International Benchmark 2011 – 2015 ProRail / NS

2017 – December
Final version

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Content

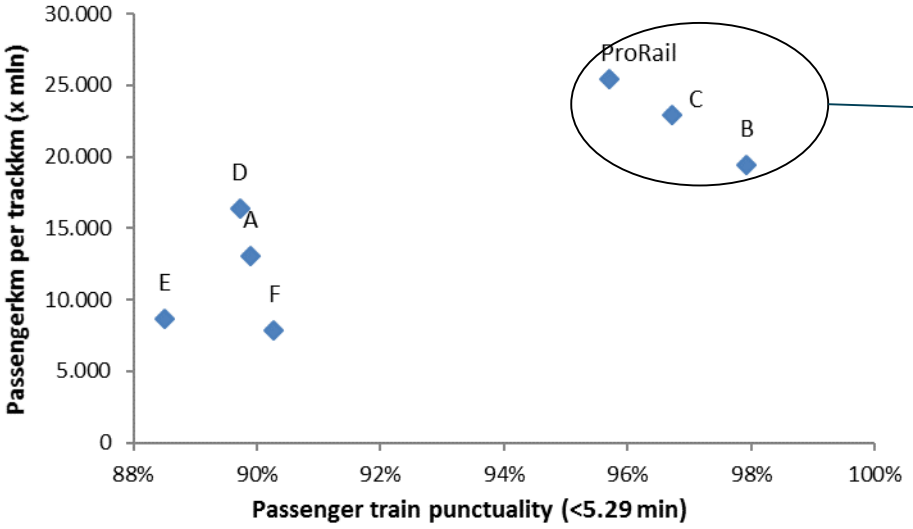
Highlighted findings from NS and ProRail perspective

- As part of the Dutch Infrastructure Management Contract and Transportation Contract, the Dutch Ministry of Infrastructure has asked ProRail and NS to carry out an international benchmarking study on other rail infrastructure managers and train operators
- The peer group consists of six North-West European countries with comparable infrastructure and transportation characteristics and challenges: Belgium, France, Switzerland, Denmark, Sweden and United Kingdom. Data was gathered via publicly available sources and via questionnaires. The data of questionnaires of the infrastructure managers were validated through visits*. The realization of this report has been audited by an independent auditor to ensure fair presentation of the results
- The results of the benchmark will be used to identify realistic potential for improving the efficiency and effectiveness of ProRail's and NS' activities and services
- Highlighted findings from the perspective of ProRail and NS relative to peer group average:
    - Rail system performance: high punctuality, low failure rate, but high percentage of cancelled trains and increased average repair time of incidents
    - Customer satisfaction: low overall customer satisfaction and high complaint rate, but improving on most aspects
    - Capacity: high utilization of infrastructure (passenger traffic) and rolling stock (high number of trains per trackkilometre, high number of passengerkm per vehicle, high seating capacity per train, relatively young rolling stock)
    - Safety: low number of accidents, high suicide rate
    - Financial: average cost per trackkm but low cost per trainkm; high percentage of infrastructure maintenance cost compared to renewal cost, average costs for passengers, low public funding of operations, low total revenues per passengerkm.

* Except for UK

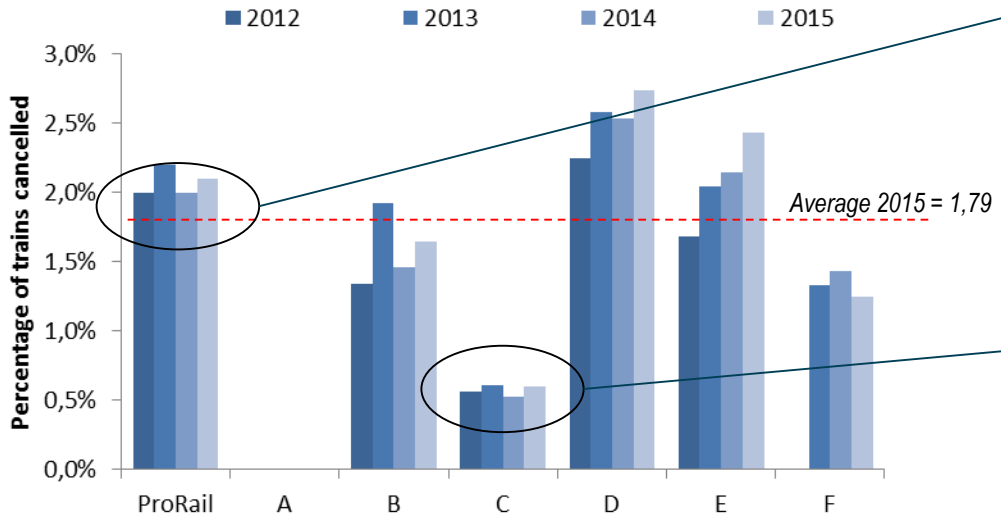
Highlighted findings – Rail system performance of NL

High utilization of infrastructure and high punctuality, but high percentage of cancelled trains



NL has high punctuality relative to utilization of the network (trainkm per trackkm). B and C have higher punctuality and slightly lower utilization

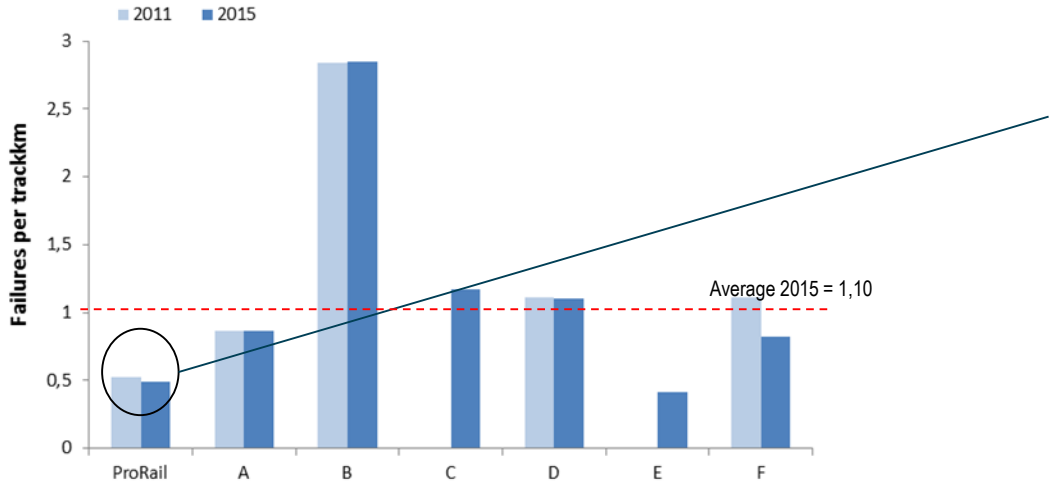
NL has a high percentage of cancelled trains relative to the peer group average



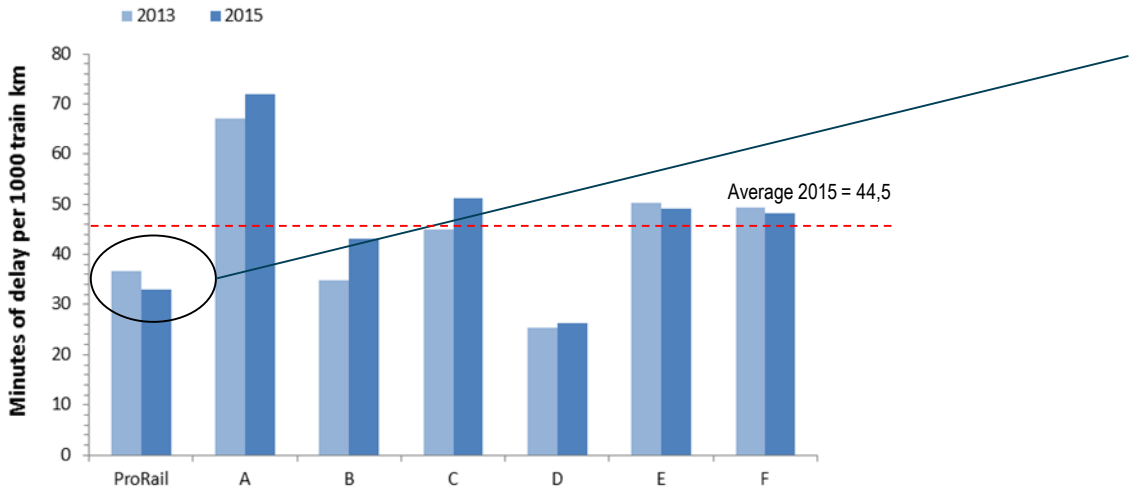
C, which has comparable high utilization and punctuality, has significantly less cancelled trains

Highlighted findings – Rail system performance of NL

NL has a low number of failures per trackkm. Delay minutes per trainkm are also low compared to peergroup



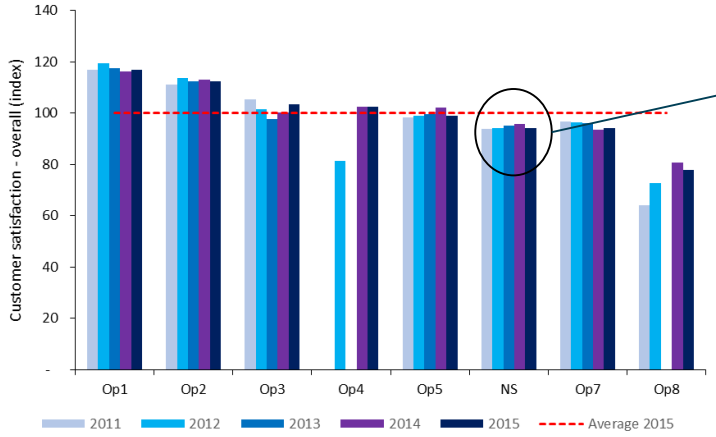
NL has a low number of infrastructure failures per trackkm and shows a slightly decreasing trend



NL has a below average number of delay minutes per trainkm. NL also shows a decreasing trend, whereas other countries show a more stable or upward trend in the period 2013-2015

Highlighted findings – Passenger satisfaction

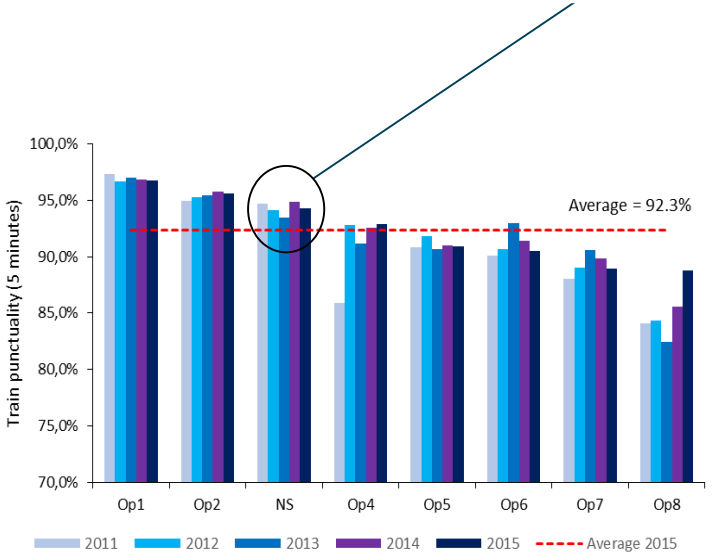
Overall customer satisfaction is below average while e.g. punctuality is above average.
Specific customer satisfaction scores show upward trends.



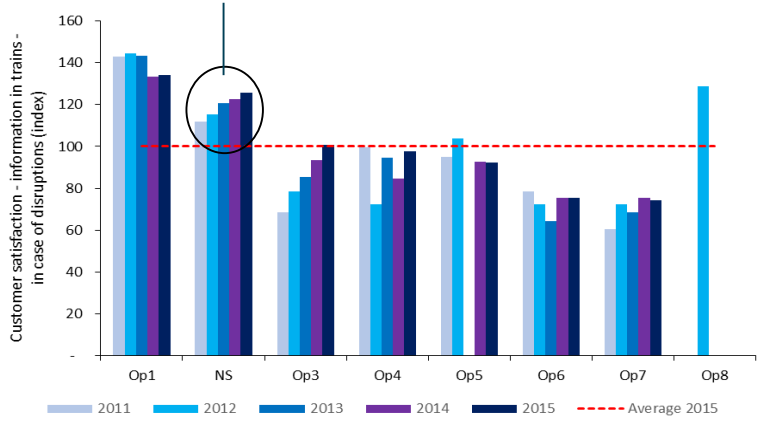
Overall customer satisfaction is below average and complaint rate is above average. Comparability is limited due to differences in methodology.

Operational performance (e.g. punctuality is above average). Data harmonization introduces some uncertainty.

No clear correlation between performance indicators and overall customer satisfaction between the peers. Customer satisfaction is determined by perception and expectations.

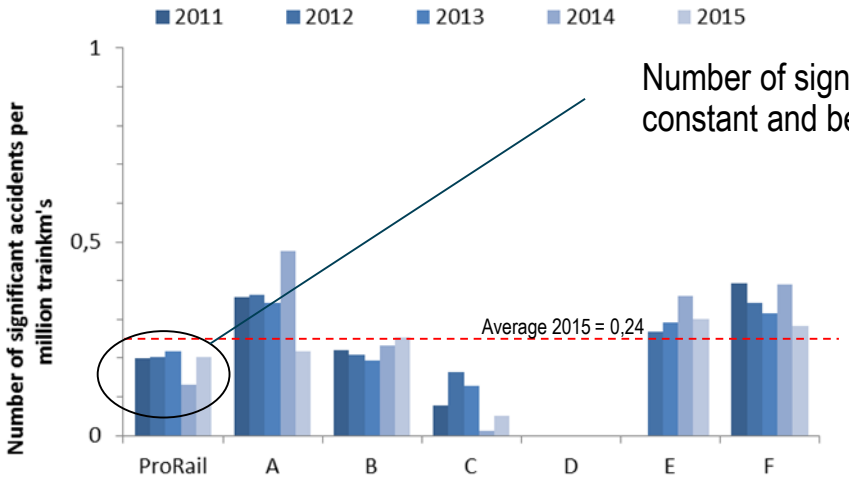


Specific customer satisfaction scores show improvement, e.g. passenger information in case of disruptions

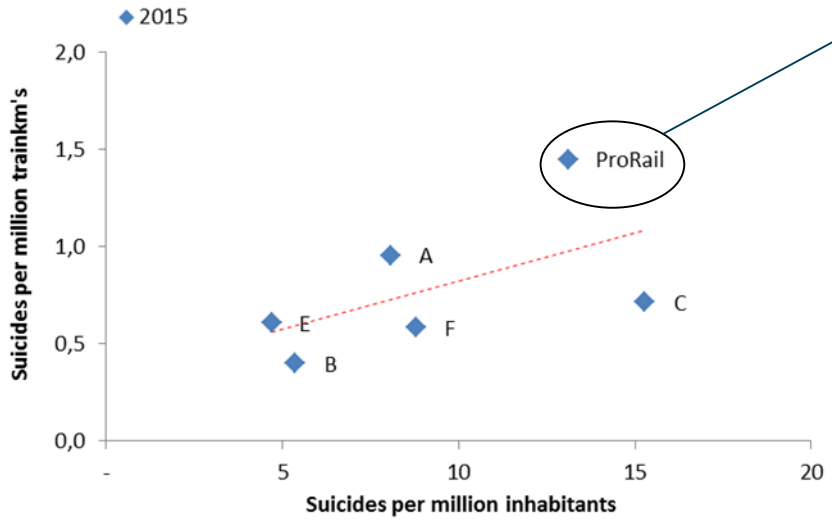


Highlighted findings – Safety

Below average number of accidents per trainkm; high suicide rate; accidents on level crossings is more or less stable

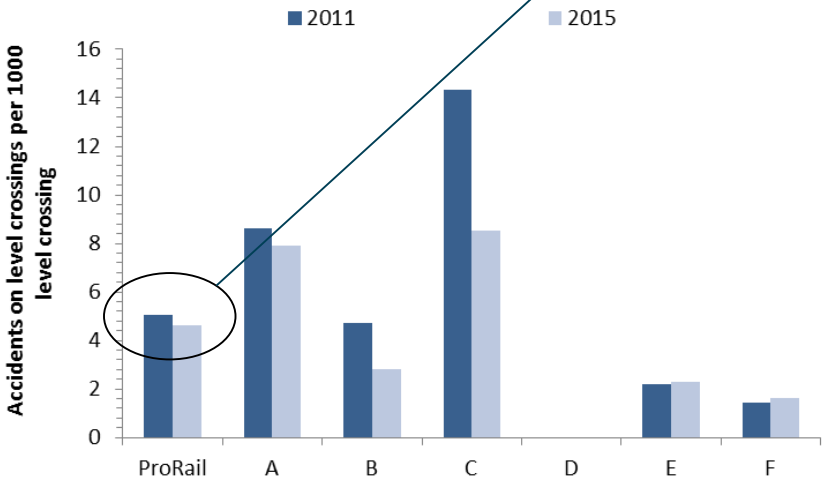


Number of significant accidents per trainkm is relatively constant and below peer group average



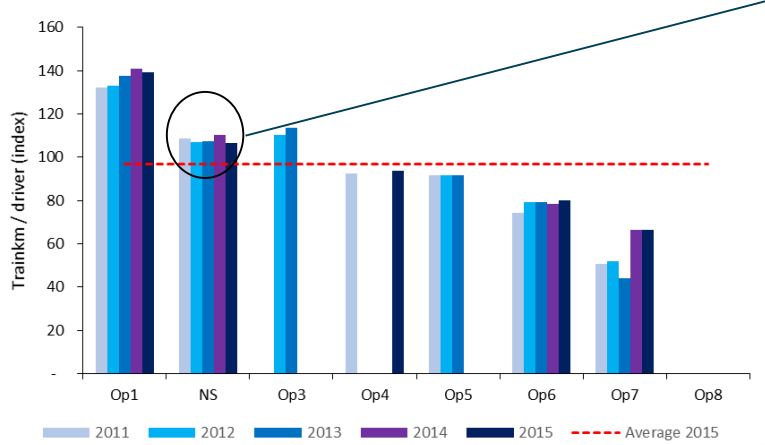
The number of rail related suicides is high, both per trainkm and per number of inhabitants

The number of significant accidents on level crossings is almost stable in NL



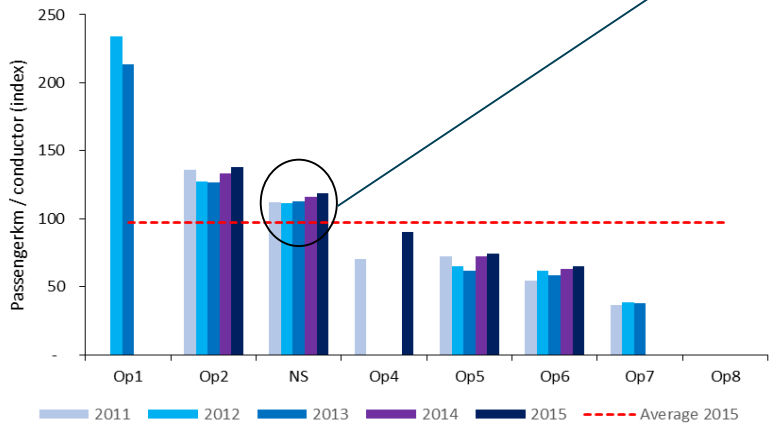
Highlighted findings – Productivity of train operations

Productivity of train staff and rolling stock are above average, system speed is driving productivity



Train drivers drive an above average number of trainkm compared to the peer group.

Main factors driving productivity: high system speed, intensive timetable.

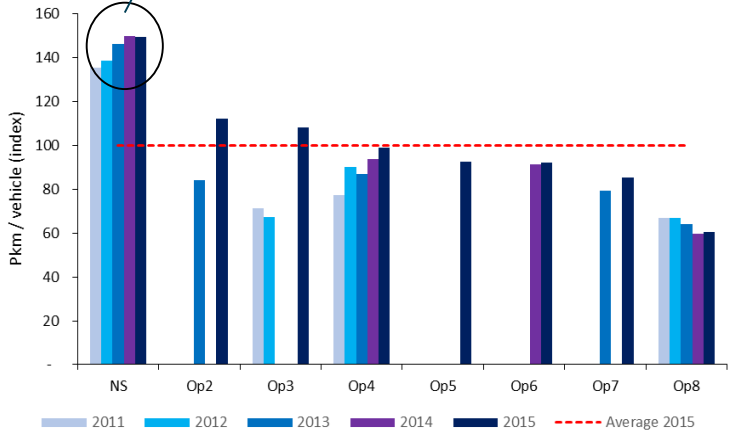


Conductors serve an above average number of passengers.

Main factors driving productivity: high system speed, adjusting timetable to demand (passengers per train), even distribution of passenger demand.

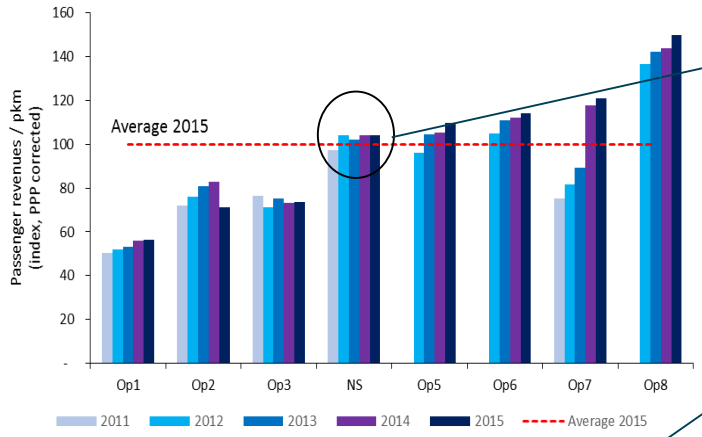
Productivity of rolling stock is high

Main factors: high system speed, high rolling stock availability (maintenance organization), even distribution of passenger demand.



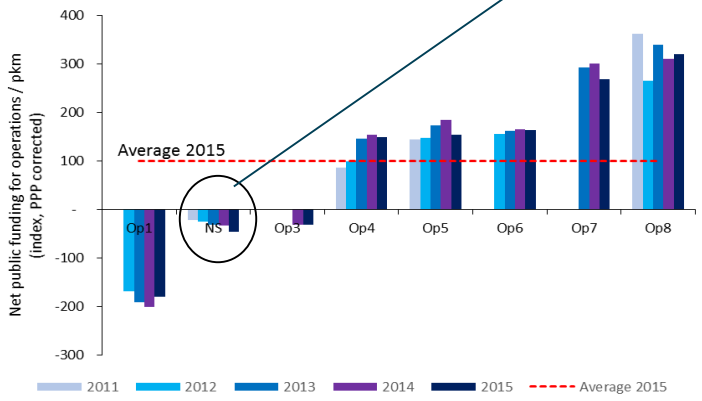
Highlighted findings – Costs of train operations

Total costs for train operations is lowest in peer group; cost level for passengers is around average and stable, net public funding of train operations is low and decreasing

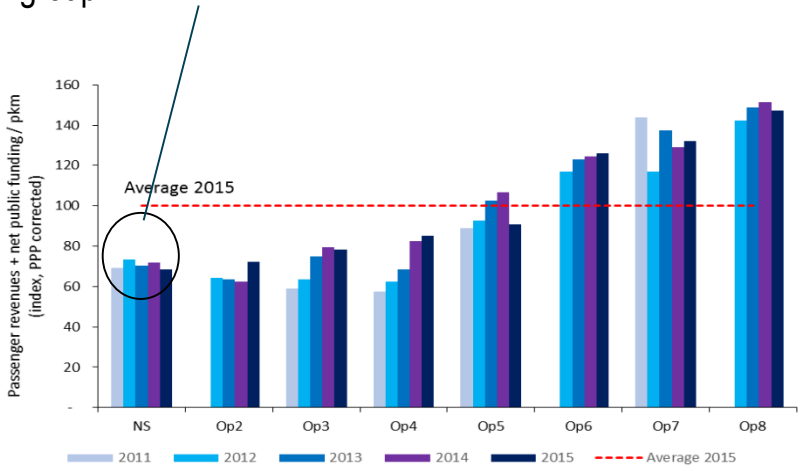


Cost level for passengers (excl. VAT) is around the average of the peer group and relatively stable. Other peers show higher price increases.

Net public funding for train operations kilometre is low (operations subsidy - concession fee - track access charges). NS pays increasing concession fees and track access charges.

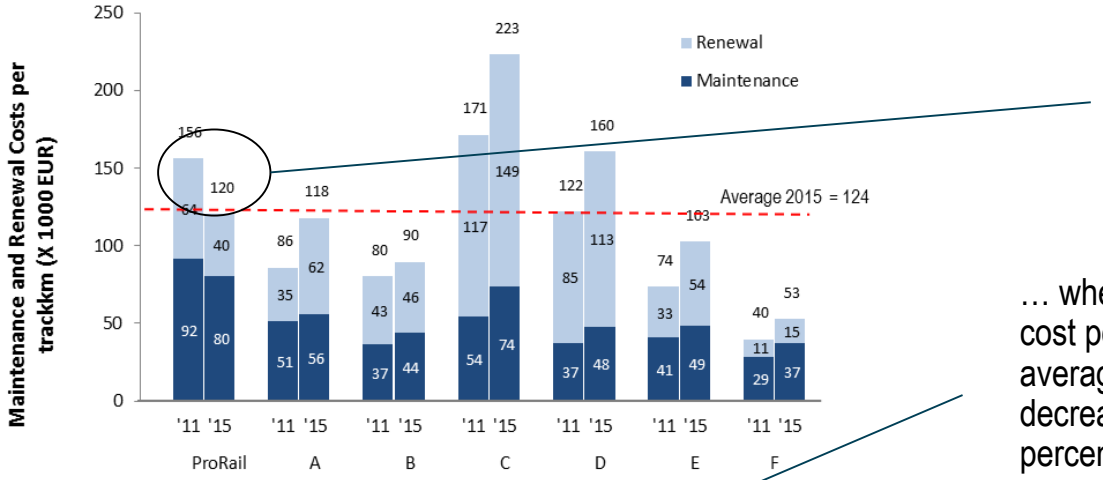


Passenger revenues and public funding add up to the lowest total revenues per passengerkm of the train operator peer group



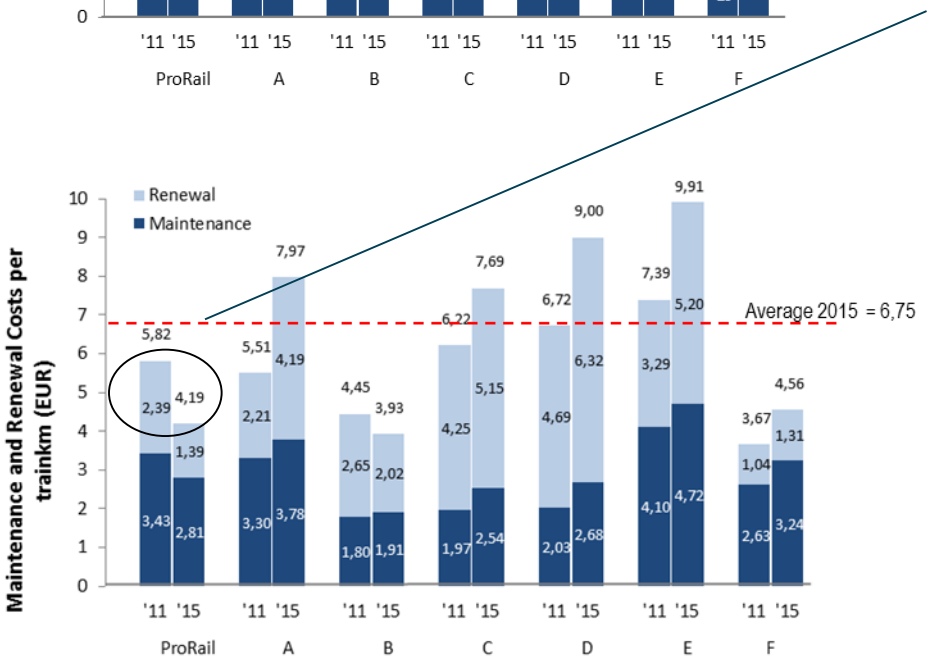
Highlighted findings – Costs of inframanagement vs performance

Average cost per trackkm but low cost per trainkm; high percentage of infrastructure maintenance cost compared to renewal cost. Overall very good performance against low cost per trainkm.

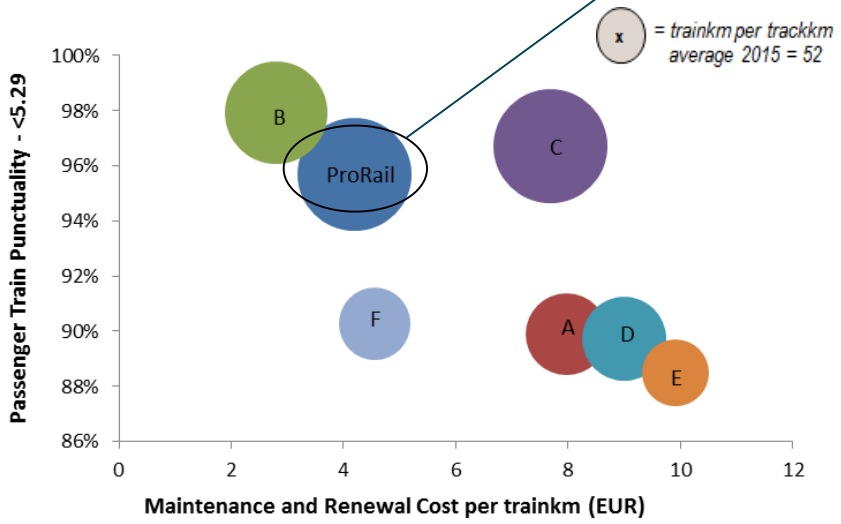


Maintenance and renewal costs per trackkm are average and show a significant decrease*…

… whereas maintenance and renewal cost per trainkm are below peer group average, also showing a strong decrease. NL also shows a high percentage of maintenance costs compared to renewals cost in 2015



ProRail combines high punctuality and utilization with low cost per trainkm



* The average maintenance and renewal cost without peer C is 92, which means ProRail is above average.

1. Introduction

Highlighted findings from NS and ProRail perspective

1. Introduction, context and methodology
    1. Objectives of the benchmark – concession obligations
    2. Approach
2. Peer group
3. Rail network and stations
4. Asset characteristics
5. Safety
6. Attractive product for travelers and freight carriers
7. Reliability
8. Sustainability
9. Railsystem capacity
10. Productivity
11. Financial performance

Appendices

1.1 Introduction, context and methodology

Objective of the international benchmark is to identify opportunities for improvement of the performance of NS and ProRail

- As part of the Dutch Infrastructure Management Contract and Transportation Contract, the Dutch Ministry of Infrastructure has asked ProRail and NS to carry out an international benchmarking study on other rail infrastructure managers and operators

- This benchmarking study is a joint effort between ProRail and NS. ProRail's latest international benchmark was presented to the ministry in 2011, whereas NS presented their latest benchmark in 2014. The ministry, ProRail and NS agreed to perform a new joint study every three years.

- With the study the ministry, ProRail and NS intend to acquire latest knowledge on ProRail's and NS' performance relative to a selection of European peers on the key performance areas mentioned in the Infrastructure Management- and Transportation contract. This includes subjects like punctuality, safety, costs, sustainability and productivity. The results of the benchmark will be used to identify realistic potential for improving the quality, efficiency and effectiveness of ProRail's and NS' activities and services.

- Rail infra managers and rail operators from six countries have contributed to this study, under the precondition that the results of the benchmark will be treated confidential. As a result, all confidential information in this benchmark will be presented anonymously, while public data is not anonymized where possible.
    - The names of the infrastructure managers are labeled ProRail and A - F. The letter for each infrastructure manager remains constant throughout the report
    - The names of train operators are labeled NS and Op1 – Op8. Operators are ranked per comparison. Therefore codes for each train operator change per analysis as stipulated in confidentiality agreements with the peers.

- The information presented in this benchmark is a combination of KPIs and best practices which are commonly used in the rail infra and transportation industry. The identified potential for improvements for ProRail and NS will be input for the future management contracts for ProRail (*Beheerplan)* and NS (*Vervoerplan)*

1.2 Introduction, context and methodology

Challenging process to gather, compare and analyse international rail data

- The peer group consists of infrastructure managers and train operators from the following countries: Belgium, France, Switzerland, Denmark, Sweden and the United Kingdom. The peer group corresponds with the peer group of earlier benchmarks of NS and ProRail to ensure continuity and a longer term perspective.

- ProRail and NS used multiple sources for this benchmarking study:

  1. Publicly available information (annual reports, internet, statistical bureaus, sector reports, etc.)
  2. Data from international benchmark platforms and working groups that ProRail or NS participate in
  3. Information from the peer group (information requests for the period 2011 - 2015)

- The data gathering and analysis process has proven to be a challenging part of this benchmark study: not all peers have all requested data for the requested years available, and not all peers were able to deliver the requested data in line with the requested definitions

- As a result, not all analyses presented in this study will be complete: countries / companies may be absent in certain analyses, or certain years may not be fully covered in certain analyses

- Because of variations in currencies and price indices of the countries in the peer group, financial data was corrected for exchange rates and price indices

- This benchmark study has been audited by the Kennisinstituut voor Mobiliteitsbeleid (KIM)

1.2 Introduction, context and methodology
Other remarks

- The definitions used for the analyses in this report **do not** necessarily match the definitions of the KPI's which ProRail and NS use in their dashboards and in the reports for the Ministry of IenM. For examples: the calculation of Life Cycle Cost (LCC) per trackkm in this report differs from the calculation of the LCC in quarterly and annual reports. Appendix A gives an overview of all the definitions used for the analyses in this benchmark report.

- In the numeric convention of this report, a period (.) is used to separate groups of thousands. A comma (,) is used to indicate the decimal space

- Punctuality scores of the train operators and customer satisfaction scores are harmonized (re-scaled) using the methodology described in Appendix B. This introduces an amount of uncertainty in the comparability. The figures are not harmonized for differences in measurement methodology (e.g. survey channel and sampling scheme for customer satisfaction and measurement points for punctuality).

- All financial comparisons are excluding VAT and harmonized using the OECD Purchasing Power Parity as described in Appendix B.

- As indicated on the previous slides, data requests were sent out to inframanagers in the peer group. For those countries in which there are more than one inframanagers, publicly available data on the country level are used for analyses where country averages are needed (for example: number of train stations per square kilometre).

- The logos of ProRail and NS in the upper right corner of the pages indicate the main party for the subject; if both logos are clear the subject concerns the entire railway sector, if one of the logos is faded the subject concerns mainly the party with the clear logo.

2. Peer group

2.1 Peer group

Peer group consists of six North-West European countries with comparable rail infrastructure, characteristics and challenges

	Inframanagers	*Train operators*
	ProRail	NS
	Infrabel	NMBS
	Trafikverket	-
	Banedanmark	DSB
	SNCF Réseau	-
	Network Rail	Greater Anglia, Scotrail, Northern Rail, Merseyrail
	SBB - Infra	SBB

The selection of the countries in the peer group is based on:

1. Participants in previous international benchmarking studies by ProRail and NS to establish a longer term perspective with time series
2. Trade off between comparability and learning potential:
   a. Infrastructure: network lay-out, potential weather / winter influences, intensive use of network; multiple operators on network
   b. Operations: commuter / regional transport, travel distance, traffic density, average speed, size
3. Cooperation of peer group / availability of data:
   a. Willingness to participate (market / competition issues, confidentiality conditions)
   b. Existing cooperation in other international working groups and/or benchmarking platforms

2.1 Peer group – key country and rail characteristics

Key country characteristics are used to calculate relevant and comparable ratio's in the various chapters of this benchmarking study

	Net length (km) – Country	3.170	3.631	10.881	2.612	30.905	16.209	5.323
	Net length (km) – IM peer	3.170	3.607	9.716	2.031	28.808	15.804	3.024
	Main track (km) – IM peer	5.379	6.514	12.867	3.254	49.253	35.502	6.026
	Surface – total (km²)[1]	41.543	30.528	450.295	43.094	551.500	243.610	41.277
	Surface – land (km²)[1]	33.893	30.278	410.335	42.434	549.970	241.910	39.997
	Population (mln)[1]	17,02	11,41	9,88	5,59	62,81	64,43	8,18
	Population density (# per km²)	502	377	24	132	114	266	204

Notes / remarks:

- In most of the peer countries the rail infrastructure is managed by more than one infrastructure manager. This can be seen in the difference between network length of the IM peer versus the network length of the country
- For some analyses in this report the net length of the country has been used (i.e. trackkilometres per km²), whereas for other analyses the net length of the IM has been used (i.e. costs per trackkilometre)

[1] Source: https://www.cia.gov/library/publications/the-world-factbook/geos/da.html

2.2 Rail infrastructure vs. other infrastructure

NL rail infrastructure (kilometres) as percentage of total infrastructure is around peer group average

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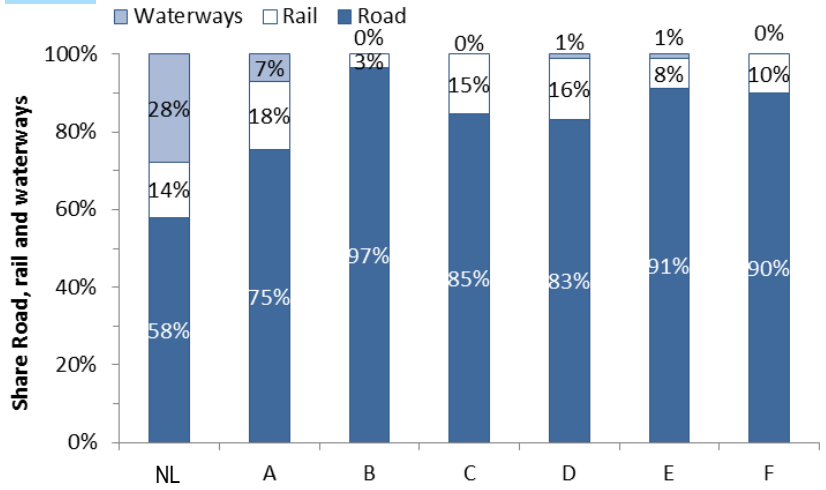


Figure 1 shows the infrastructure modal split per country (kilometres).

Road = Motorways + main national roads + secondary roads

Rail = Conventional + high speed rail

Interpretation:

- Relative size of NL rail infrastructure (14% of total infrastructure) is around peer group average (12%)
- NL has a relative large percentage of waterways compared to the peer group (28% vs. 5% peer group average)

2

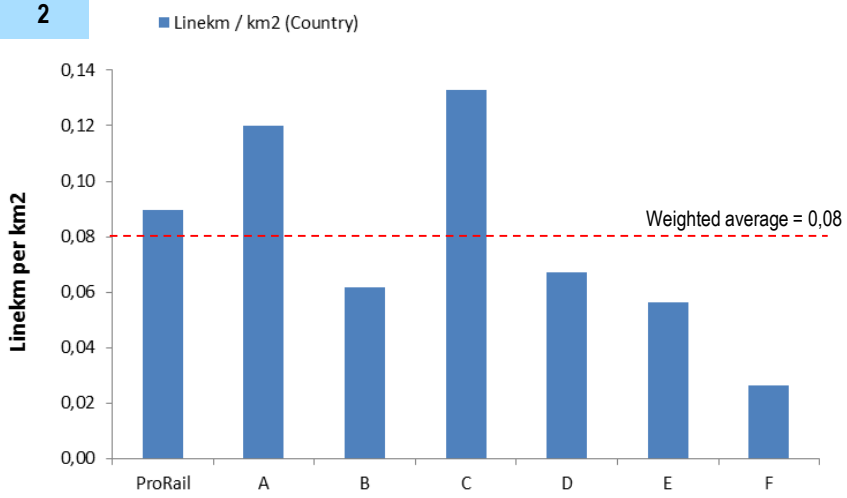


Figure 2 shows rail line kilometres per km2 of land

Interpretation:

- NL has approximately 90 metres of rail per km2 of land
- This is around peer group average
- Only A and C have more line metres per km2

2.2 Peer group – market regime may influence comparability of results

Market regime for HS Passengers and freight is similar among peers. Market regime for IC passengers, commuter trains and regionale passengers differs only by how PSC's are awarded

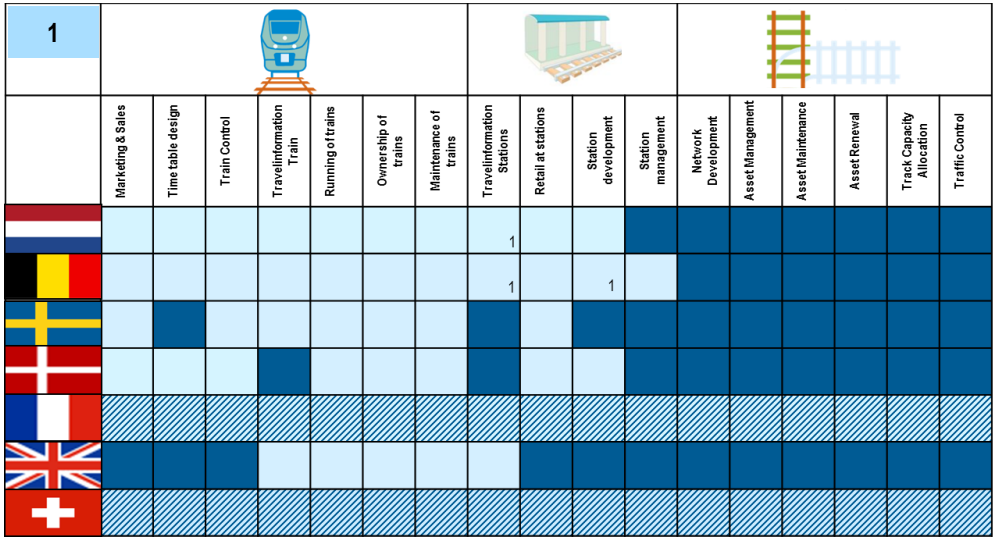
Market segment							
HS passengers	Open access	Open access	Open access	Open access	PSC direct award	Open access	Not relevant
IC passengers	PSC direct award	PSC direct award	PSC tendered	PSC direct award	PSC direct award	PSC tendered	PSC direct award
Commuter trains	PSC direct award	PSC direct award	PSC tendered	PSC direct award	PSC direct award	PSC tendered	PSC direct award
Regional passengers	PSC tendered	PSC direct award	PSC tendered	PSC tendered	PSC direct award	PSC tendered	PSC direct award
Freight	Open access	Open access	Open access	Open access	Open access	Open access	Open access

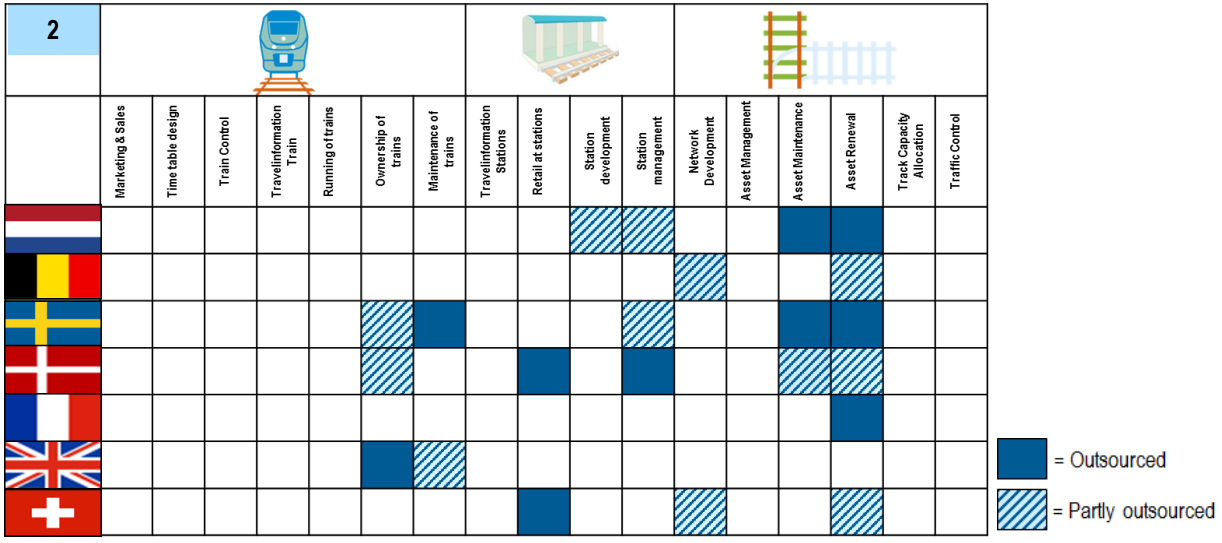
The market regime of a country has influence on the relative performance of countries: it affects key performance drivers like utilization and network complexity

- High Speed (HS) passenger transport is open access in all countries except for FRA, but the number of new entrants are limited
- Inter City (IC) passenger and commuter trains are mainly operated under directly awarded Public Service Contracts (PSC). Only in Sweden and UK tendering of transport contracts is prominent
- Regional passenger trains are mainly operated under tendered Public Service Contracts. In Belgium and Switzerland these trains are operated under directly awarded contracts
- Freight transport is open access in all countries of the peer group

2.2 Peer group - organization of the rail sector also affects comparability of results

Separation of responsibilities between inframanager and train operators differs per country





Interpretation:

Figure 1 shows the distribution of activities in the value chain between infrastructure manager and train operators

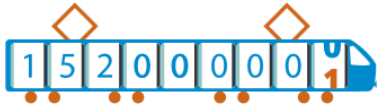
1. Split of responsibilities is not very clear in case of integrated companies
2. Split of responsibilities in other cases predominantly in activities related to stations
3. Some inframanagers are also responsible for time-table design

Interpretation:

Figure 2 shows which activities in the value chain are outsourced by the inframanager

1. Asset Maintenance and Asset Renewal are often outsourced by inframanagers
2. In some cases also network development is outsourced

3. Rail network and stations



3.1 Passenger kilometres - total

NS is one of the larger operators of the peer group

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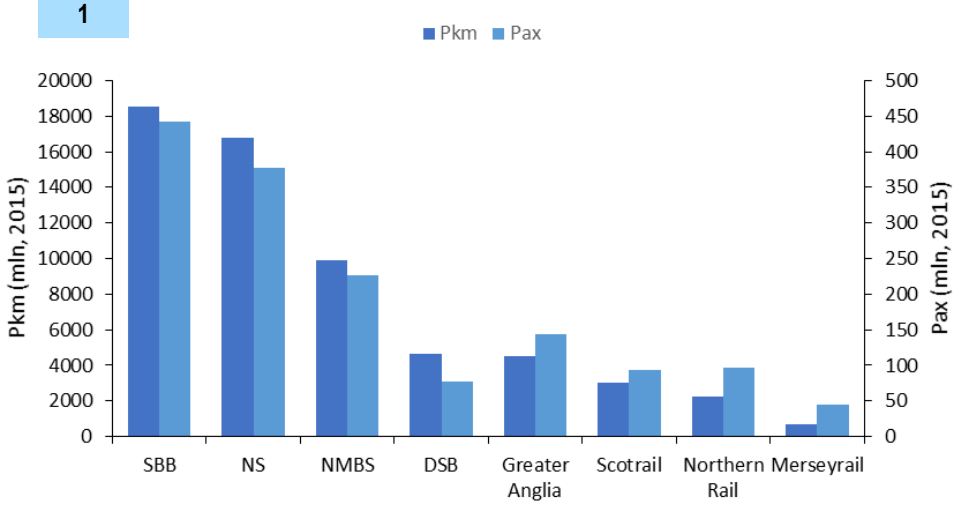

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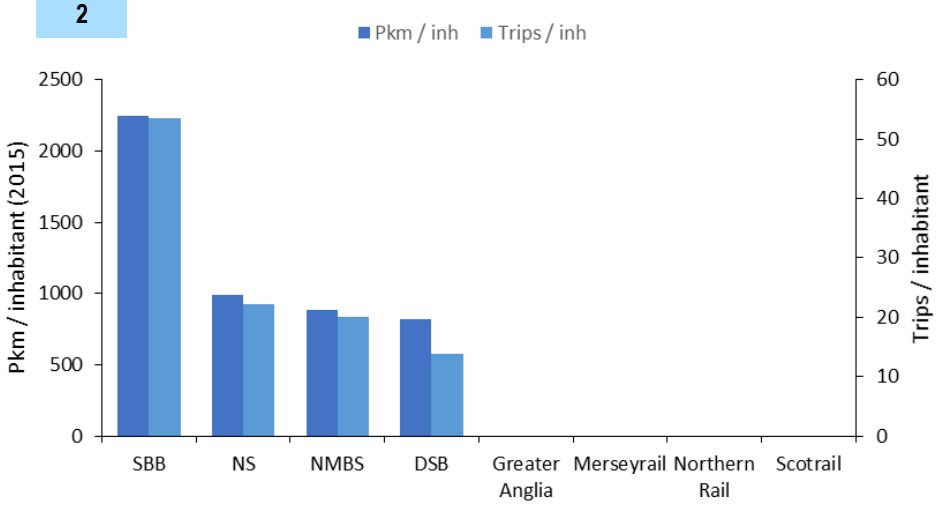

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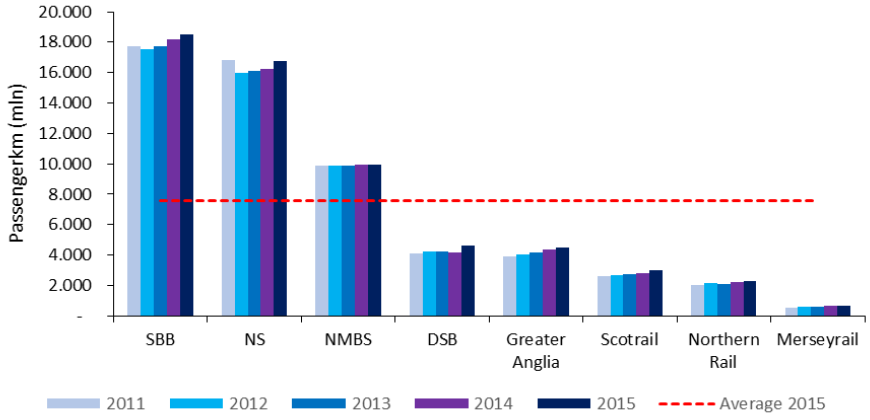

Interpretation:

1 NS and SBB are the largest operators of the peer group

2 Swiss inhabitants use the train twice as much as the average

3 NS passenger volume grows slowly, mainly due to shift of passengers to HSL and regional concessions (both out of scope)

- Average annual growth rate of passenger kilometres is 2,2%. UK operators show considerable higher growth rates, European operators lower.
- Other research shows that growth of rail transport is mainly determined by economic and policy factors, e.g. economic growth; costs of fuel, road taxes and parking; investments in road vs. rail infrastructure

3.1 Passenger kilometres – peak versus off-peak

NS carries more passengers off-peak than average, but there is a wide variation in definitions of peak hours

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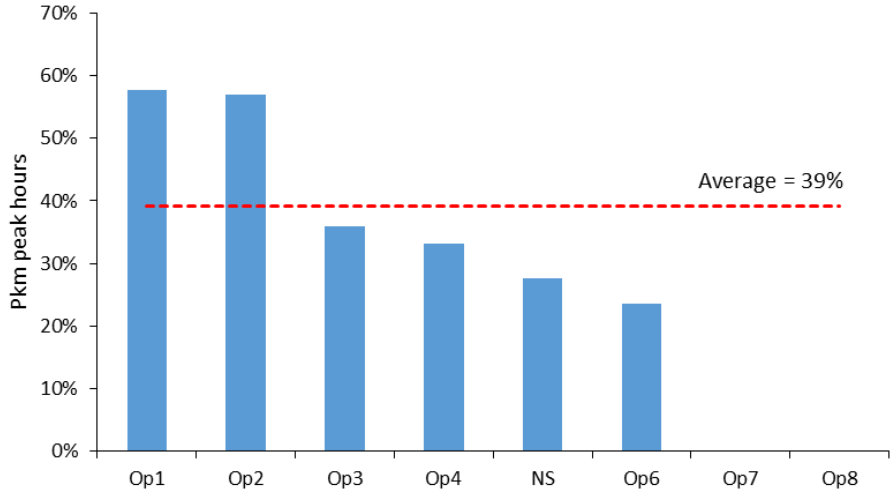

Interpretation:

- Percentage peak hour traffic varies between 24% and 58%
- Definitions of peak hours vary between operators
  - NS: Mo-Fr 6.30-9.00 and 16.00-18.30
  - NMBS: Mo-Fr 6.00-9.00 and 16.00-19.00
  - Merseyrail: 07.30-09.30, 16.00-18.00
  - SBB: Mo-Fr 6.00-8.59 and 16.00-18.59
- Considering the different definitions, NS peak hour traffic seems to be slightly below average. However the differences in definition limit the possibility to draw conclusions.

