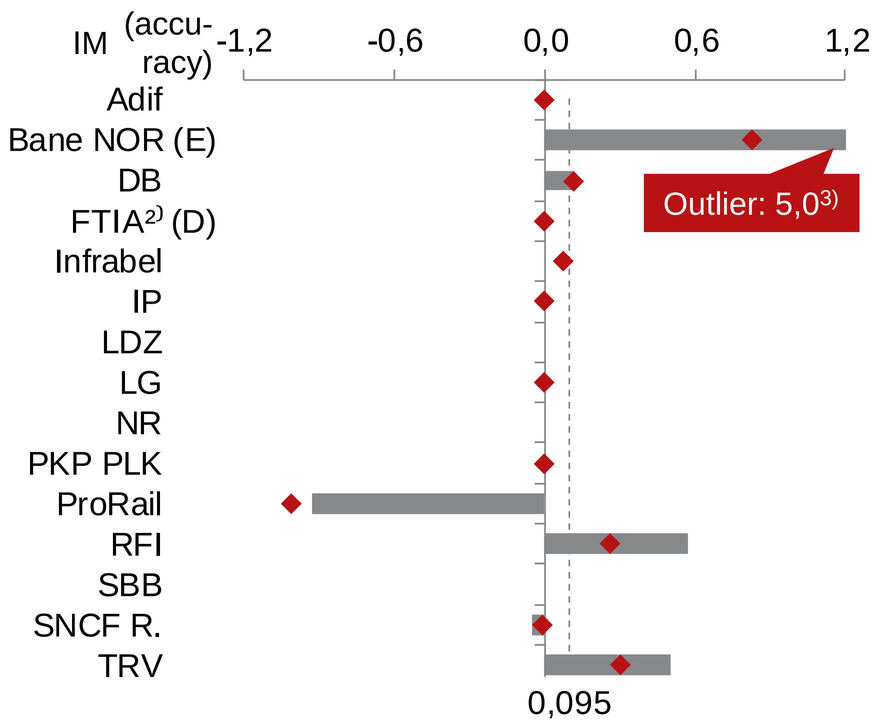
1) Results are normalised for purchasing power parity

The average annual income from incentives of representative peers is 95 Euros per main track-kilometre

Income from incentive regimes in relation to network size[1)]

KPI 91

1.000 Euro per main track-km (2017)



- Compared to the total volume of annual expenditures and revenues, incentive regimes play a minor role
- Six out of 12 IMs neither receive a bonus nor pay a malus
- RFI and TRV receive larger bonuses, Bane NOR receive the most by far
- ProRail is the only IM who regularly pays a significant malus
- Since national incentive schemes are not comparable it would be worth understanding the different regimes and what criteria they are based on

- This KPI will be separated from costs and revenues as an individual category within finance

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

1) Results are normalised for purchasing power parity
2) Data of 2015
3) Not part of weighted average