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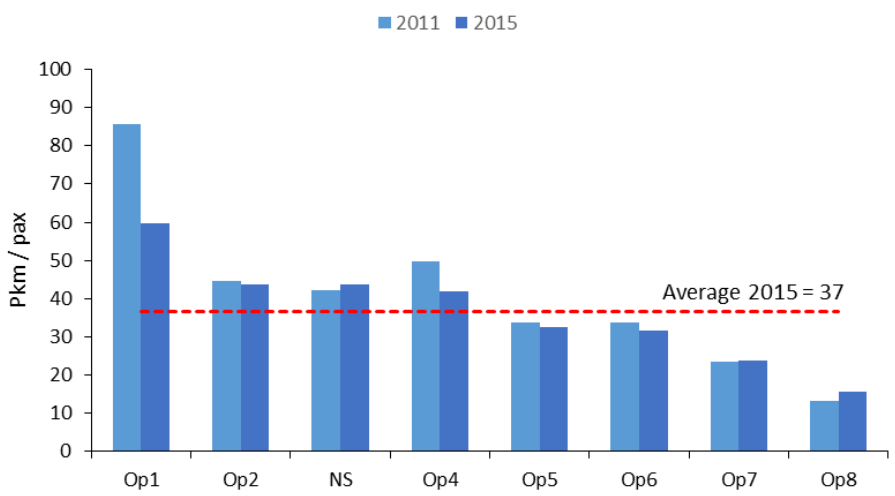

Interpretation:

- The average distance per trip is 37km
- NS passengers travel on average 44km per trip
- Changes over the years are mainly due to change of scope; e.g. tendering of parts of the network, introducing new (high speed) lines, etc.

3.1 Passenger kilometres – allocative efficiency

NS shows a high level of allocative efficiency with high capacity trains; supply grows in line with demand

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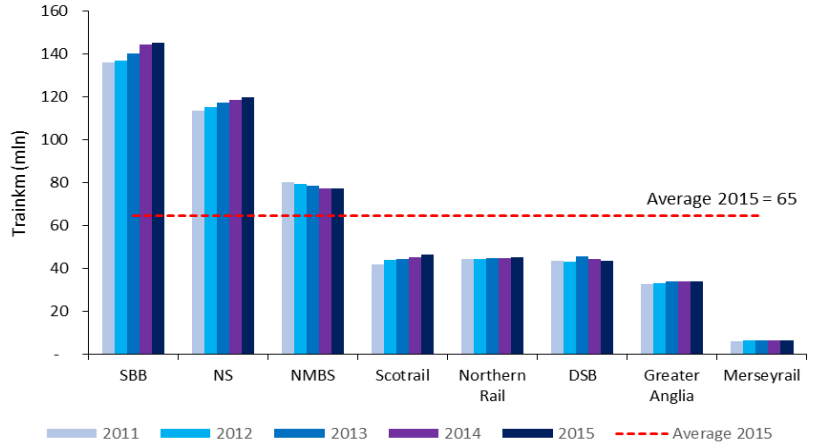

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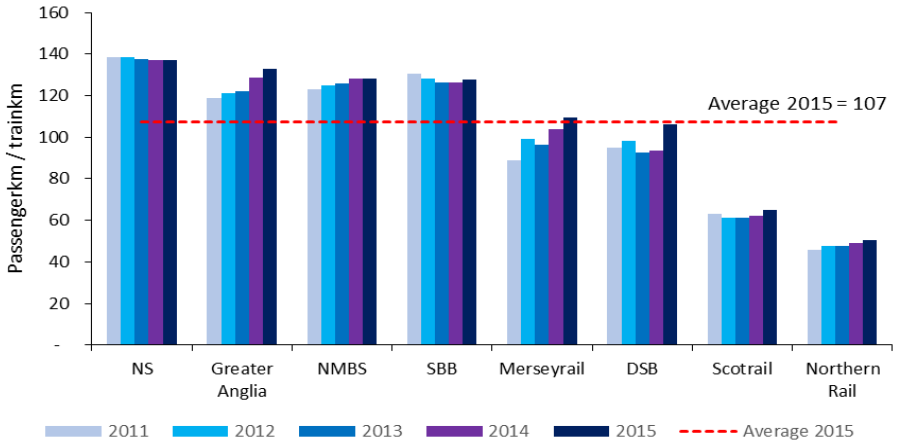

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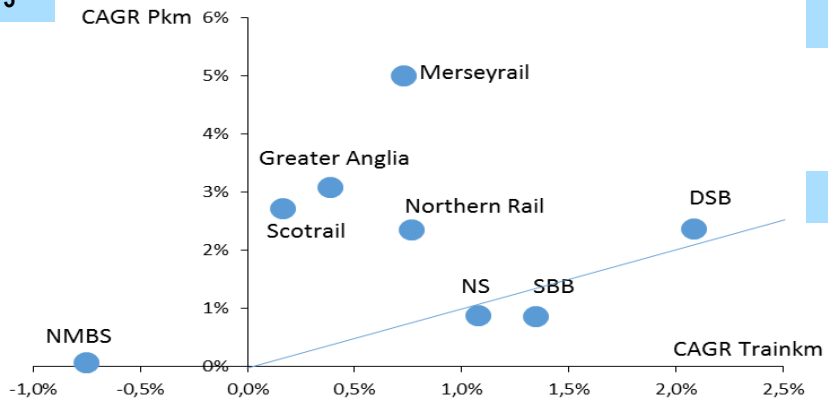


CAGR = Compound Annual Growth Rate

Interpretation:

2 NS carries 28% more passengers per train than the average of the group, indicating a high level of allocative efficiency

- Factors are: matching demand and supply in the timetable, use of double deck rolling stock and long trains where needed and possible

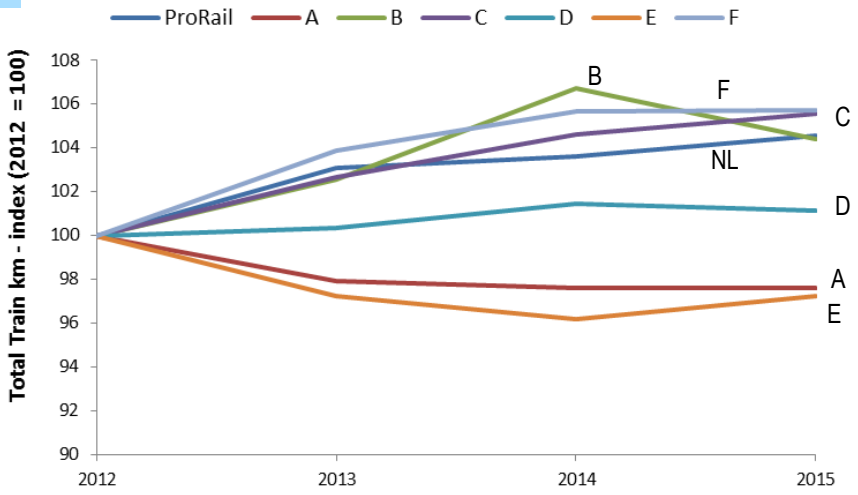
3 NS supply growth is in balance with demand growth, with trains offering 24% more seats per train than the average of the peer group

- SBB supply grows significantly and grows slightly ahead of the demand
- In UK and Belgium the demand grows faster than the supply. This can lead to capacity problems on specific routes (e.g. around large cities).
- Note: in Denmark there was a change of scope in 2015

3.1 Train kilometres - total

ProRail shows growth in total train kilometres of 4,6% in period 2012 – 2015. Train kilometres per track kilometre has increased by 4,3%

1



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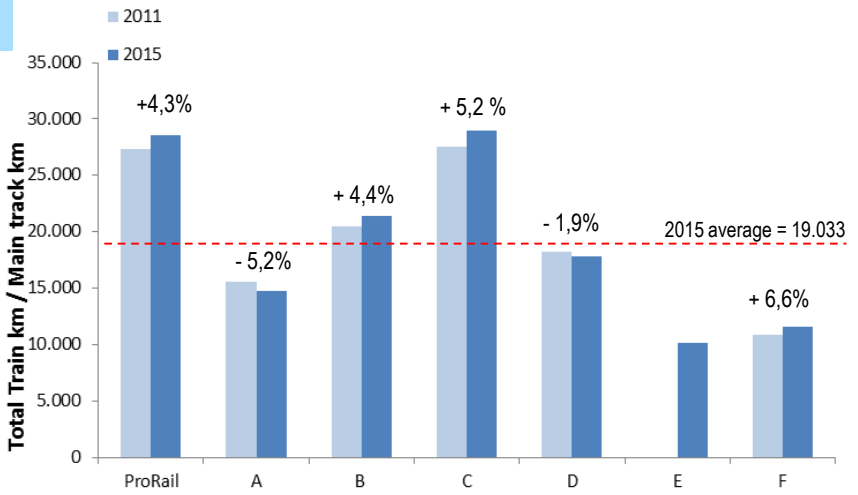


Total Train Kilometres - explanation :

Figure 1 shows the indexed development of total train kilometres (passenger and freight) per year (2012 = 100). This gives an indication of the development of the total volume on the network of the inframanager.

Interpretation:

1 ProRail shows a 4,6% growth in total train kilometres in the period 2012 – 2015. F and C show a larger growth rate. B shows a similar growth rate

- Not all countries show an increase in year-to-year total trainkms

Figure 2 shows the total train kilometres per main track kilometre per year.

Interpretation:

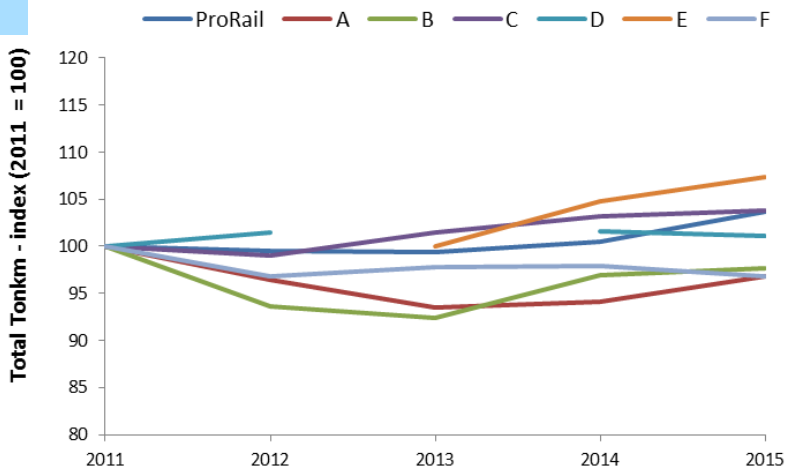
2 ProRail and C score above peer group average in terms of train kilometres per km main track.

- F shows the biggest increase in train km's per main track km. A shows the biggest decrease in trainkm per maintrackkm.

3.1 Tonkilometres - total

ProRail shows growth in terms of total tonkm, together with peers C, D and E. Other peers show a decrease.

1



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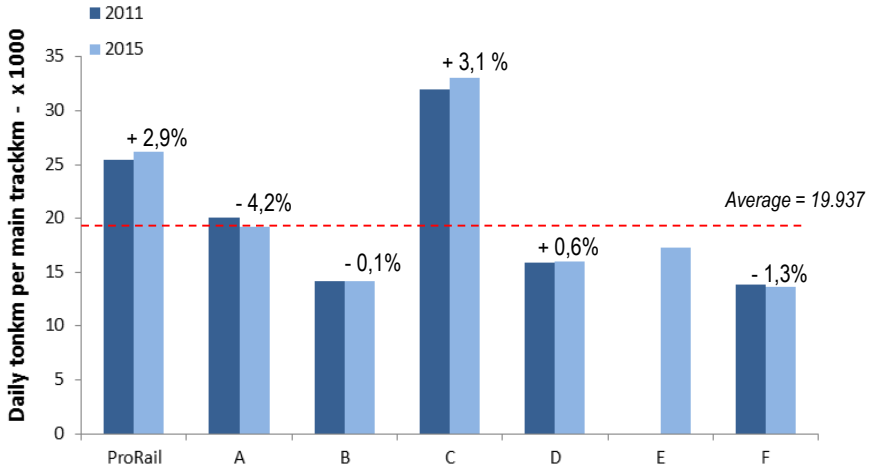


Interpretation:

1 ProRail and C's tonkm have grown by 4% in the period 2011 - 2015. The other IM's in the peer group show a more or less stable trend

1 Peer D data are missing for 2013

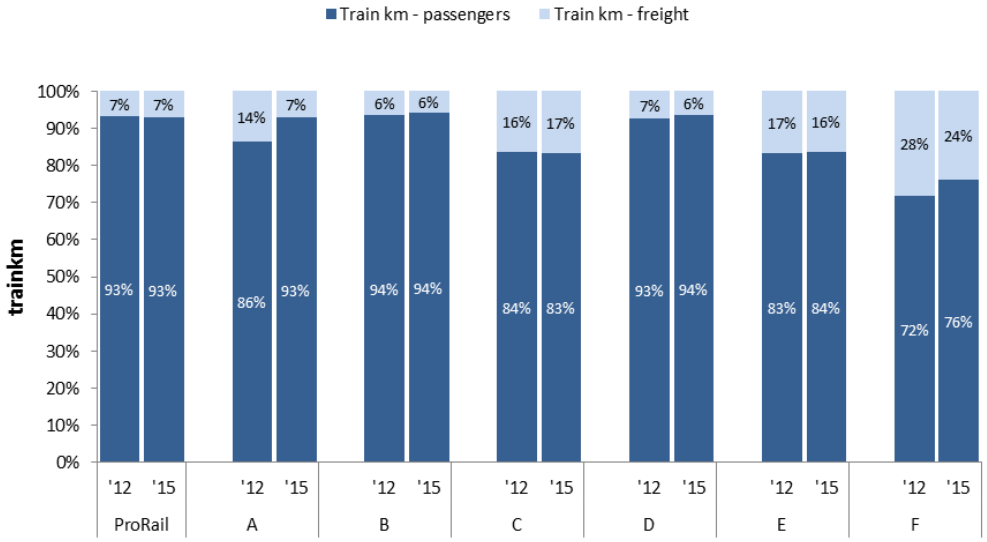
1 Due to missing data for 2011 and 2012, peer E has 2013 as index 100

2 Relative to the total number of trackkm, the daily number of tonkm per main trackkm of ProRail exceeds the peer group average in 2011 and 2015

2 C shows the highest daily tonkm per main trackkm in the peer group

3.1 Network usage – passenger vs freight

Share of freight trainkilometres at ProRail is low compared to peer group



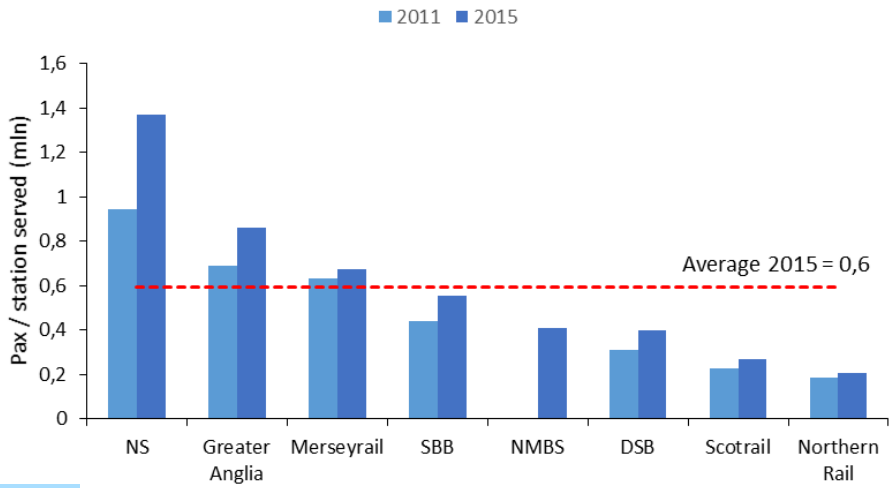
Interpretation:

1. In relative terms, NL has few freight trainkilometres compared to total train kilometres
2. NL shows stable trend
3. There is no clear trend visible in the peer group as far as the ratio passenger / freight is concerned: some countries move towards a higher percentage of freight kilometres, others towards more passengers kilometres
4. F clearly shows the largest percentage of freight kilometres as percentage of total train kilometres in the peer group

3.2 Utilization of stations

Stations served by NS are used intensively

1



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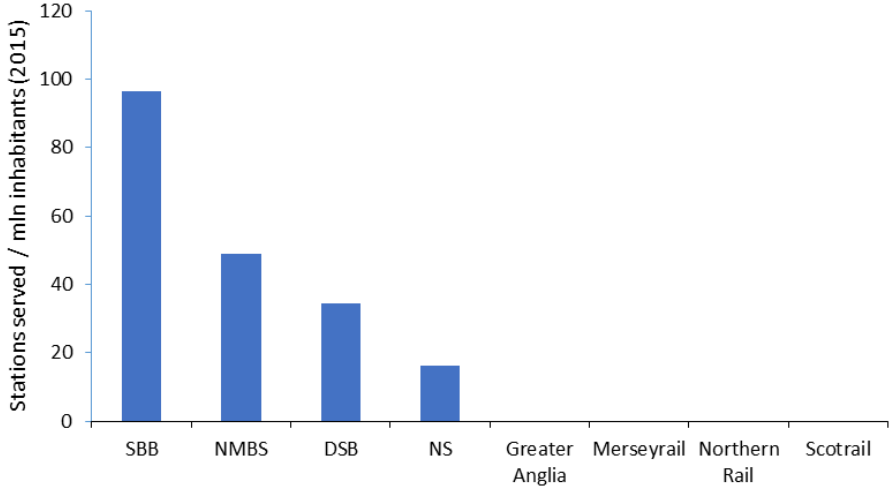

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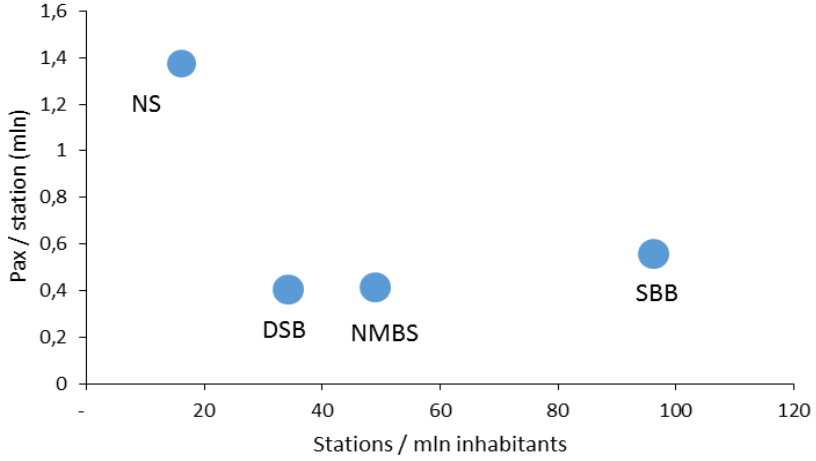


Interpretation:

1 Stations served by NS handle on average 2,6x the average number of passengers of the peer group.

2 Station coverage of stations served by NS is below the average of the peer group. Regional stations in the Netherlands are served by other operators.

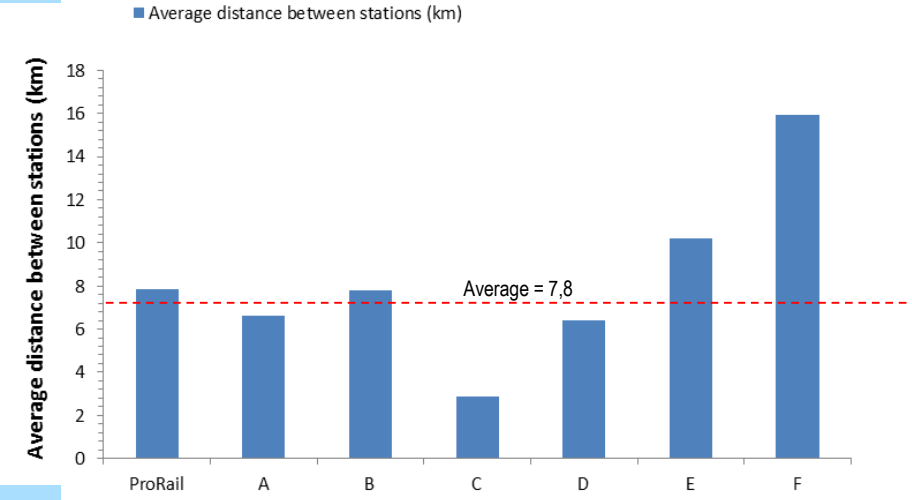
- The lower station density allows for higher average speeds, resulting in faster travelling, higher efficiency and therefore lower average costs.

1+3 The higher passenger numbers per station and a higher average serving area are further increased by the tendering of regional lines; NS serves stations with highest passenger numbers.

3.2 Passenger train stations

NL has average distance between stations, but also the highest average population per station

1



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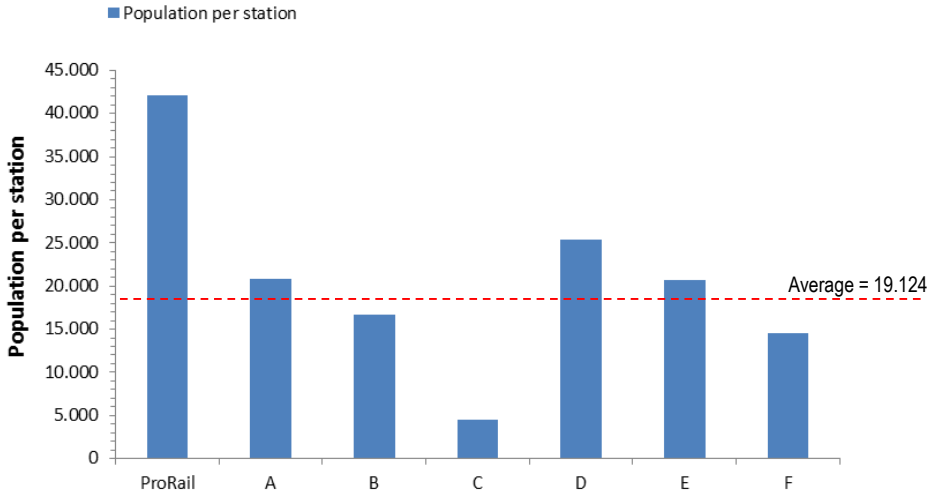


Interpretation :

1 Average distance between stations in NL is on peer group average

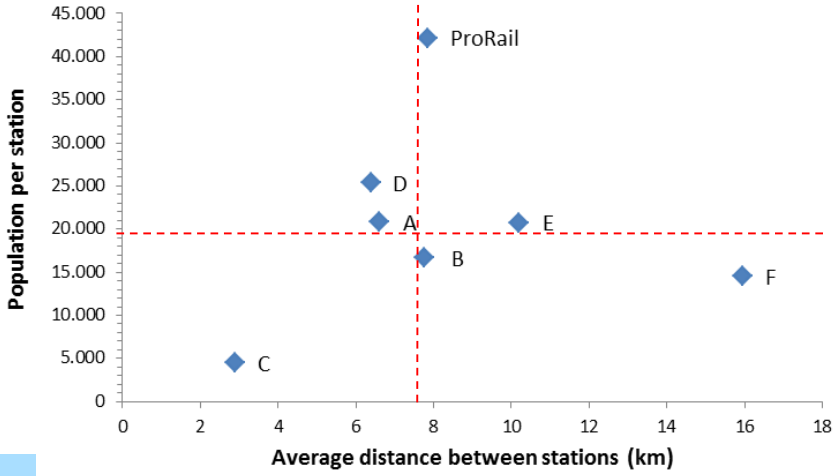
2 Relative to peer group. NL has very high average population per station

Note: letters refer to countries, not inframanagers. In all peer countries the railway network is bigger than the network managed by the IM peer.

3.2 Passenger train stations

NL stations: high average population per station, small area covered per station

1



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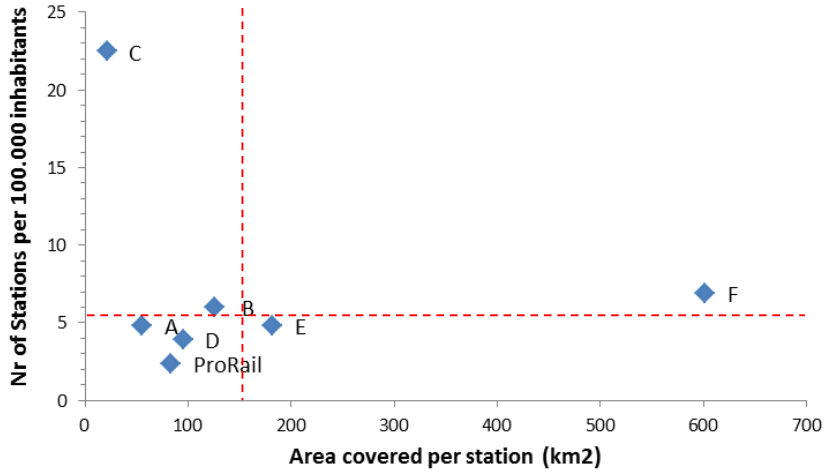


Passenger train stations

Figure 1 shows the average population per train station versus the average distance between train stations.

Interpretation:

- ProRail shows high average number of population per train station
- ProRail distance between stations is on peer group average

Figure 2 shows the average number of train stations per 100.000 inhabitants versus the average area (km2) covered by each train station

Interpretation:

- NL has the lowest number of train stations per 100.000 inhabitants
- When F is taken out of comparison, NL has around average area coverage per station
- C can be regarded as the country with highest density of stations: short distance between stations, high number of stations per inhabitant, small area covered per station

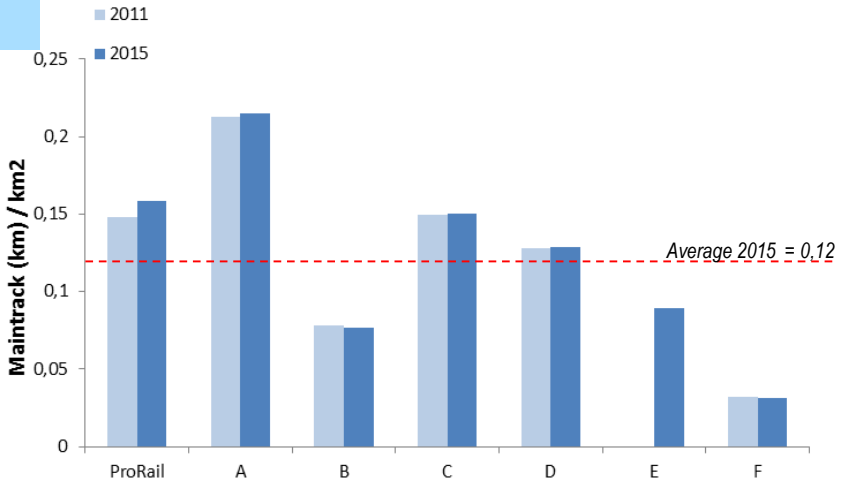
Note: letters refer to countries, not inframanagers. In all peer countries the railway network is bigger than the network managed by the IM peer.

4. Asset characteristics

4.1 Maintrackkilometres vs country characteristics

Relative to total population, ProRail has the smallest network of the peer group. Relative to country size, the network is around peer group average

1



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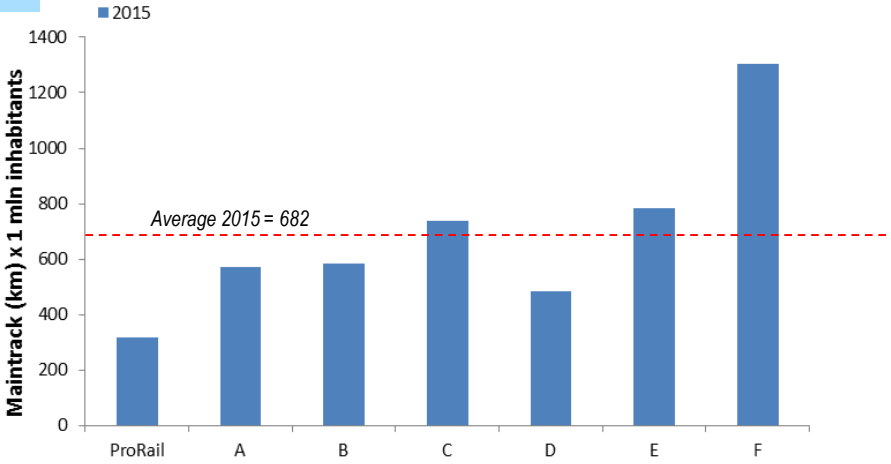

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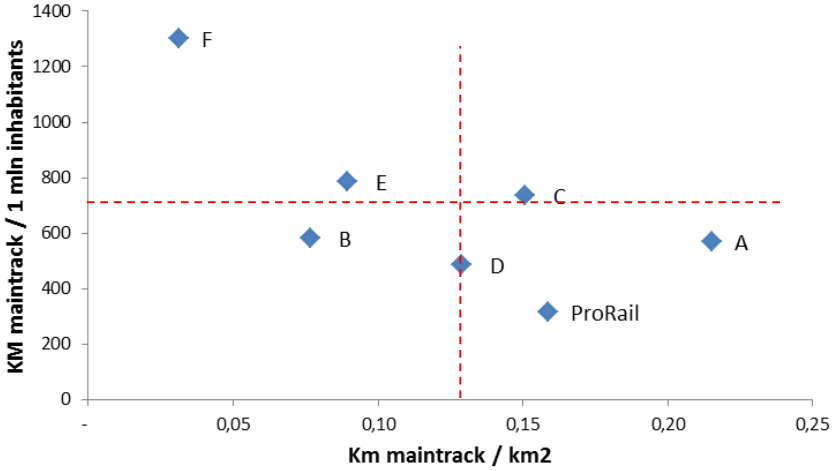


Interpretation:

1 In 2015, ProRail has 160 metres of maintrack per km2 of land. ProRail scores above the average of 120 metre of the peer group

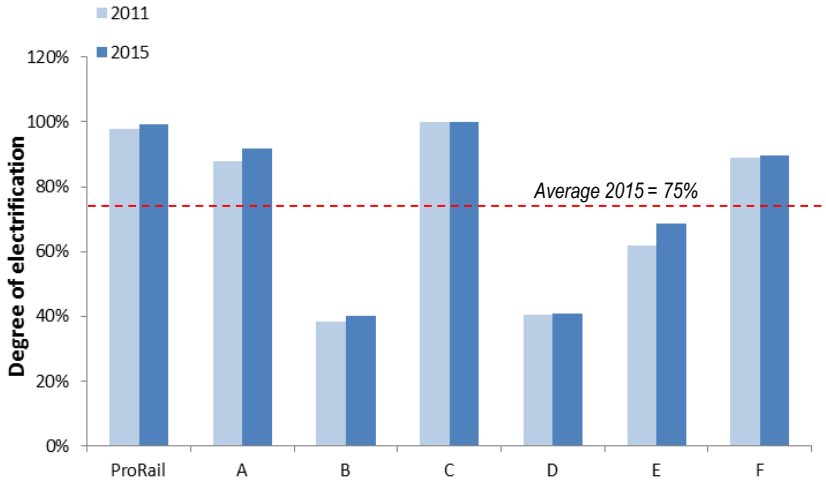
2 However, relative to the total population of the country, ProRail has a small network: ProRail has 316 kilometres of maintrack per one million inhabitants. The average of the peer group is 682 kilometre, without peer F 579 kilometre

3 The network of C is relatively larger than peer group in terms of kilometres per km2 and per inhabitant

4.1 Electrification and multiple tracks

ProRail has high degrees of electrification and multiple maintrack compared to peer group average

1

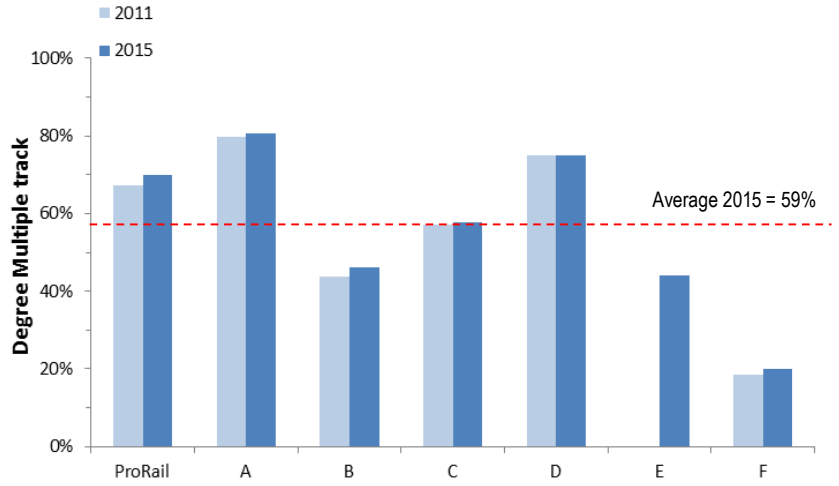


Graph 1 shows the degree of electrification of the main track

Interpretation:

1. 99% of ProRail maintrack is electrified, whereas the average of the peer group is 75%
2. A, C and F also score high on degree of electrification
3. B and D show a relatively low degree of electrification

2



Graph shows the degree of multiple track as percentage of total line length

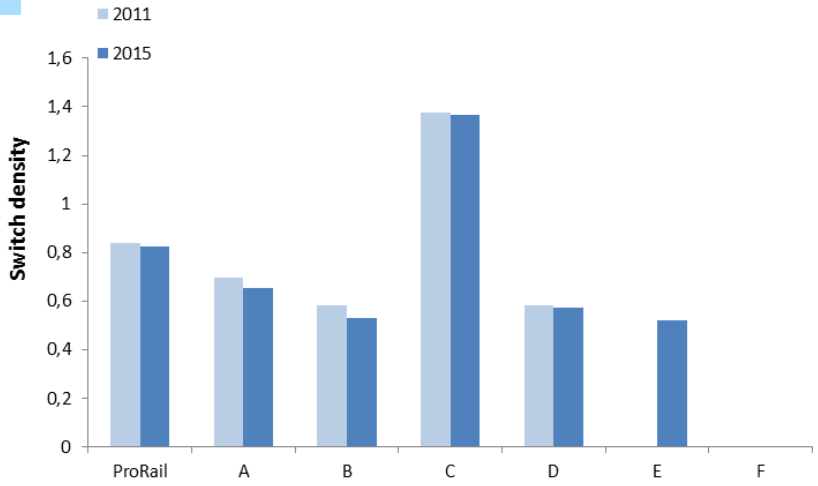
Interpretation:

1. ProRail scores slightly above peer group average on degree of multiple track
2. A and D have relatively more multiple track
3. F scores low on degree of multiple track

4.1 Switch density and complexity

ProRail switch density has decreased slightly, just as switch complexity

1



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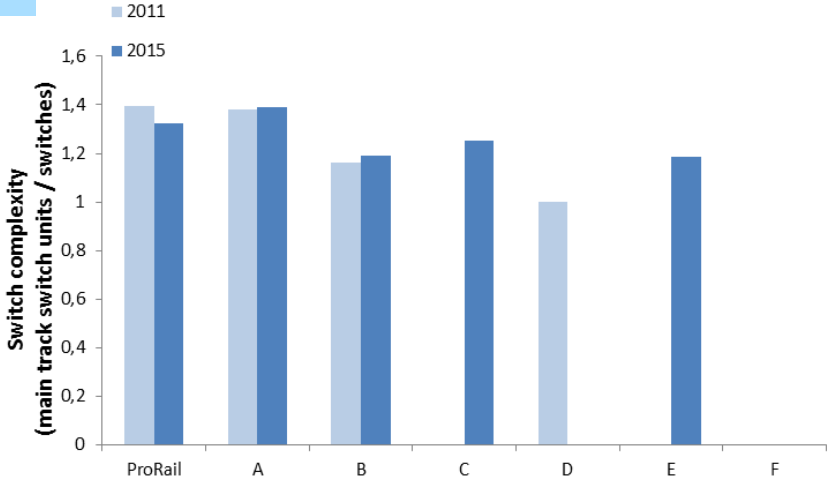

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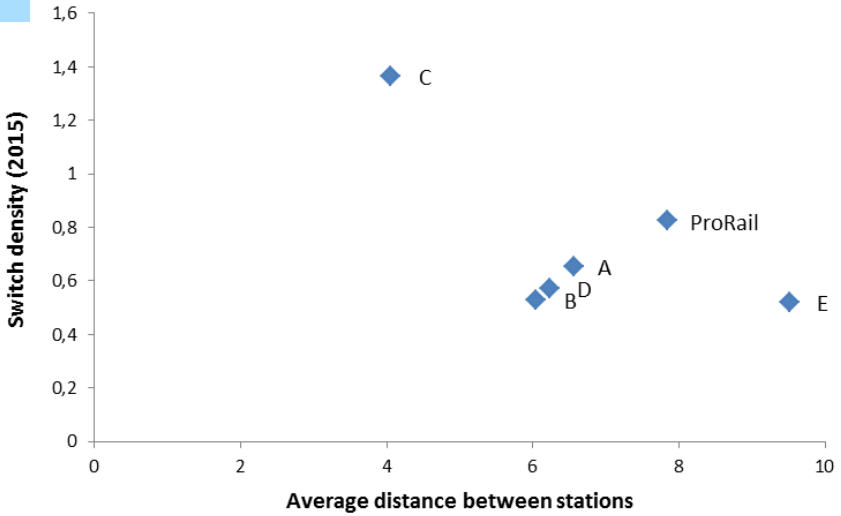


Interpretation:

Graph 1 shows the numbers of switches per kilometre of maintrack

1. Switch density at ProRail decreased from 0,84 in 2012 to 0,82 in 2015
2. The overall trend shows a decrease in number of switches per main track kilometre
3. C shows significantly more switches per maintrack km than other peers

Graph 2 shows the number of switch units per switch

1. ProRail switch complexity decreased from 1,39 in 2012 to 1,33 in 2015
2. Other peers show an increase switch complexity.
3. Not all inframanagers have relevant data available

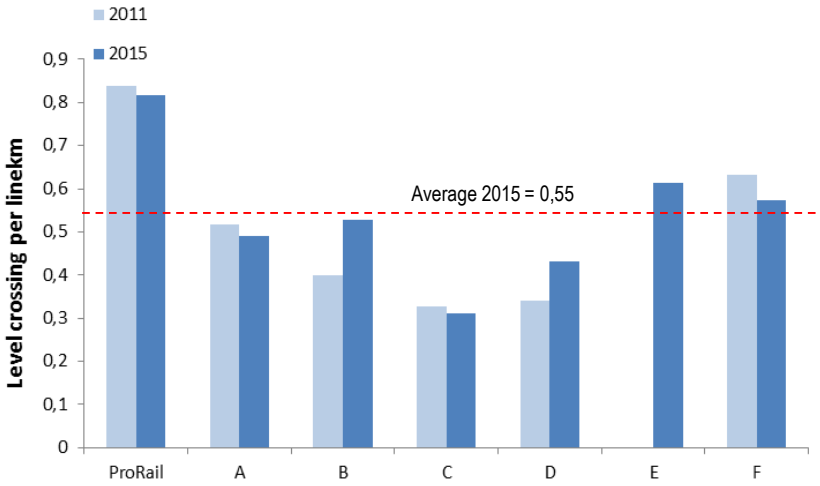
Graph 3 shows the relation between switch density and distance between stations:

1. High switch density may be caused by small distance between stations

4.1 Level crossings – secured and unsecured

NL scores high on the number of level crossings per linekm. The percentage of unsecured level crossings in NL has slightly decreased, and is just below peer group average

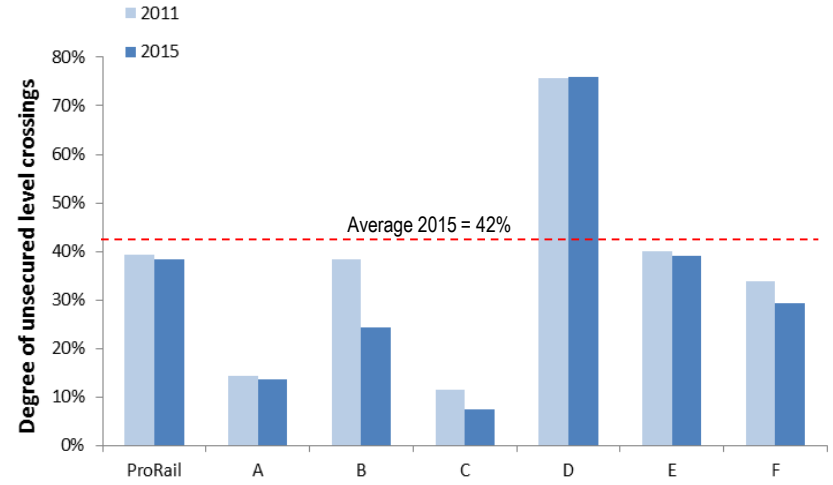
1



Interpretation:

- ProRail has the highest level crossing density compared to peers: 0,82 level crossings per linekm, versus an peer group average of 0,55
- At ProRail the level crossing density has decreased from 0,84 to 0,82. Among peers the level crossings density development varies, some increase and some have a decreasing trend.

2



Interpretation:

- Percentage unsecured level crossings in NL has decreased from 39% to 38%
- The average percentage of unsecured level crossings in the peer group in 2015 is 42%. Peer D has a much higher degree of unsecured level crossings compared to the other peers. The average without peer D is 34%.

4.1 Signal density

Number of signals per track kilometre is high in NL

1

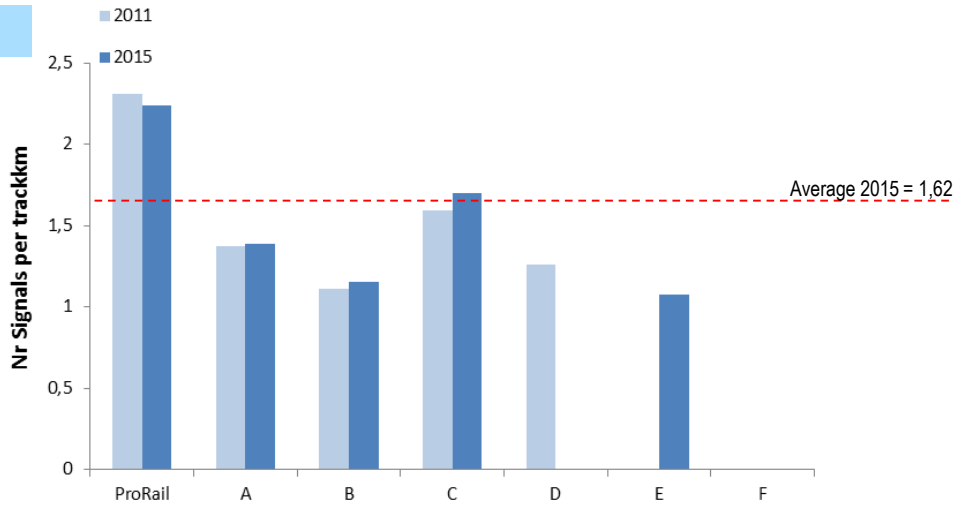


Figure 1 shows the number of signals per trackkm

Interpretation:

- ProRail has the highest number of signals per trackkm of the peer group
- Number of signals per track kilometre in NL has decreased between 2012 and 2015
- No clear trend in the peer group is visible in terms of signals per trackkm
- Not all peers (D, E and F) have all relevant data available

2

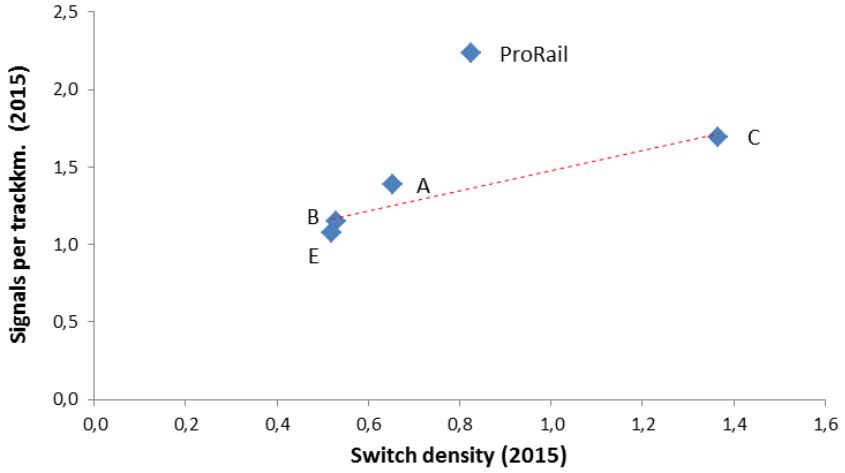


Figure 2 shows the relation between switch density and signals per trackkm

Interpretation:

- Switch density and signals per trackkm seem to be positively correlated. Data for peer D and F are missing.
- ProRail has more signals per trackkm than peer group trend line would suggest

4.1 Asset failures – total*

ProRail's total number of failures* per track kilometre is below peer group average and has decreased by 12%.

1

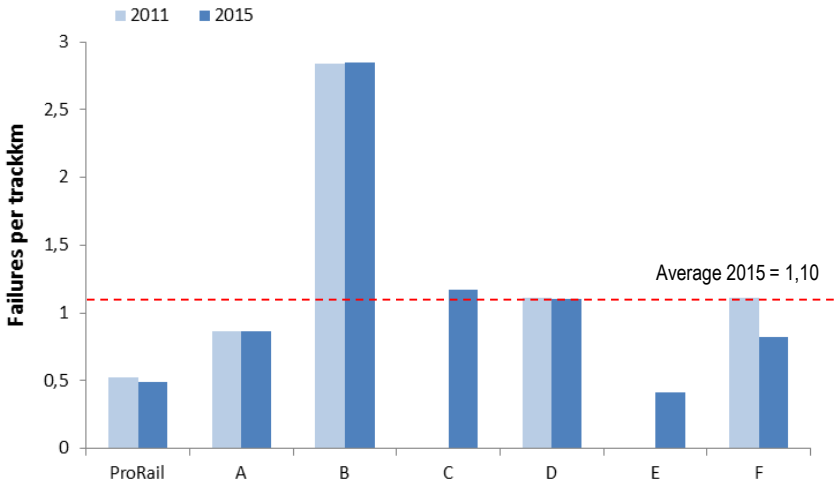


Figure 1 shows the total number of failures per track kilometre

Interpretation:

- In 2015, ProRail has 0,49 failures per track kilometre per year
- ProRail's failures per track decreased by 12% in 2015 compared to 2011
- E has the lowest number of failures per track kilometre
- If average is calculated without peer B, the average changes in 0,81. ProRail is still below peer group average.

2

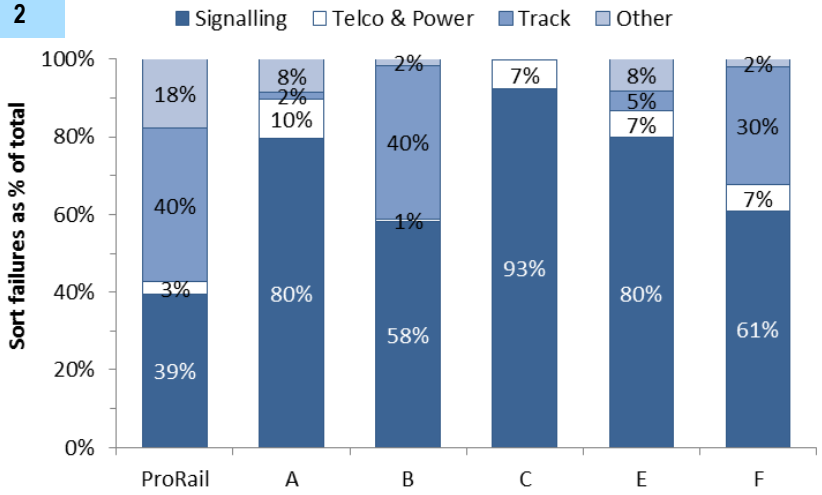


Figure 2 shows the type of failures as percentage of total failures in 2015 per inframanager

Interpretation:

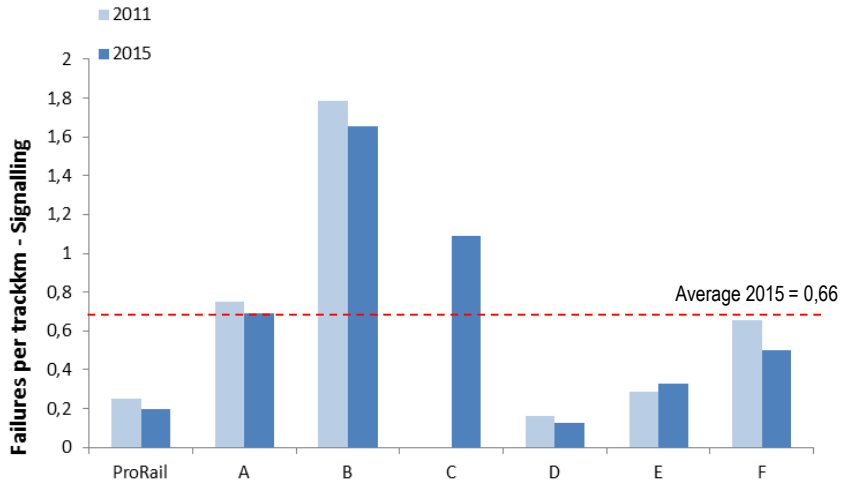
- 39% of NL failures are signalling failures; 40% are track failures
- In most countries, signalling failures represent the largest part of total failures. The countries with a high share of signalling failures have a lower share of track failure.

* Only train effecting failures are taken into account, failures which don't lead to a delayed train more than 5.29min are not taken into account

4.1 Failures – signalling and telecom / power failures

Both signalling and telecom / power failures at ProRail are below peer group average

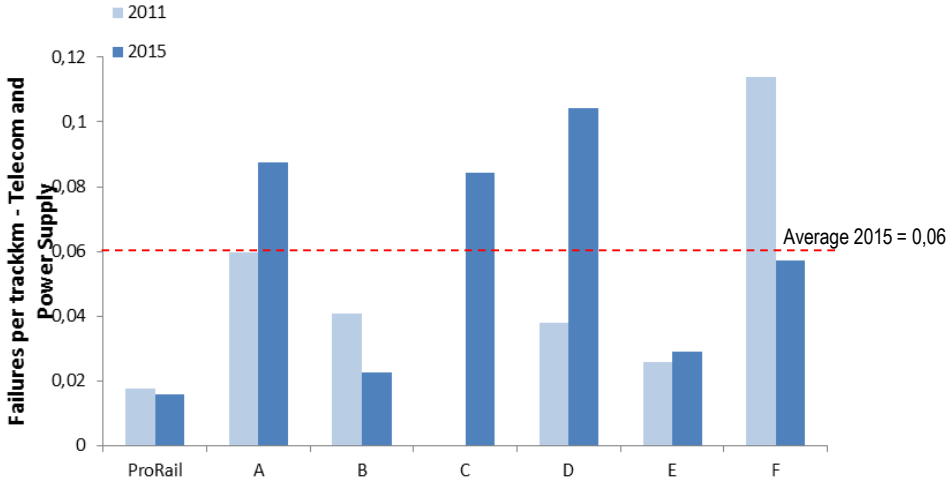
1



Interpretation:

- In 2015, NL has 0,19 signalling failures per track kilometre per year. This is a 22% decrease relative to 2011
- All countries except for E show a decrease in the number of signalling failures per track kilometre per year
- D has the lowest number of signalling failures per track kilometre of the peer group

2



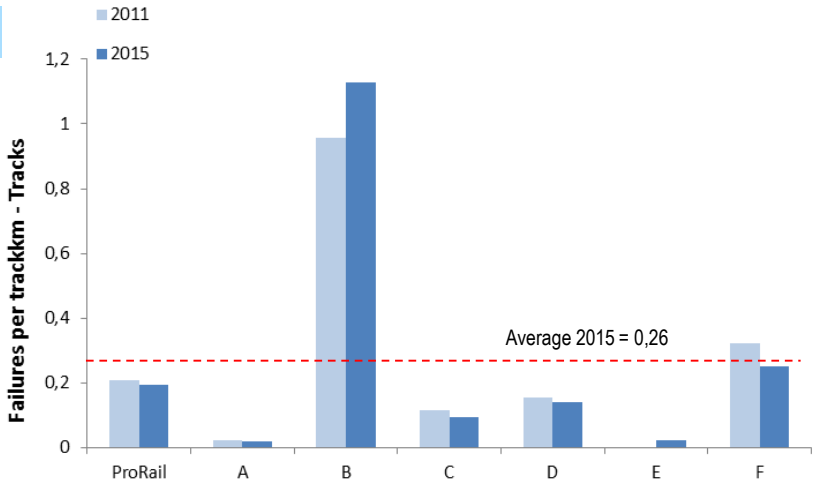
Interpretation:

- In 2015, ProRail has 0,016 telecom / power supply failures per track kilometre per year. This is a 11% decrease relative to 2011
- ProRail has the lowest number of this telecom / power failures of the peer group
- B and F show sharp decreases in the number of failures
- A and D show sharp increases

4.1 Failures – track failures and 'other' failures

Track failures of ProRail are below peer group average, 'other failures' are above average

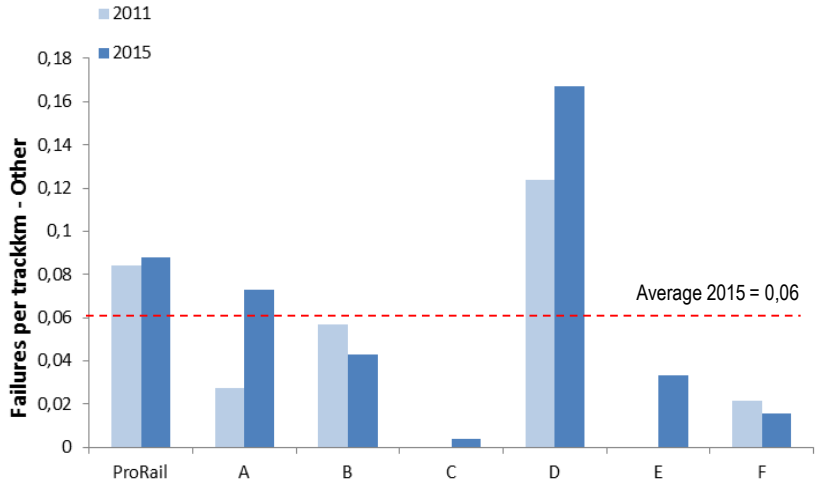
1



Interpretation :

- In 2015, ProRail has 0,20 track failures per track kilometre per year. This is a 5% decrease relative to 2011
- ProRail has an average score relative to the peer group
- Most countries – except for B – show stability or a decrease in the number of track failures per track kilometre
- If the average is calculated without peer B, the average changes in 0,12. ProRail is above the peer group average.

2

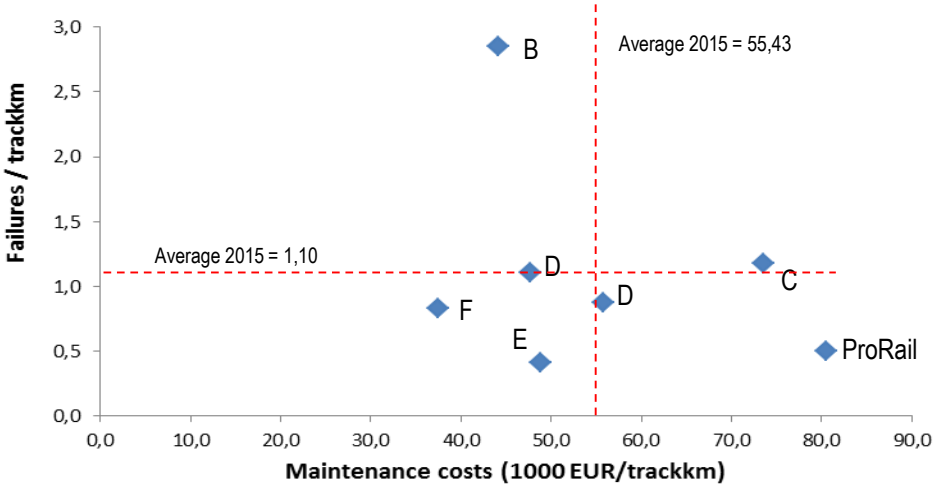


Interpretation:

- In 2015, ProRail has 0,09 'other failures' per trackkm. This number remained stable in the period 2011 - 2015
- Average of the peer group was 0,06 'other failures'
- Peer D has a large number of 'other failures' per track kilometre compared to the peer group

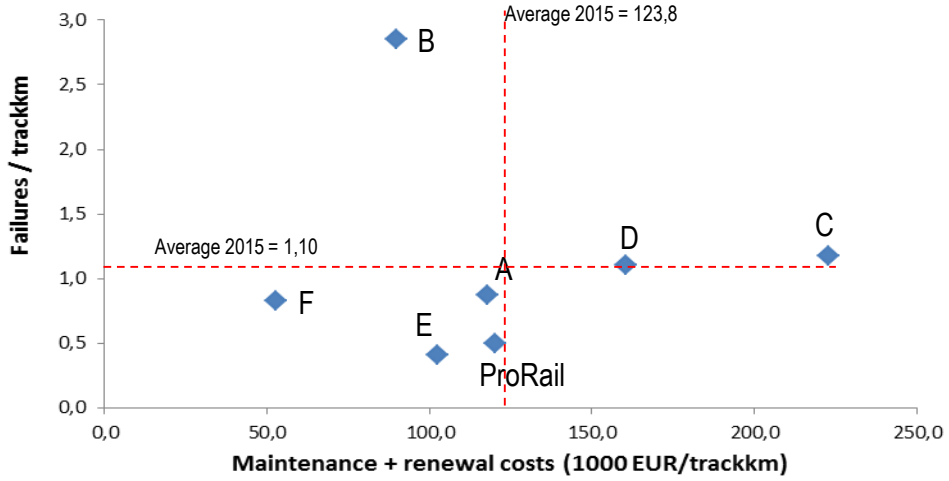
4.1 Asset failures vs maintenance costs

ProRail has low number of failures per trackkm relative to high average maintenance costs per trackkm.
ProRail combines low number of failures with average total cost per trackkm (maintenance + renewal)



Interpretation :

- Maintenance costs of ProRail per trackkm are highest of the peer group, but the number of failures per trackkm are amongst the lowest of the peer group
- B combines a relatively high failure rate with below average maintenance costs
- E, F and D combine low failures rates per trackkm with low maintenance costs



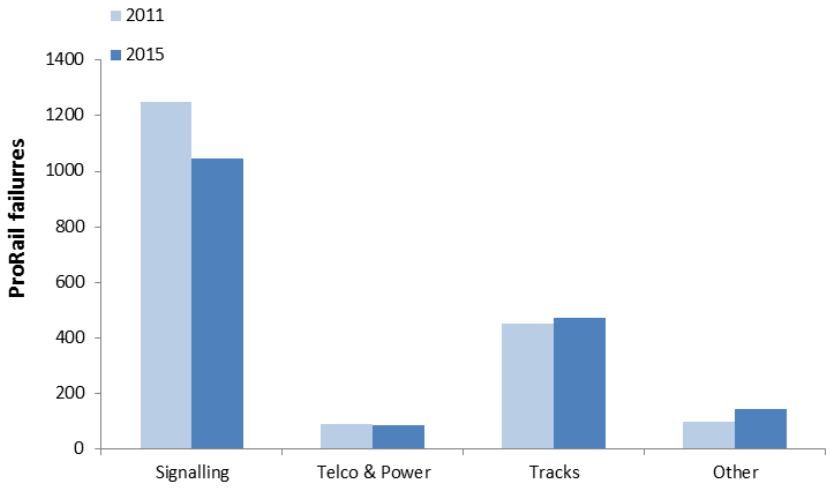
Interpretation:

- ProRail combines average maintenance + renewal costs per track km with a low rate of failures per trackkm.
- C has the high combined costs of maintenance and renewal, against average failure rate
- F and E combine low costs per trackkm with low failure rates

4.1 Failures – summary NL

Relative to track kilometres, all failure categories show a decrease for 2015 compared to 2011

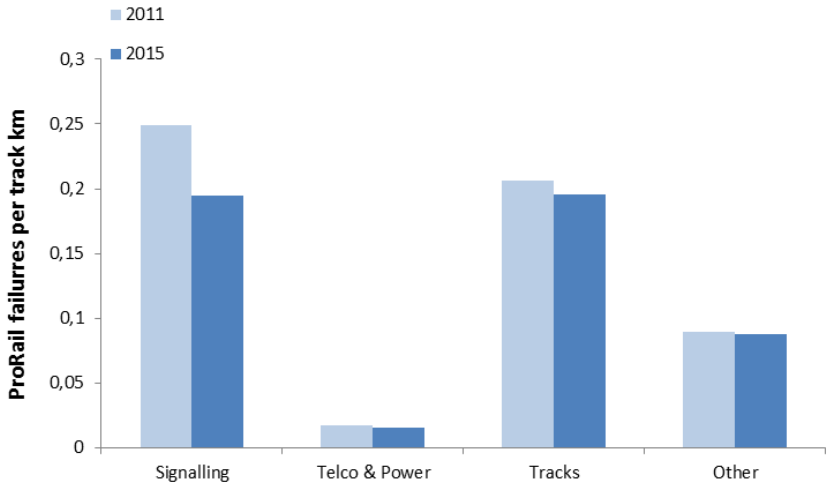
1



Interpretation:

- Total number of failures has decreased by 7%
- Failures have decreased in absolute terms for the categories *Signalling* and *Telco & Power*
- Track failures and other failures have increased in the period 2011-2015

2



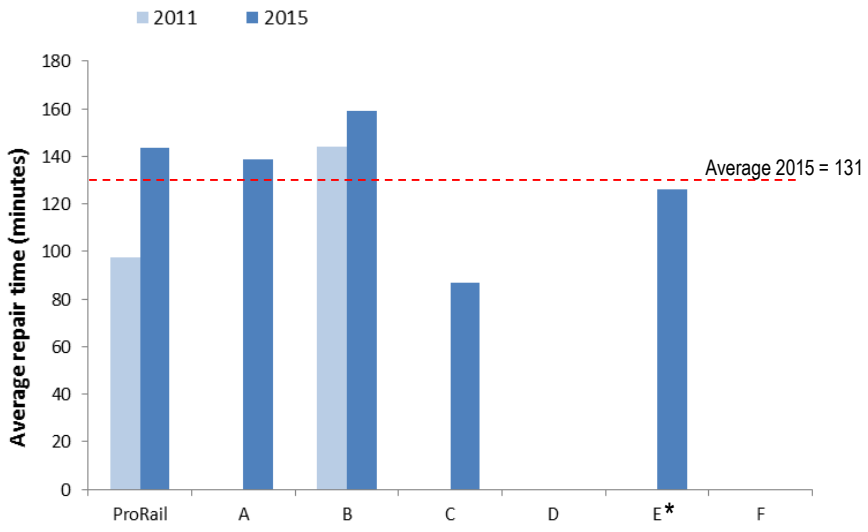
Interpretation:

- 2015 shows a 12% decrease in total failures per track kilometre.
- All failure categories show a decrease relative in 2015 relative to 2011
- Signalling and track shows the biggest decrease in failures

4.1 Repair time

ProRail's average repair time of failures in NL has increased considerably and is above peer group average in 2015

1



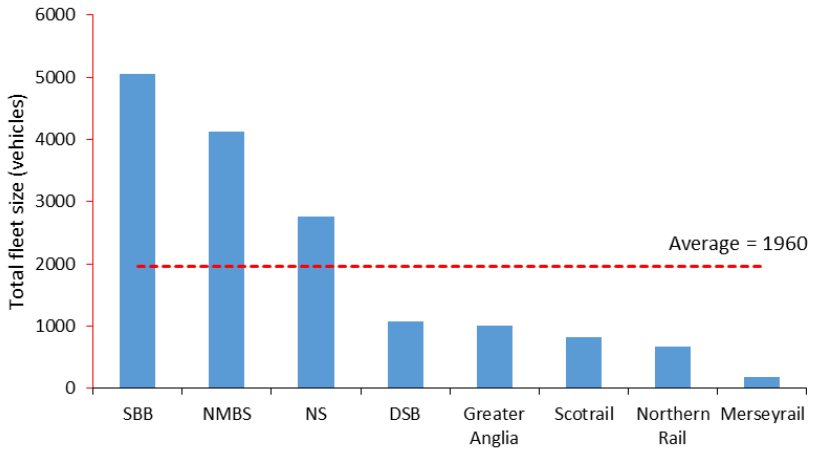
Interpretation:

- Average repair time of train affecting failures at ProRail has increased from 97 to 144 minutes in the period 2011 – 2015
- This is an increase of 47%
- Not all countries in the peer group have relevant data available. For those who do, the average repair time in 2015 was 131 minutes
- E: average repair time reflects only signalling defects and catennary defects

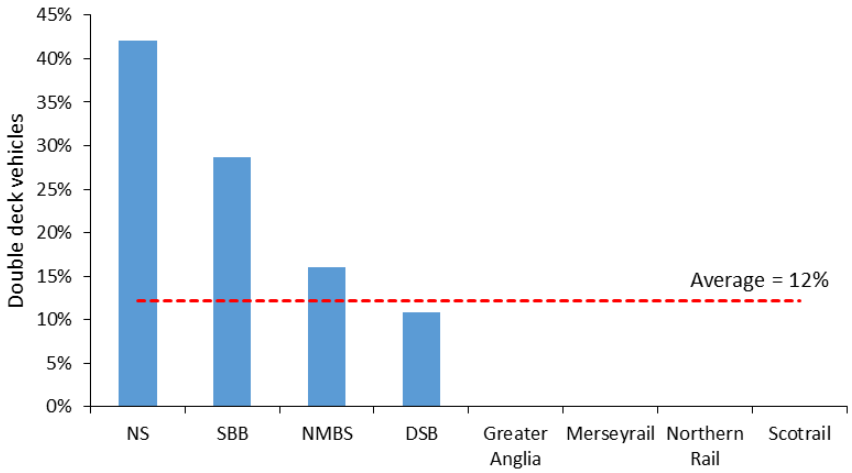
4.2 Asset characteristics – rolling stock characteristic

NS fleet has the highest proportion of double deck units

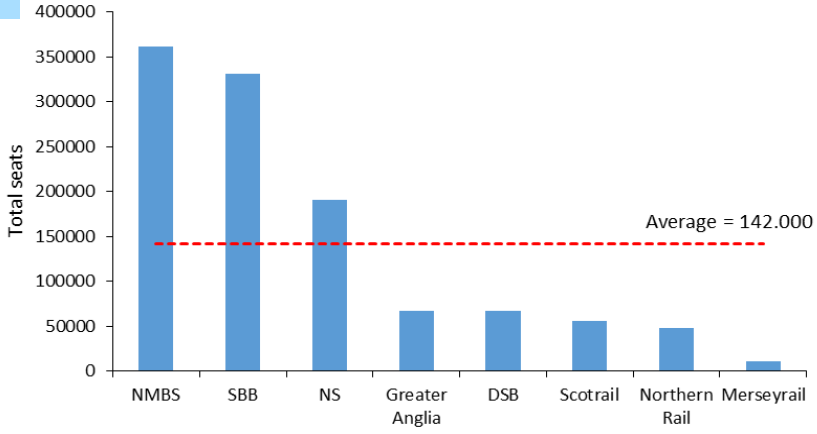
1



2



3



Interpretation:

1 NS has a medium sized fleet, above the average of the group

2 NS' fleet has the highest percentage double deck coaches

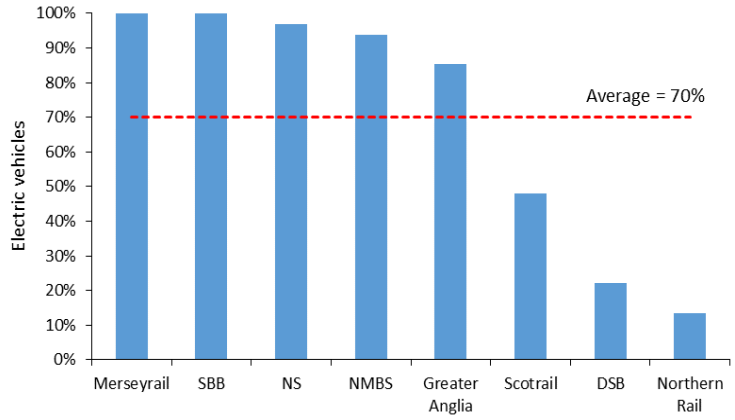
- Operators that use double deck coaches generally have a stable percentage of double deck fleet

3 NMBS and SBB have a larger total number of seats

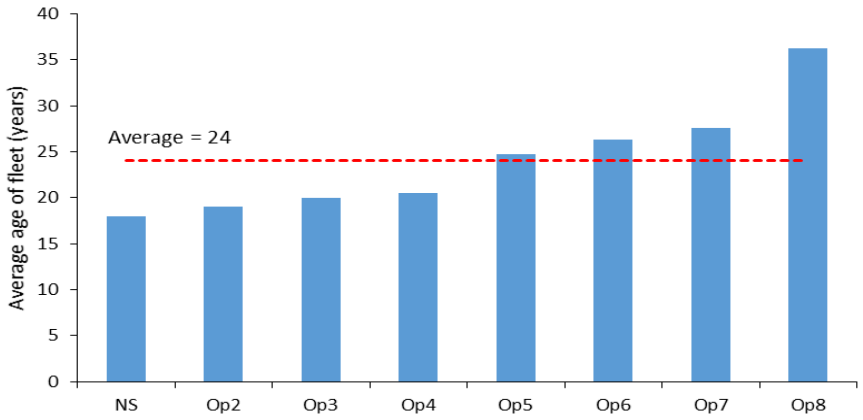
4.2 Asset characteristics – rolling stock electrification

NS has a relatively young fleet, mainly electric multiple units

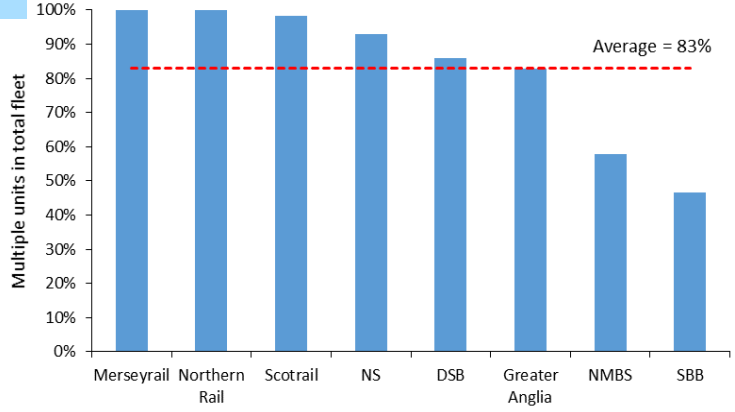
1



2



3



Interpretation:

1 NS' fleet is almost completely electric

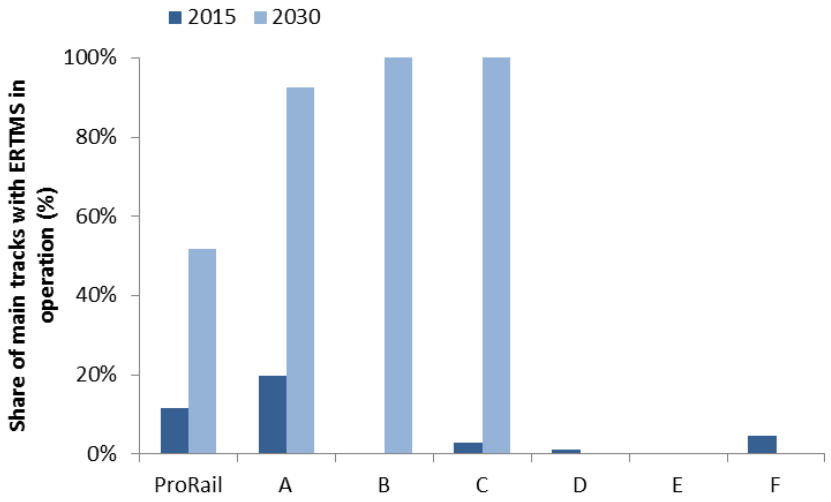
- All rolling stock of SBB and Merseyrail is electric, Greater Anglia has a growing proportion of electric rolling stock

2 NS has the youngest fleet of the peer group

3 NS' fleet consists mainly of multiple units. There is a trend amongst the operators of the peer group to replace locomotive hauled rolling stock by multiple units

4.2 Asset characteristics – ERTMS

Ambitions of peer group regarding ERTMS in operation in 2030 differ



Interpretation:

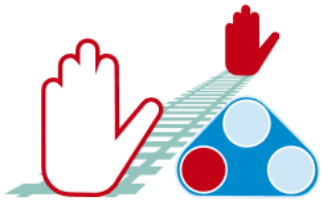
- An above-average part of the Dutch network is already equipped with ERMTS compared to peers that implement ERMTS.
- Looking forward, a limited part of the Dutch network is to be equipped compared to other peers that implement ERTMS: NL plans to equip 50% against 90-100% at peers.

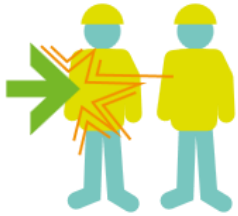
NOTE: data regarding ERTMS (current percentage and future ambition) were not easily accessible in the peer group, for both the inframanagers and the train operators.

Percentage of rolling stock with ERTMS:
only available for NMBS; around 30%

Percentage of trainkm operated with ERTMS:
not available from any of the peers

5. Safety

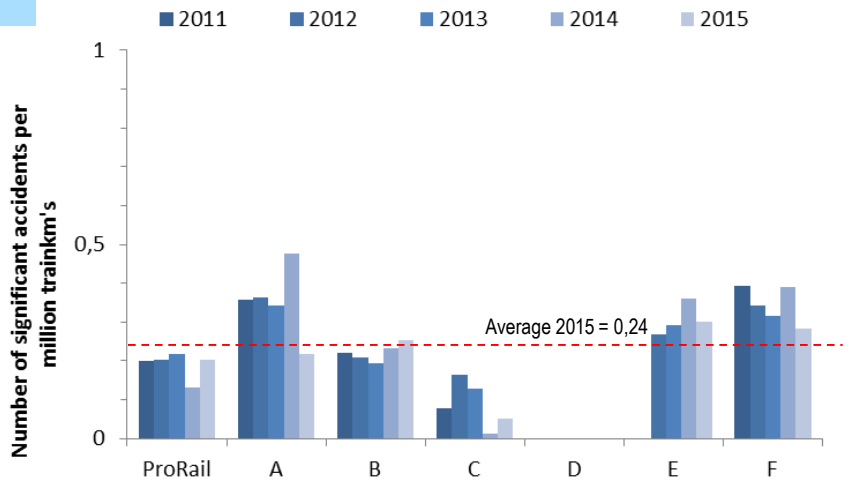




5.1 Safety - persons

Number of significant accidents per trainkilometre at ProRail is stable and around average

1

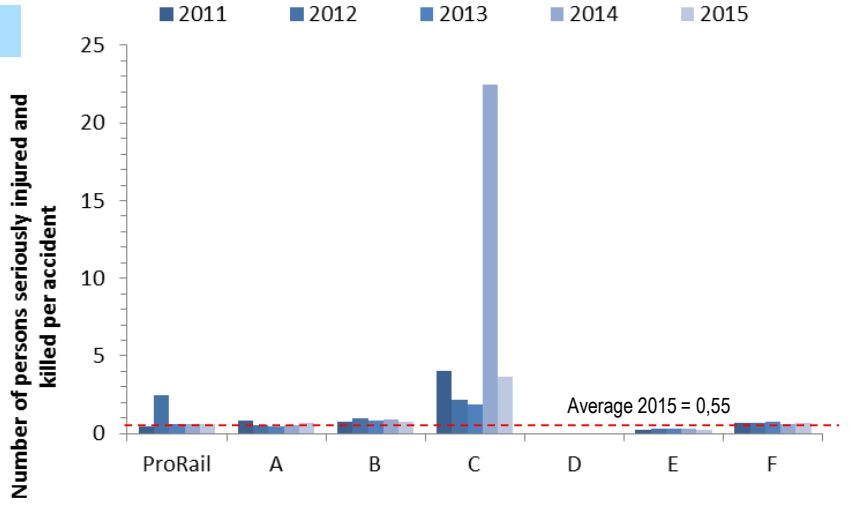


Interpretation:

Figure 1 shows the number of significant accidents per million trainkms.

- Number of accidents per trainkm of ProRail is just below peer group average.
- For peer D data are not available

2



Interpretation :

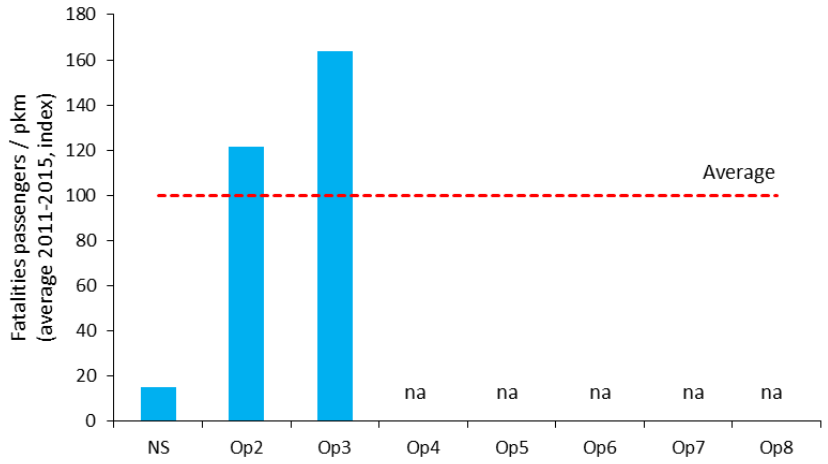
Figure 2 shows the number of persons seriously injured or killed per accidents.

- Except for 2012 the number of persons seriously injured or killed per accidents at ProRail is just below peer group average.
- For peer D data are not available
- Due to the low accidents rates and the low number of persons seriously injured or killed the ratio is strongly affected by one serious accident.
- Peer C has a low number of significant accidents in 2014 but a high number of people seriously injured/killed per accident. This is probably an outlier caused by one incident. If the value of peer C is not taken into account the average becomes 0,44.

5.1 Safety - passengers

Relatively low passenger fatality rates. Wounded passenger rates are higher but definitions may vary.

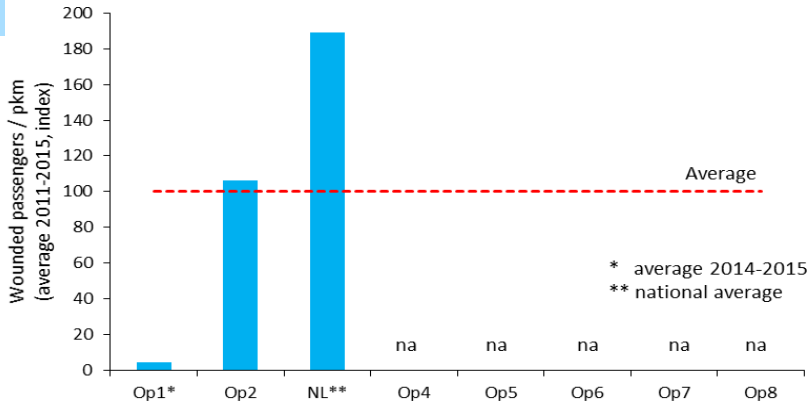
1



Interpretation:

- NS has the lowest fatality rate for passengers of the peer group
- The comparison is based on 5 year averages to balance out large accidents.

2



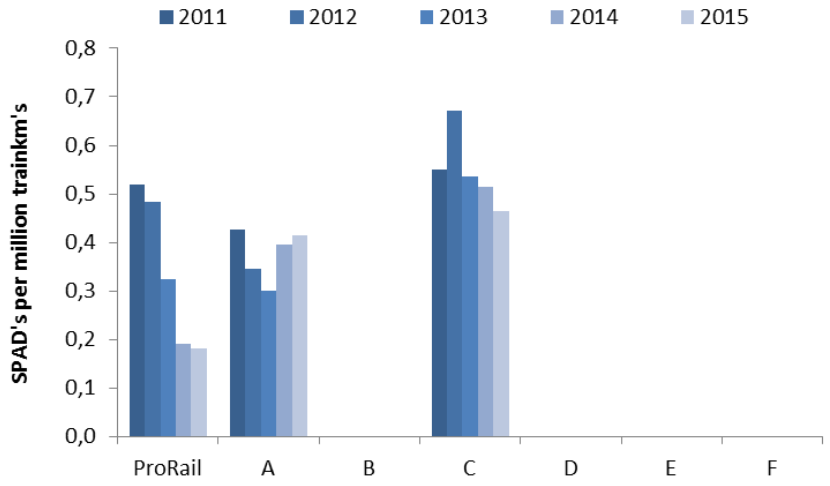
Interpretation:

- The Dutch rate for wounded passengers is the highest of the peer group.
- Definitions of “wounded passengers” may vary per country, which may render the figures incomparable.
- The comparison is based on 5 year averages to balance out large accidents.

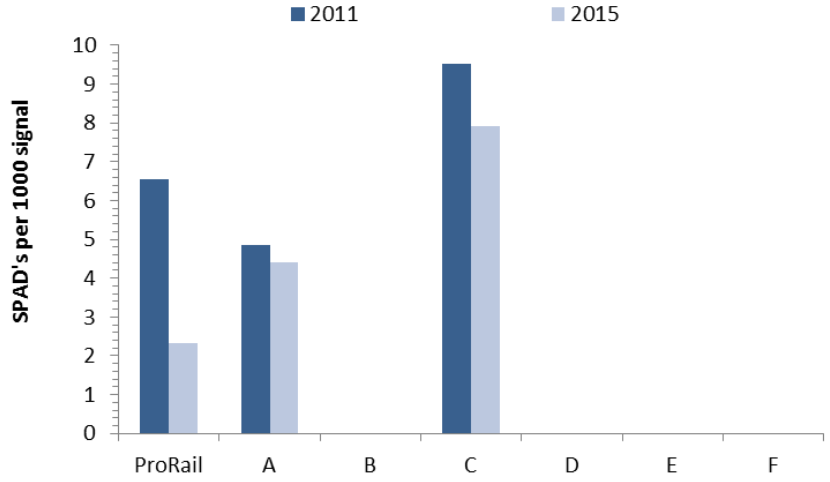
5.1 Safety- Signals Passed at Danger

ProRail's number of Signals Passed at Danger (SPAD's) per trainkm has decreased by 66%. ProRail has the lowest number of SPAD's per signal in 2015.

1



2



Interpretation:

1 The number of SPAD's per million trainkms at ProRail has decreased by 66% in the period 2011 – 2015.

- Other peers show a less steep decline or a more stable trend

2 The number of SPAD's per 1000 signals also shows a sharp decrease (64%) in the period 2011 – 2015.

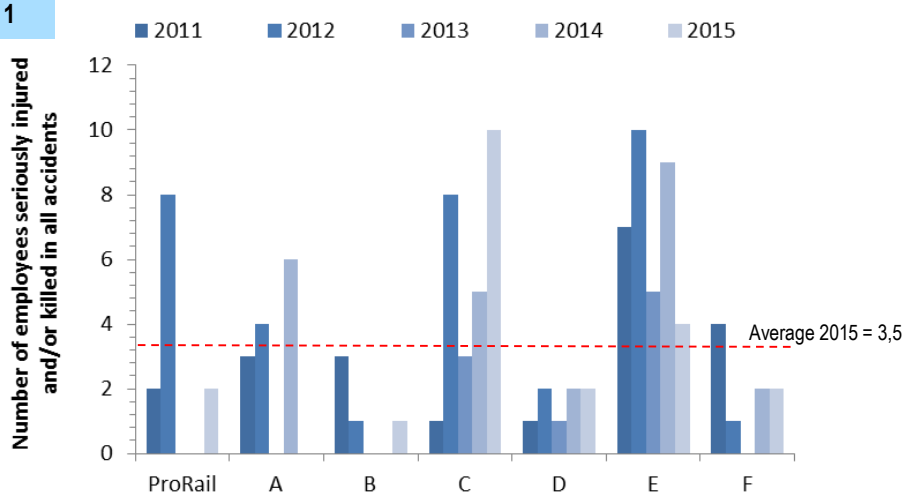
- ProRail has the lowest number of SPAD's per 1000 signals.
- All peers also show a decrease in the number of SPAD's per 1000 signals in the period 2011 – 2015

Peer D, E and F have no SPAD-data available

5.2 Safety - employees

ProRail is a safe place to work relative to the peer group average

1



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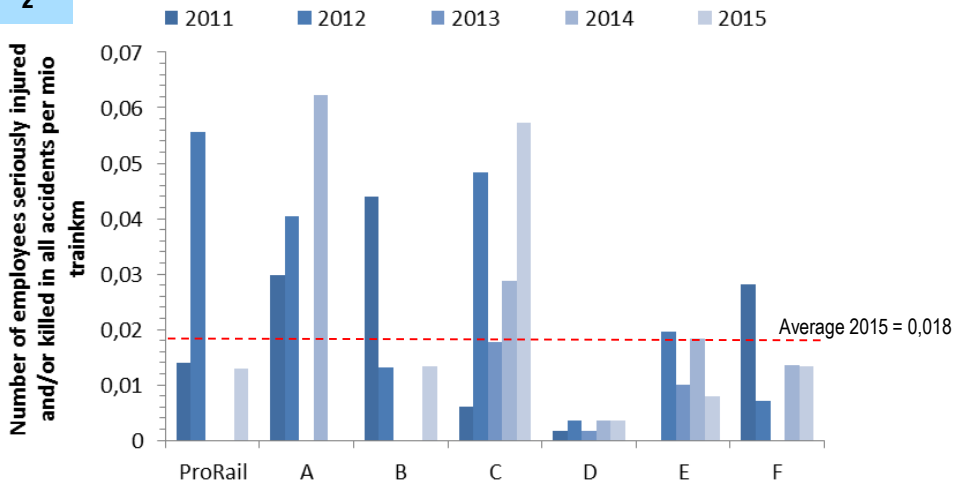


Interpretation:

Figures 1 and 2 show the number of employees seriously injured and/or killed in all accidents (absolute and per million trainkms)

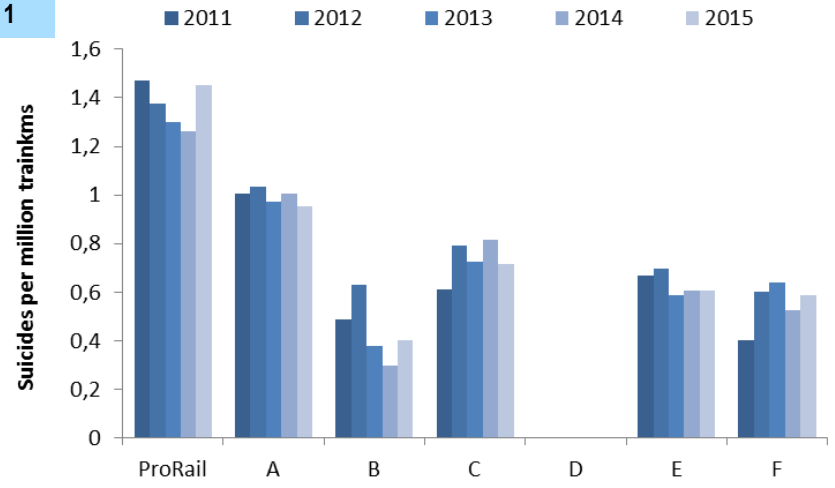
Analyses are based on ERA (SS00) statistics. The numbers represent country statistics. Some countries in the peer group have more than one Infrastructure managers. These numbers therefor do not necessarily reflect the performance of the IM's as mentioned on page 16.