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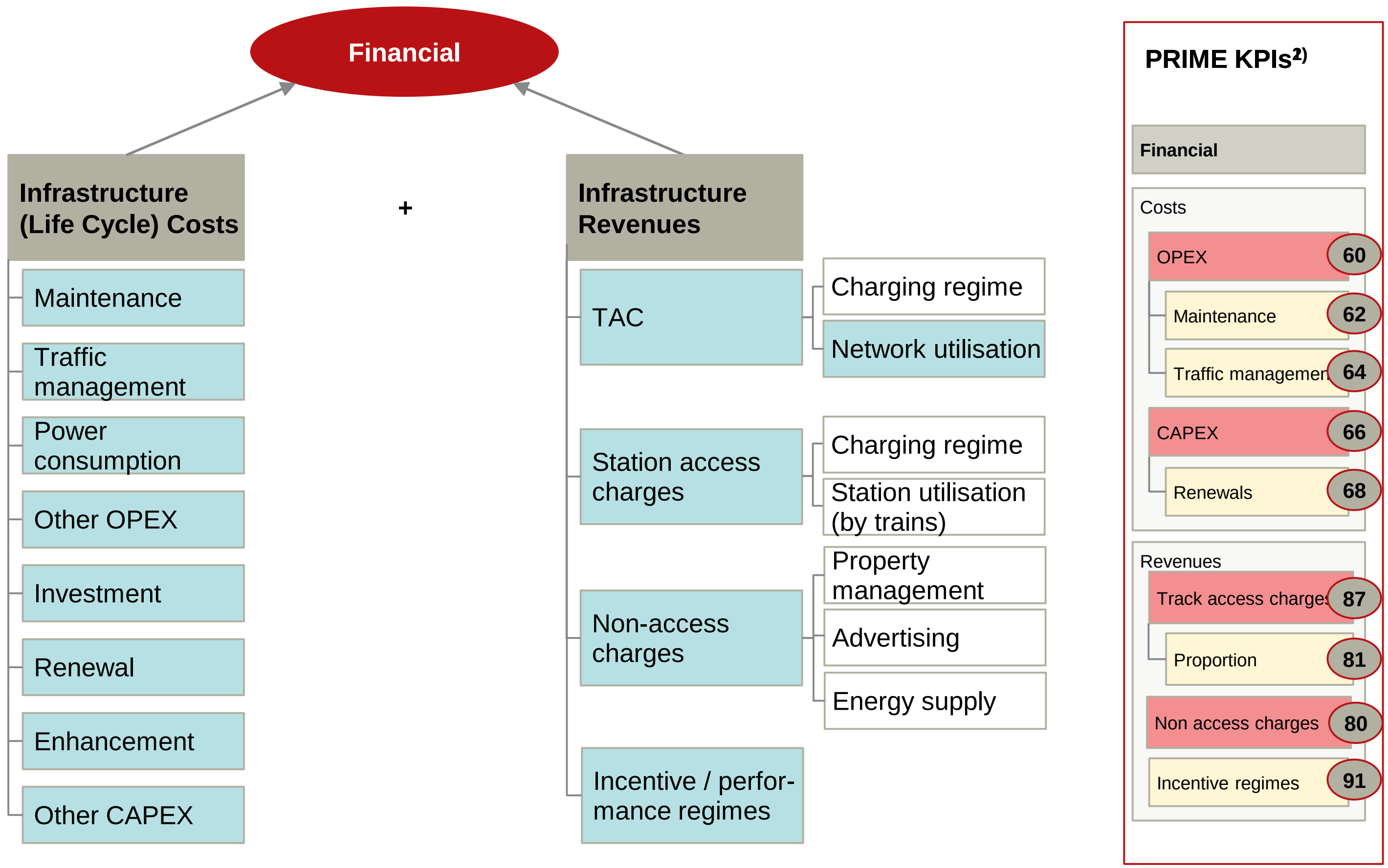
IMs are encouraged to use civity's first draft of a root-cause analysis as basis for discussing performance differences

Financial – drivers[1)]



1) Drivers which are currently collected in PRIME are coloured light blue
2) As currently collected and evaluated in PRIME

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Further analysis should focus on effectivity and efficiency of expenses and revenues in order to identify good practice

Financial – Further analysis

- **Financial** data is **nearly complete** as it appears to be easy to access/ to provide for the IMs
- It needs to be stated clearly that all comparisons only provide levels of annual expenditures and revenues with a **wide range of individual results**
- The comparisons do not provide any information **neither on effectivity** (how much was done) **nor on efficiency** (how much did it cost)
- In order to identify good practice and to enable individual gap analyses, major **cost drivers** outside the (immediate) control of an IM need to be taken into consideration or even **normalised** such as
  - Network characteristics (asset densities)
  - Network utilisation (train frequencies, gross tonnage)
  - Current stage of key assets/ asset groups within the entire life cycle e.g. current renewal rates compared to steady state renewal rate
- Furthermore, different **operational conditions** need to be **taken into account** such as
  - Signalling technologies/ degree of centralisation
  - Asset age/ condition
  - Available budgets/ funding agreements
  - Track access charge regimes/ track access pricing systems
- A financial task force has been established to improve the analysis on financial data; it will continue its efforts to provide further insights into infrastructure managers‘ funding, e.g. grants.

Table of contents

Aim is to describe the current / future network use / technology, and integration with other transport modes

Growth – objectives

- Improve the use of the overall capacity of the railway network;
- Encourage modal shift to rail from road and air;
- Promote multi-modal transport integration;
- Understand and use new technology, such as ERTMS, effectively and efficiently to support the objectives of the IM and the integrated railway.

Source: PRIME Catalogue Version 2.1, 31 May 2018

Growth – Utilisation – Overview

PRIME

Context | Safety & Environment | Performance | Delivery | Financial | **Growth**

Utilisation
- Train-km 92
  - Passenger trains 93
  - Freight trains 94

Asset Capability & ERTMS
- Deployment today 98
- Deployment 2030 101

Intermodality
- Intermodal stations 116
- Passengers at accessible stations 117

Utilisation is an essential measure of the performance of an IM. One of the most important objectives for an IM is to use its infrastructure as effectively as possible. This measure also distinguishes between passenger and freight traffic. Utilisation has a major impact on the ability of an IM to cover its costs and the utilisation of the infrastructure will also affect the future performance (other KPIs) of the infrastructure, e.g. overall condition.