- There is no clear trend visible for 2011 – 2015 for most of the infra managers in the peer group. Only D shows a rather stable trend
- Trends are easily disrupted in case of an incident
- At ProRail no accidents with seriously injured and/or killed occurred in 2013 and 2014
- At ProRail, the number of employees seriously injured or killed in an incident is below peer group average 2015. This counts for both absolute and relative numbers

5.3 Safety - suicides

Suicides on railway at ProRail are high relative to both trainkms and inhabitants

1

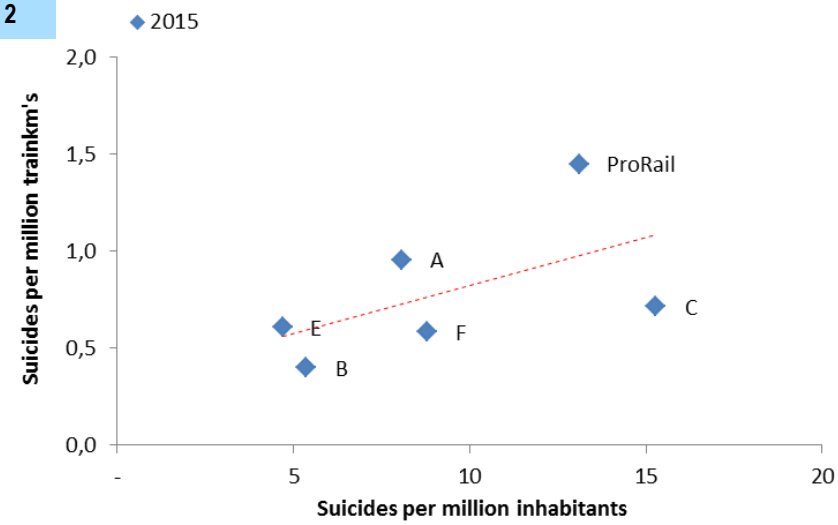


Interpretation:

Figure 1 shows the number suicides per million trainkms.

- Number of suicides per trainkm at ProRail is above peer group average.
- At ProRail the trend for suicides was decreasing till 2014, in 2015 of suicides per trainkm has increased
- Data for peer D are missing

2



Interpretation:

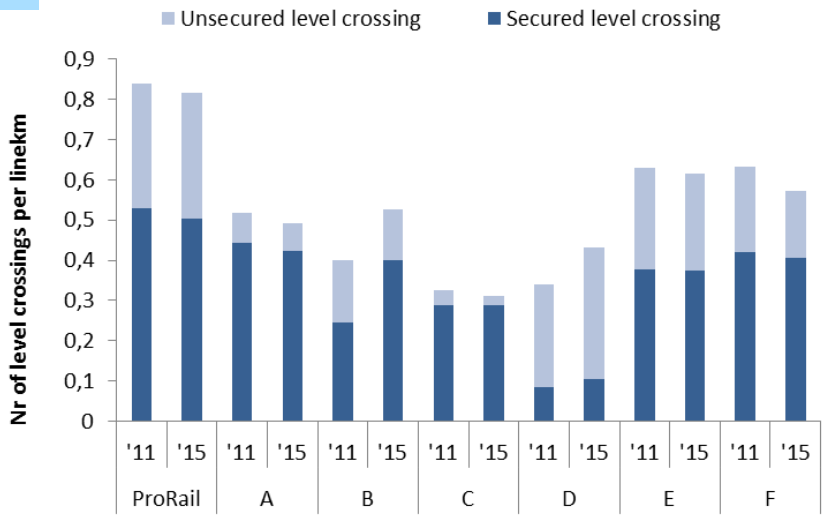
Figure 2 shows the number of suicides per million trainkms vs suicides per million inhabitants on railway

- ProRail has a higher number of suicides than peer average, taking into account the number of suicides per inhabitant (red dotted line)
- Data for peer D are missing

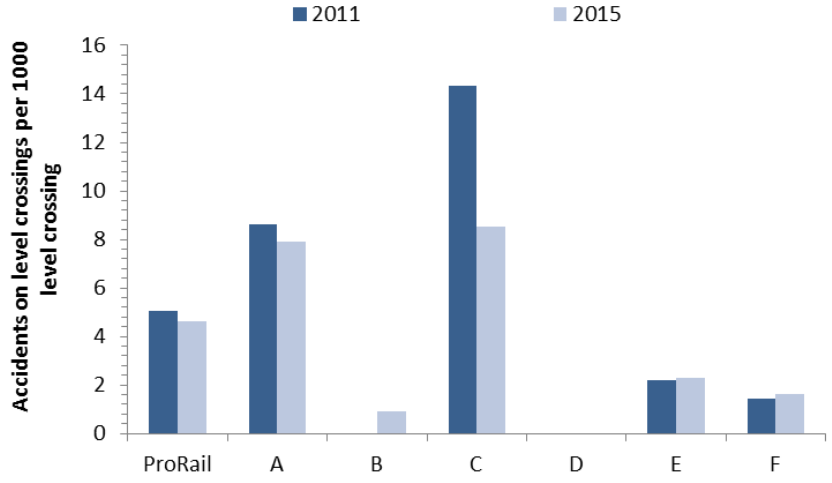
5.3 Safety – level crossings

ProRail has many level crossings per linekm. The number of incidents at level crossings has decreased, but the number of persons seriously injured or killed at incidents at level crossings has increased

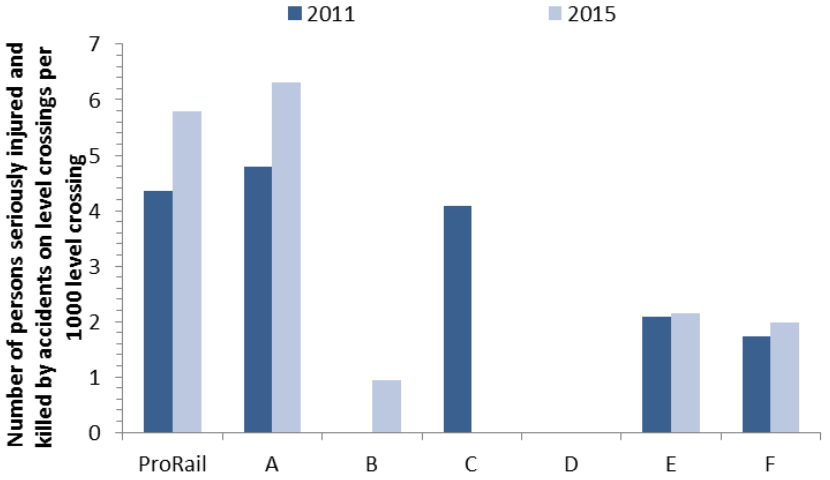
1



2



3



Interpretation:

1 Figure 1 shows that ProRail has the highest number of level crossings per linekm of the peer group. Also, many of these level crossings are unsecured

2 The number of accidents at level crossings has slightly decreased from 2011 to 2015

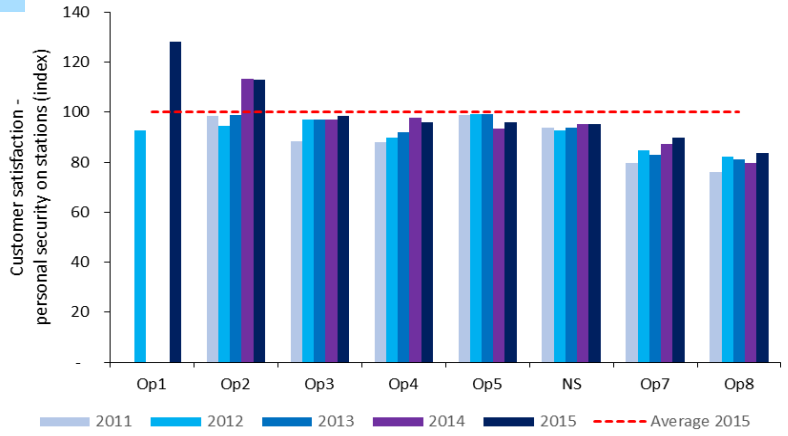
3 The number of persons seriously injured or killed by accidents on level crossings has increased at ProRail

Peer D has no data available for accidents at level crossings, Peer B had no significant accidents on levelcrossing in 2011

5.3 Personal security – customer satisfaction

Customer satisfaction on personal security is slightly below average but increasing while the incident rate is low

1



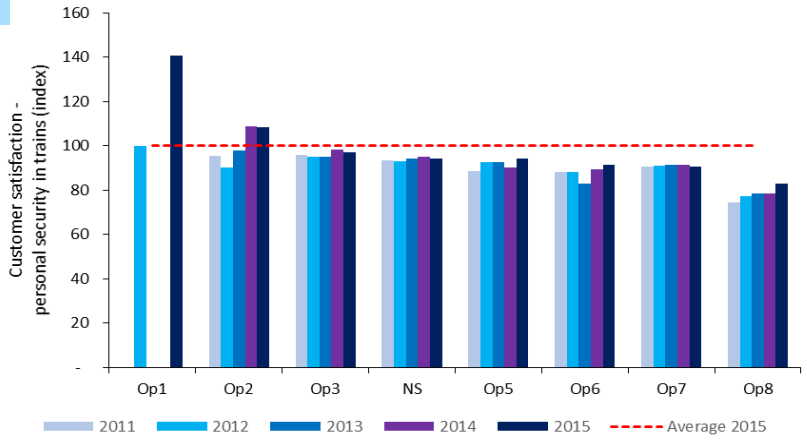
Interpretation:

1 + 2 Customer satisfaction about personal security on stations and in trains is 5-6% below average of the peer group with a positive trend

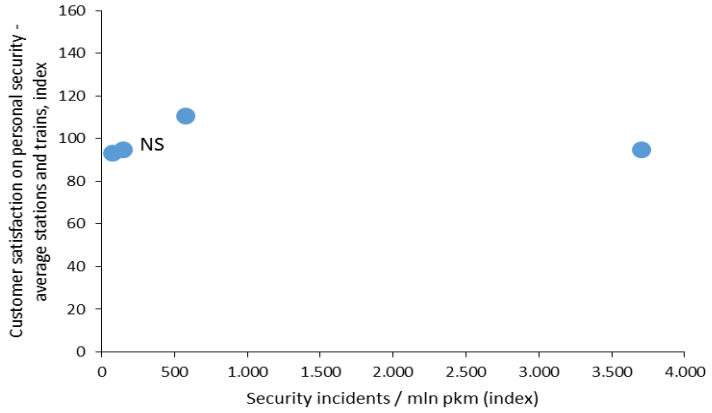
- Generally passengers rate their security in trains 5-10% higher than on stations
- Most peers show gradual increasing customer satisfaction ratings over the years. Step changes can be caused by change of methodology.

3 There is no clear correlation between customer satisfaction and numbers of security incidents. However the sample size is limited.

2



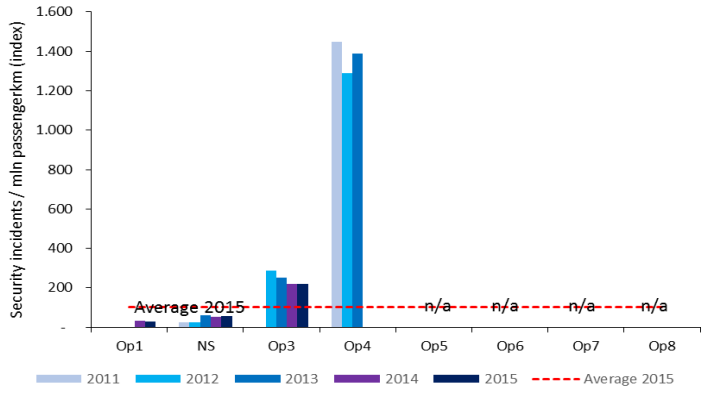
3



5.3 Personal security – reported incidents

Numbers of reported security incidents and violence against passengers are below average

1



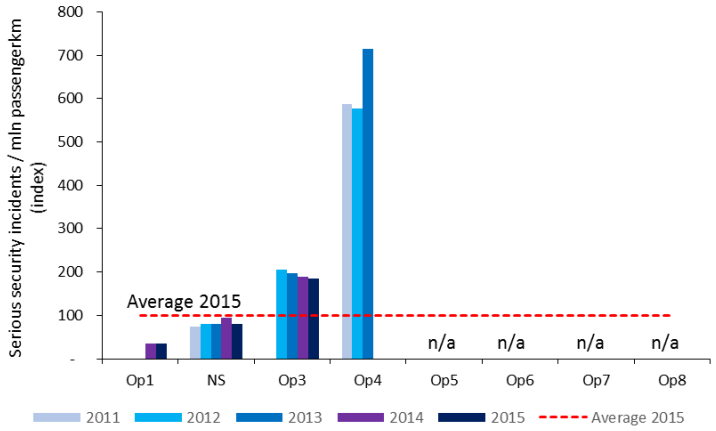
Interpretation:

1 + 2 The number of reported security incidents and serious security incidents of NS is below the average of the peer group.

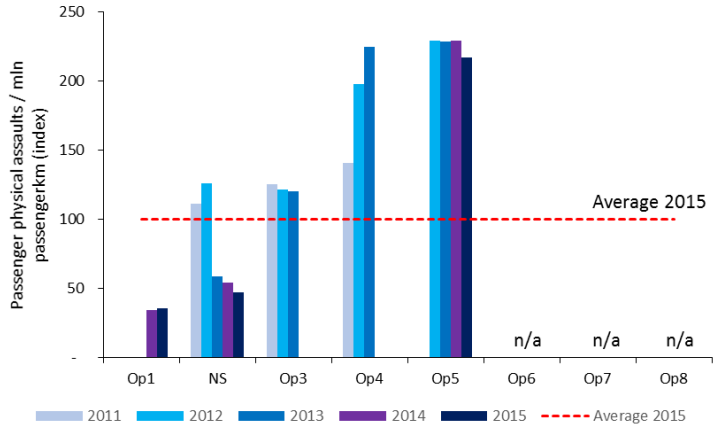
- 4 operators did not provide data on general security incidents.
- One of the peers is an outlier, which may be caused by a different operating environment and/or the incident reporting practice.

3 The number of passenger physical assaults is below average and declining.

2



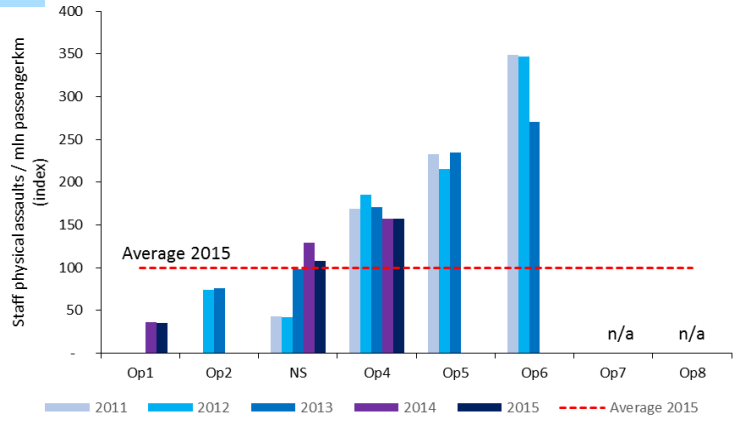
3



5.3 Personal security – reported incidents

Numbers of reported incidents against staff vary widely, possibly due to operating environment and incident reporting practice.

1



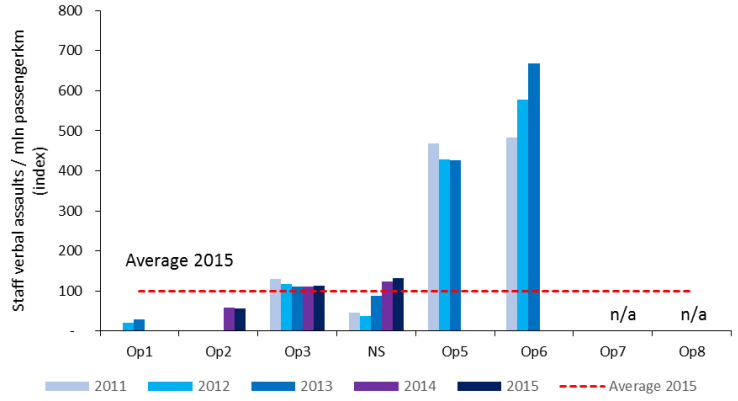
Interpretation:

1 + 2 The number of reported staff physical assaults and staff verbal assaults are around average.

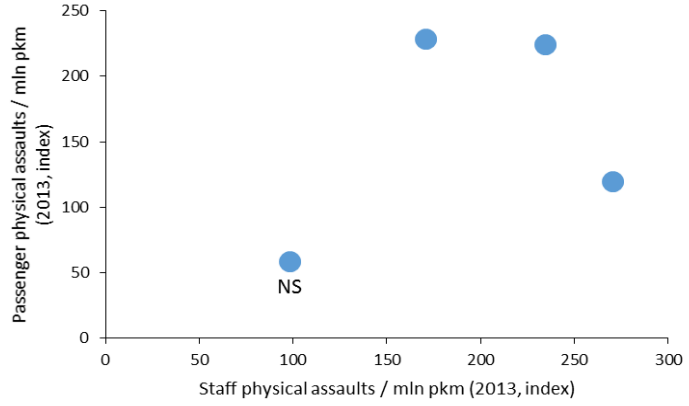
- One of the peers is an outlier, which may be caused by a different operating environment (demographics) and/or the incident reporting practice (method of reporting e.g. via PDA or call centre, willingness to report) and more emphasis on checking tickets.

3 Violence against staff and against passengers are not clearly correlated.

2



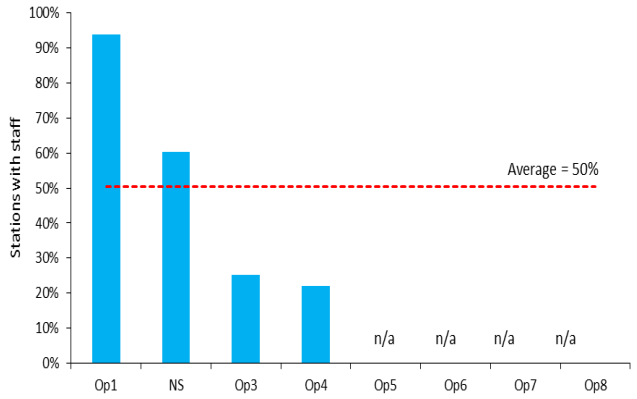
3



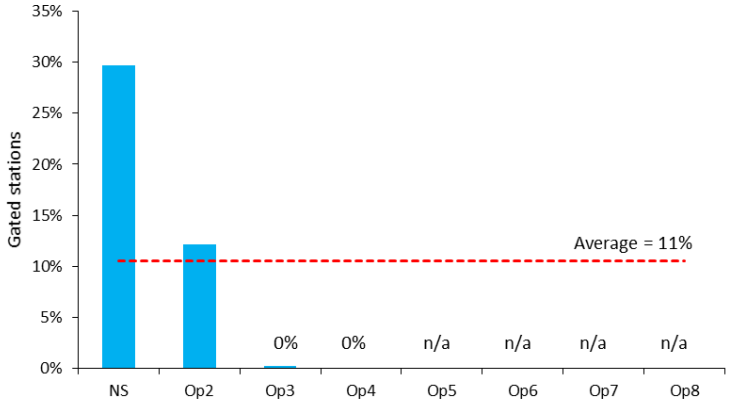
5.3 Personal security – station measures

NS operates a relatively high proportion of staffed stations and gated stations

1



2



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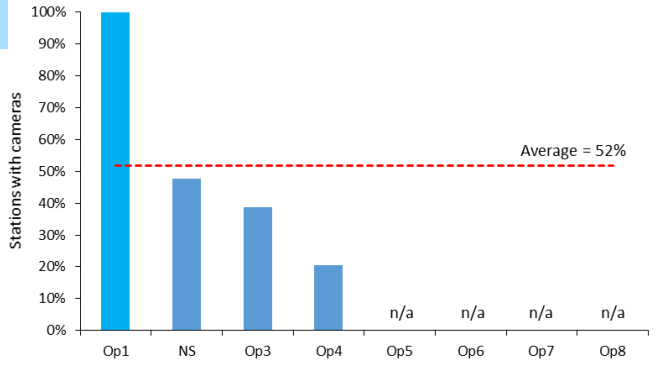


Interpretation:

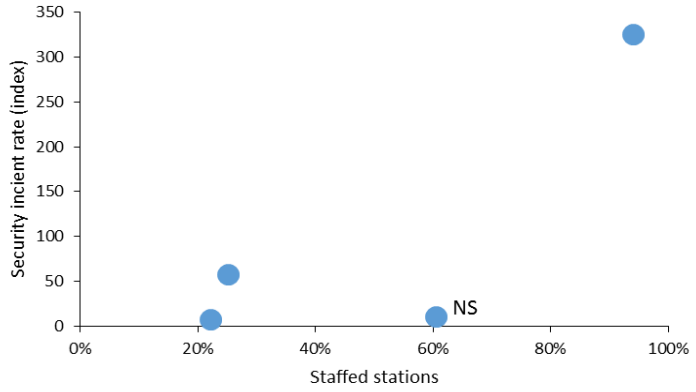
1 + 2 NS has a relatively high proportion of staffed stations and gated stations.

3 The percentage of stations with camera's in the Netherlands is around the average of the peer group.

5.3 Personal security – station measures

NS station security measures go together with relatively low incident rates.

1



Interpretation:

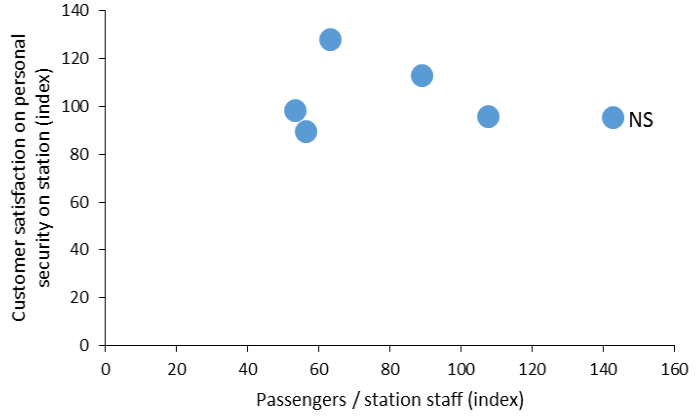
- The number of security incidents and customer satisfaction may be related to staffing of stations and the number of passengers present on stations.

1 There is no clear correlation between the security incident rate and the percentage of staffed stations. However the sample size is limited due to unavailability of data.

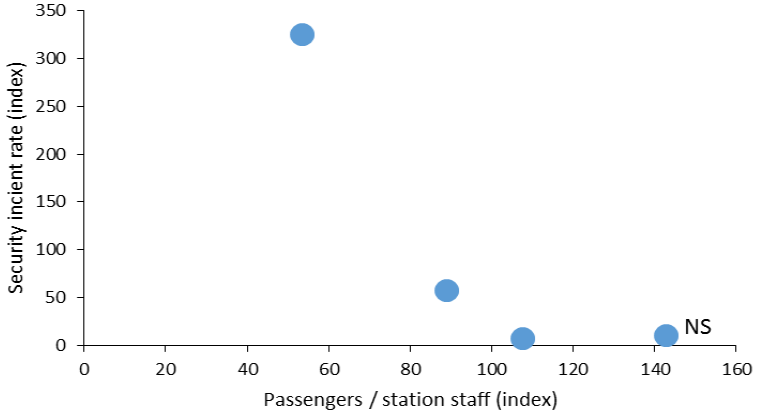
2 + 3 NS has low numbers of security incidents with a relatively high percentage of staffed stations.

- There is no clear correlation between the customer satisfaction on personal security on stations and station staff numbers.

2



3

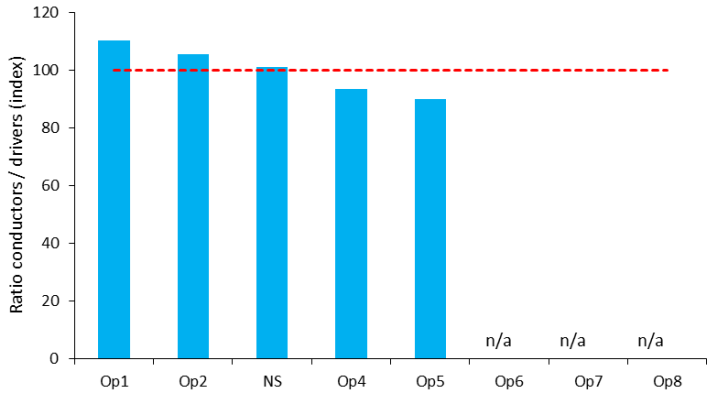


5.3 Personal security – train staff

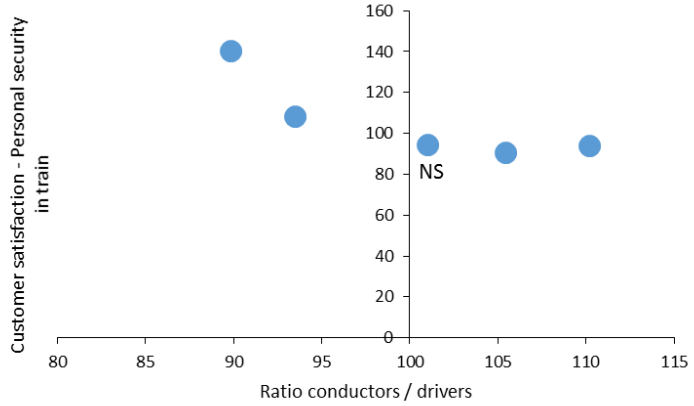
NS' ratio of conductors and drivers is around the average of the peer group

No clear relationship beween customer satisfaction on security and conductor/driver ratio

1



2



Interpretation:

- There is no quantitative data available about the average number of conductors per train at the peers.
- Qualitative rules for staffing vary between 0 and 3 conductors per train.

1

- The overall ratio of conductors and drivers can be used as a proxy for the number of conductors per train.
- This ratio of NS is around the average of the peer group.

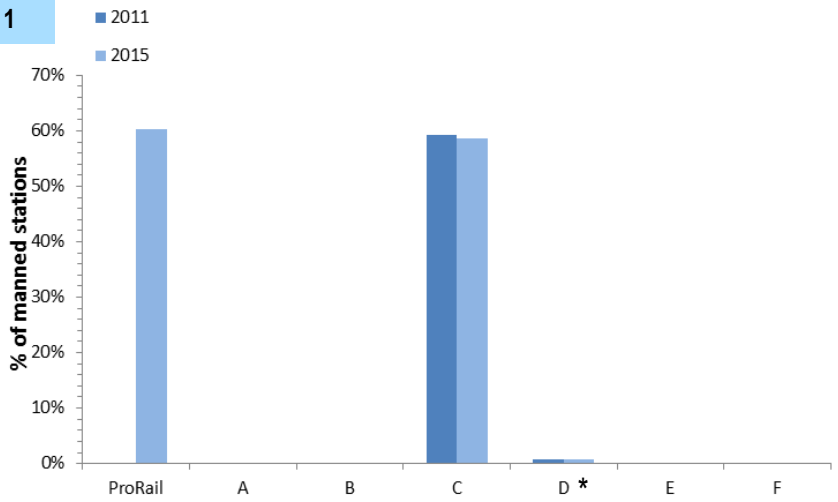
2

- This overall ratio shows no clear correlation with the customer satisfaction on personal security in the train.
- Customer satisfaction may be more related to train type and the deployment policy for conductors (e.g. more conductors or mobile teams on trains with a high risk profile).

5.4 Safety – Manned, gated and camera surveillance at stations

Around 60% of NL stations are manned, and approximately 20% of the stations have gated access

1



Interpretation:

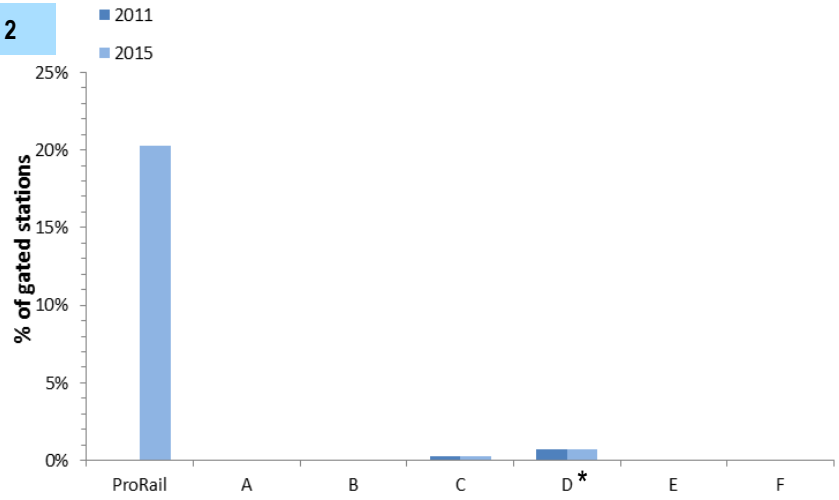
Data regarding manned, gated stations and CCTV surveillance are not available, except for ProRail and C

1 Around 60% of the stations in NL are manned (i.e. with a ticket office or a shop). This is a comparable percentage with C

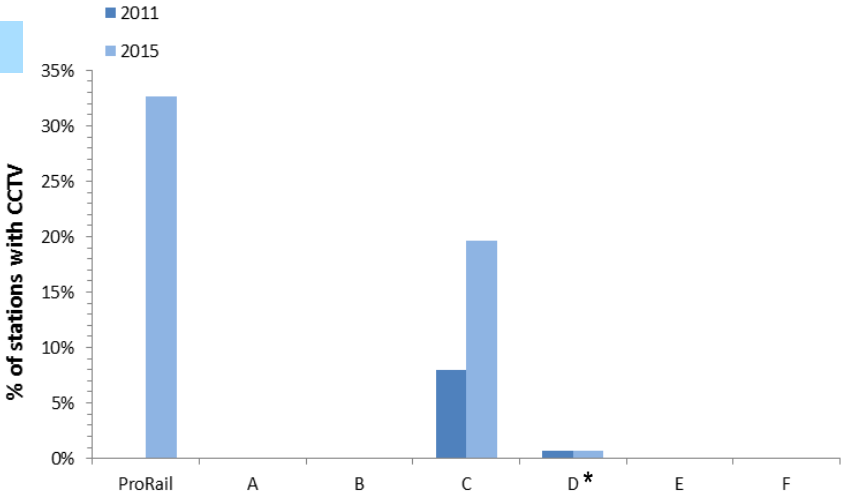
2 NL has a high percentage of gated stations compared to C

3 NL has a high percentage of stations with camera surveillance

2



3



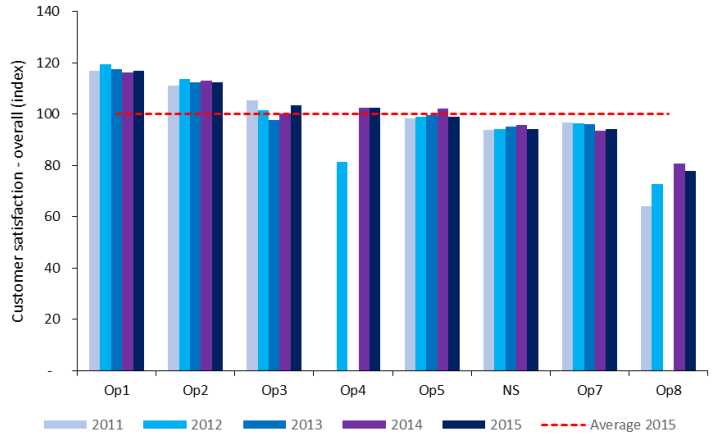
* Information of D only applies to the number of stations managed by the IM as percentage of total number of stations

6. Attractive product for passengers and freight carriers

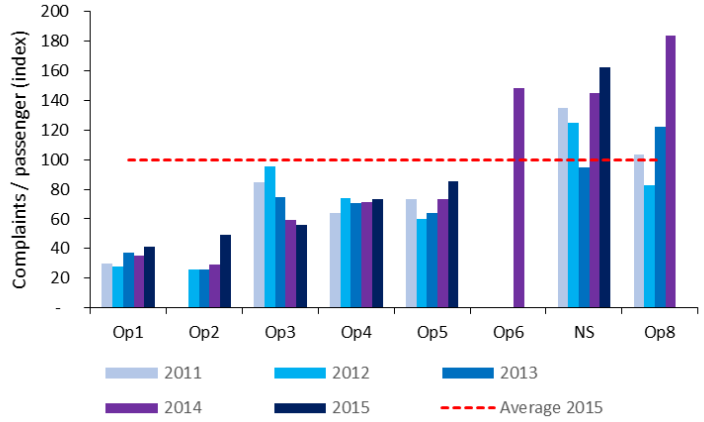
6.1 Attractive service for passengers – customer satisfaction

Customer satisfaction is below average, complaint rate above average

1



2



Interpretation:

1 Overall customer satisfaction about travelling by train at NS is 6% below the average of the peer group and stable.

- Most peers show overall stable scores; step changes are mainly due to changes in methodology of measuring customer satisfaction (e.g. moving from questionaires in trains to web based research).
- Customer satisfaction scores are harmonized (re-scaled) using the methodology described in Appendix B. This introduces some uncertainty in the comparability. The figures are not harmonized for differences in methodology (e.g. survey channel and sampling scheme).

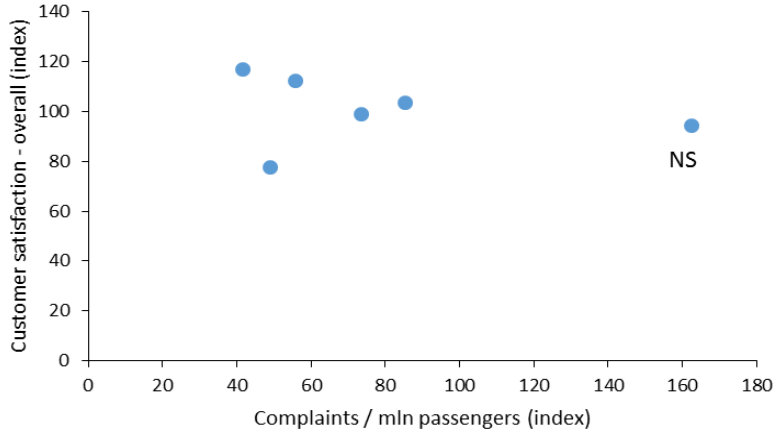
2 Complaint rate at NS is significantly above the average level of the peer group.

- The complaint rate may also be influenced by the ease of making complaints (e.g. web based vs.form at ticket counter) and the scope of what is logged as a complaint.
- Differences in complaint procedures (e.g. channels, complaint definitions, registration practice) are not taken into account. This limits the comparability.

6.1 Attractive service for passengers – customer satisfaction

No clear relationship between customer satisfaction and complaint rate – many influencing factors

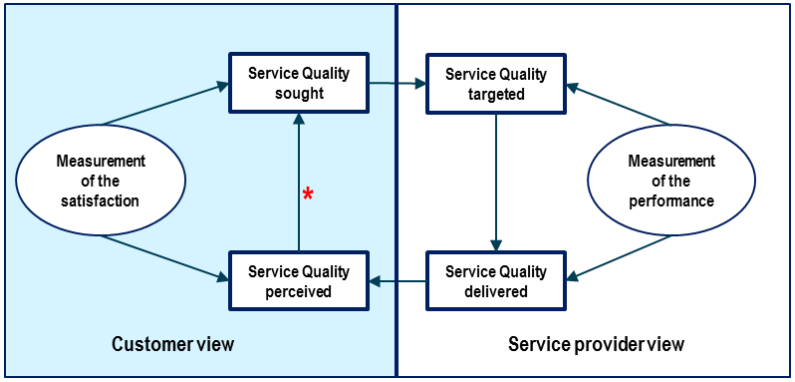
1



Interpretation:

1 There is no clear correlation between overall customer satisfaction and the complaint rate.

2



EN 13816: 2002; Public Passenger Transport,
Service Quality deffinition, targeting and measurement

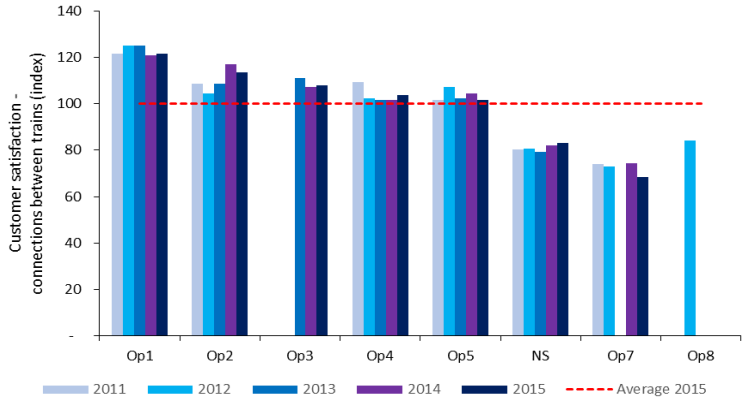
2 On many aspects of this benchmark there is a weak correlation between customer satisfaction and actual performance.

- Often customer satisfaction is low in the case of NS while the actual performance (e.g. punctuality) is above average.
- This disparity is explained in European Standard EN13816; customer satisfaction is determined by the difference between expected service and perceived service (see *).
- Beside the actual service delivery there are many factors influencing both perception and expectation.

6.1 Attractive service for passengers – Frequency and connections

Frequency is appreciated below average but improving. No clear correlation with actual train frequencies.

1

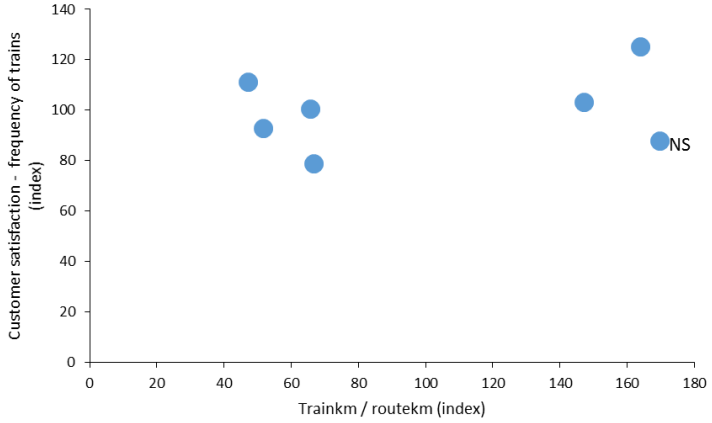


Interpretation:

1 NS' customer satisfaction about frequency of trains and connections is below the average of the peer group but improving.

- Customer satisfaction about connections between trains improves with satisfaction about frequency of trains.

2



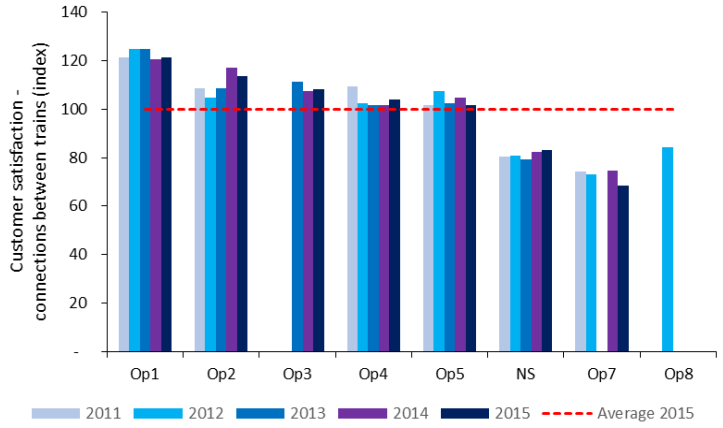
2 To evaluate the relationship between customer satisfaction and actual train frequency, train density (trainkm / routekm) is chosen as a proxy for average frequency of trains for passengers.

- There appears to be no clear correlation between customer satisfaction about frequency of trains and the train density.

6.1 Attractive service for passengers – customer satisfaction

Customer satisfaction on train connections is below average but improving.

1



Interpretation:

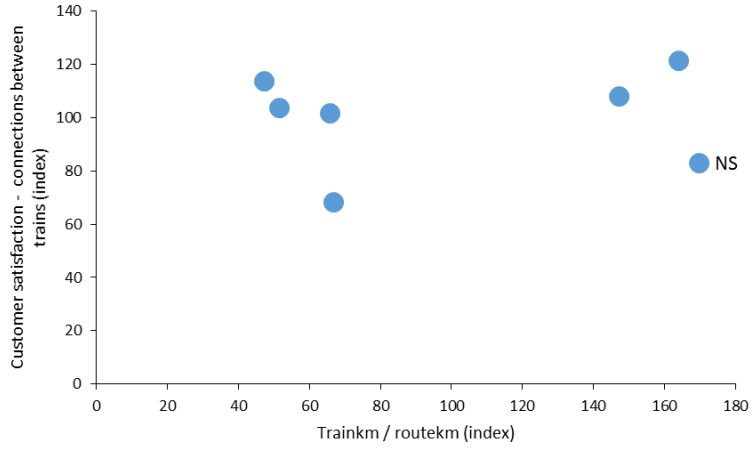
1 Customer satisfaction on train connections is below average but improving.

2 To evaluate the relationship between customer satisfaction and actual train frequency, train density (trainkm / routekm) is chosen as a proxy for average frequency of trains for passengers.

- Correlation between customer satisfaction on train connections and actual train frequency (proxy: trainkm/routekm) is not clear.

3 Customer satisfaction on train connections could also be related to the punctuality of train services. However this correlation is also not clear.

2



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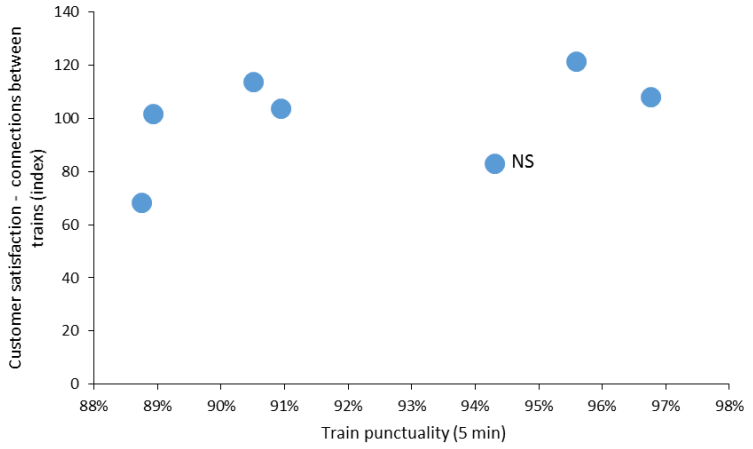
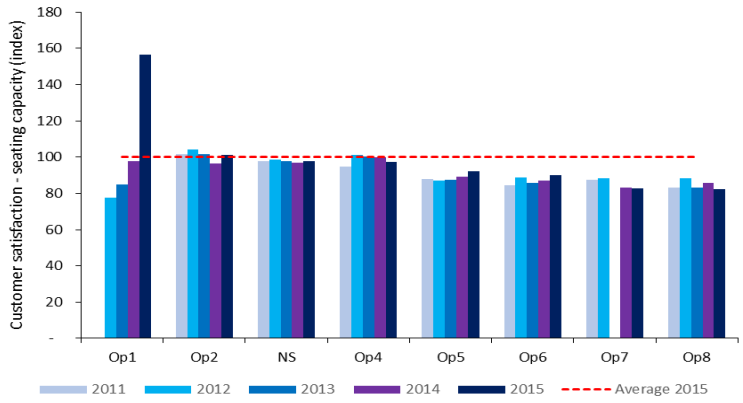


6.1 Attractive service for passengers - capacity

Customer satisfaction is around average, seat occupancy below average, capacity per train above average

1



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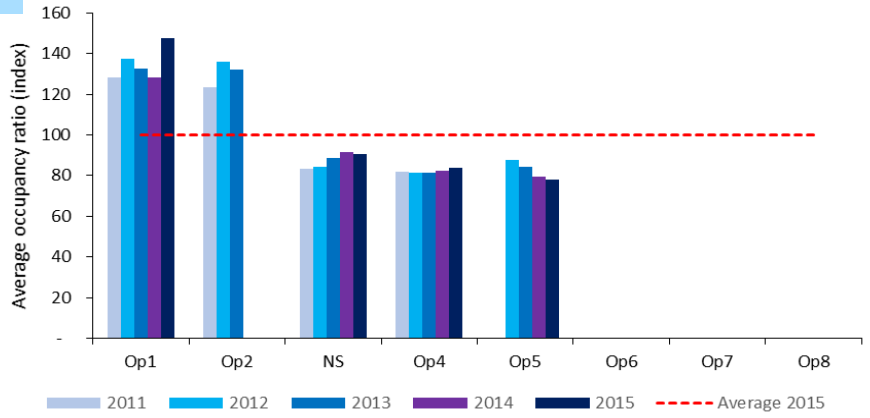

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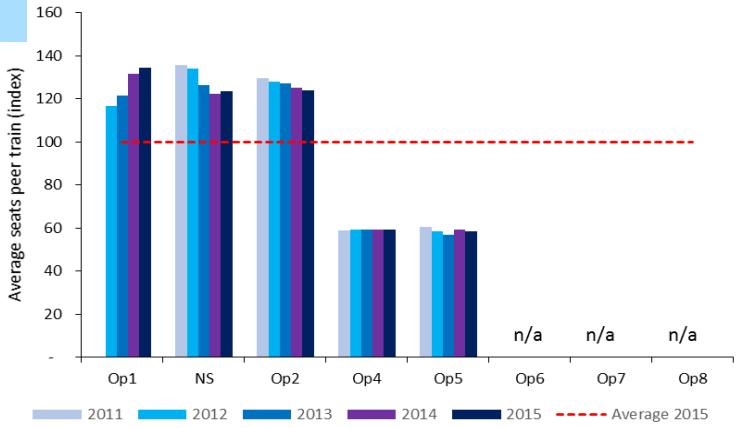


Interpretation:

1 NS' customer satisfaction on seating capacity is around average, both overall and in peak hours. Without the outlier Op1 NS's score is above average.