KPI Name	KPI Definition
Degree of utilisation – all trains	Average daily train-km on main track (passenger and freight revenue service only, no shunting, no work trains) related to main track-km
Degree of utilisation – passenger trains	Average daily passenger train-km on main track (revenue service only, no shunting, no work trains) related to main track-km
Degree of utilisation – freight trains	Average daily freight train-km on main track (revenue service only, no shunting, no work trains) related to main track-km

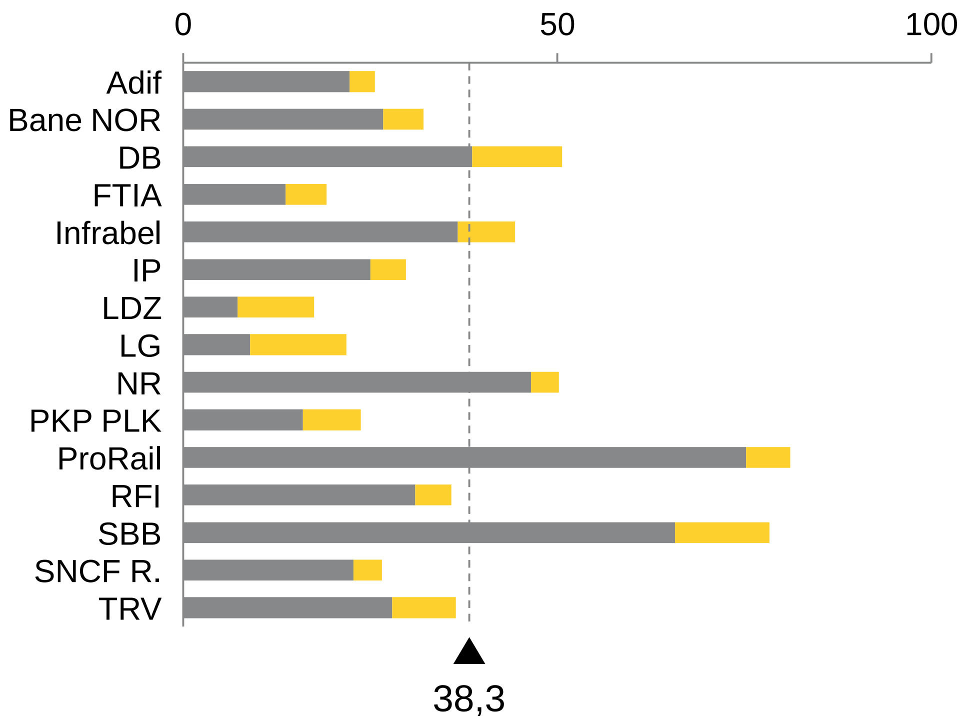
High Level Industry KPI | Benchmarking KPI | KPI under review

The majority of the peer groups' networks is frequented by passenger trains

Degree of network utilisation – all trains

KPI 92

Daily train-km per main track-km (2017)



- On average each of the peer group's railway tracks is frequented by 38 passenger and freight trains per day
- The utilisation of the peer groups' railway networks varies widely
- On average railway tracks are frequented between 17 to 81 times per day
- Only LDZ and LG are frequented by more freight than passenger trains
- Of course these figures do not provide any information about the distribution of utilisation in the network and across different types of lines
- The reasons for this situation are manifold and should be further explored: the geographic characteristics of the country, its location in Europe (transit countries), the quality and acceptance of railway services etc.

Passenger trains   Freight trains   ----- Total weighted average of sum of all trains

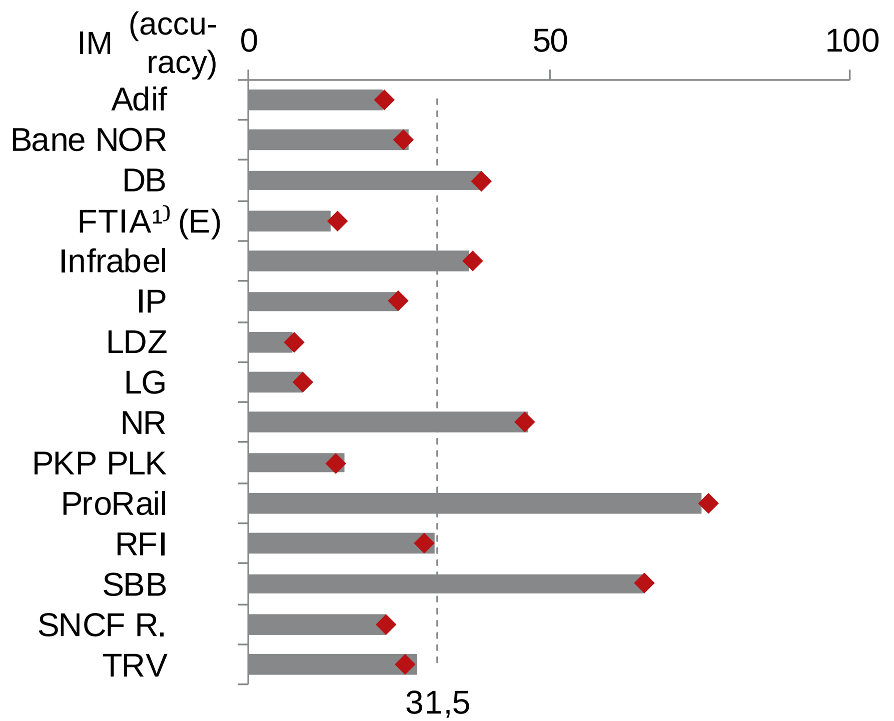
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

On average each of the peer group's railway tracks is frequented by 32 passenger trains per day

KPI 93

Degree of network utilisation – passenger trains

Daily passenger train-km per main track-km (2017)



- The intensity of network use by passenger trains ranges from 9 to 75 trains a day
- While most organisations show frequencies between 22 and 39 trains, some like SBB and ProRail use their networks more than average
- Passenger traffic appears to be very constant over time
- Recommended questions for further analysis:
  - How is the utilisation distributed across networks?
  - To what extent are there congested and significantly underutilised parts?
  - Are there opportunities for a better use of existing infrastructure?

■ Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

1) Data of 2016

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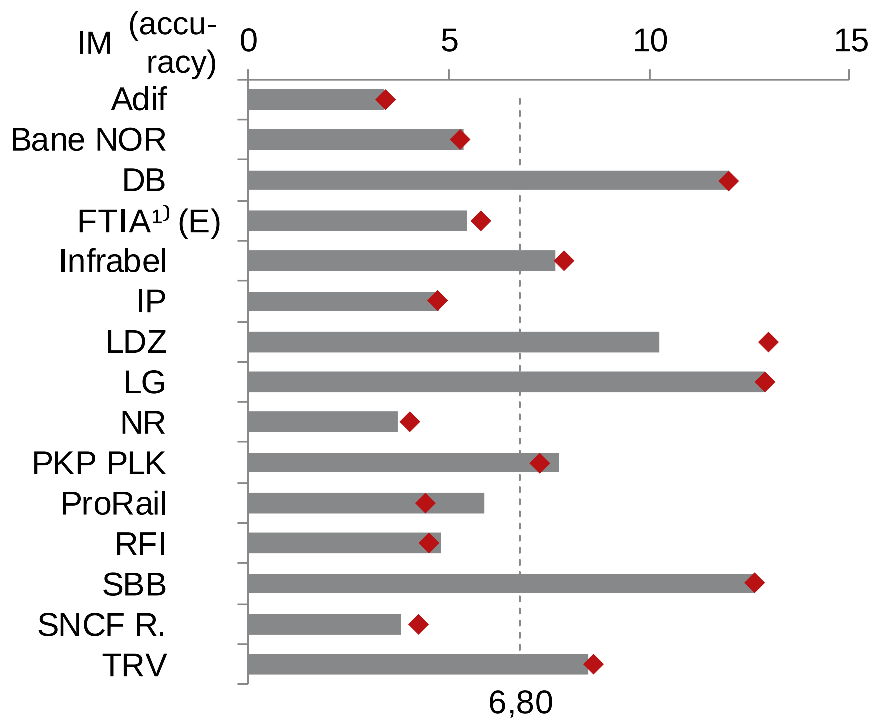
On average 7 freight trains are running daily on each of the peer group's railway track-kilometres

Degree of network utilisation – freight trains

KPI 94

Daily freight train-km per main track-km (2017)



- While passenger trains on average use the peer group's network 32 times a day, the figure for freight trains is more than four times lower
- The different role of rail freight is expressed by varying degrees of utilisation
- Freight traffic appears to be relatively constant over time, except for decrease for LDZ and an increase for ProRail
- What drives these results? Aspects for a more in-depth analysis could be the service offering in freight, its competitiveness against other modes or the comparative size of the infrastructure network

■ Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year
Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary
Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019
1) Data of 2016

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Growth – Asset Capability & ERTMS – Overview

PRIME

Context | Safety & Environment | Performance | Delivery | Financial | **Growth**

Utilisation
- Train-km (92)
  - Passenger trains (93)
  - Freight trains (94)

Asset Capability & ERTMS
- Deployment today (98)
- Deployment 2030 (101)

Intermodality
- Intermodal stations (116)
- Passengers at accessible stations (117)

Asset capability describes the functionality of the IM's railway network. It provides the overview of the capability of the network and specifically the extent to which the network meets the TEN-T requirements. The asset capability describes the IM's part of the interoperability of the peer group's railway network, although it is recognised that achievement of interoperability requires capability and functionality from the railway operators as well.

KPI Name	KPI Definition
ERTMS deployment	Main tracks with ERTMS in operation in proportion to total main tracks (measured in track-km)
Planned extent of ERTMS deployment by 2030	In 2030, the percentage of main track-km planned to have been deployed with ERTMS, i.e. main tracks equipped with both - ETCS (European train control system; any baseline or level) and GSM-R (Global System for Mobile Communications); and where ETCS and GSM-R are used in service

High Level Industry KPI | Benchmarking KPI | KPI under review

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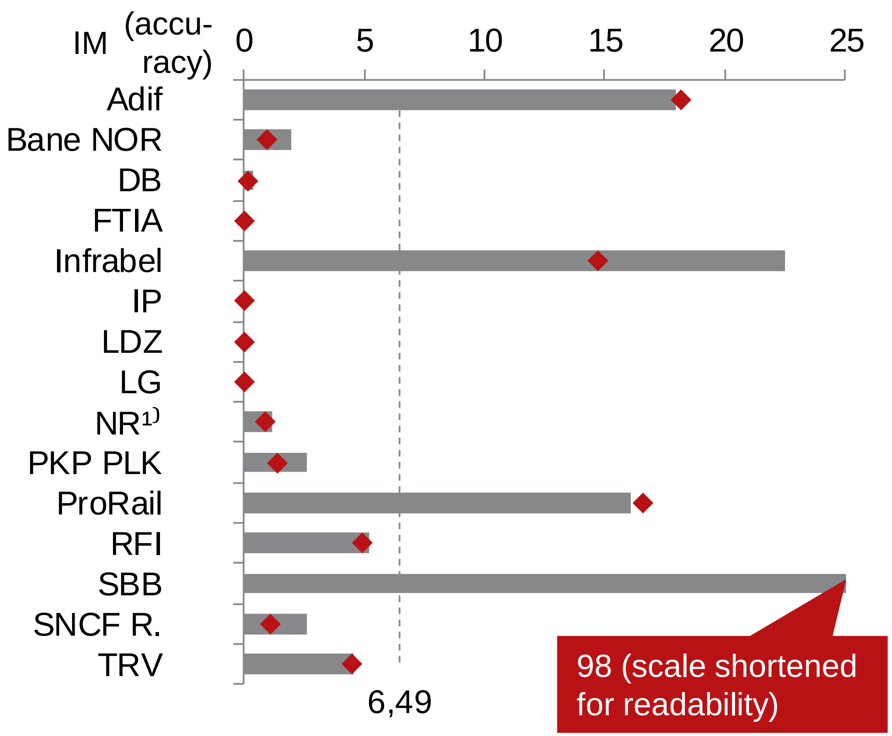
ERTMS is deployed on about 6% of all tracks of the peer group's railway network

KPI 98

ERTMS track-side deployment

% of main track-km (2017)



- The IM's implementation strategies are heterogeneous which is reflected in no ERTMS deployment in some countries vs. a high share in others of more than 20%
- In this sample Infrabel is showing the most dynamic development, being one of the few countries in Europe that has opted for a nationwide roll-out of ERTMS
- The motivation to deploy ERTMS is different (capacity, safety, obsolescence etc.) and should be explored further to understand the dynamics of implementation in the context of the EU deployment plan
- Decreasing values over time are due to added main track-kilometre without ERTMS