- Most peers show fairly stable scores, step changes are due to change of scope or change of methodology (e.g. on-line vs. On-train)

2 Average occupancy ratio of NS trains is below the average of the peer group.

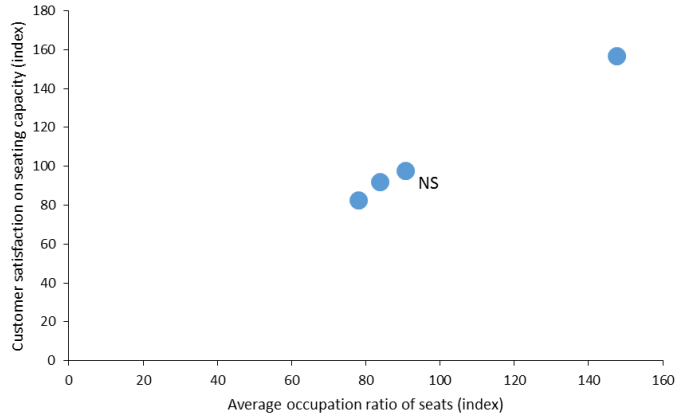
- Higher occupation ratios are generally caused by using a reservation system and/or (strongly) decreasing train length and/or frequency in off-peak hours

3 NS runs trains with 24% more seats per train than the average of the peer group (more double deck, longer trains). This could decrease with increasing train frequencies.

6.1 Attractive service for passengers

Comparison between peers gives no clear indication of drivers of customer satisfaction on seating capacity

1



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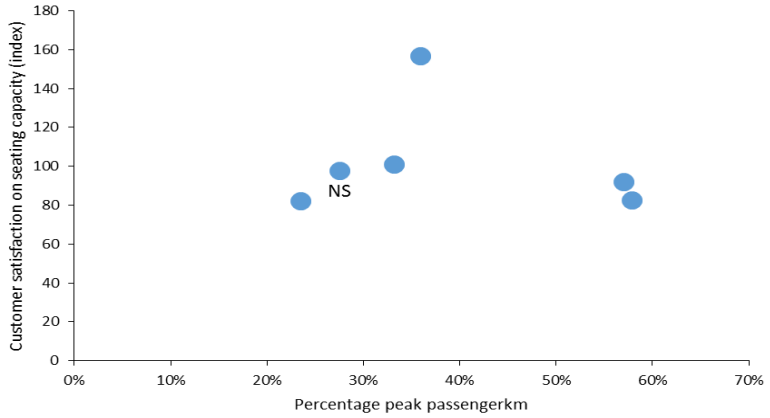

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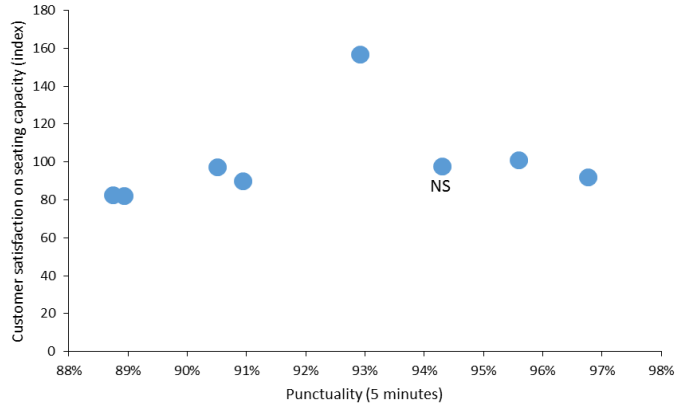


Graphs based on 2015 data

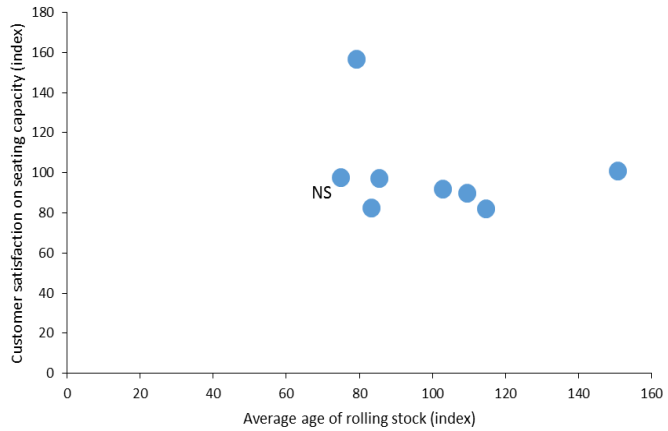
Interpretation:

- Customer satisfaction on seating capacity could be related to occupancy ratio, peak/off-peak ratio or punctuality (disrupting distribution of passengers over trains)
- However comparison between peers shows no clear relationship between customer satisfaction on seating capacity and:
  - **1** Average occupancy ratio of seats
  - **2** Percentage passengerkm in peak hours
  - **3** Average punctuality of trains
- These relationships might occur in timeseries within peers, but there is no sufficient data available to evaluate this.

6.1 Attractive service for passengers

No clear correlation between customer satisfaction and age of rolling stock or train utilization

1



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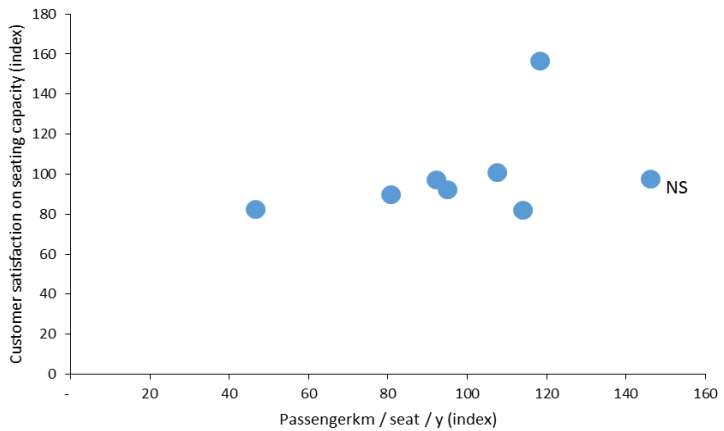

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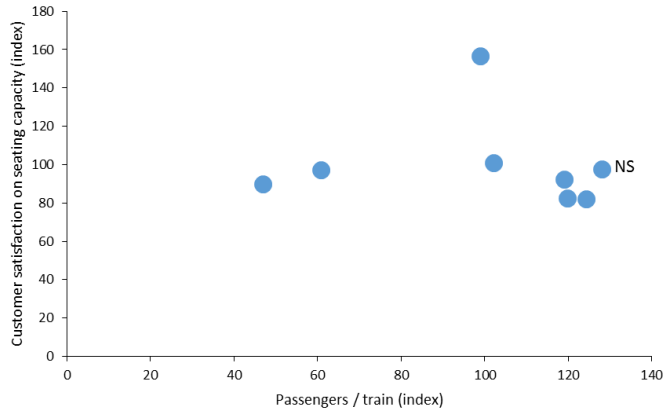


Interpretation:

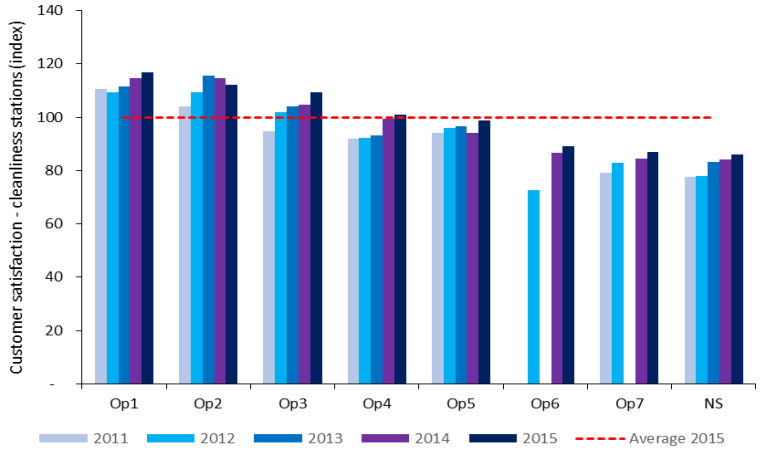
- Customer satisfaction on seating capacity could be related to the average age of the rolling stock (perceived as comfortable), the productivity of rolling stock (possibly associated with “over using” or overcrowding) or the average number of passengers per train (possibly associated with overcrowding of parts of the train)
- However comparison between peers shows no clear relationship between customer satisfaction on seating capacity and:

1	Average age of the rolling stock
2	Productivity of the rolling stock (passengerkm/seat/y)
3	Number of passengers per train

6.1 Attractive service for passengers

Customer satisfaction on cleanliness is below average but improving

1

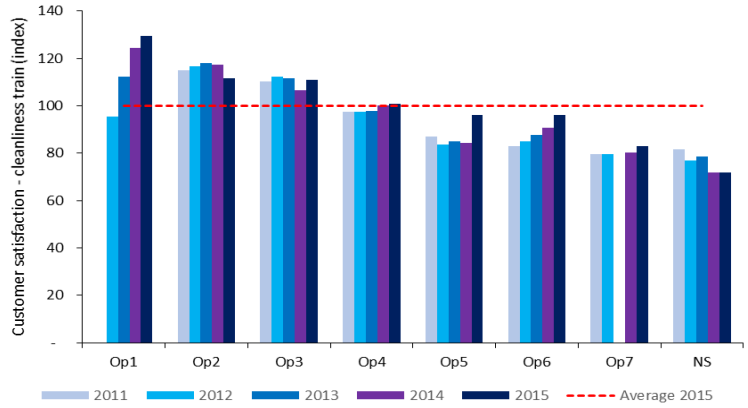


Interpretation:

1 NS' customer satisfaction about cleanliness of stations is 14% below the average of the peer group

- Like most peers NS shows significant improvement over time.
- Customer satisfaction on larger stations may be negatively influenced by construction activities and strikes by cleaning staff.

2



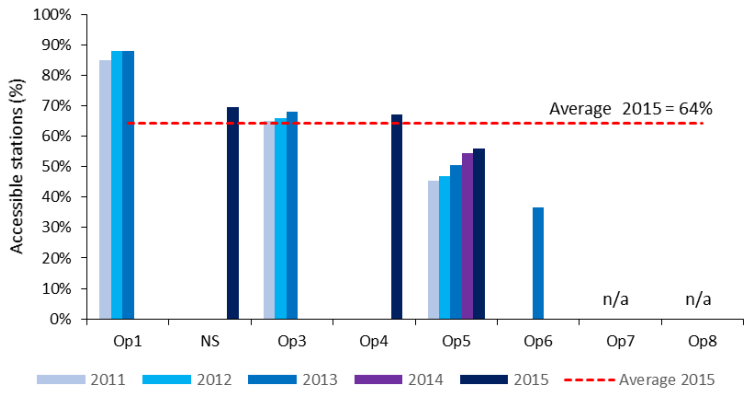
2 NS' customer satisfaction about cleanliness of train interiors is 28% below the average of the peer group

- Scores of 2014 and 2015 are lowes, possibly partly due to strikes by cleaning staff.
- Other peers show more significant improvements over time.
- This issue is addressed by NS in the rolling stock delivery (4J) programme that has been started in 2015.
- Other research indicates that customer satisfaction on cleanliness is related to performance on other aspects.

6.2 Attractive service for Passengers with Reduced Mobility (PRM)

Accessibility of Dutch station is above average, fully accessible rolling stock is rare among the peer group

1



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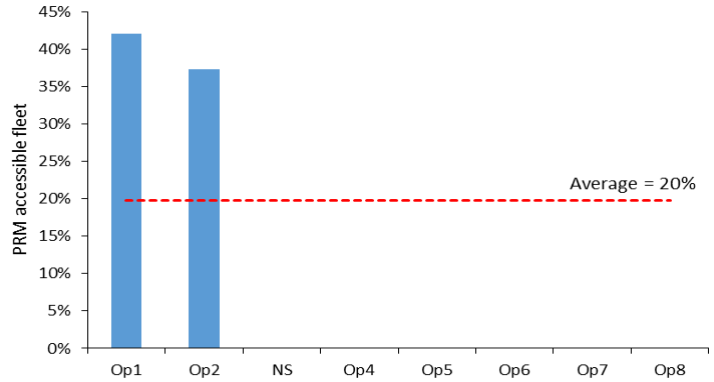


Interpretation:

- Full accessibility of the railway system for PRM is a combination of accessible stations and accessible rolling stock, both being aligned (e.g. platform height).

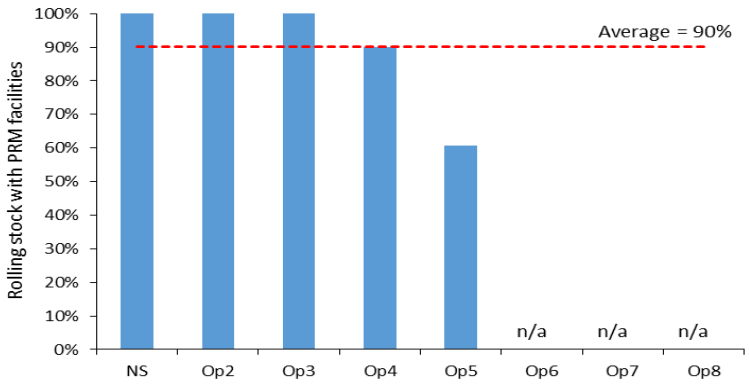
1 Not all peers use the TSI PRM* definitions of accessibility. Differences in definitions of accessibility limit comparability.

- The proportion of NS / ProRail stations that is stepfree accessible (including lifts or ramps), is slightly above average.

2 There are only 2 peers of which a part of the fleet stepfree accessible. With modernization of fleets this proportion becomes larger.

3 Although the rolling stock may not yet comply the TSI PRM, most peers have facilities for passengers with reduced mobility in rolling stock, such as wheelchair accessible toilets, priority seats, etc.

3

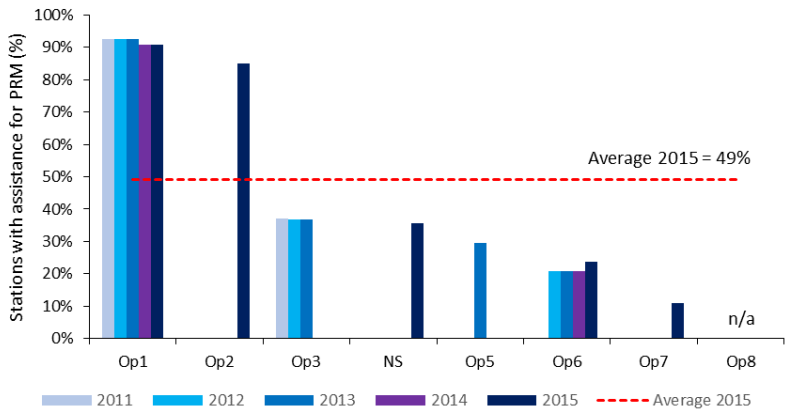


* Technical specifications for interoperability relating to accessibility of the Union's rail system for persons with disabilities and persons with reduced mobility (cf. 1300/2014/EU)

6.2 Attractive service for Passengers with Reduced Mobility (PRM)

Coverage for assistance at stations is around average, notification time is short

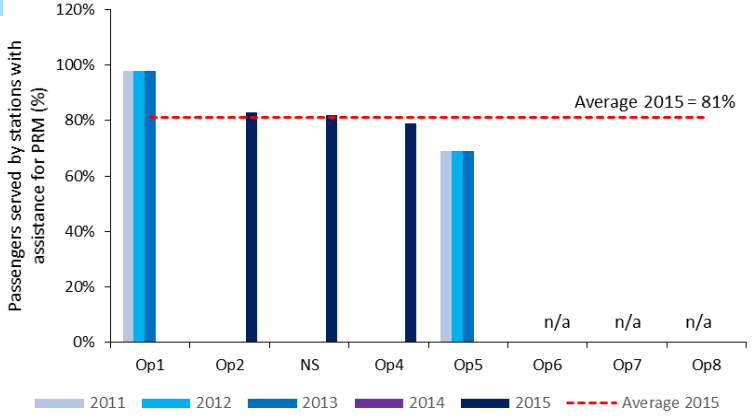
1



Interpretation:

1. The proportion of NS with assistance for passengers with reduced mobility is below average
2. However coverage is chosen in such a way, that the stations with assistance for PRM serve over 80% of the total boarding/unboarding passengers of NS.
3. With a notification time of 1 hour for assistance, NS is among the more flexible operators on this aspect.

2



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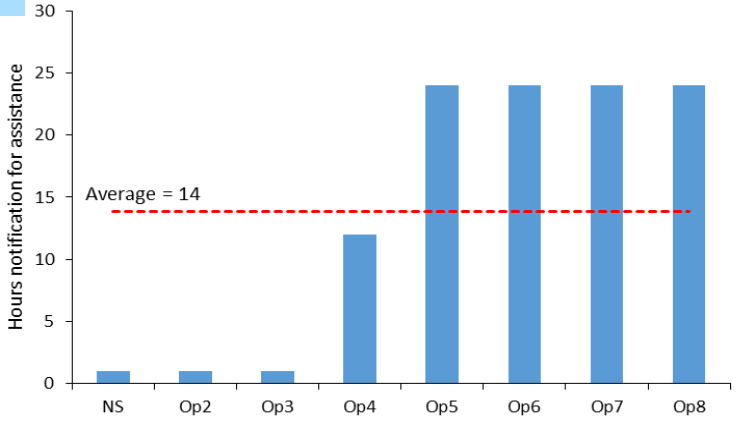
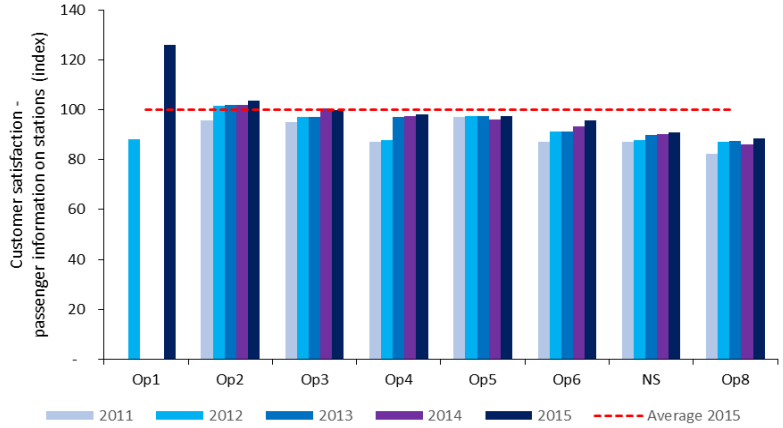


6.3 Attractive service for passengers - information

Information on stations is improving, particularly in case of disruptions

1

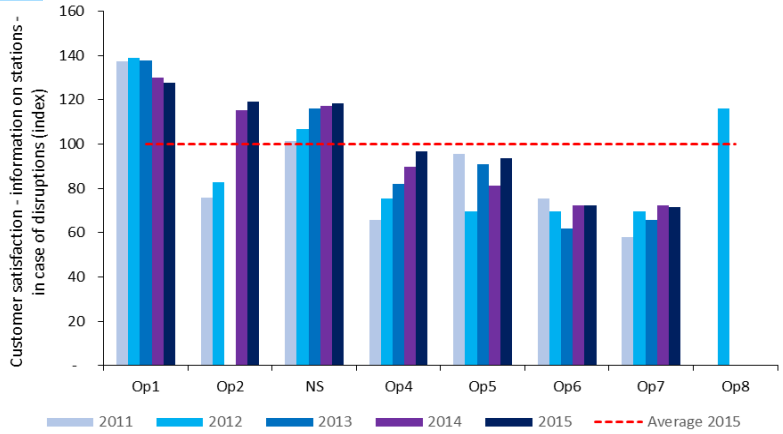


Interpretation:

1

- NS' customer satisfaction on passenger information on stations is 9% below the average of the peer group. Excluding the Op1 outlier NS scores above the average.
- Most peers show gradually increasing scores, in case of a step change there is a change of methodology of customer satisfaction measurement
- Customer satisfaction on large stations may be negatively influenced by construction activities.

2



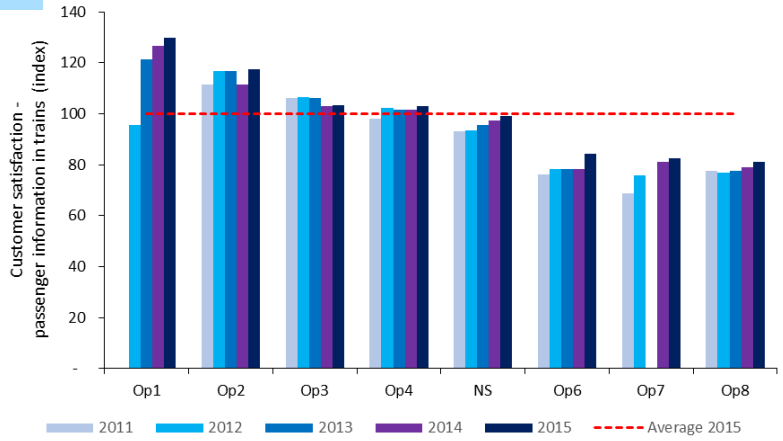
2

- NS' customer satisfaction on passenger information on stations in case of disruptions is 18% above the average
- Most peers show gradually increasing scores
- NS score shows a significant increase in 2013, when the InfoPlus system was rolled out and passenger information was organized separate from traffic control

6.3 Attractive service for passengers

Information in trains is improving, in case of disruptions above average

1

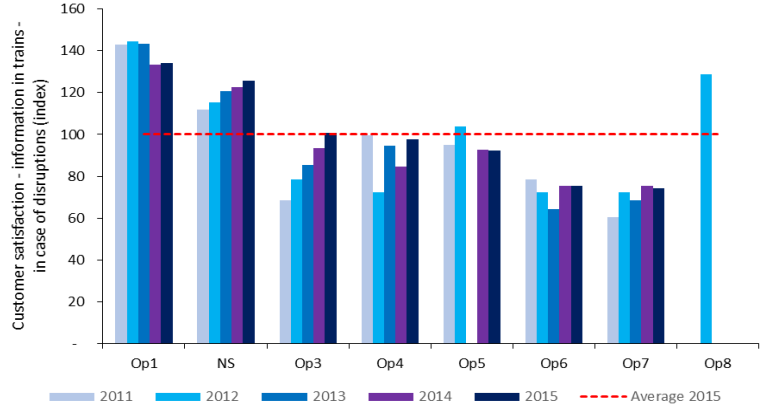


Interpretation:

1 NS' customer satisfaction on passenger information in trains has improved gradually and is now around the average of the peer group.

- Most peers show improvement over the years, partly by introducing displays and/or automatic announcement systems in new rolling stock and during refurbisment.
- NS also implemented extra training of staff, adjustment of announcements and the use of the InfoPlus system

2



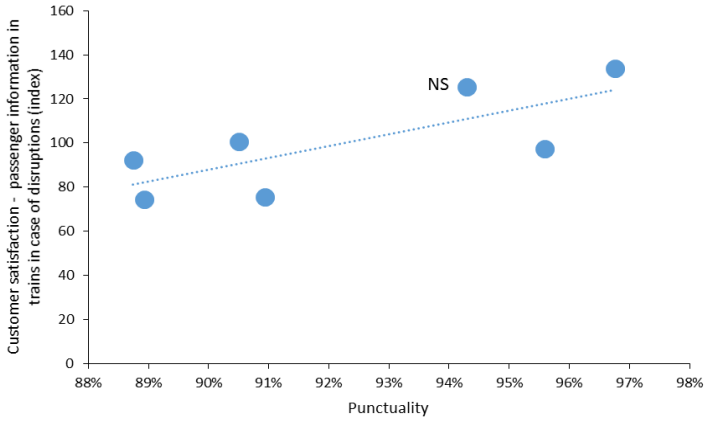
2 NS' customer satisfaction on passenger information in trains in case of disruptions has significantly improved and is now 26% above the average.

- Information in case of disruptions has improved by extra training of train staff, adjustment of announcements, increasing the number of display systems in trains and implementation of the InfoPlus system

6.3 Attractive service for passengers

Customer satisfaction on passenger information in case of disruptions correlates clearly with punctuality, but less so with cancellations

1



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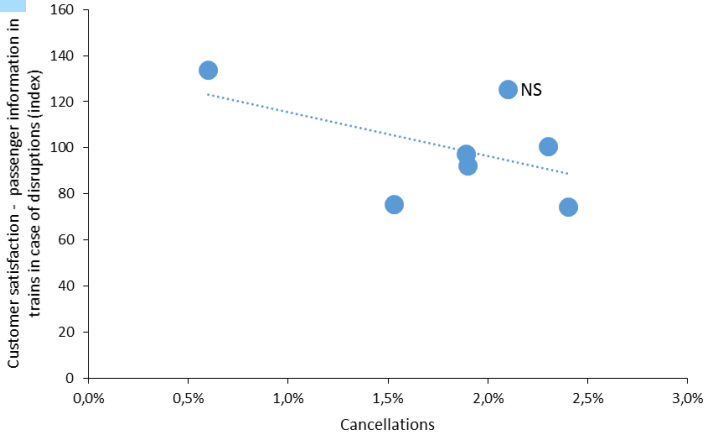


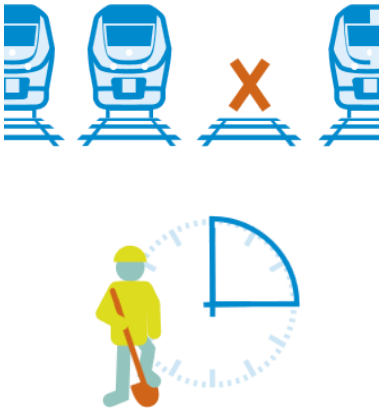
Interpretation:

1 Customer satisfaction on passenger information in case of disruptions could be related to the reliability of train services (punctuality) and the absence of larger disruptions (cancellations)

- There appears to be a positive correlation between customer satisfaction on passenger information in case of disruptions and the punctuality of trains.

2 There appears to be a negative correlation between customer satisfaction on passenger information in case of disruptions and the cancellation rate of trains. However this correlation is less clear than the correlation with punctuality.

7. Reliability



Highlighted findings from NS and ProRail perspective

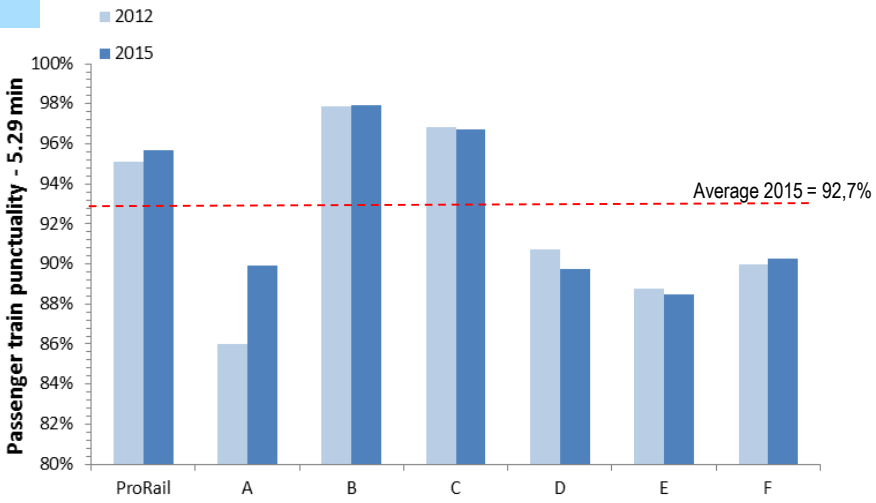
1. Introduction, context and methodology
2. Peer group
3. Rail network and stations
4. Asset characteristics
5. Safety
6. Attractive product for passengers and freight carriers
7. Reliability
    1. Punctuality
    2. Trains cancelled
    3. Delays
    4. Other
8. Sustainability
9. Railsystem capacity
10. Productivity
11. Financial performance

Appendices

7.1 Punctuality – passenger trains ≤ 5.29 minutes

ProRail punctuality has increased, and is above peer group average

1



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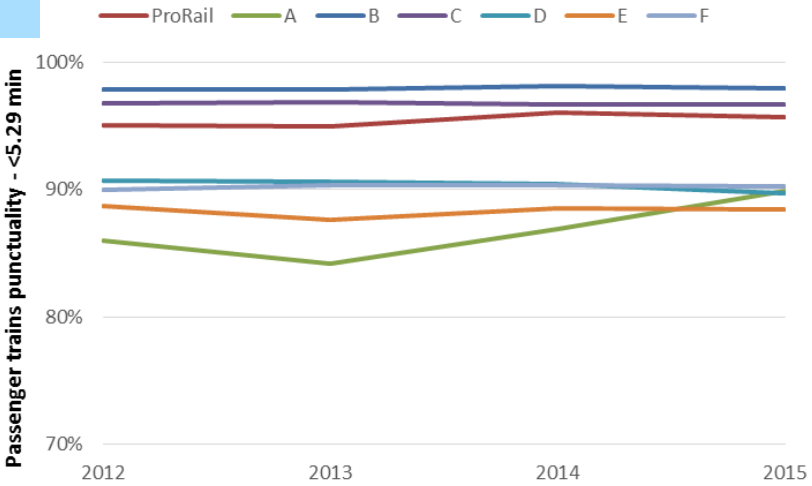

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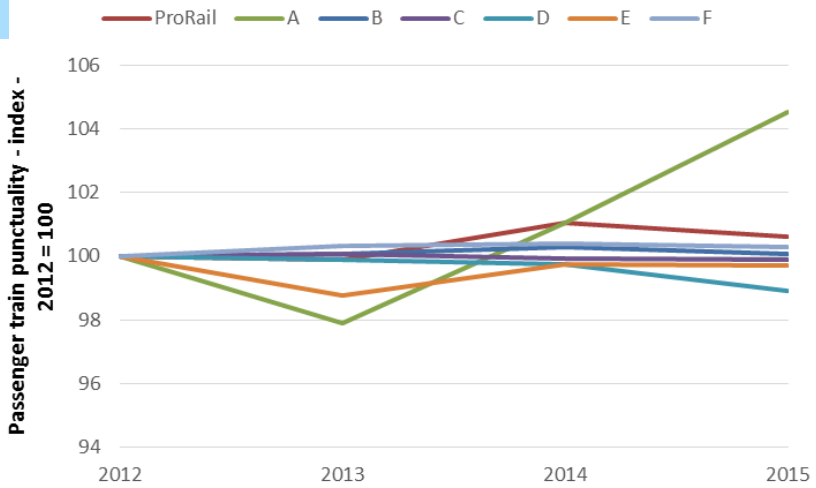


Interpretation:

1 NL shows improved passenger train punctuality in the period 2012 – 2015 from 95,1% to 95,7%

- ProRail scores above peer group average of 91,2% in 2015
- B shows the highest passenger train punctuality in 2015: 97,8%
- Punctuality of C is measured against a threshold of 4.59 minutes (meaning that 5.29 punctuality would be higher)

2 + 3 All countries except for A show a more or less stable punctuality over the years

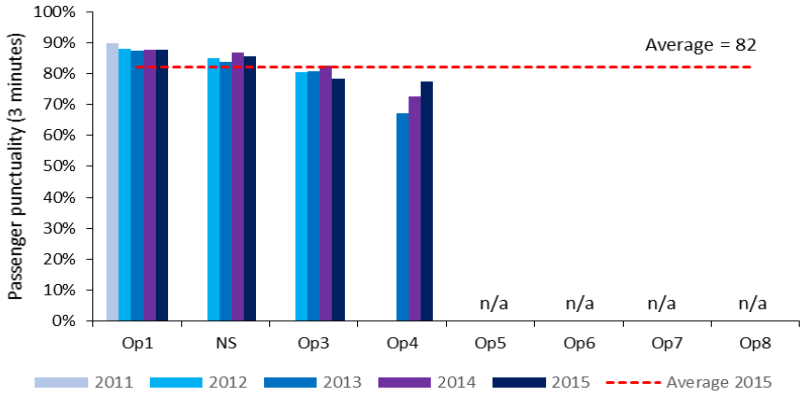
- A shows the biggest improvement in punctuality (+4,5%)

See Appendix A – punctuality for the definitions used

7.1 Punctuality – passenger punctuality

NS passenger punctuality and train punctuality are above average

1



Interpretation:

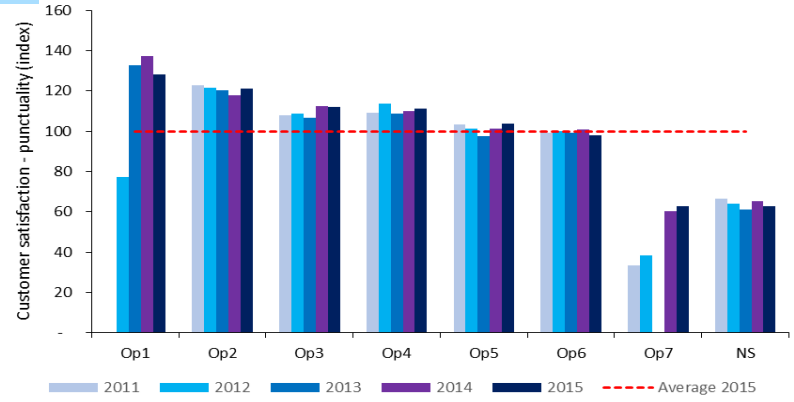
1 Only NS and three other peers do actively manage passenger punctuality; other peers only manage train punctuality and cancellations.

- Passenger and train punctuality are measured and calculated using different methods amongst the peers. Harmonization for cutoff times has been performed using a model described in Appendix B. These differences in methodology and harmonization of the data introduce a degree of undertaincy in the comparisons.

2 NS passenger punctuality (3 minutes) is 4% above the average of the peer group. This high passenger punctuality does not translate into a higher customer satisfaction.

3 NS train punctuality is 2% above the average of the peer group, but cancellation rate is also 0,1% above the average of the peer group

2



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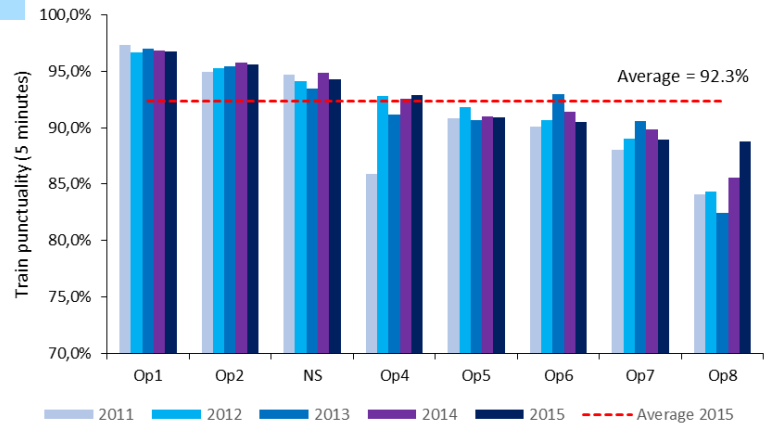
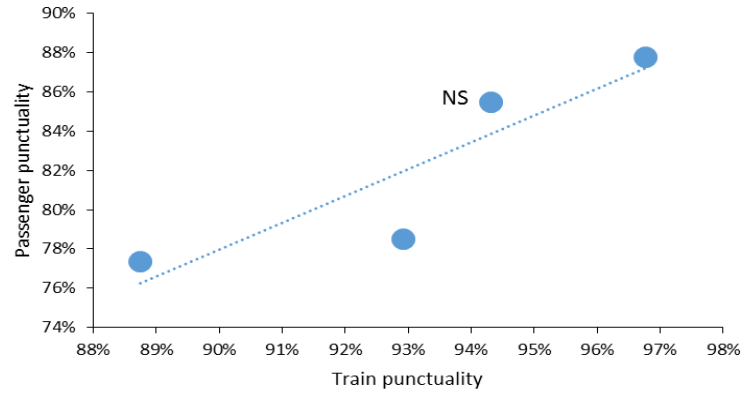


7.1 Punctuality – passenger punctuality

Passenger punctuality has a positive relation with train punctuality and negative with cancellation rate

1



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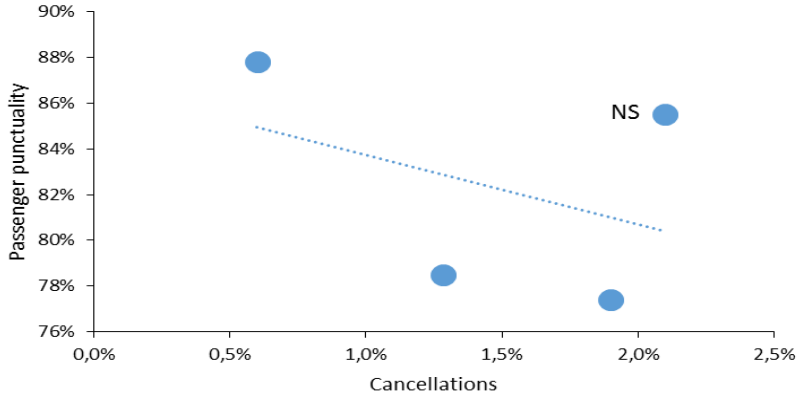


Interpretation:

- Generally passenger punctuality is related to train punctuality, quality of connections and cancellation ratio of trains (weighted by the number of passengers).
- Due to the limited number of peers that manage passenger punctuality and the uncertainty introduced by data harmonization, these statistical analyses are indicative only.

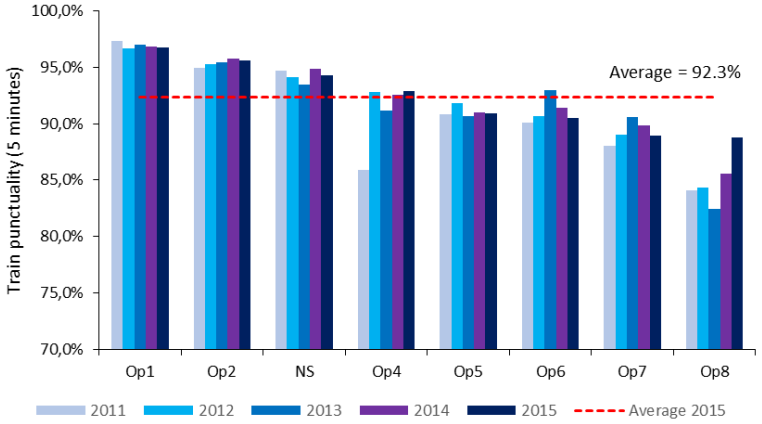
1 Passenger punctuality has a positive correlation with train punctuality

2 Passenger punctuality has a less clear negative correlation with train cancellation ratio

7.1 Punctuality – passenger trains <4.59 minutes

NS train punctuality and cancellations are above average

1



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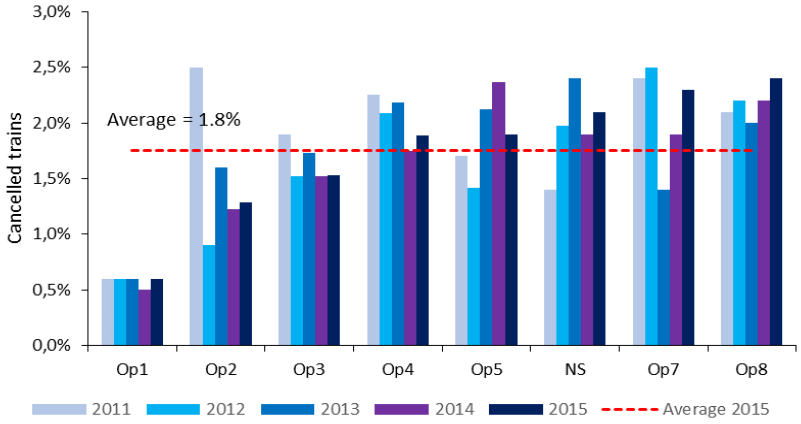

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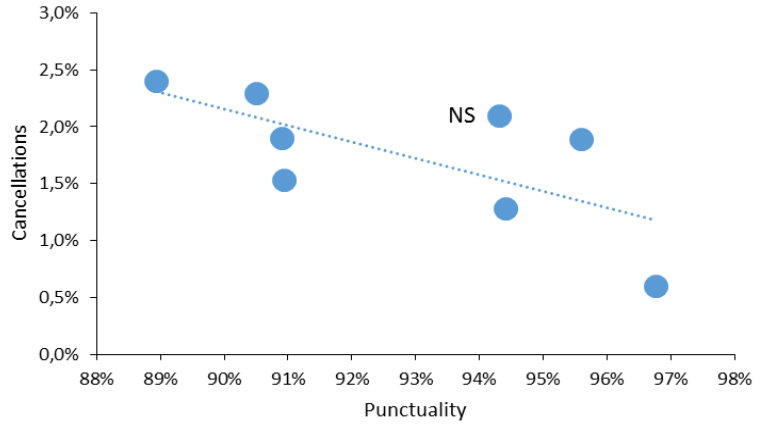


Interpretation:

1 + 2 NS train punctuality is 2% above the average of the peer group, but cancellation rate is also 0,1% above the average of the peer group.

3 Generally peers with higher punctuality have lower numbers of cancelled trains.

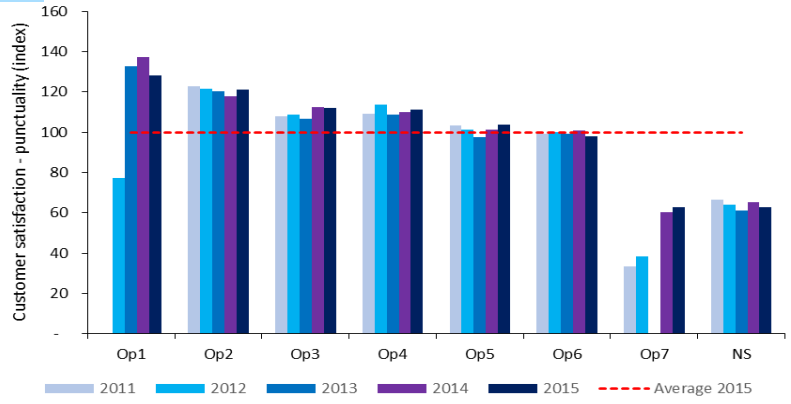
2 NS has a relatively high level of cancellations, which might be related to high train frequencies and a intensely utilized network.

- Cancellations are generally associated with larger disruptions (weather, collisions, infrastructure failures).

7.1 Punctuality – customer satisfaction

NS customer satisfaction on punctuality is below average while the punctuality is above average

1



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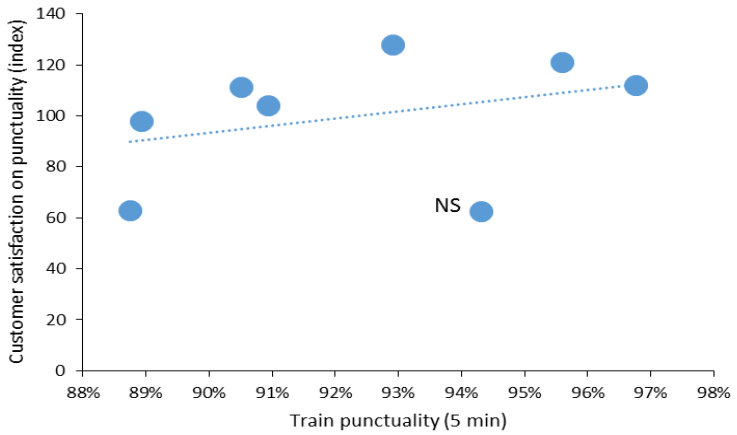

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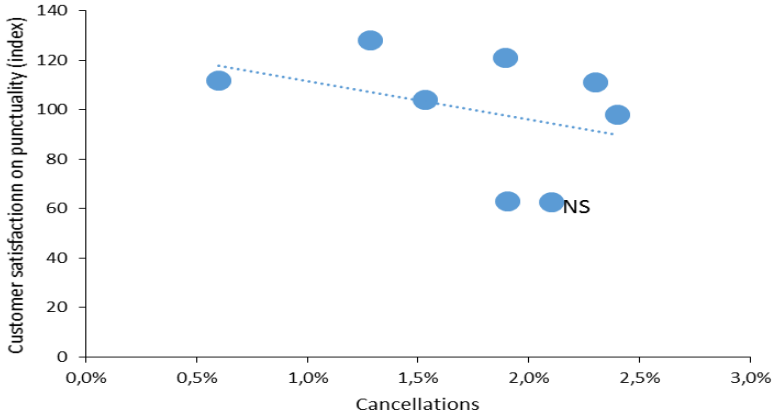


Interpretation: :

1 NS customer satisfaction on punctuality is significantly below the average of the peer group.

2 There is a weak positive correlation between customer satisfaction and punctuality across the peer group. NS is an outlier with a low customer satisfaction while the punctuality is above average.

3 There a weak negative correlation between customer satisfaction and cancellation ratio of trains across the peer group. NS is again an outlier.

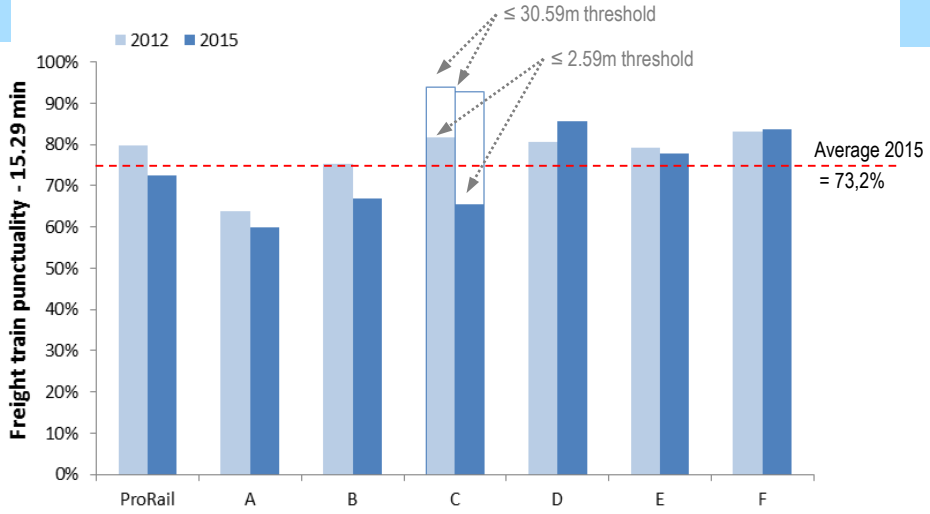
Low customer satisfaction may be related with high customer expectations

- The sample of the peers measuring passenger punctuality is too small to draw conclusions about the relationship with customer satisfaction

7.1 Punctuality – freight trains ≤ 15.29 minutes

ProRail's freight train punctuality has decreased and is around peer group average in 2015

1



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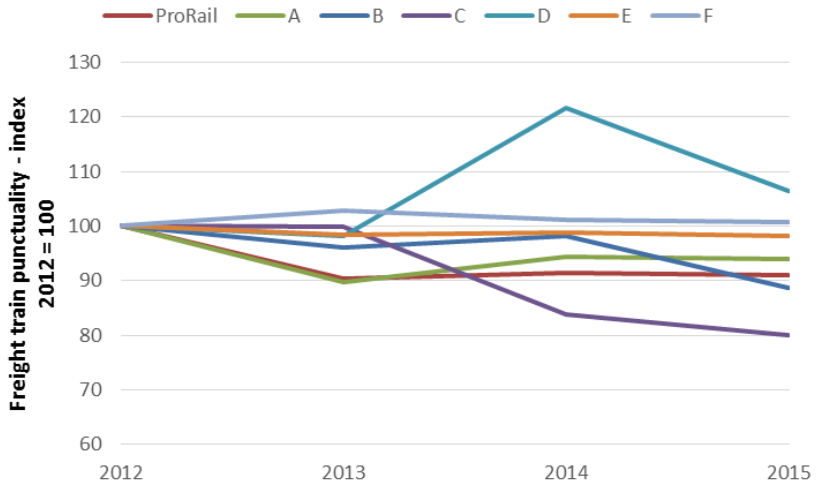

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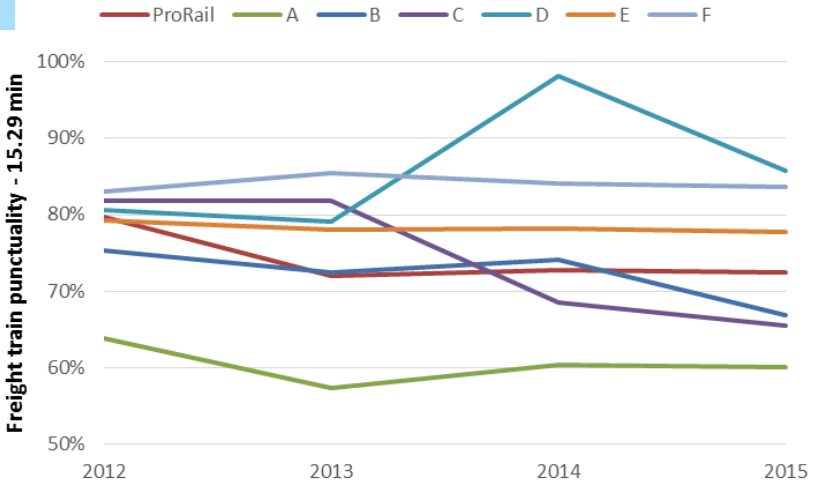


Interpretation:

1 Freight train punctuality has decreased from 79,8% to 72,5% in NL in the period 2012 - 2015

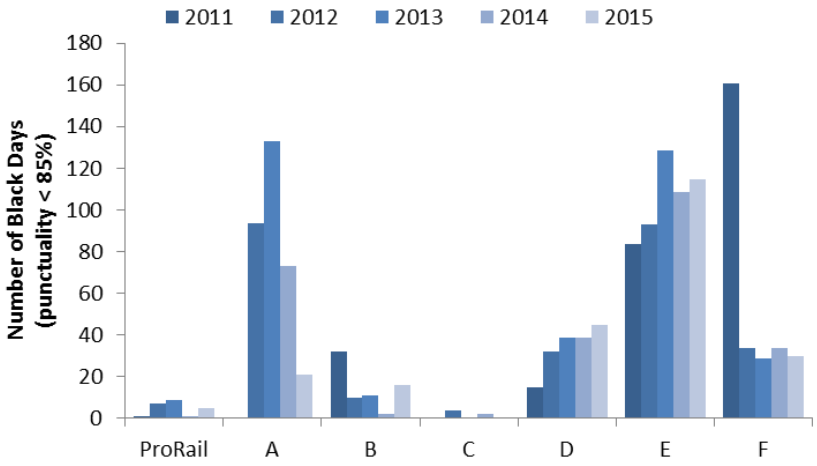
- ProRail scores around peer group average of 73,2% in 2015
- C shows a sharp decrease of freight train punctuality with threshold value of 2.59 minutes, while as for threshold of 30.59 minutes the punctuality is stable
- A has the lowest freight train punctuality of the peer group, whereas D, E and F are slightly above peer group average

2 + 3 Most of the peers see a drop in freight punctuality, except D and F

7.1 Black Days

Relative to the peer group, NL has very few days with total punctuality below 85%

1

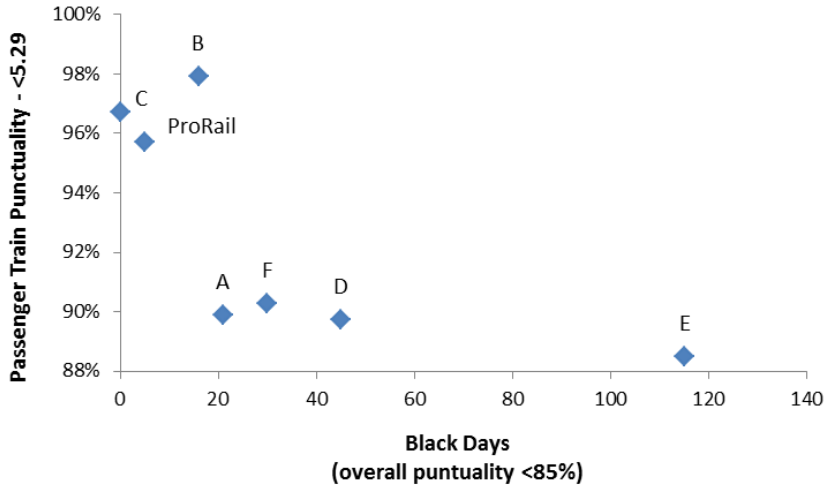


Interpretation:

Figure 1 shows the number of days in which overall punctuality is lower than 85% for the period 2011 – 2015

- NL, B and C have a very low number of black days compared to the peer group

2



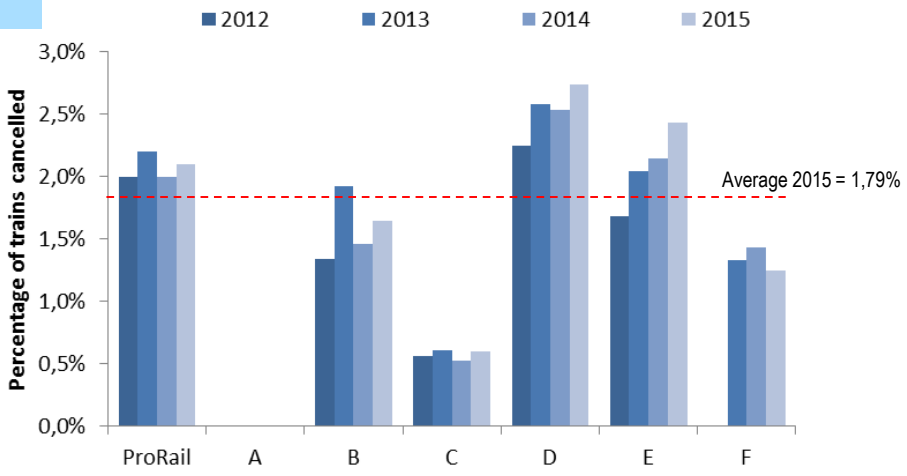
Interpretation:

- NL, B and C combine high punctuality with low number of Black Days in 2015

7.2 Percentage of trains cancelled

In NL, trains are cancelled more than average

1



Interpretation:

- The total percentage of trains cancelled is relatively stable in NL in the period 2012 – 2015
- NL has more trains cancelled than the peer group average
- C clearly outperforms the peer group, with trains cancelled averaging around 0,5% over the years

2

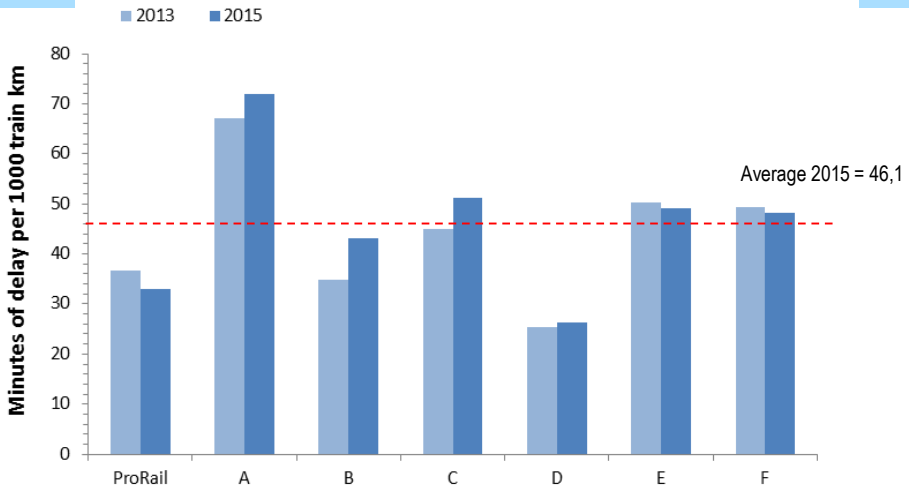
Interpretation:

- The total percentage of trains cancelled caused by the infrastructure manager has increased significantly in NL, from 22% to 37%
- D clearly has the highest percentage of train cancelled caused by the IM, but also shows a strong downward trend
- Excluding D from the average changes the average into 28,9%.

7.3 Delay minutes and repair time

ProRail's total minutes of delay per trainkm has decreased and stays below peer group average

1



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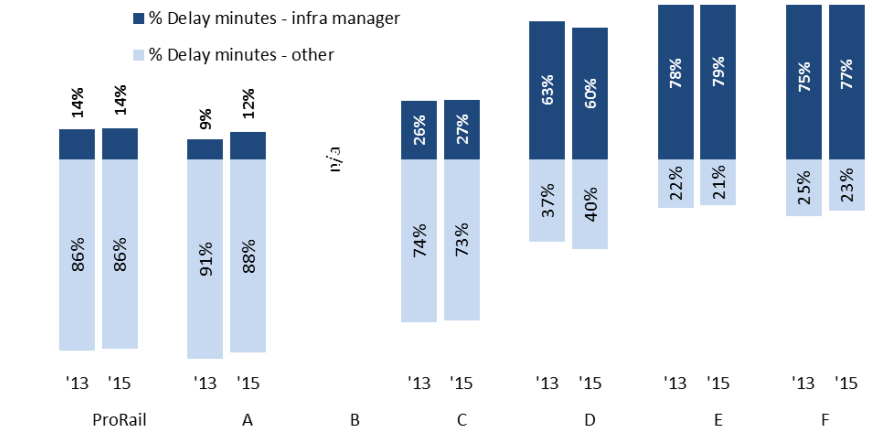

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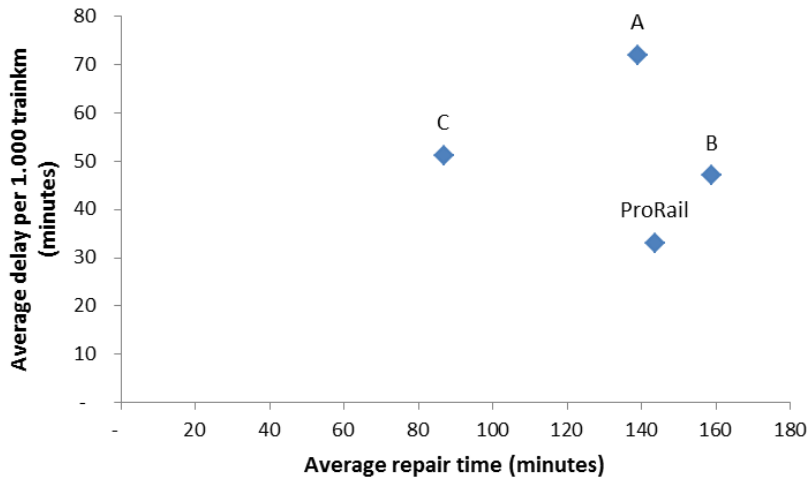


Interpretation:

1 Delay minutes relative to total trainkm at ProRail has decreased in the period 2013 – 2015 and is both below peer group average

- E and F also show a decrease in delay minutes per train kilometre
- The average without peer A changes into 42,4%

2 Delay minutes caused by the IM as a percentage of total delay minutes has remain constant at 14% at ProRail

- Most countries in the peer group show a stable percentage of delay caused by the IM
- NL and A have a relatively low percentage of delay caused by the IM compared to other peers

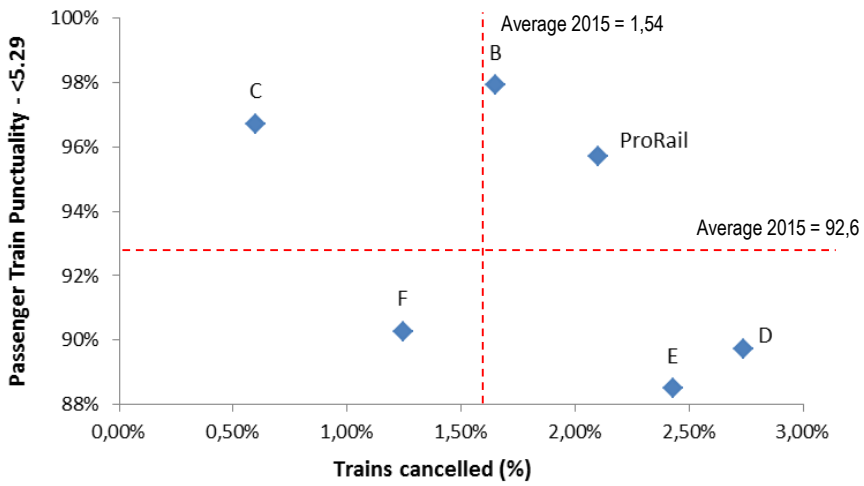
3 Despite relative long repair time per delay, average delay minutes at ProRail are relatively low compared to the peer group

* Reliable and comparable data are only available for the period 2013 - 2015

7.4 Punctuality vs. other variables (1/4)

NL scores high on total passenger train punctuality, but also on number of trains cancelled

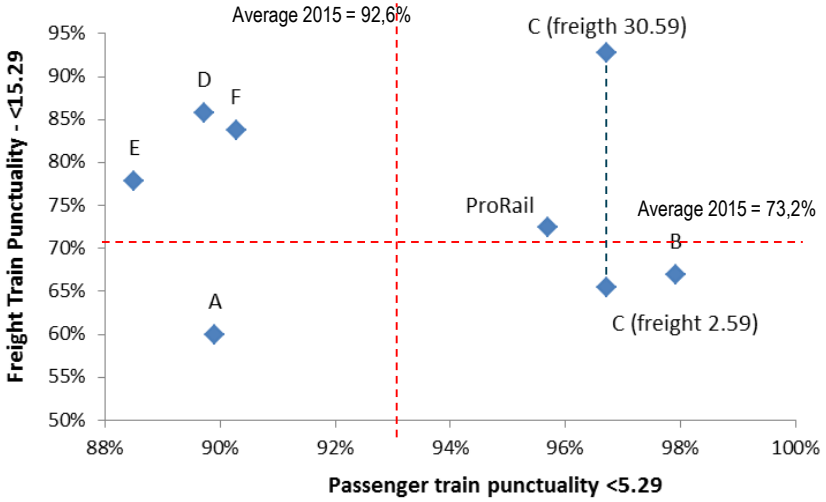
1



Interpretation:

- NL and B score high on total passenger train punctuality, but also on number of trains cancelled
- C scores good on both variables

2



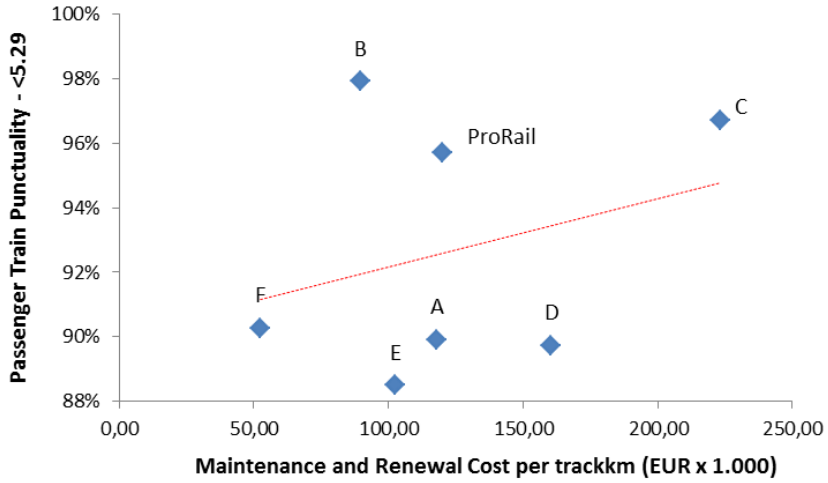
Interpretation:

- ProRail scores high on passenger train punctuality, but average on freight train punctuality
- D and F score high on freight train punctuality, but below average on passenger train punctuality

C's freight punctuality score is measured against a threshold of 31 or 3 minutes (instead of 15.29 min), and is therefore not comparable with the peer group. Both freight punctualities are shown in graph 2, the freight punctuality for C with a threshold of 15.29 lies between 3 min and 30 min.

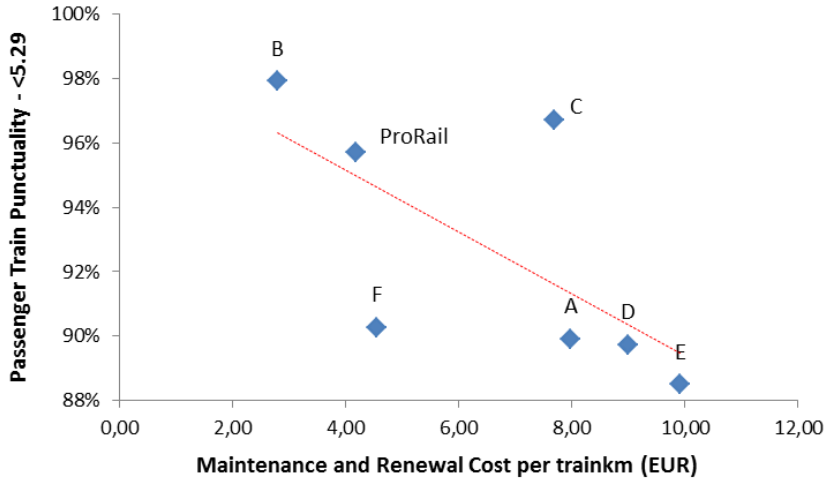
7.4 Punctuality vs other variables (2/4)

NL has high punctuality relative to Maintenance and Renewal cost per trainkm and trackkm.



Interpretation:

- NL has high punctuality relative to cost (maintenance and renewal - MRC) per trackkm
- B has highest punctuality combined with low cost per trackkm
- C has higher punctuality than NL, but also almost double the cost per trackkm
- F has lowest MRC cost per trackkm, but also a relatively low punctuality
- More cost benchmarking can be found in chapter 11

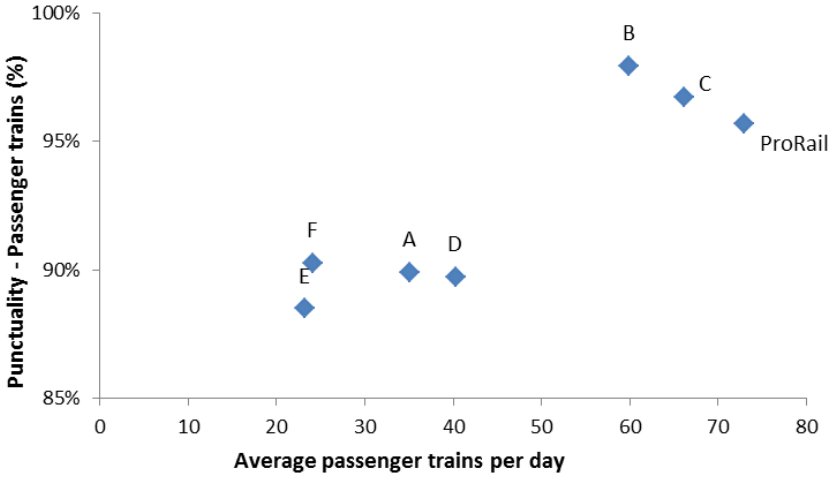


Interpretation:

- NL has high punctuality relative to average cost (maintenance and renewal - MRC) per trainkm
- C has higher punctuality, but also almost double the cost per trainkm
- B has high punctuality in combination with low cost per trainkm.
- A, D and E have relatively low punctuality, combined with high cost per trainkm

7.4 Punctuality vs other variables (3/4)

ProRail combines high network utilization with high passenger train punctuality

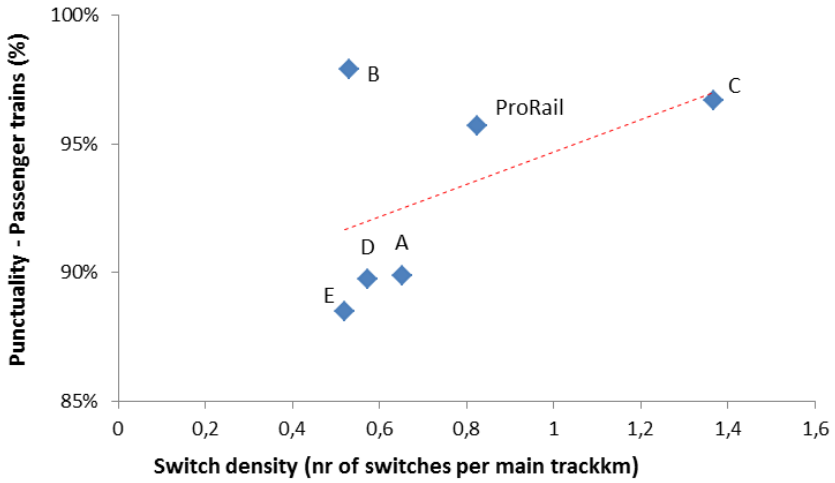


Interpretation:

- Average trains per day and punctuality seem to be negatively correlated, punctuality decreases when average trains increases.
- B, C and ProRail follow the same trend, only at a different level

7.4 Punctuality vs other variables (4/4)

NL combines high punctuality with moderate switch density



Interpretation:

- Trend between punctuality and switch density is positive
- Punctuality of NL and B is above the trend related tot switch density

8. Sustainability

Highlighted findings from NS and ProRail perspective

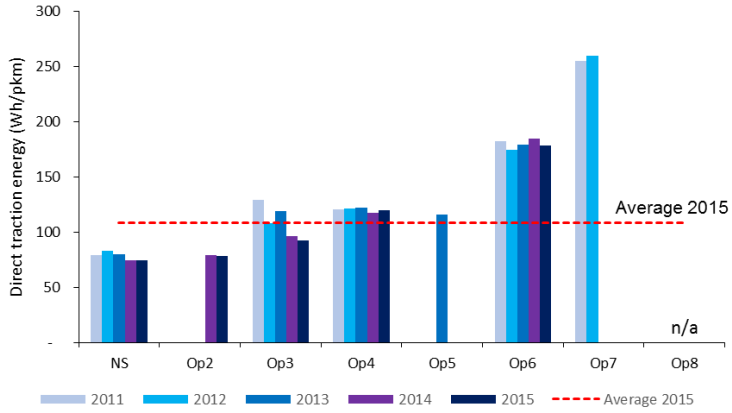
1. Introduction, context and methodology
2. Peer group
3. Rail network and stations
4. Asset characteristics
5. Safety
6. Attractive product for passengers and freight carriers
7. Reliability
8. Sustainability
    1. Energy usage
    2. CO_2 emission
    3. Electrification
9. Rail systemcapacity
10. Productivity
11. Financial performance

Appendices

8. Sustainability

NS shows high energy efficiency and low CO_2 emissions, both improving

1



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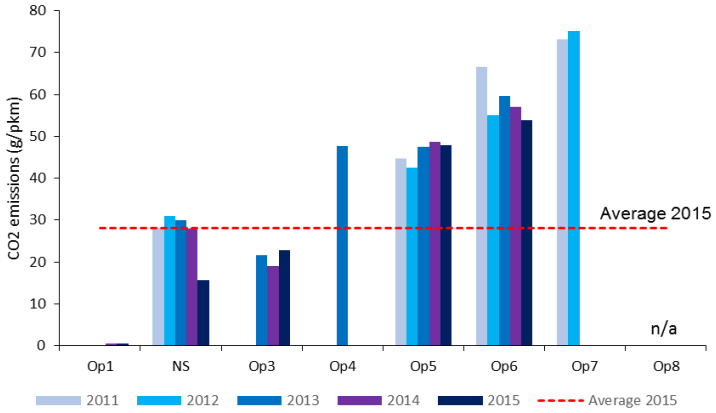

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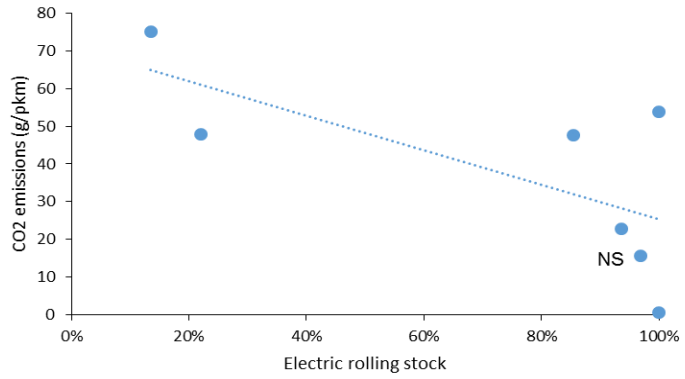


Interpretation:

1 NS has the lowest energy consumption per passengerkm; around 30% below average and declining

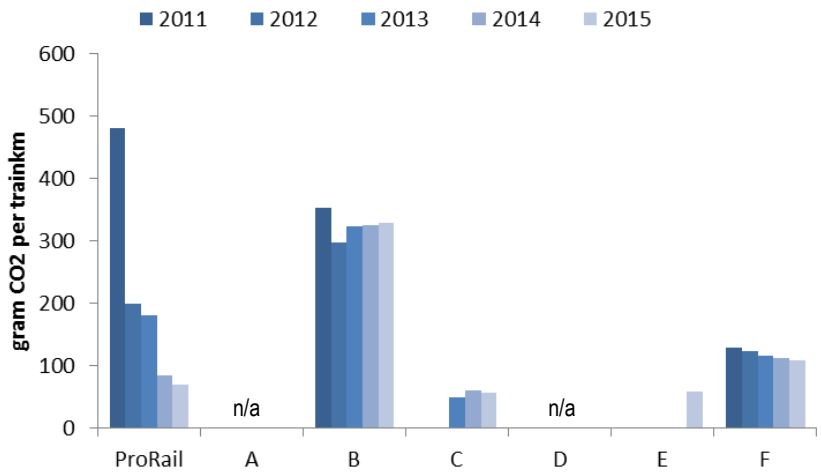
- Factors showing to improve energy efficiency and emissions :
  - High occupancy ratio
  - Electric rolling stock
  - Energy efficient driving programmes

2 NS has the lowest CO_2 emissions per passengerkm; around 44% below average and strongly declining due to sourcing of energy from renewable sources

- Factors showing to reduce CO_2 emissions:
  - Energy efficiency
  - Sourcing of energy; wind, hydro or nuclear sources

8. Sustainability

CO_2 footprint of ProRail decreased, mainly due to buying green energy



Interpretation:

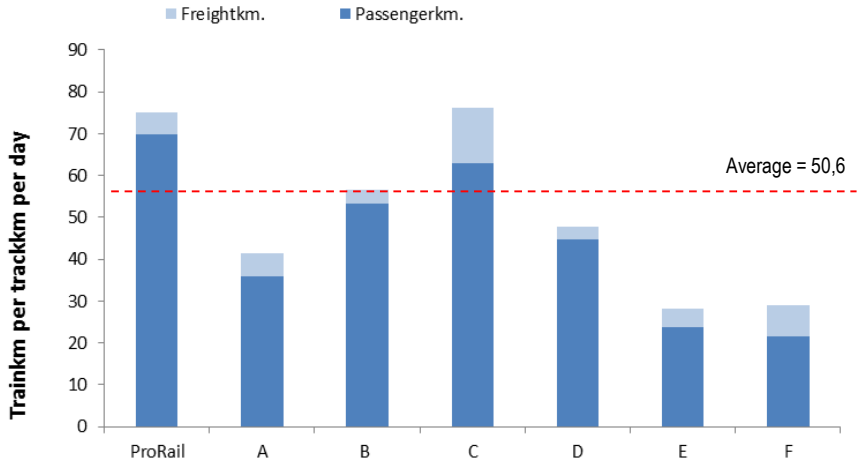
- Comparability of CO_2 footprint is difficult due to different in-/outsourcing strategies and the CO_2 emisions related with these activities.
- CO_2 footprint of ProRail has decreased a lot in the period 2011-2015, mainly caused by buying green energy.
- Not all Inframanagers have CO_2 emission data available. Peer C started in 2013 and peer E started in 2015 with keeping track of its CO_2 emission.

9. Rail system capacity

9. Rail system capacity

Trainkms and tonkms per trackkm are high at ProRail. Peer C and A have a bigger spread between lowest and highest utilised line than ProRail

1



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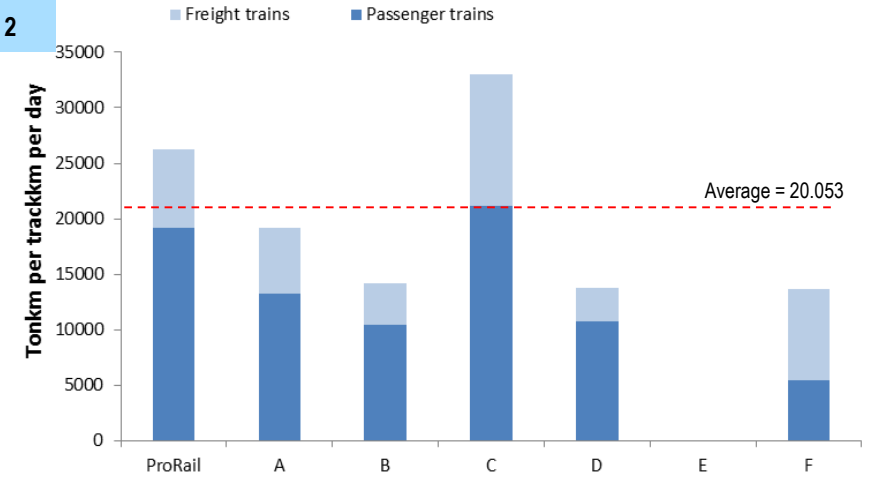

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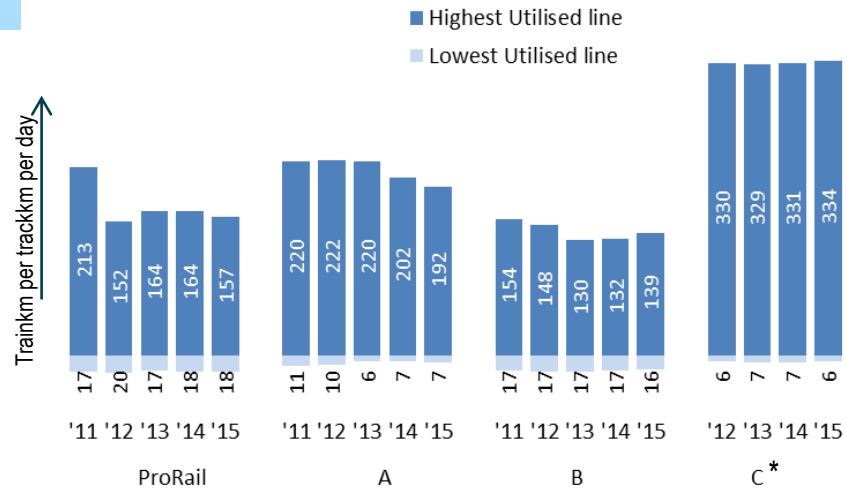


Interpretation:

1 ProRail and C have the most trainkms per trackkm per day

- C has the highest share of freight trainkm's

2 C has the most tonkm per trackkm per day

- ProRail also scores above peer group average

3 C has the lines with highest utilization; more than double the utilization of the most utilized line at Prorail in 2015

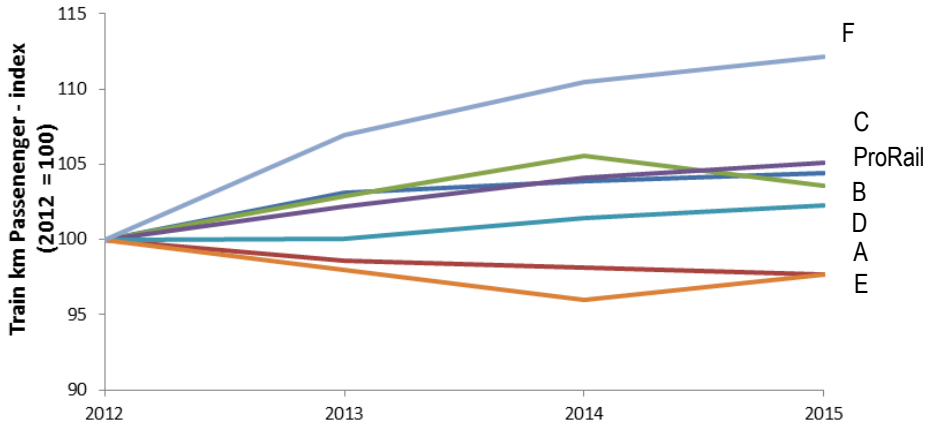
- Lowest utilized line at ProRail has more than double the utilization of the lowest utilized line of C

* C has no data for 2011

9. Train kilometres - passenger

ProRail shows 4.5% growth in total passenger kilometres in period 2012 – 2015. Passenger kilometres per trackkm are stable

1



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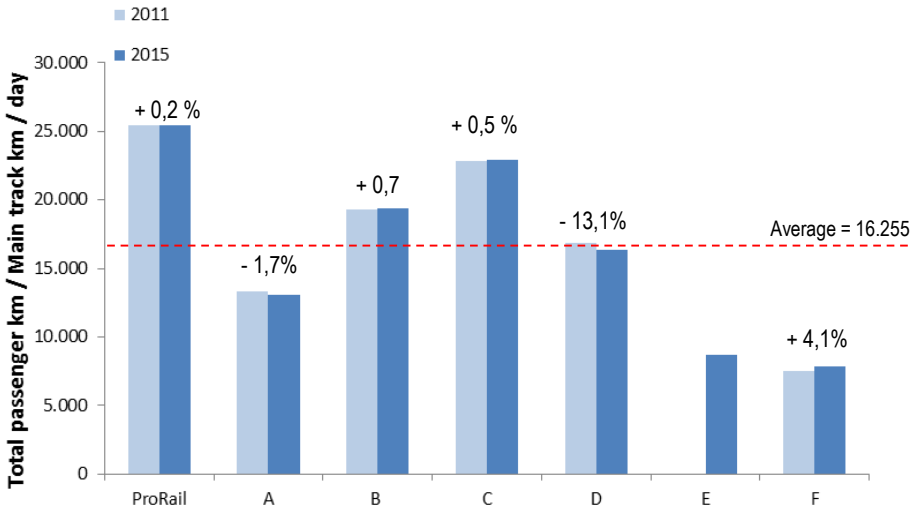


Interpretation:

1 ProRail shows a 4,5% growth in passenger kilometres in the period 2012 – 2015

1 C and F show a larger increase

2 Relative to the total length of the main track, NL shows a 0,2% increase in the total number of passenger kilometres

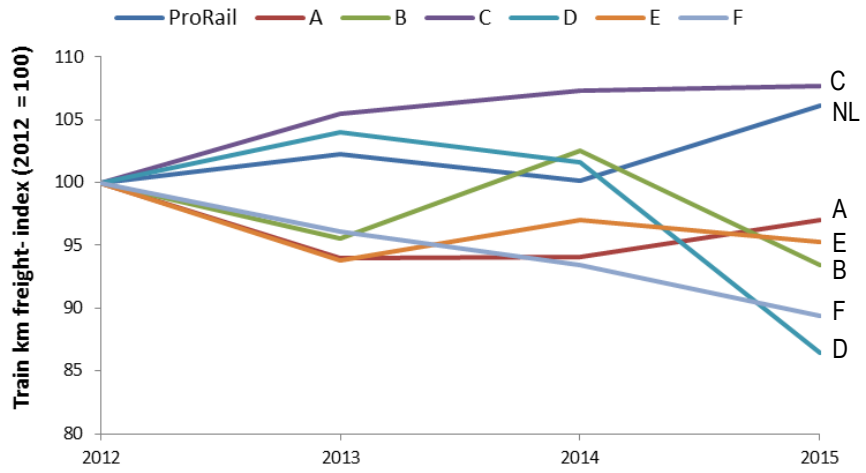
2 F shows a significant increase in total passenger kilometres relative to total main track kilometres

2 NL, B and C have a higher ratio of total passengers per main track kilometre than the peer group average

9. Train kilometres - freight

ProRail freight kilometres increased by 6%. Freight trainkm per trackkm still below peer group average

1



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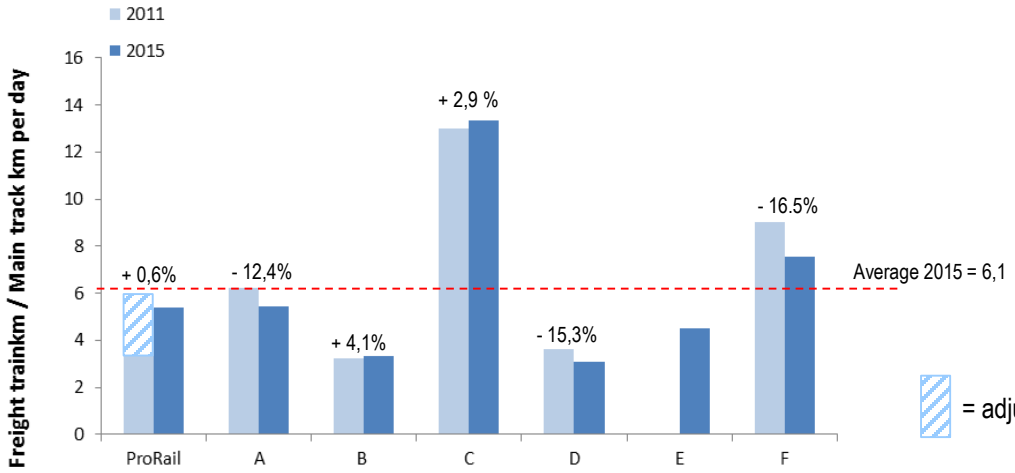


Interpretation :

1 ProRail shows an increase in total freight train kilometres of 6% in the period 2012 – 2015.

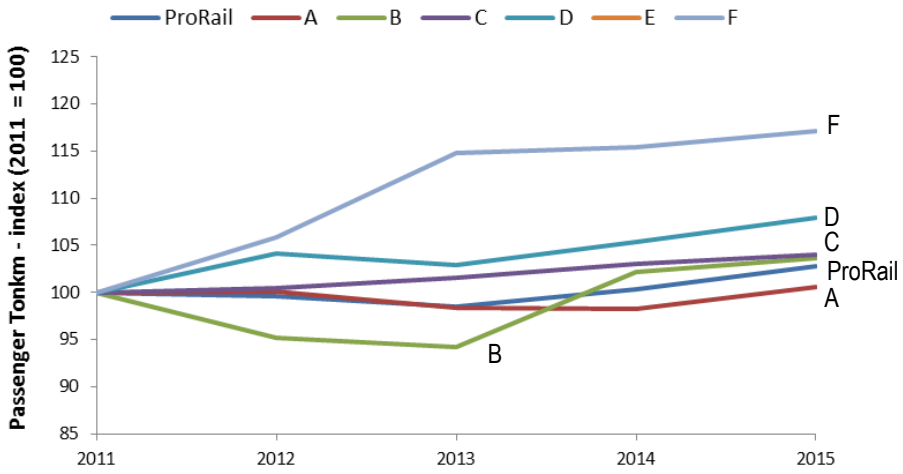
2 Relative to total main track kilometres, ProRail freight kilometres score slightly below peer-group average

- C clearly has the most freight kilometres per main track kilometre of the peergroup
- The average without peer C drops to 4,9
- No clear trend is visible for the entire peer group

9. Tonkilometres - passenger

Passenger tonkilometres relative to main track kilometres are above peergroup average and have increased

1



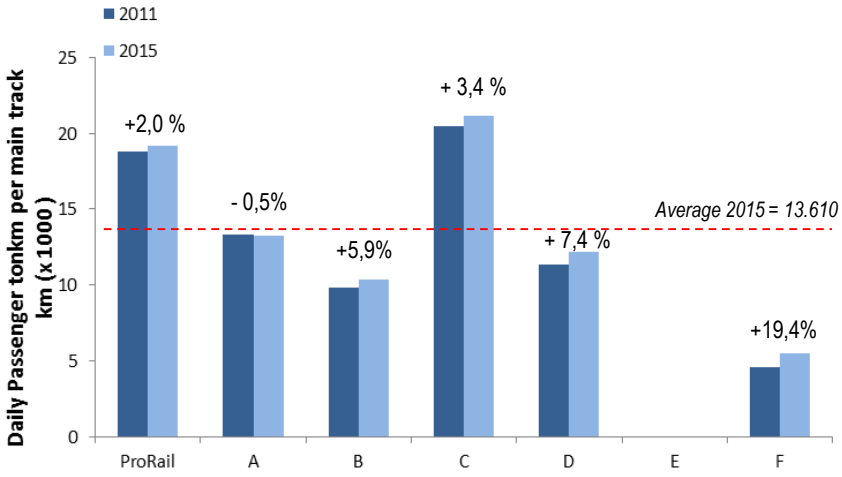
Interpretation:

1 Passenger tonkm shows a relative stable trend in the peer group. Only F shows a marked increase of 17%

1 ProRail increase of passenger tonkilometres is modest with 4%

2 Relative to total maintrack kilometres, the daily passenger tonkilometres has increased by 2% at ProRail between 2011 and 2015

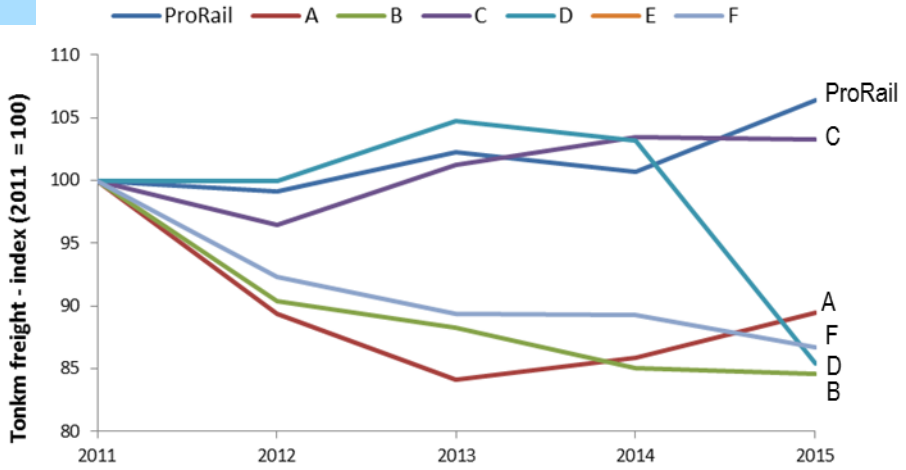
2



9. Tonkilometres - freight

NL shows a increase in absolute and relative freight tonkm.