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

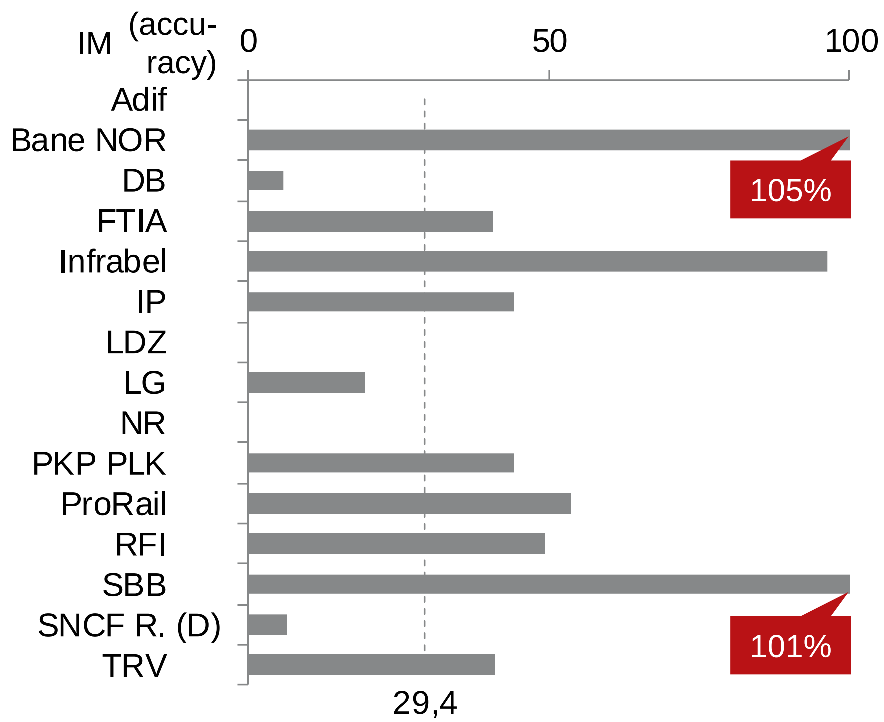
1) Data of 2015

By 2030 ETCS is expected to cover about 29% of the peer group's railway network

Planned extent of ERTMS deployment by 2030

KPI 101

% of current main track-km (2017)



- Also with respect to the future development, the pattern remains heterogeneous
- Whilst some countries plan to equip the complete network with ETCS, others show more modest roll-out plans, ranging between an extent of 0% to 110%
- On average ETCS is expected to be implemented in about half of the peer group's railway network by 2030
- BaneNOR and SBB: value greater than 100% as the ETCS equipped network will be larger than the current network; in a future version of the report this could be improved by introducing and using a new input “planned main track-km in 2030”

Latest available year ◆ Average of available years 2012-2017 ----- Total weighted average of each IMs latest available year

Data accuracy: No entry = Normal E = Estimate D = Deviating from definition P = Preliminary

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

1) Data of 2016

Growth – Intermodality – Overview

PRIME

Context | Safety & Environment | Performance | Delivery | Financial | **Growth**

Utilisation
- Train-km (92)
  - Passenger trains (93)
  - Freight trains (94)

Asset Capability & ERTMS
- Deployment today (98)
- Deployment 2030 (101)

Intermodality
- Intermodal stations (116)
- Passengers at accessible stations (117)

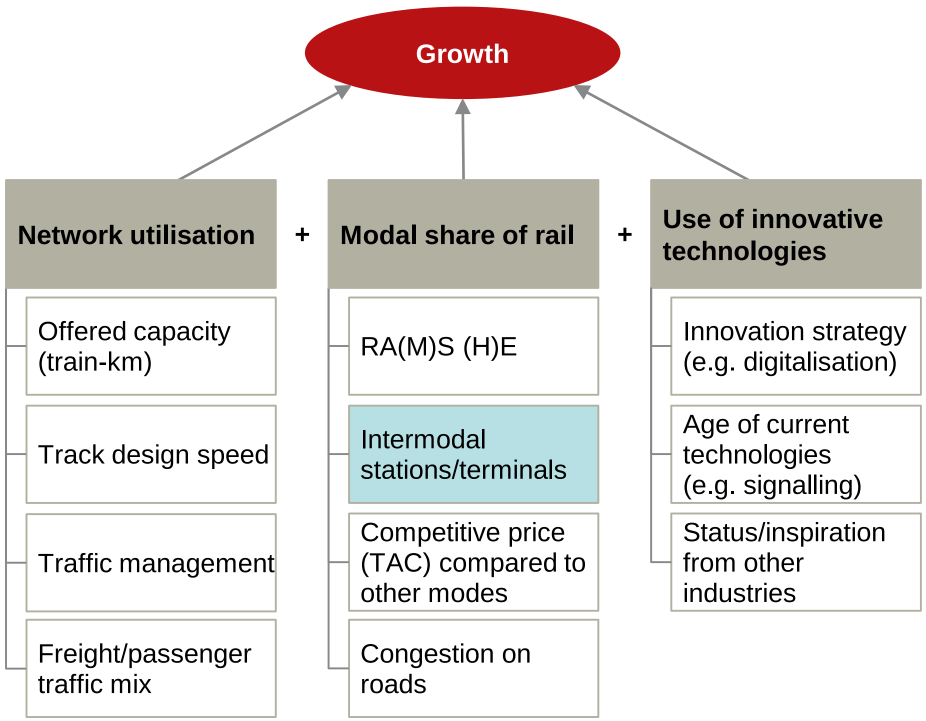
A highly functional intermodality between different transport modes can bring traffic and business to the rail network. Since trains rarely offer a door-to-door solution, and rather is a part of the mobility chain, connections between modes become essential for the customers. Intermodality promotes efficiency for both freight and passenger traffic. Intermodality also increases the number of potential customers for rail.