1



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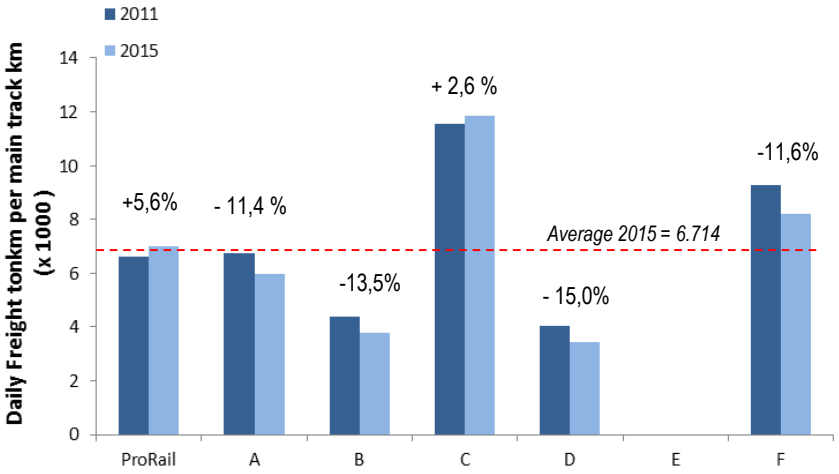

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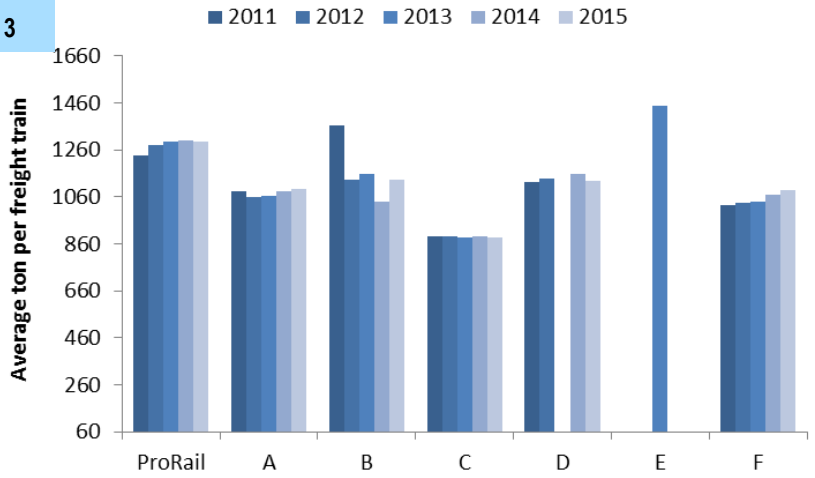


Interpretation:

1 ProRail shows an increase in freight tonkm in 2015 compared to 2011

- Peer group shows a trend towards less freight tonkilometres or stability

2 Daily freight tonkilometres per main track kilometre increased by 5% at ProRail, and is on peer group average in 2015

- C clearly shows highest freight ton kilometres per main trackkm in the peer group

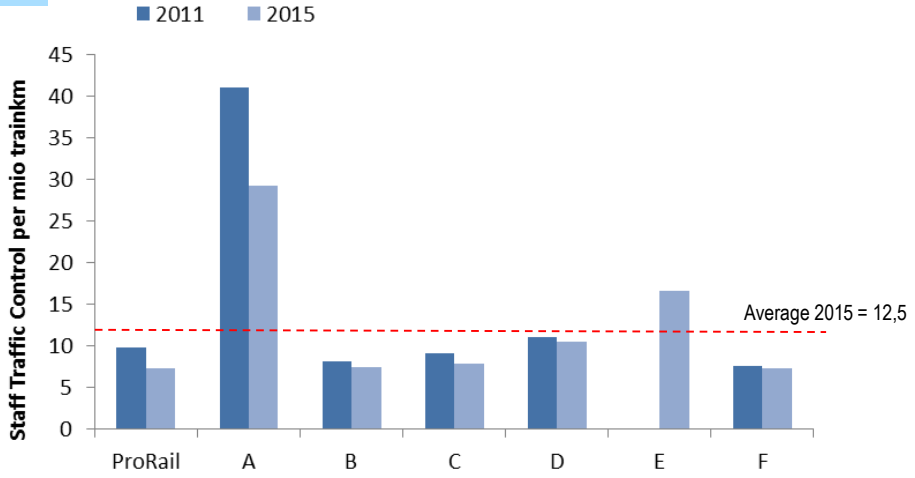
3 Average ton per freight train at ProRail higher than peers, besides peer E

10. Productivity

10.1 Staff Productivity – ProRail

Average number of Traffic Controllers per train- and trackkm at ProRail has decreased. Overall staff costs are high compared to some peers, mainly due to outsourcing of “blue collar” work

1



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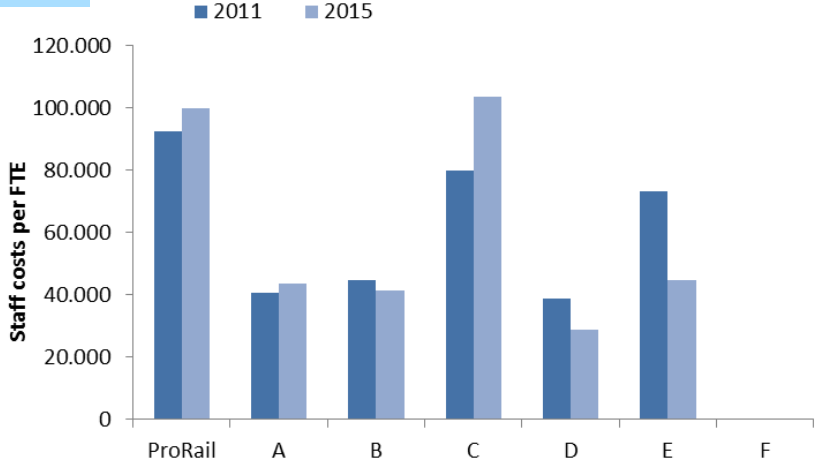

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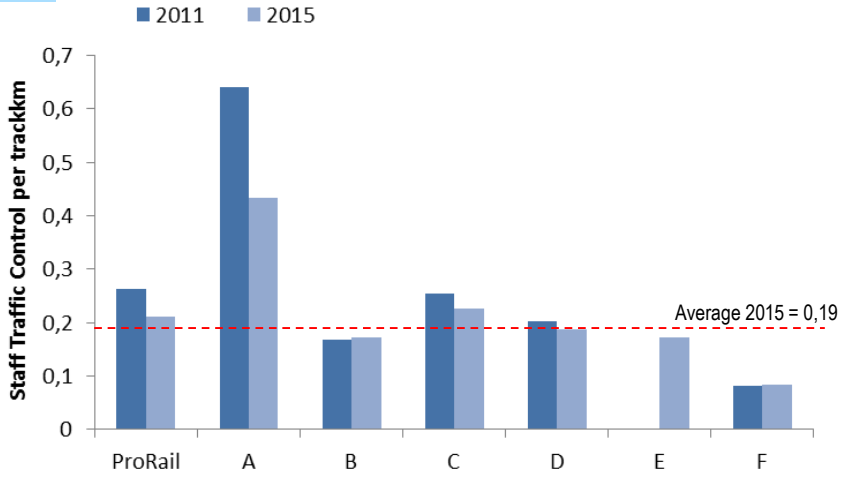


Interpretation:

1+3 Staff Traffic Control per trainkm is below peer group average, while per staff Traffic Control per trackkm is just above peer group average. The average changes into 11,5 and 0,17 if peer A is not taken into account.

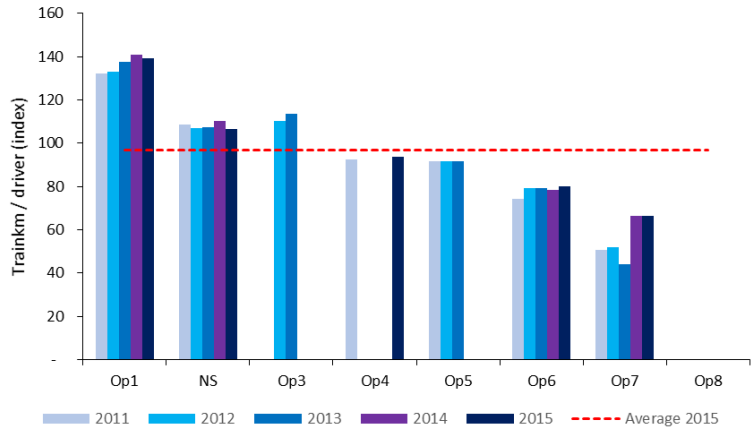
1 All peers show a decreased in Staff Traffic Control per trainkm in 2015 compared to 2011

2 Staff Costs per FTE are harmonised to euro and adjusted for PPP differences.

2 Due to differences of outsourcing strategies staff costs are not comparable, staff costs tend to be low if maintenance work is done in-house

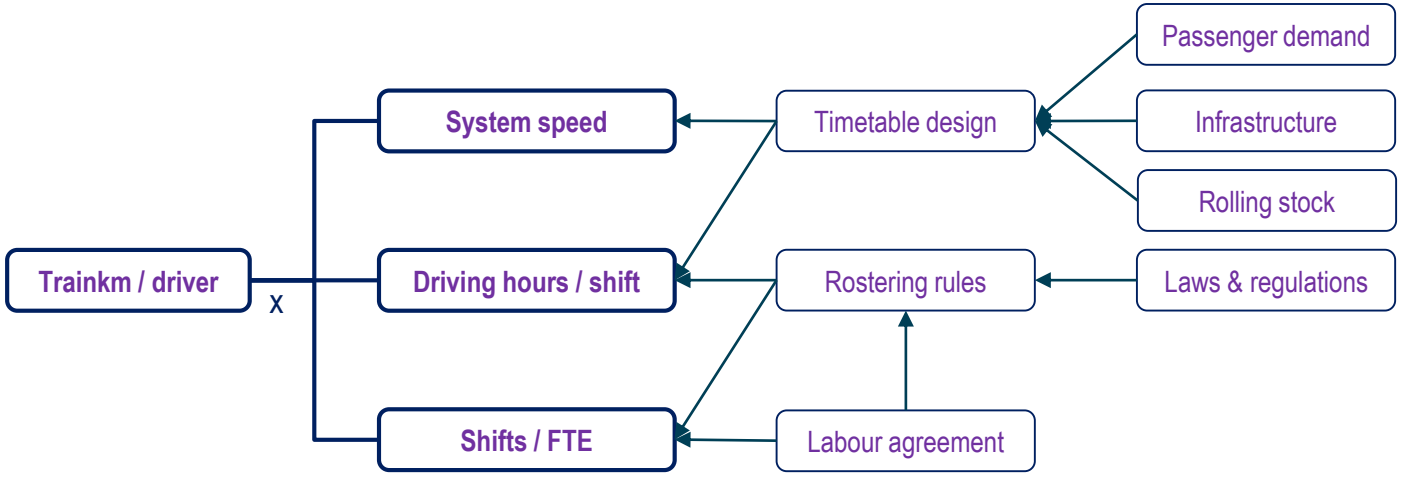
10.2 Staff productivity NS – train staff

NS drivers drive 10% above average trainkm, partly due to timetable design and system speed



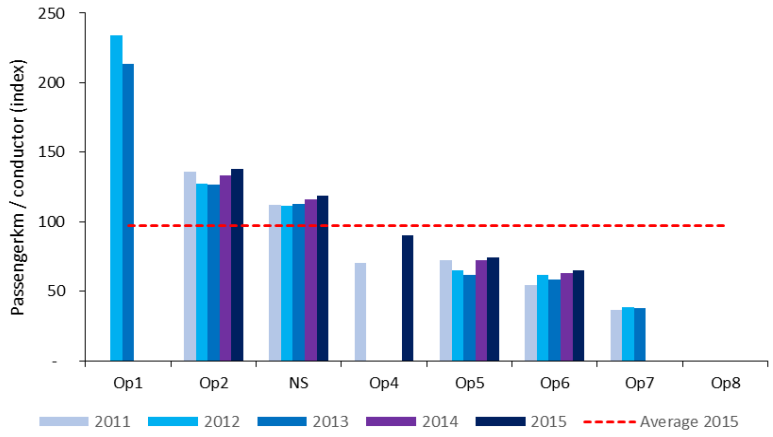
Interpretation:

- NS drivers drive 10% more trainkm than the average of the peer group
- Factors that are driving this productivity:
  - System speed (timetable, infrastructure, rolling stock)
  - Optimized rostering (timetable, rostering tools)
  - Contract hours per week
- The comparison has been corrected for the number of contract hours, not for system speed, due to missing data
- Most operators show fairly stable productivity due to the structural character of most productivity driving factors.



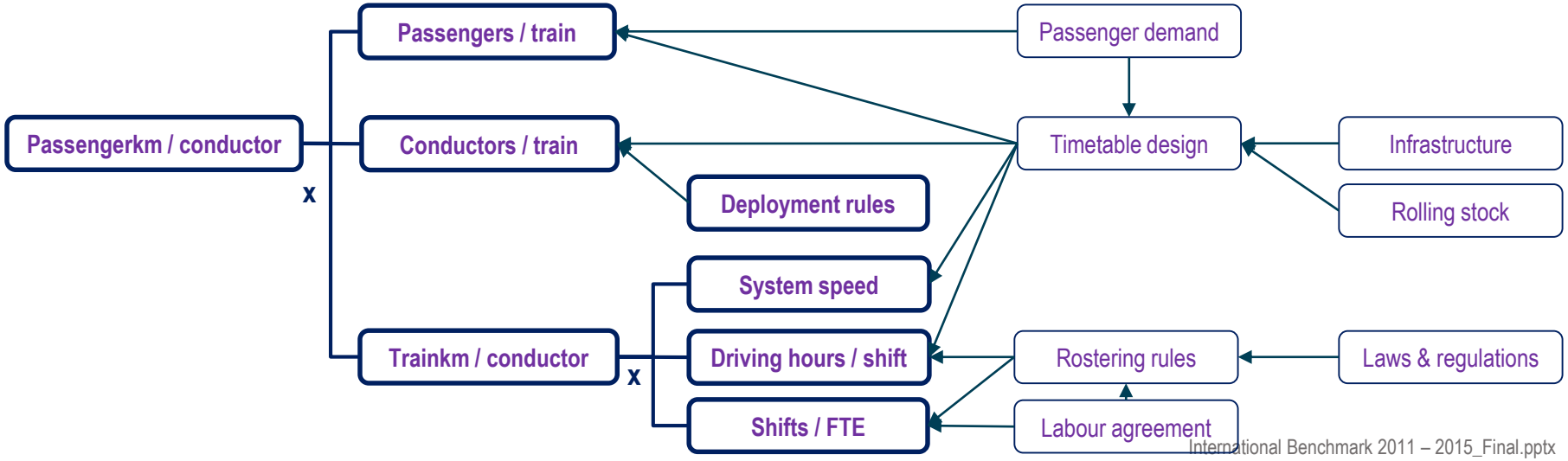
10.2 Staff productivity NS – train staff

NS conductors handle 18% more passengerkm than average, influenced by a large number of factors



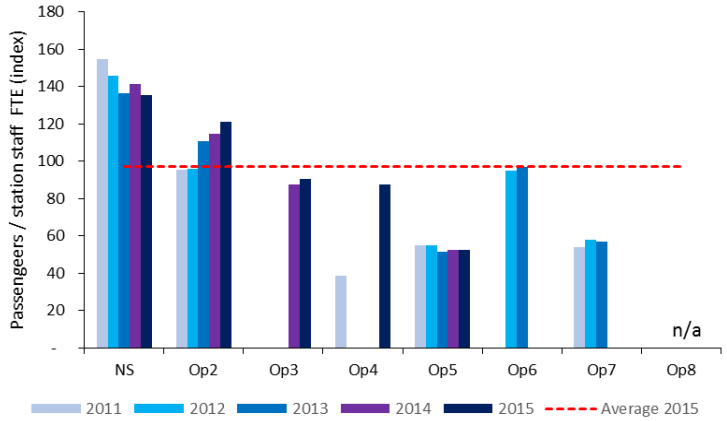
Interpretation:

- NS conductors handle 18% more passengerkm than average of the peer group
- Factors that are driving this productivity:
  - Tasks of conductor (safety, security, service, revenue protection)
  - Number of passengers per train; average train length and even distribution of passenger demand
  - Deployment rules (number of conductors per train)
  - Timetable: system speed, turnaround times, reducing train length and/or frequency in off-peak hours
  - Contract hours per week
- The comparison has been corrected for contract hours, not for system speed, due to missing data



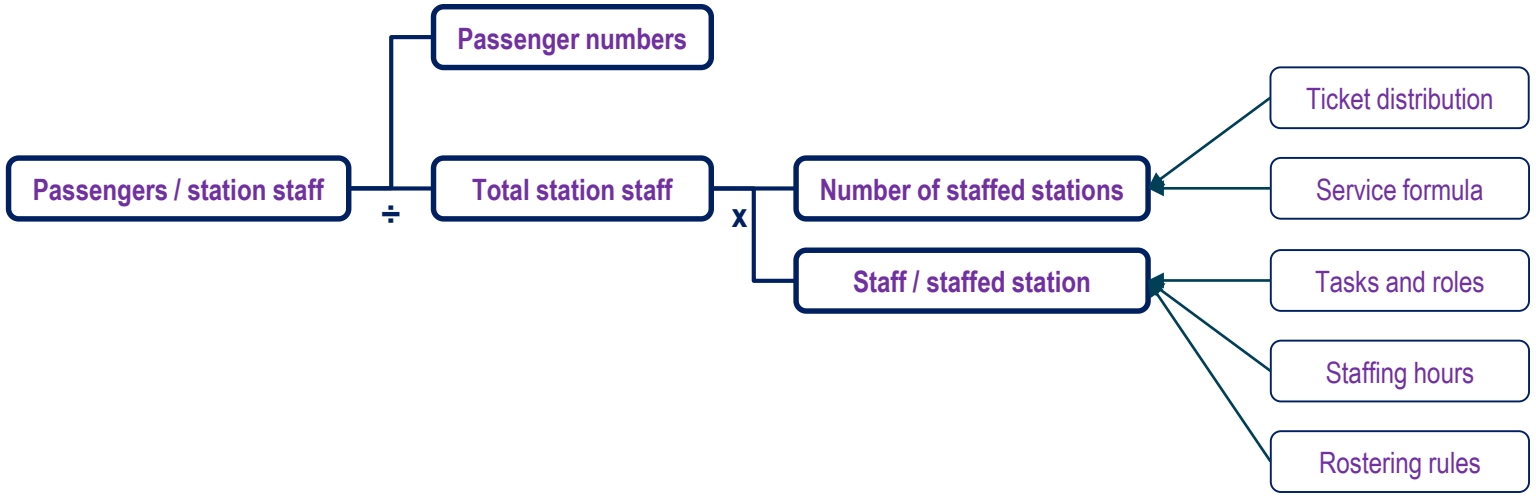
10.2 Staff productivity NS – station staff

NS station staff shows a significantly higher productivity than the average of the peer group



Interpretation:

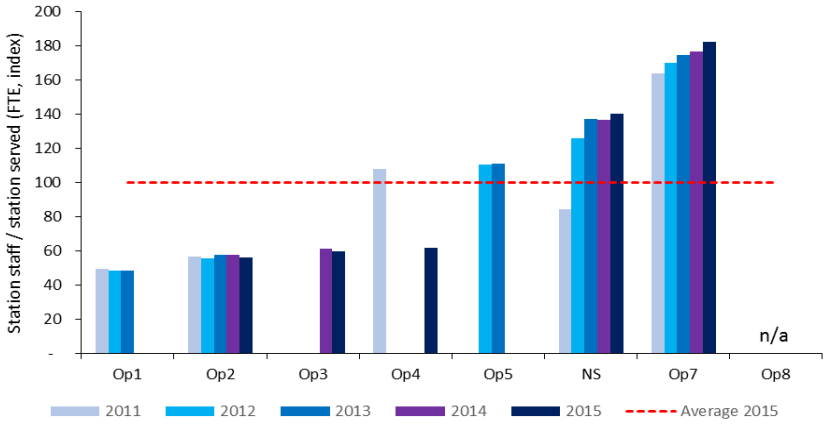
- NS station staff serve 35% more passengers per FTE than the average of the peer group
- Factors that are driving this productivity:
  - Intensity of use of the stations (passengers / station)
  - Number of staffed stations, staffing rules and staffing hours
  - Ticket distribution (e.g. ticket machines, smart cards)
  - Tasks and roles of station staff (e.g. sales, customer service, passenger information, assistance of PRM, station management, etc)
  - Contract hours and rostering rules of staff



10.2 Staff productivity NS – station staff

NS stations and staff shows a significantly higher productivity than the average of the peer group

1



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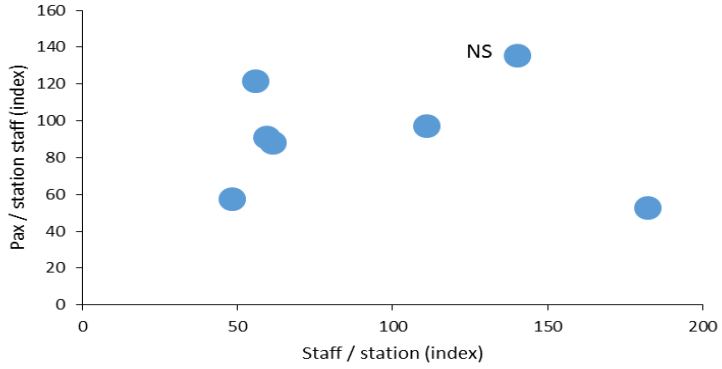


Interpretation:

1 NS stations have 40% more staff per station than average of the peer group

2 NS station staff serve 35% more passengers per FTE than the average of the peer group

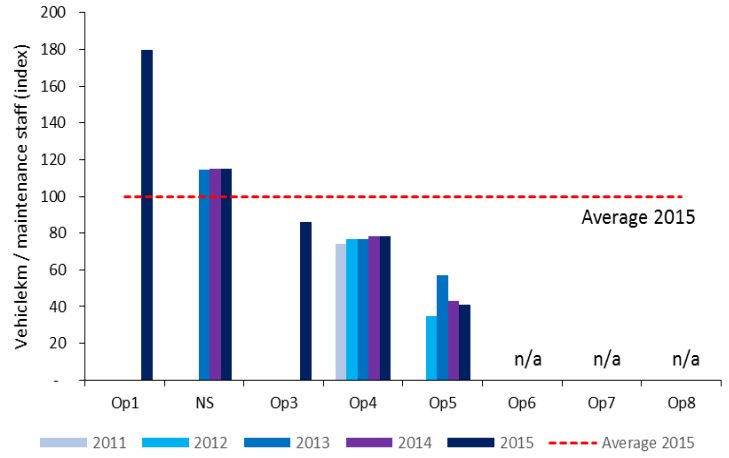
- Factors that are driving this productivity:
  - Number of passengers per station
  - Sales and distribution (e.g. ticket machines / smart cards)
  - Staffing rules and staffing hours of stations
  - (Combining) tasks and roles of station staff

- NS serves a network of intensively utilized stations (on average 2,6x the average number of passengers per station of the peer group)

10.2 Staff productivity NS – rolling stock maintenance staff

Productivity of NS rolling stock maintenance staff is above the average of the peer group

1



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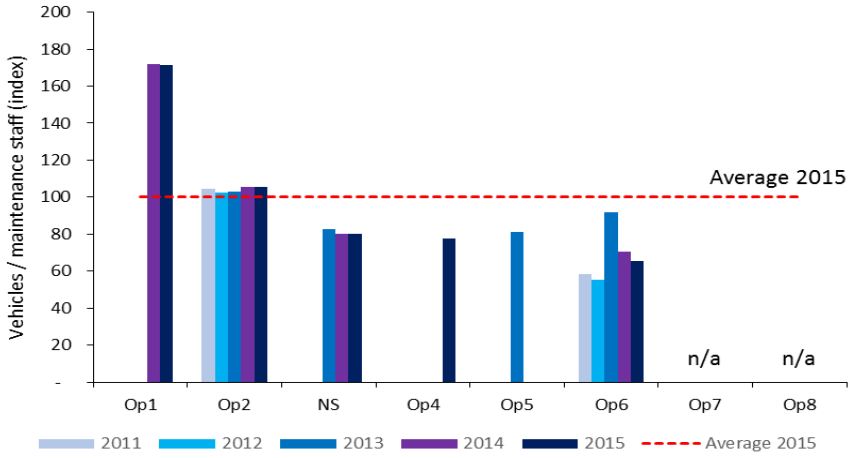
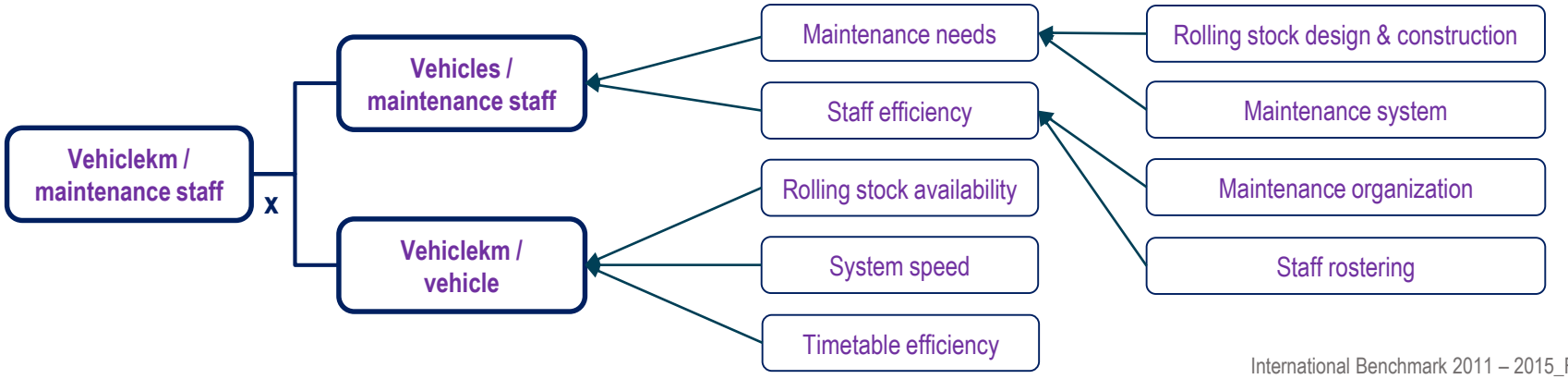


1 Productivity of NS rolling stock maintenance staff is 15% above average (vehiclekm/staff).

- However these comparisons does not account for the level of outsourcing of maintenance

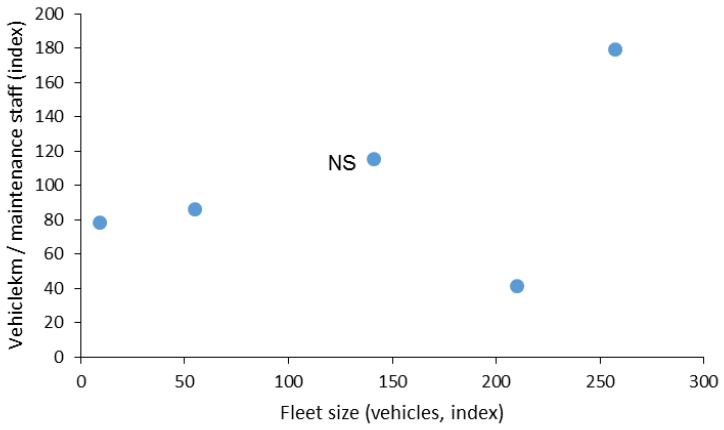
2 NS' number of vehicles per maintenance staff is below average, but the fleet is used intensively.



10.2 Staff productivity NS – rolling stock maintenance staff

Factors driving productivity of rolling stock staff show a mixed picture

1



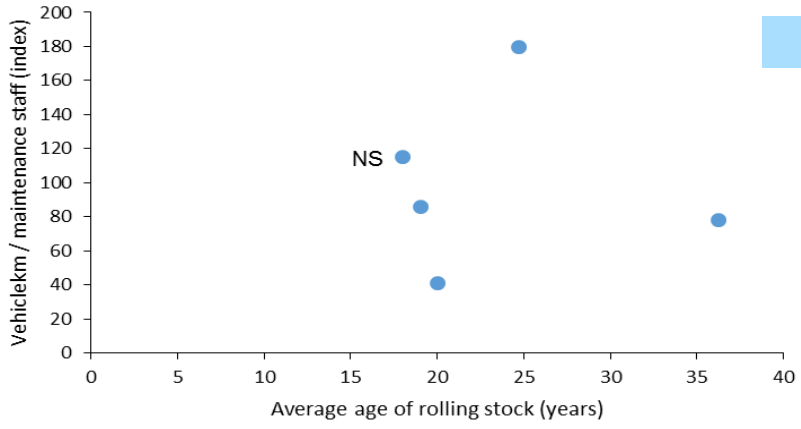
Interpretation:

- Productivity of rolling stock maintenance staff may be related to intensity of use, economies of scale, level of outsourcing, age of rolling stock, electrification, number of rolling stock types, etc.
- There are differences in the level of outsourcing of the operators, specially concerning heavy maintenance. However there is no data available on the level of outsourcing. Therefore no definitive conclusions can be drawn from these comparisons.

1 There is an indication of economies of scale in rolling stock maintenance

2 + 3 Other factors (average fleet age, electification) show less clear impact on productivity of maintenance staff.

2



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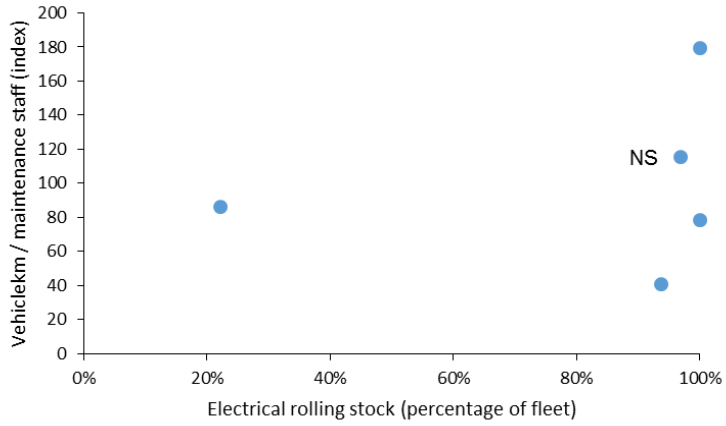
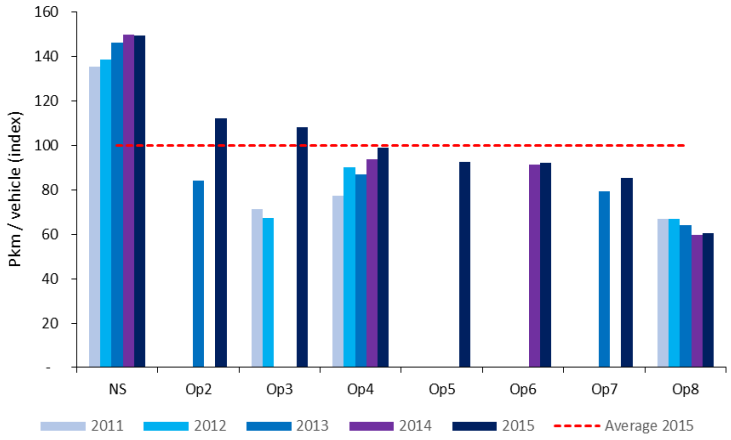


10.2 Asset productivity NS – rolling stock

Productivity of NS rolling stock is around 50% above average, both in terms of passengerkm / vehicle as per seat

1



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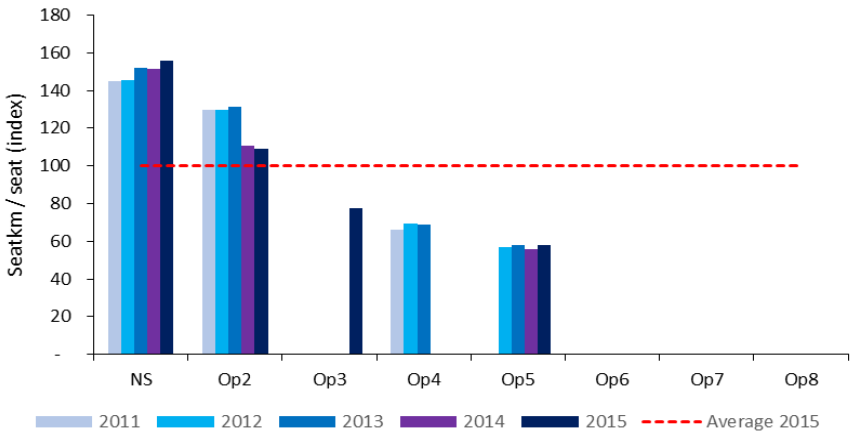

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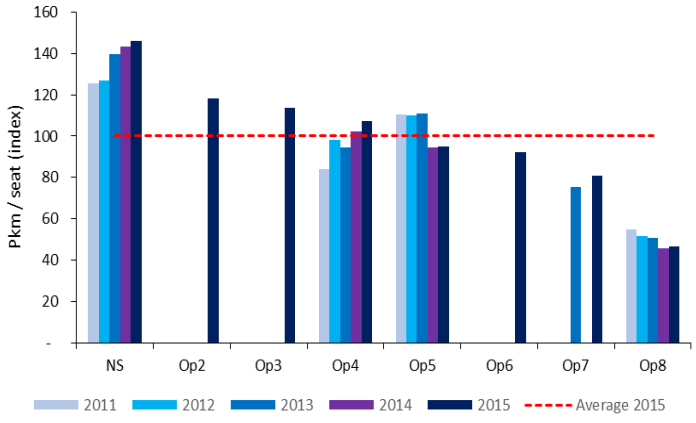


Interpretation:

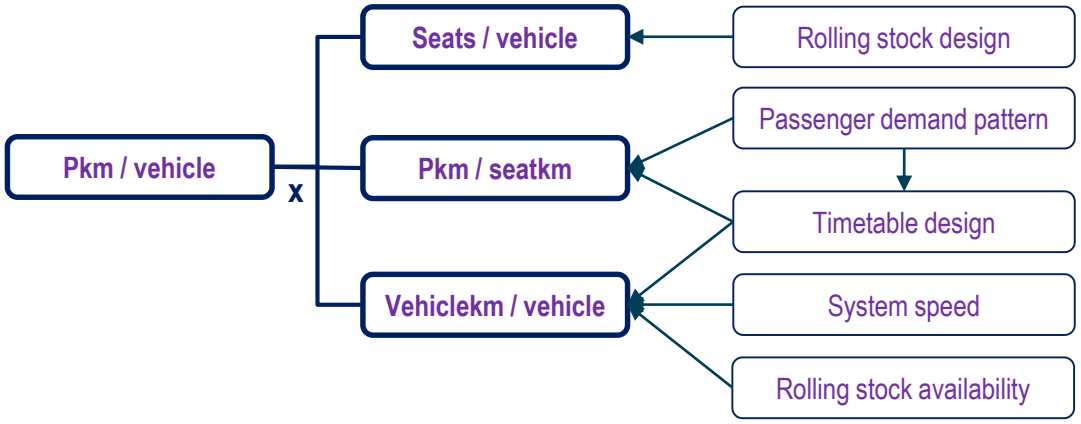
1 + 3 Productivity of NS rolling stock is around 50% above average, both in terms of passengerkm / vehicle as per seat

2 Seatkm / seat is 56% above average, indicating efficiency of timetable and rolling stock maintenance as main driving factors.

1+2+3 All indicators of rolling stock productivity at NS are rising significantly

10.2 Asset productivity NS – rolling stock

Productivity of rolling stock is driven by demand pattern, timetable design and rolling stock availability



Interpretation:

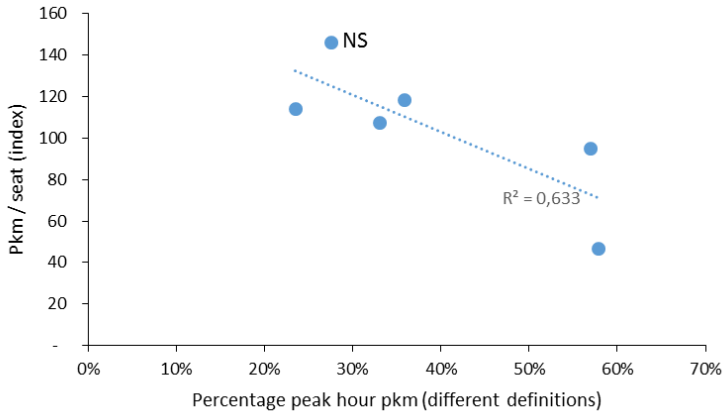
- Factors driving rolling stock productivity are:
  - Occupancy ratio of seats
  - Even demand pattern (geographical distribution and peak hour%)
  - Timetable (system speed and diagramming)
  - Rolling stock availability

1 NS has evenly distribution of demand, allowing for higher productivity of rolling stock.

- However different definitions of peak hours limit the conclusions that can be drawn.

2 NS supplies a high number of seatkm per seat due to high availability and timetable design (system speed, turnaround times)

1



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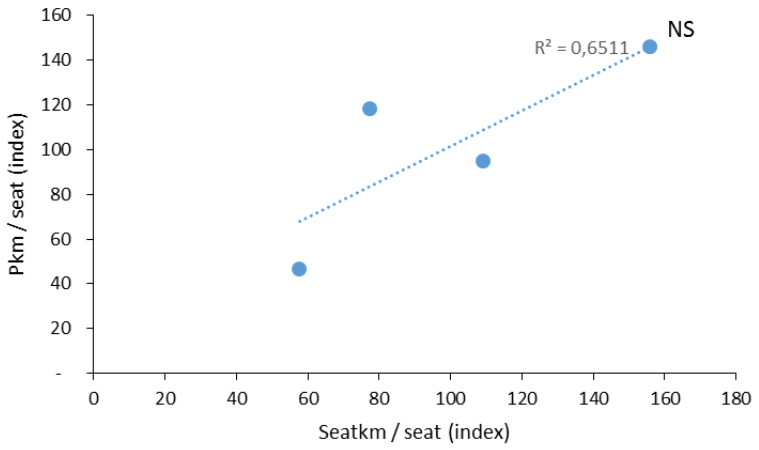
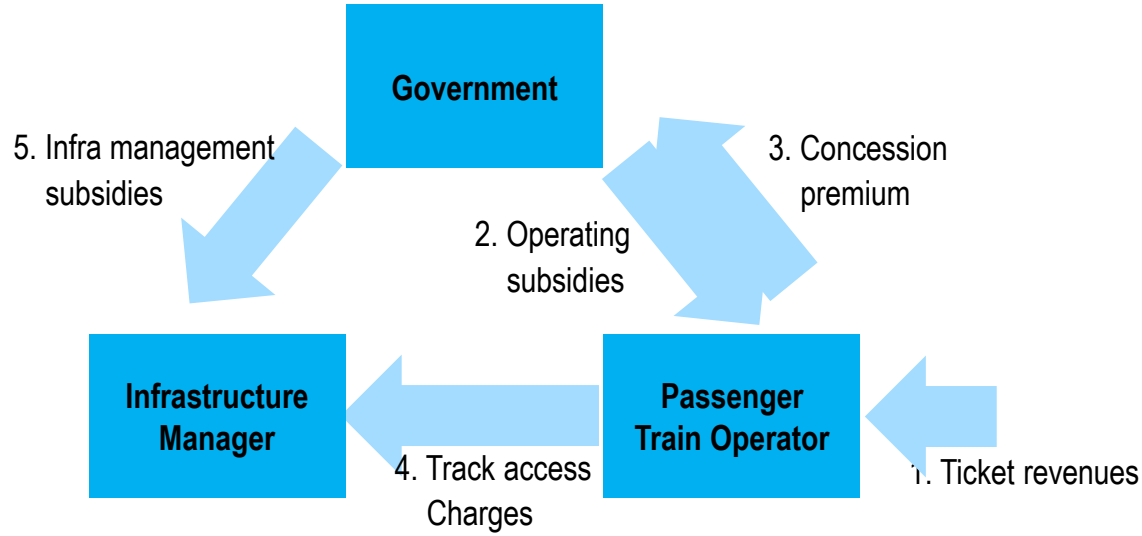


11. Financial performance

11.1 Financial performance of passenger operations

A comparison of financial performance should include all relevant financial flows

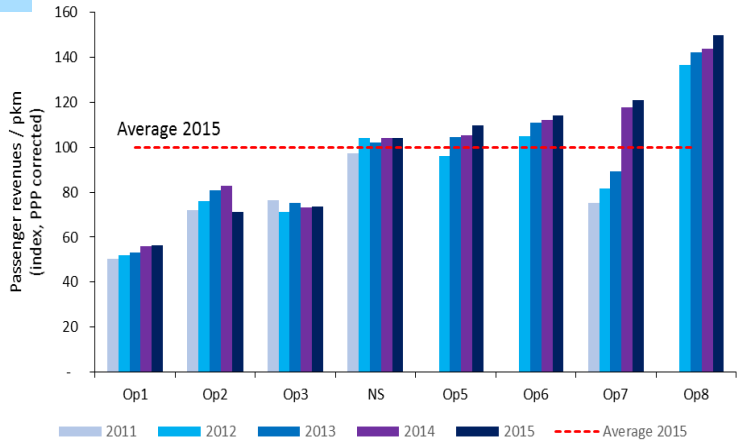


- The total ticket revenues (1) divided by the total number of passengerkm indicates the **cost level for passengers**
- The total operating subsidies (2) minus the concession premium (3) and minus the track access charges (4) indicates the total level of **net public funding** for the passenger train **operator**.
- The sum of ticket revenues (1) and net public funding (2. – 3. – 4.) indicates the **net costs** of the passenger train **operator**.
- The sum of operating subsidies (2) and infra management subsidies (5) minus concession premium (3) is a measure for the total public funding of the railway industry. Due to differences in operational situation (e.g. multiple passenger and freight operators) this comparison can not included in this benchmark.
- The scope for this operations funding excludes funding of investments (e.g. infrastructure, stations and/or rolling stock).
- All financial comparisons are excluding VAT and corrected for purchasing power parities as described in Appendix B.

11.1 Financial performance of passenger operations

NS has average fare levels and low public funding

1



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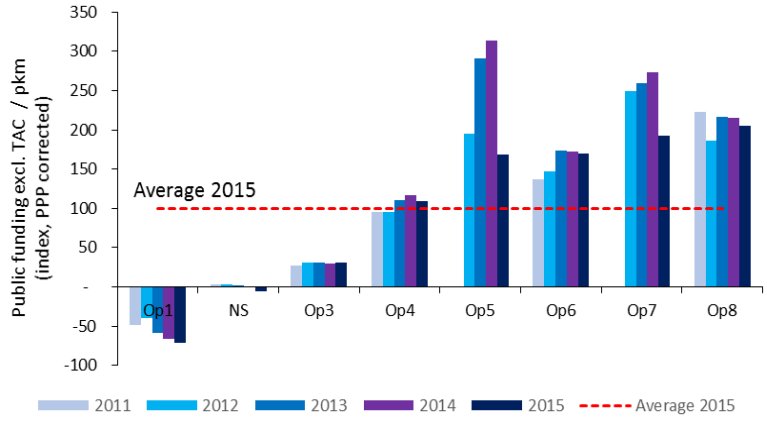

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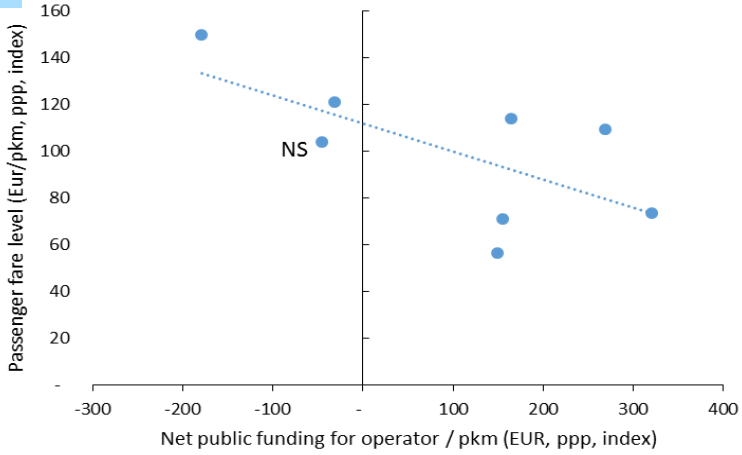


Interpretation:

1 Average fare levels for passengers are around average and relatively stable (€ / pkm).

- However there are differences in VAT regimes for train fares between the peers.

2 NS and Op1 pay a franchise premium,other operators receive subsidies.

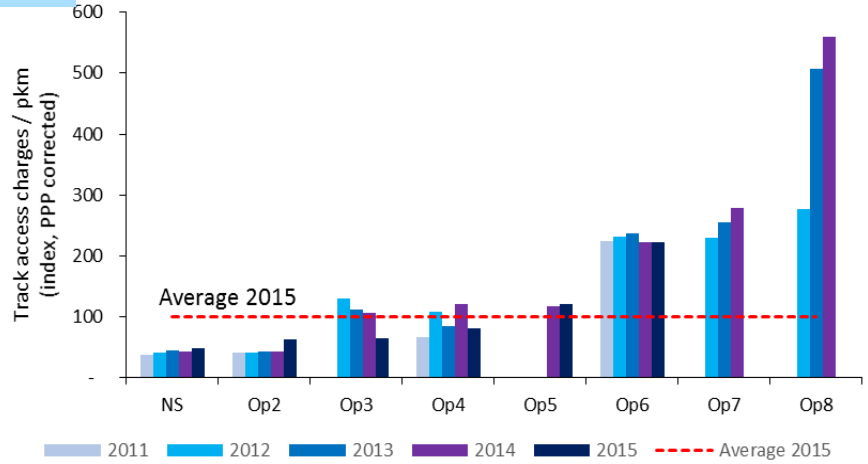
3 Net public funding for NS is negative (subsidy – franchise premium – track acces charges

- Higher net public funding correlates with lower average costs for passengers

11.1 Financial performance of passenger operations

NS' track access charges are lowest of the peer group while net public funding is low

1



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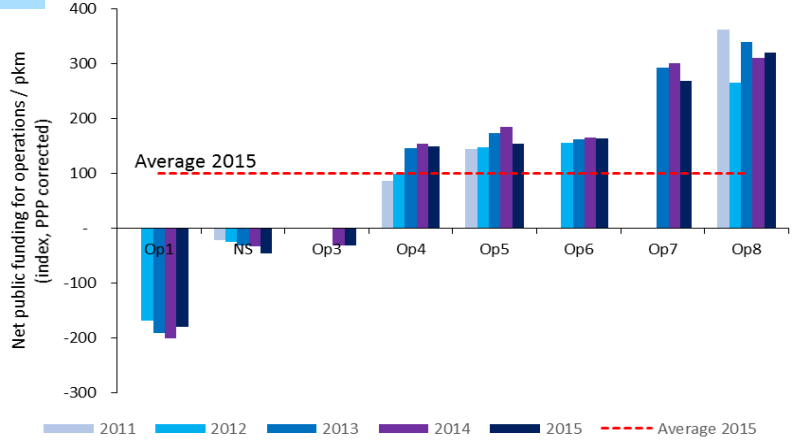

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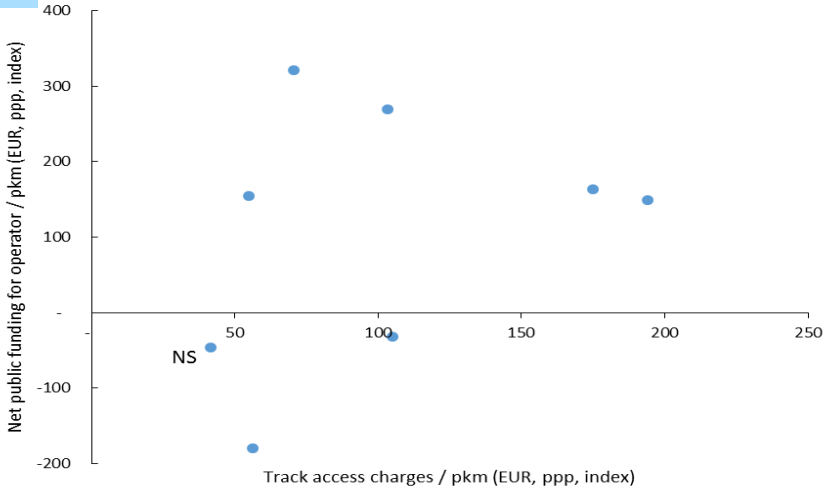


Interpretation:

1 Track access charges for NS are the lowest of the peer group, partly due to the high number of passengers per train.

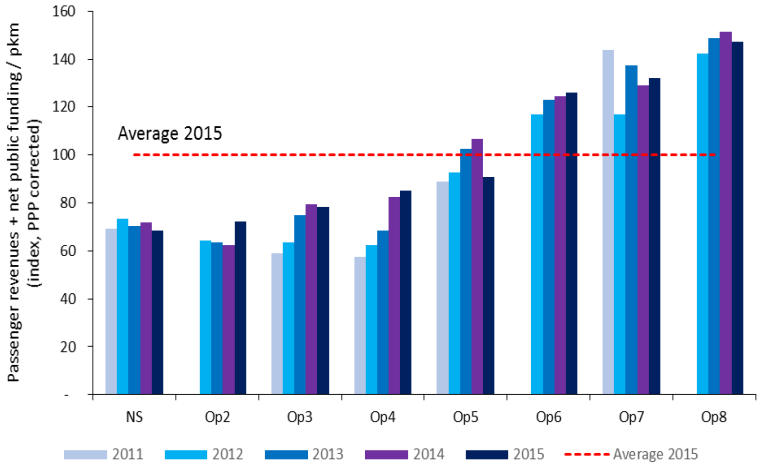
2 Net public funding (subsidy – franchise premium – track acces charges) for NS is negative.