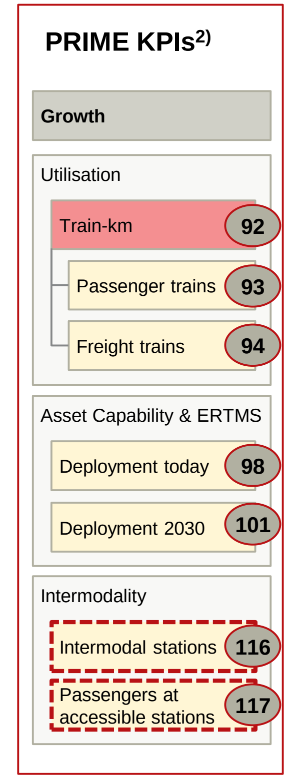
KPI Name	KPI Definition
Intermodal stations	Percentage of public passenger railway stations with connections to public urban transport (metro, bus, tramways, light rail, ferries etc.…) within the entire railway infrastructure network, independent of ownership (Source "Passenger stations": European Commission, RMMS)
Passengers using accessible stations	Percentage of passengers registered annually in all accessible stations within the entire railway infrastructure network, independent of ownership, related to the total number of passengers. An accessible station is one on which a passenger can, from entering the station, reach the platform via level-access, without steps or equivalent.

High Level Industry KPI | Benchmarking KPI | KPI under review

IMs are encouraged to use civity's first draft of a root-cause analysis as basis for discussing performance differences

Growth – drivers[1)]





1) Drivers which are currently collected in PRIME are coloured light blue
2) As currently collected and evaluated in PRIME

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Further analysis should account for underlying root causes and identify opportunities for improvement

Growth – Further analysis

- From a total network perspective the utilisation of European railway infrastructure varies significantly; in order to better understand to what extent parts of the networks are over- or underutilised a **drill-down into the distribution of utilisation** would be valuable
- Furthermore, discussion with IMs should be started to investigate the **activities undertaken to manage capacity**, for example by increasing the use of existing infrastructure or downsizing parts of the network
- The development of freight traffic over the years is quite different, too. Some countries face a slight increase while others remain stable or even run less trains per day. To understand these developments the drivers should be analysed as well as the activities that IMs have undertaken to **increase the attractiveness of rail freight**
- From country to country the **motivation to roll out ETCS** can be different (capacity, safety, obsolescence etc.) and should be explored further in order to understand the different levels and dynamics of its implementation
- Signalling failures account for the majority of infrastructure related unreliability and in general ERTMS provides the opportunity to reduce them; however, the correlation is not quite clear and further analysis would be helpful to understand the **trade-offs between the signalling system and reliability**
- With regards to KPIs on intermodal stations and passengers using accessible stations more effort is needed to **complete these datasets**

Table of contents

Country characteristics & market and operations

Contextual information – Countries (2017)

	Countries														
	Spain	Norway	Germany	Finland	Belgium	Portugal	Latvia	Lithuania	United Kingdom	Poland	Netherlands	Italy	Switzerland	France	Sweden
Country characteristics															
Country area (thousand km^2)	506	324	357	338	31	92	65	65	244	313	42	301	4	633	450
Population (million)	47	5	83	6	11	10	2	3	66	38	17	61	8	67	10
Currency	EUR	NOK	EUR	EUR	EUR	EUR	EUR	EUR	GBP	PLN	EUR	EUR	CHF	EUR	SEK
GDP per head (index - EU28 100)	93	146	124	109	117	77	67	78	105	70	128	96	161	104	122
Number of border countries	6	3	9	3	4	1	4	4	1	7	2	6	5	8	2
Population density (persons/km^2)	92	16	231	16	372	112	30	44	270	121	411	201	204	106	22
Market and operations (national)															
Number of RUs[1] (2016)	38	7	448	3	7	10	6	12	41	82	39	33[4]	47	21	32
Share of NW managed by main IM[2]	100%	100%	85%	100%	100%	100%	100%	100%	97%	96%	100%	84%	59%	100%	89%
% of main lines in TEN-T core network[3]	54%	0%	25%	22%	34%	57%	53%	45%	22%	25%	28%	33%	0%	31%	36%
Modal share of rail freight	5%	13%	19%	27%	11%	15%	77%	65%	8%	25%	6%	15%	38%	11%	29%
Modal share of rail passengers	7%	5%	9%	6%	8%	4%	4%	1%	9%	7%	11%	6%	17%	10%	9%
% of freight in total train-km	13%	15%		30%	19%	16%	49%	58%	7%	32%	7%	13%	16%	14%	23%
% of international in passenger-km[1] (2016)	1%	1%	5%	3%	4%	3%	7%	33%	2%	3%	7%	1%	N/A	12%	4%
% of international in tonne-km[1] (2016)	18%	46%	48%	35%	78%	8%	98%	74%	0%	43%	91%	50%	N/A	30%	36%

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019 unless otherwise noted
1) EC RMMS; 2) IRG Rail; 3) TENtec database; all provided by the European Commission, 03 January 2019; 4) RFI (25/02/19)

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Organisation & Network

Contextual information – Infrastructure Managers (2017)

	Adif	Bane NOR	DB	FTIA	Infrabel	IP	LDZ	LG	NR	PKP PLK	Pro Rail	RFI	SBB	SNCF R.	TRV
Organisation															
Is the IM state-owned	Yes	Yes		Yes		Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes
Are IM and operators integrated	No	No		No		No	Yes	No	No	No	No	No	Yes	Yes	No
Number of FTE employees	12.079	4.420		639		3.697	6.494	2.987	38.594	39.349	4.280	25.963		53.624	7.135
Age average	53,7	45,0		48,5		49,6	46,0	46,0		46,0	46,7	48,8		41,2	47,0
Male employees among IM's workforce	84%	76%		60%		76%	64%	68%		68%	74%	88%		88%	62%
Network															
Main line km (lines in commercial use)	15.302	3.856		5.926		2.546	1.860			18.513	3.169	16.787		28.120	9.676
Total main track-km	21.029	4.125	55.311	6.708	6.515	3.244	2.217	1.911	31.221	27.120	5.409	27.044	6.183	48.992	11.775
Total passenger high speed main track-km	5.248	0		1.527		0		0	0	0	294	2.428		4.401	0
Single track-km per total track-km	37%	85%		61%		53%	47%	77%		28%	15%	31%		20%	54%
Electrified track-km per total track-km	60%	60%	69%	59%	86%	75%	16%	9%		69%	77%	77%	100%	56%	84%
Million train-km	197	48	1.022	48	105	36	14	15	572	235	160	354	178	475	157

Source: civity calculations using data as provided by the infrastructure managers until 29 January 2019

We used a scoring model to evaluate the overall robustness of the KPIs across all IMs

Methodology: Robustness traffic light

1 Measure

For each measure, IMs evaluate robustness levels. Weightings were assigned to each level.

2 Calculations

Depending on the number of evaluations for each level a total score was calculated.

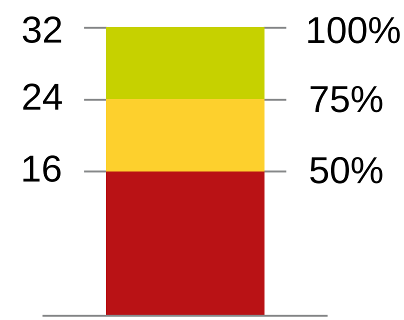
3 Robustness outcome

The total score was compared to the maximum score to determine the robustness outcome.

Level	Weighing		Count for each level (examples)		Score for each level
"Normal"	4	•	5	=	20
"Estimate"	2	•	2	=	4
"Deviating from definition"	1	•	0	=	0
"Preliminary"	1	•	1	=	1

Total score $\sum 25$

"Maximum score[1)] depends on the number of evaluations"



1) The maximum score implies that the level of all provided robustness evaluations was "normal"

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