3 There seems to be no clear correlation between average net public funding and the average height of the track access charges.

11.1 Financial performance of passenger operations

NS' total net revenues per passengerkm are 30% below average of the peer group

1



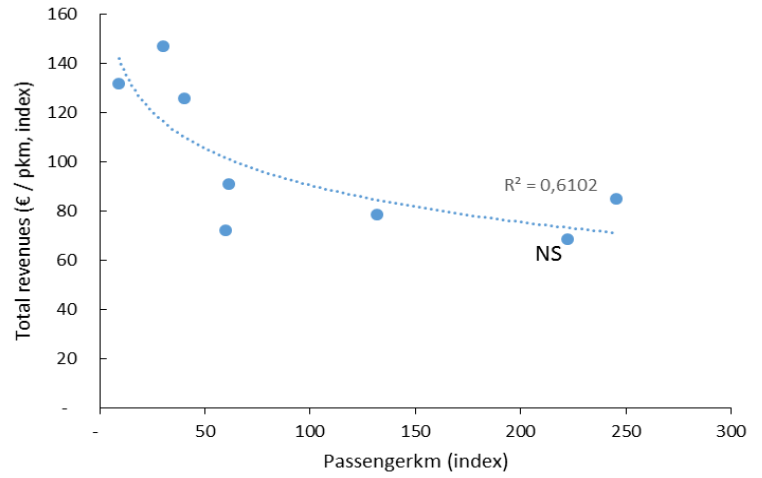
Interpretation:

1 Total net revenues for operator (passenger revenues + net public funding) for NS is lowest in the peer group; 30% below the average

2 + 3 Comparing net revenues per passengerkm with total passengerkm and average passengers per train indicates a degree of economies of scale (total passengerkm) and economies of density (average passengers / train)

The average travel distance also has some impact on the total cost level, but less clear so.

2



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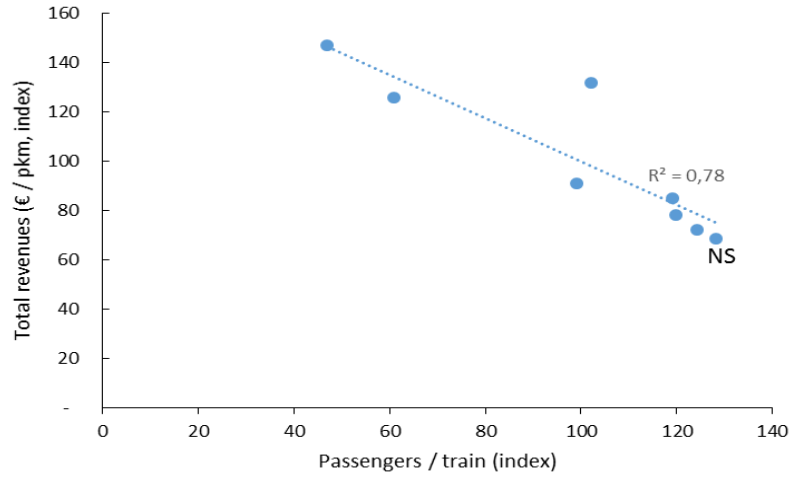
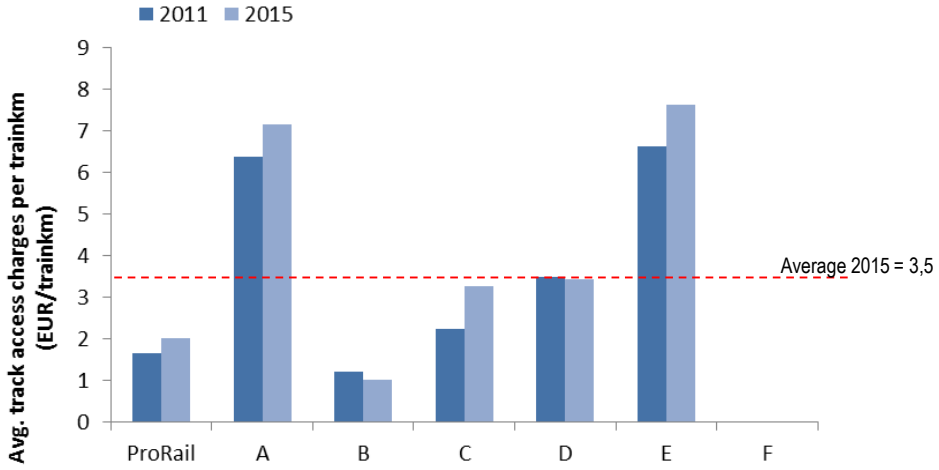
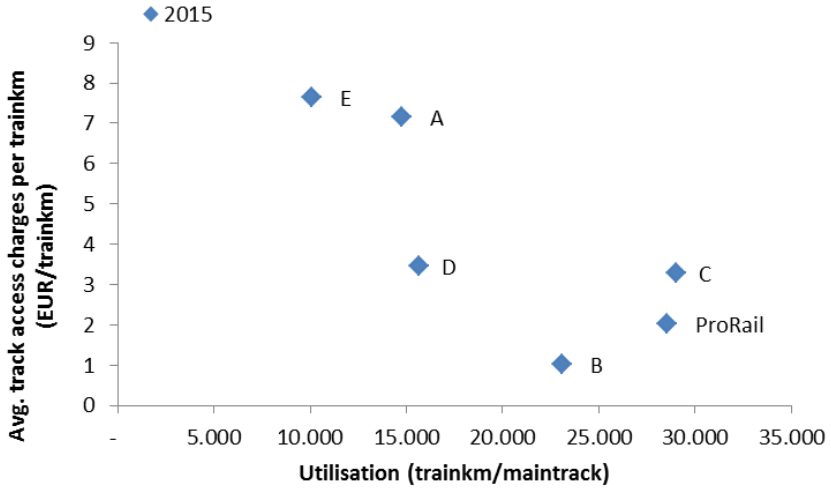
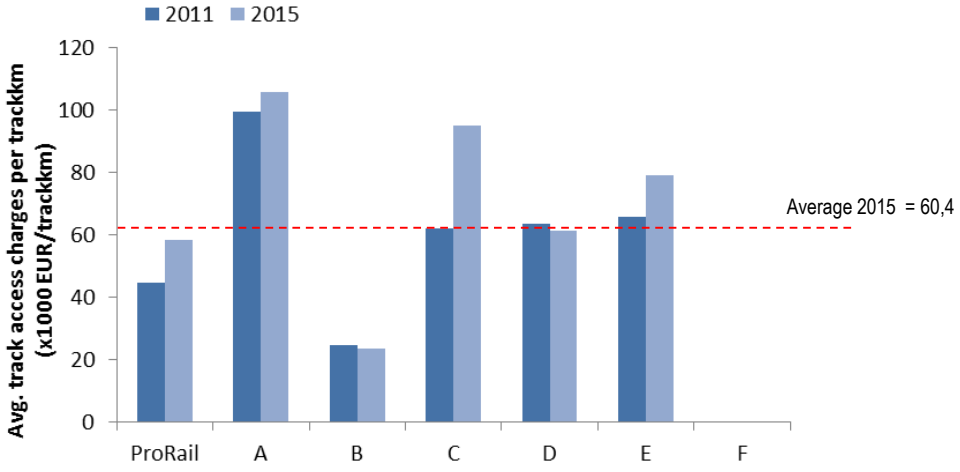


11.2 Financial performance – Track Access Charge (TAC)

Revenue TAC per trainkm is low, while average revenue from TAC per trackkm is closer to peergroup average.





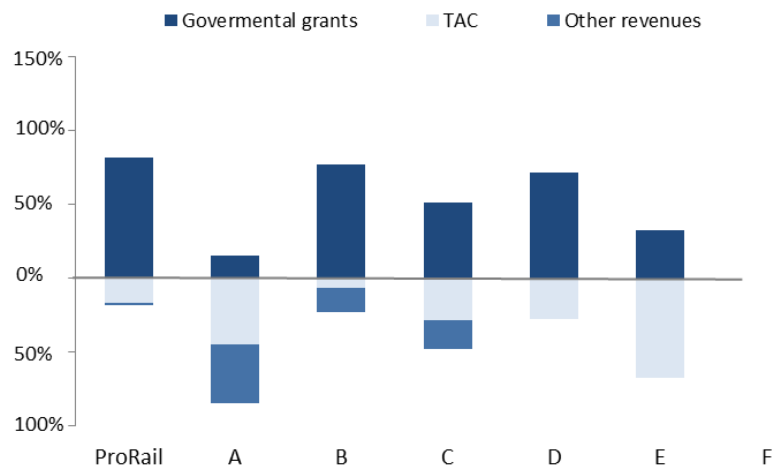


Interpretation:

- Average Track Access Charge (TAC) per trainkm is low compared to peer group
- Revenue of TAC per trackkm is closer to average due to relatively high utilisation
- Within peer group, average TAC per trainkm is higher in networks with lower utilisation

11.2 Financial performance - Track Access Charge (TAC)

Government grants are the biggest source for income for 4 out of 6 IM's.

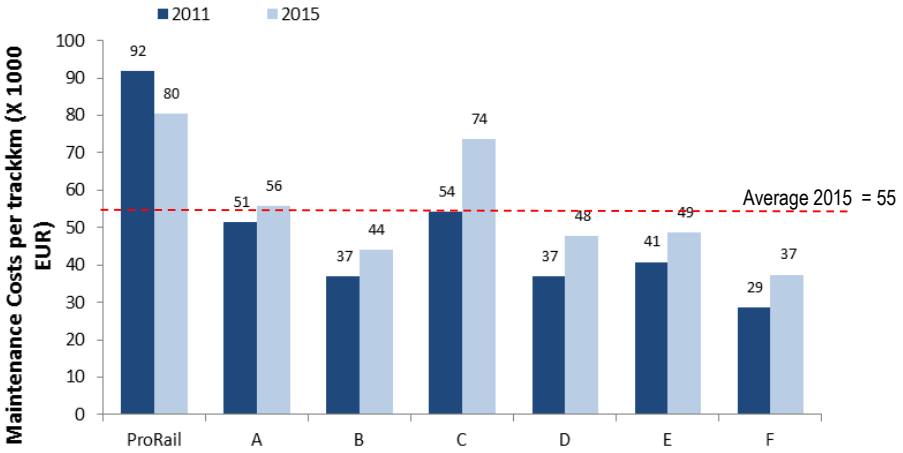


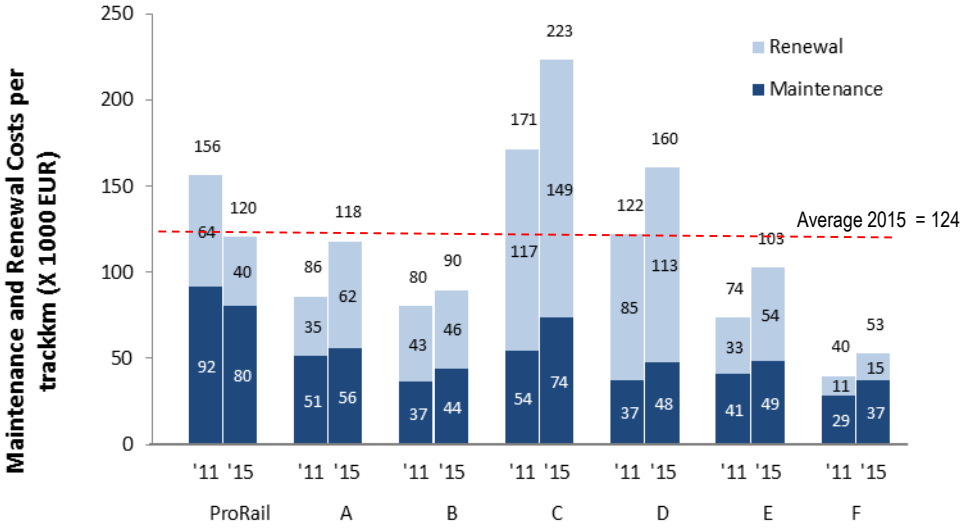
Interpretation:

- ProRail's major incomes comes from Governmental grants. Four (including ProRail) IM's get most of there income through grants.
- Only 2 of the 6 peers receive the biggest revenue from TAC's and other sources than grants.
- IM's with less government grants tend to have a bigger share of TAC

11.3 Financial performance – Maintenance and renewal costs per trackkm

Per trackkm the maintenance cost are above peergroup average and the renewal cost are below the peergroup average. The sum of maintenance and renewal cost are just below peergroup average in 2015.





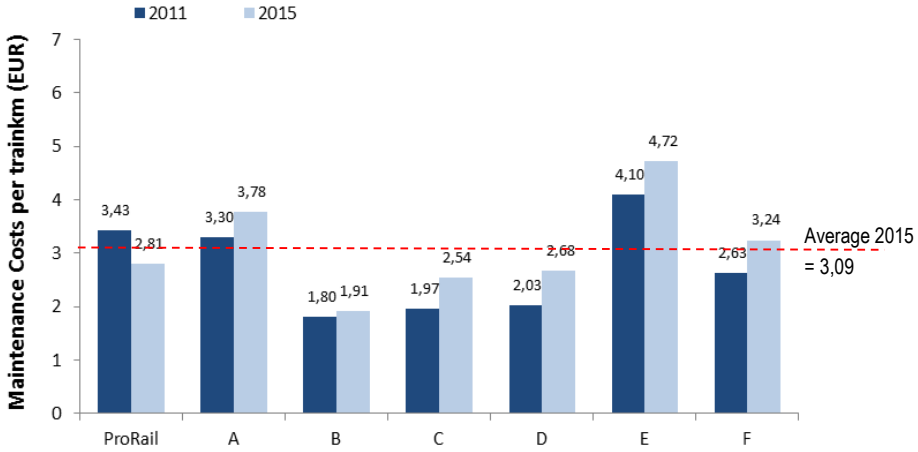
Interpretation:

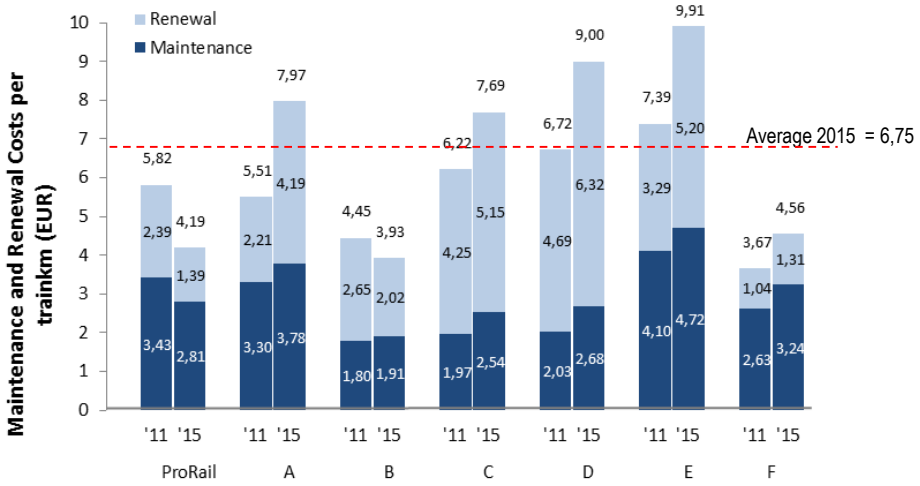
- Maintenance cost per trackkm at ProRail are above peer average and have decreased in 2015 compared to 2011.
- ProRail renewal cost per trackkm are below peer average and also decreased in 2015 compared to 2011. The average without peer C is 55.
- Sum of Maintenance and Renewal cost decreased from above peergroup average in 2011 to peergroup average in 2015. The average without peer C is 92. ProRail would then be above average

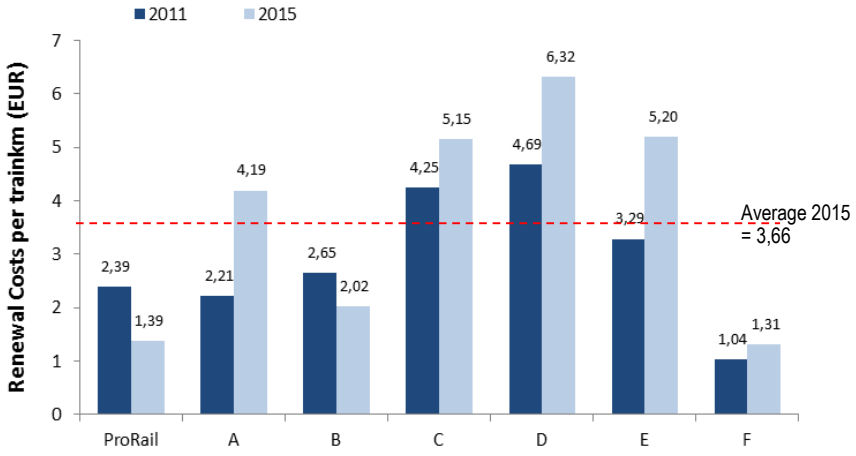
Renewals are related to the age distribution of assets, networks which are laid out in waves in the past will also have waves in renewal cost over time. Renewal costs in 2011 or 2015 can be different from future renewal costs.

11.3 Financial performance– Maintenance and renewal costs per trainkm

Maintenance and renewal cost are below average compared to peergroup in 2015. Both maintenance and Renewal show a decreasing trend in 2015 compared to 2011.





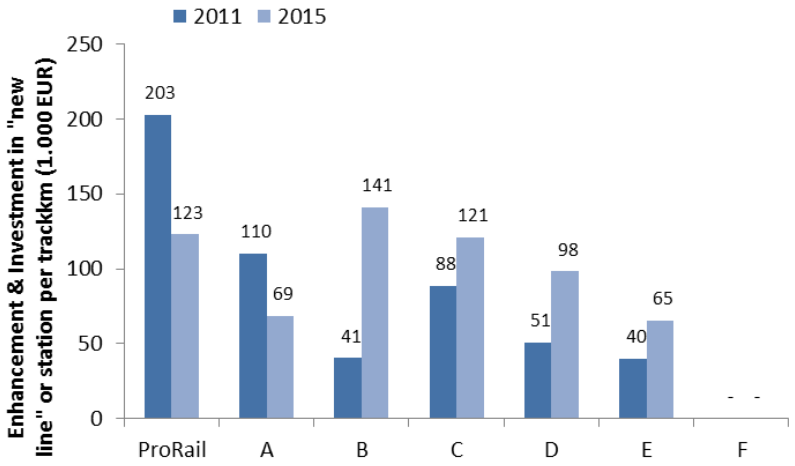


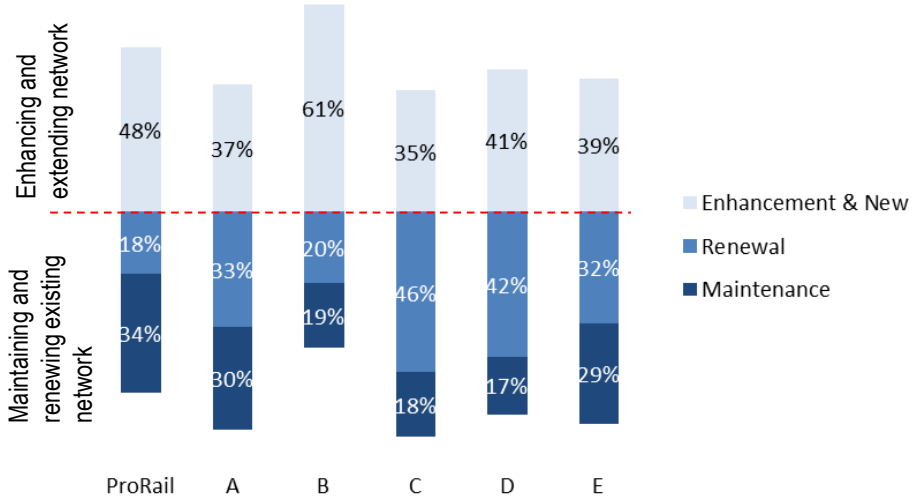
Interpretation:

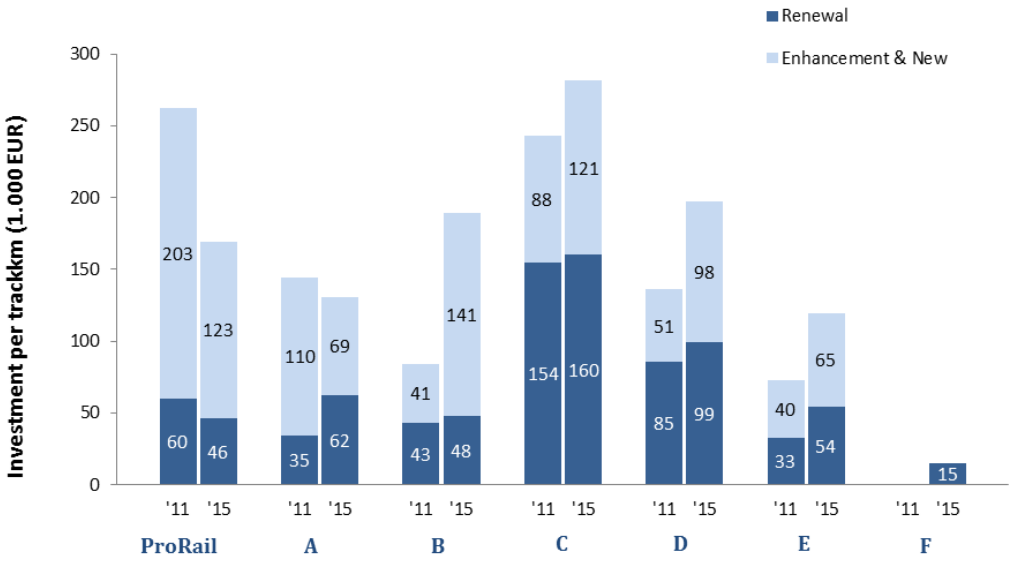
- Maintenance cost per trainkm at ProRail are below peer average and have decreased compared to 2011.
- ProRail renewal cost per trackkm are below peer average and show a decreasing trend.
- Per trainkm ProRail the sum of maintenance and renewal cost are below peergroup average
- Share of renewal cost at ProRail is low compared to peergroup
- Due to the high utilisation at ProRail the cost related to trainkm is relatively lower compared to peergroup than per trackkm.

11.3 Financial performance– Maintenance and Investments

ProRail's enhancements and investments in new lines or stations have decreased significantly. Maintenance and renewal of the existing network is balanced with enhancing and extending the network





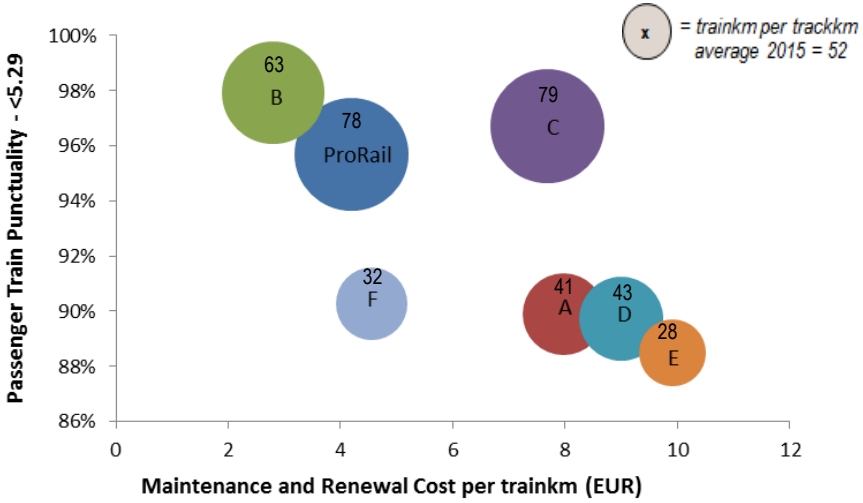


Interpretation:

- Enhancement & Investments in "New Lines" are lower in 2015 compared to 2011
- All other peers, except peer A, have increased Enhancement & Investment in "New Lines"
- Relatively ProRail's spending is evenly distributed between 1) maintaining and renewing the existing network and 2) enhancing and extending the network, given the 48% share of enhancement & New.
- Share of renewal is the lowest at ProRail compared to peers, and the maintenance share is the highest amongst peers.

11.3 Maintenance and renewal vs Punctuality

NL combines high punctuality with high track utilization at low cost



Interpretation:

Figure 1 shows the passenger train punctuality versus total cost per trainkm, in combination with the number of trainkm per trackkm

- NL has high punctuality relative to cost (maintenance and renewal - MRC) per trainkm
- B has lowest MRC cost per trackkm, and also a high punctuality
- C has higher punctuality, but also almost double the cost per trainkm.
- NL, B and C combine high punctuality with high number of trainkm per trackkm.
- A, D and E have relatively low punctuality, combined with high cost per trainkm.

Appendix A - Questionnaire and *Definitions*

Appendix A – Questionnaire and Definitions

- Appendix A shows the definitions used in the questionnaires of the data requests to the peer group
- Yellow lines indicate the datasets which not all peers were able to collect, or which datasets were incomparable

Appendix A – Questionnaire and Definitions
Network Utilization

Indicator	Definition	Source / reference
trainkm - total	Sum of trainkm - passenger trains and trainkm - freight trains	-
trainkm - passenger trains	Unit of measure representing the movement of all passenger trains taking into account their journey length. Empty passenger train movements included.	UIC, LICB Glossary 2.0, page 18
trainkm - freight trains	Unit of measure representing the movement of all freight trains taking into account their journey length. Empty freight train movements included.	UIC, LICB Glossary 2.0, page 19
utilization - lowest utilized	Lowest utilization (freight and passenger together) per line, with utilization measured as: trainkm per day per trackkm	-
utilization - highest utilized	Highest utilization (freight and passenger together) per line, with utilization measured as: trainkm per day per trackkm	-
tonkm - total	Sum of tonkm - passenger trains and tonkm - freight trains	-
tonkm - passenger trains	Unit of measure representing the movement of all passenger trains (including empty passenger train) taking into account the journey length and weight of the train (including weight of passengers)	UIC, LICB Glossary 2.0, page 18
tonkm - freight trains	Unit of measure representing the movement of all freight trains (including empty freight train) taking into account the journey length and weight of the train (including weight of cargo).	UIC, LICB Glossary 2.0, page 20

Appendix A – Questionnaire and Definitions
Assets (1/3)

Indicator	Definition	Source / reference
Length of line-km	Total length of permanent way in maintained working order. Every kilometre of double or multiple track counts as one line kilometre	UIC, LICB Glossary 2.0, page 15
Length of line-km single track	Total length of lines in single tracks	UIC, LICB Glossary 2.0, page 16
Length of main track	Main running tracks providing end-to-end line continuity and used for working regular trains between stations or places indicated in the tariffs as independent points of departure or arrival for the conveyance of passengers or freight	UIC, LICB Glossary 2.0, page 16
Length of electrified main track	Main running tracks provided with an overhead catenary or with conductor rail (3rd rail) to permit electric traction	UIC, LICB Glossary 2.0, page 16
Number of Switches in main-track	Points in main tracks in maintained working order managed, owned, maintained by the Infrastructure Manager.	-
Number of Switch units in main-track	Points in main tracks in maintained working order managed, owned, maintained by the Infrastructure Manager. For a better comparability switch-units are calculated as follows: • ordinary point (standard turnout / diamond crossing) = 1 switch-unit • single slip diamond crossing = 2 switch-units • double slip diamond crossing = 4 switch-units	UIC, LICB Glossary 2.0, page 17
Level crossings - secured	Any level intersection between a road or passage and a railway, as recognized by the infrastructure manager and open to public or private users, which are secured by gates, barriers and/or road traffic light signals	-
Level crossings - unsecured	Any level intersection between a road or passage and a railway, as recognized by the infrastructure manager and open to public or private users, which are not secured by gates, barriers and/or road traffic light signals	-

Appendix A – Questionnaire and Definitions
Assets (2/3)

Indicator	Definition	Source / reference
Number of signals	Number of Signals in main track	-
Number of failures	Total number of train effecting failures of responsibility of Inframanager. Threshold level for delay is 5.29 mins	Prime KPI Condition indicator KPI 3
	A. Signaling (installations and level crossings) according to UIC leaflet 450-2, number 20 & 21	Prime KPI Condition indicator KPI 3a
	B. Telecommunications and Power Supply according to UIC leaflet 450-2, number 22 & 23	Prime KPI Condition indicator KPI 3b
	C. Tracks according to UIC leaflet 450-2, number 24	Prime KPI Condition indicator KPI 3c
	D. Others according to UIC leaflet 450-2, number 25, 28 & 29	Prime KPI Condition indicator KPI 3d
Average repair time	Average repair time of train effecting failures (repair time defined as time repaired minus time notification defect)	-
Permanent Speed Restriction	The total km of tracks with some restriction or decreased speed according to what it's built for related to total track km on main tracks.	Prime KPI Condition indicator KPI 4a
Temporary Speed Restriction	The km of tracks weighted with the numbers of days for restrictions during the year.	Prime KPI Condition indicator KPI 4b
Possession time	Share of possession time for IM's activities (maintenance, renewal and enhancements) on main tracks. The KPI is based on the planned work in the yearly time table. The KPI is calculated as sum (length of possession * possession time) / total length * 365 * 24	Prime KPI Capacity indicator KPI 2a

Appendix A – Questionnaire and Definitions
Assets (3/3)

Indicator	Definition	Source / reference
Multiple unit	Self propelled train set consisting of several vehicles. Can be propelled by electrical traction (EMU) or diesel traction (DMU)	-
Vehicles	Sum of cars of multiple units, locomotive hauled coaches and locomotives	-
Vehiclekm	Measure of train movement of vehicles; sum of kilometres moved by total fleet or total trainkm multiplied by average number of vehicles per train	-
Seatkm	Measure of seating capacity offered. Total trainkm multiplied by average number of seats per train.	-

Appendix A – Questionnaire and Definitions
Punctuality

Indicator	Definition	Source / reference
Trains punctuality.	Trains arrived at a strategic points with less than 5 minutes delay compared to all trains. Rounding rule no. 2 according to UIC 450, which means actual threshold value is 5.29 minutes. The comparison are to be done between all trains ran against the original time plan, including international traffic.	Prime KPI punctuality indicator A1
Passenger trains punctuality.	Passenger trains arrived at strategic points with less than 5 minutes delay compared to all passenger trains. Rounding rule no. 2 according to UIC 450, which means actual threshold value is 5.29 minutes. The comparison are to be done between all trains ran against the original time plan, including international traffic.	Prime KPI punctuality indicator A2
Freight trains punctuality.	Freight trains arrived at strategic points with less than 15 minutes delay compared to all freight trains. Rounding rule no. 2 according to UIC 450, which means actual tresshold value is 15.29 minutes. The comparison are to be done between all trains ran against the original time plan, including international traffic.	Prime KPI punctuality indicator A3
Minutes of delays	Total Cumulative delay minutes, all sorts of delays are to be included	
Minutes of delays caused by the infrastructure manager	- Cumulative delay minutes caused by incidents that are regarded as IMs responsibility according to UIC leaflet 450-R. - Cumulative delay minutes caused by weather incidents which has led to disruptions in the railway infrastructure.	Prime KPI punctuality indicator A4
Percentage of train cancelled	Cancellations of all passenger trains that are included in the last Time Table issued the day before service (or the Time Table that is valid when the train service take place). All sorts of cancelled trains are to be included.	
Percentage of train cancelled caused by the infrastructure manager	Cancellations of passenger trains that are included in the last Time Table issued the day before service (or the Time Table that is valid when the train service take place) and are caused by incidents for which the infrastructure manager has the responsibility. All sorts of cancelled trains are to be included.	Prime KPI punctuality indicator A5
Number of "black days"	Number of days of which the daily punctuality was lower than 85%, based on 5 min. tresshold.	

Appendix A – Questionnaire and Definitions
Punctuality and service quality

Indicator	Definition	Source / reference
Passenger punctuality	Percentage of passengers arriving within 2 minutes and 59 seconds to their scheduled arrival time. NB measurement and calculation systems may vary across the different operators. Scheduled time is defined in the daily timetable,set 48 hours before actual operation.	-
Train punctuality	Percentage of trains arriving with a delay of less than 4 minutes and 59 seconds on the scheduled time. Scheduled time is defined in the daily timetable,set 48 hours before actual operation.	-
Cancelled trains	Percentage of trains that are not running parts of the route as scheduled in the daily timetable,set 48 hours before actual operation. Partial cancellations and replacement trains are included proportionally.	-
Occupancy ratio	Ratio of number of passengerkilometres and number of seatkilometres offered	-
Accessible stations	Stations with step free access to the platforms, conforming TSI PRM. Platforms that can be reached with a ramp or elevator are included as accessible.	TSI PRM
Accessible rolling stock	Rolling stock with step free access from the station platform,that can be accessed without assistance. Conforming TSI PRM	TSI PRM
Rolling stock with facilities for PRM	Rolling stock that is not fully compliant with the TSI PRM, but has facilities for passengers with reduced mobility, such as priority seats, wheel chair accessible toilets, tactile siging, etc.	-
Assistance for PRM	Assistance for passengers with reduced mobility for boarding or unboarding the train in case no step free access is available. Assistance can be given by train staff or station staff and includes the use of mobile ramps or wheel chair elevators.	-
Hours notification for assistance	The minimum number hours in advance of the journey that passengers with reduced mobility need to contact the railway operator to ensure that assistance is available on the origin and destination stations.	-

Appendix A – Questionnaire and Definitions
Safety

Indicator	Definition	Source / reference
Number of significant accidents	Total number of significant accidents based of 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	Prime KPI Safety indicator A1
Number of persons seriously injured and killed	Total number of persons seriously injured and killed 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	Prime KPI Safety indicator A2
Accidents on level crossings	Total number of significant accidents on level crossings	
Number of persons seriously injured and killed by accidents on level crossings	Total number of persons seriously injured by accidents on level crossings	
Suicides	Total number of suicides	Prime KPI Safety indicator B2
SPAD's	Total number of signal passed at danger when passing a danger point	ERA, ERA/GUI/02-2015
Number of accident involving the transport of dangerous goods	Total number of accident involving the transport of dangerous goods. “Accident involving the transport of dangerous goods” means any accident or incident that is subject to reporting in accordance with RID (1) / ADR section 1.8.5.	ERA, ERA/GUI/02-2015

Appendix A – Questionnaire and Definitions
Staff, stations and environment

Indicator	Definition	Source / reference
Total staff	Total number staff of whole company (FTE)	
Staff Inframanagement	Number staff working for the inframanagement department, which are responsible for maintaining and renenewing track and stations (FTE)	
Staff Traffic Control	Number staff working at traffic control (FTE)	

Indicator	Definition	Source / reference
Number of passenger stations	Stations in maintained working order where passenger trains stop. All are counted even if they are not maintained or owned by the Infrastructure Manager	UIC, LICB Glossary 2.0, page 17
Number of manned stations	Number of passenger stations which are manned, with for example a ticket office or small shop	
Number of gated stations	Number of passenger stations with controlled access.	
Number of stations with	Number of passenger stations equipped with CCTV/camera surveillance	
Number of parkings places	Number of available car parking places at stations	
Number of bike parking place	Number of available bike parking places at stations	
Number of stations with busstop	Number of stations wich have a bus stop	
Number of stations which are independant accessable of disabled persons	Number of passenger stations which are independant accessable for persons with reduced mobility. For example stations wich have step free acces to the platforms (by elevators) and are equipped with tactile guidelines for visually impaired persons	

Indicator	Definition	Source / reference
CO2 emmision	CO2 emmision produced from rail bound working/maintenance machines	Prime KPI Environment and Sustainability indicator A2

Appendix A – Questionnaire and Definitions
Track Acces Charges

Indicator	Definition	Source / reference
Total TAC	Total TAC for passenger and freight trains, includes charges for: 1. Minimum Track Access Charges for the passenger, freight and service train path 2. Mark-ups No other charging components are included	Prime KPI TAC indicator C1
TAC passenger trains	Total TAC for passenger trains, includes charges for: 1. Minimum Track Access Charges for the passenger, freight and service train path 2. Mark-ups No other charging components are included	Prime KPI TAC indicator C2a
TAC freight trains	Total TAC for freight trains, includes charges for: 1. Minimum Track Access Charges for the passenger, freight and service train path 2. Mark-ups No other charging components are included	Prime KPI TAC indicator C2b
TAC commuter train	TAC for minimum acces packages and mark-ups for a commuter train of 120 ton	-
TAC long distance train	TAC for minimum acces packages and mark-ups for a long distance passenger train of 300ton	-
TAC normal freight trains	TAC for minimum acces packages and mark-ups for a normal freight train of 1950 ton	-
TAC heavy freight trains	TAC for minimum acces packages and mark-ups for a heavy freight train of 4300ton	-

Appendix A – Questionnaire and Definitions
Finance

Indicator	Definition	Source / reference
Total revenues	**Total revenues**	
- Track access charges	All track access charges related revenues	
- Revenues from station / retail activities	Revenues from renting and/or exploiting stations and real estate.	
- Other revenues		
Govermental grants	Operational and investment grants	
Change in external debt	Yearly changes in external debt (plus if debt is increased, minus if debt is decreased)	
Maintenance costs	Cost of maintaining current infrastructure and/or stations	
Operating costs	**Total operating costs**	
- Staff costs	Labour costs and all other costs related to personnel	
- Other operating costs		
Investment Costs	**Total investment costs**	
- Renewal cost	Renewal cost of existing infrastructure and/or stations	
- Enhancement costs	Cost of enhancing the current function of infrastructure and/or stations	
- Investment in "new line" or station	Investment in new infrastructure and/or stations	

Appendix A – Questionnaire and Definitions
Finance and sustainability

Indicator	Defintion	Source / reference
Average fare level	Average price per passengerkm. Total ticket revenues of train operator divided by the total number of passengerkm of that operator	-
Net public funding	Sum of subsidies for train operator - concession fee paid to the government - track access charges paid to infrastructure manager	-
Total net revenues	Sum of ticket revenues and net public funding of the train operator	-
PPP	Financial data adjusted for purchasing power parity ratios as provided by OECD. All cost and revenu levels adjusted to the Dutch price level 2015.	OECD

Indicator	Defintion	Source / reference
Direct traction energy	Energy directly used for propulsion of trains, including electrical and fuel energy, excluding transportation losses trough the distribution network. Diesel fuel is included using the equivalent value of 1 liter diesel =10kWh.	-
CO^2 emissions	CO2 emissions directly due to the use of direct traction energy. Emissions due to transport losses are not included.	-

Appendix A – Questionnaire and Definitions
Costs (1/3)

Indicator	Definition	Source / reference
Maintenance costs - total	Total annual expenditures for the IM on maintenance. Includes overhead (such as financials, controlling, IT, human resources, purchasing, legal and planning), labour (operative personnel), material (used/consumed goods), internal services (machinery, tools, equipment incl. transport and logistics) and contractors (entrepreneurial production) as well as investment subsidies. All assets as defined below are to be considered*. Central or holding overheads are to be allocated proportionally to maintenance costs.	UIC, LICB Glossary 2.0, page 22
Maintenance costs - plain line	Examples for plain line maintenance: - All track measurement trains (also multifunctional) such as track geometry or ultrasonic - Inspections such as foot patrols, video or georadar - Tamping - Grinding - Thermal neutralisation of rails - Repair welding - Spot replacements (repair) of rail, sleepers, ballast, joints - Snow clearance - Stone blowing/blasting - Vegetation control - "Drainage clearance" or similar, i.e. re-formation of ditches (earth works/rock works), drain tube hosing (rinsing), clean out wells	UIC, LICB Glossary 2.0, page 23
Maintenance costs - switches and crossings	Examples for switches and crossings maintenance: - Measurements - Inspections - Tamping/levelling and aligning - Grinding - Lubrication - Repair welding - Replacement of all switch components (repair) - Snow clearance for S&C heating systems	UIC, LICB Glossary 2.0, page 23

Appendix A – Questionnaire and Definitions
Costs (2/3)

Indicator	Definition	Source / reference
Maintenance costs - civil engineering	Examples for civil engineering maintenance: - Inspections - Sandblasting - Painting - Civil structure repairs - Assessment examination - All work on lining and in tunnel safety systems - Testing of safety systems, pumps, technical installations in tunnels - Re-stressing steel bridges	UIC, LICB Glossary 2.0, page 24
Maintenance costs - traction power supply	Examples for traction power supply maintenance: - Measurements - Inspections - Spot replacements (repair) of masts, overhead line, circuit breakers, cabling … - Tensioning of overhead system - Painting of steel masts - De-icing of overhead line	UIC, LICB Glossary 2.0, page 24
Maintenance costs - train control, signalling, IT, telecom	Examples for train control, signalling, IT and Telecom maintenance: - Measurements - Inspections - Maintenance, inspections, examinations on train control buildings - Spot replacements of all assets/components (repair) - Tuning/adjustment of asset components	UIC, LICB Glossary 2.0, page 24
Maintenance costs - miscellaneous	Maintenance at track related assets wich are not covered above.	UIC, LICB Glossary 2.0, page 24

Appendix A – Questionnaire and Definitions
Costs (3/3)

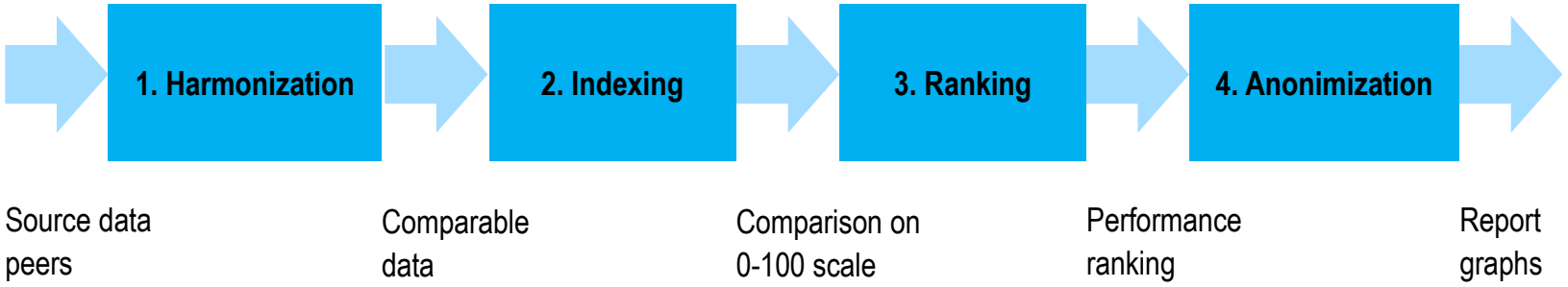
Indicator	Definition	Source / reference
Renewal - total	Total annual expenditures for renewal and re-investment in the existing network, paid by the infrastructure manager, government or other investment subsidies. Includes overhead (such as financials, controlling, IT, human resources, purchasing, legal and planning), labour (operative personnel), material (used/consumed goods), internal services (machinery, tools, equipment incl. transport and logistics) and contractors (entrepreneurial production). Central or holding overheads are to be allocated proportionally to renewal costs. All assets as defined below are to be considered*. All activities are to be counted, if they are triggered by the end of asset lifetimes. They are not to be counted, if the purpose is to change the functional requirements such as speed or capacity. Where a line is closed on a permanent or semi-permanent basis, and costs are incurred to remove assets, this expenditure shall be excluded on the basis that the capability of the infrastructure has been fundamentally changed.	UIC, LICB Glossary 2.0, page 26
Renewal - plain line	Renewal cost for plain line	
Renewal - switches and crossings	Renewal cost for switches and crossings	
Renewal - civil engineering	Renewal cost for civil engineering	
Renewal - traction power supply	Renewal cost for traction power supply	
Renewal - train control, signalling, IT, telecom	Renewal cost for train control, signalling, IT and telecom	

Appendix A – Questionnaire and Definitions
ERTMS

Indicator	Definition	Source / reference
Main tracks with ERTMS in operation	Current main tracks (measured in track-km) with ERTMs in operation in proportion to all main tracks (measured in track-km).	Prime KPI ERTMS indicator KPI A1
Train-km with ERTMs in operation	Current train-km with ERTMs in operation compared to totality of train-km.	Prime KPI ERTMS indicator KPI A2
In 2020, main tracks with planned deployment of ERTMs.	In 2020, the sum of IMs main tracks (measured in track-km) planned to have deployment of ERMTs compared to the totality of the IMs main track, (measured in track-km).	Prime KPI ERTMS indicator KPI A3
In 2030, main tracks with planned deployment of ERTMs.	In 2030, the sum of IMs main tracks (measured in track-km) planned to have deployment of ERMTs compared to the totality of the IMs main track, (measured in track- km).	Prime KPI ERTMS indicator KPI A4

Appendix B. Methodology

Appendix B. Methodology
Harmonization and anonimization process NS



1. Harmonization

- In the following sheets the harmonization processes for a number of parameters (customer satisfaction, reliability, financial) are summarized

2. Indexing

- The indexing step divides all data from the preceding step by the average of the scores in 2015 and multiplying by 100. Therefore all data are expressed as a percentage of the 2015 average.

3. Ranking

- After indexing the data is ranked by performance, in a descending order of performance

4. Anonimization

- All peers are labelled by their performance ranking Op1 to Op8 (operator), except NS and/or the peer for which a feedback report is intended
- Publicly available data however is not anonimized. Therefore steps 2 and 4 are skipped in the process

Appendix B. Methodology
Harmonization of customer satisfaction scores

Comparable output

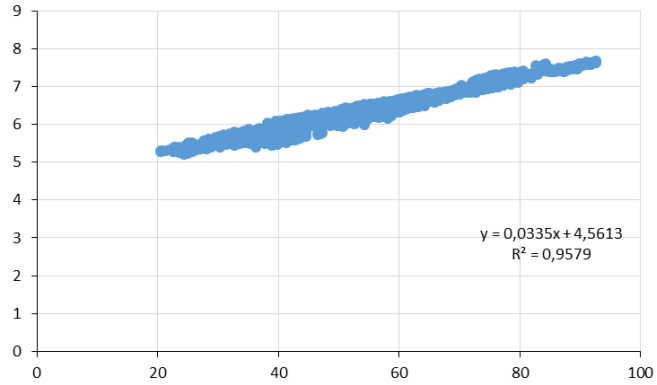
- Customer satisfaction scores are to be compared as close as possible to the NS score of “percentage respondents scoring a 7 out of 10 or higher”
- In some cases the data delivered by the peer was in this format (NMBS, SBB and older DSB data)

Input: percentage satisfied or very satisfied

- In the case of UK operators the score of the peer is in the format “percentage satisfied or very satisfied”. Based on the Dutch definitions of school grades, this score is considered to be comparable to “percentage 7/10 or higher”.

Input: average score on a 10-point scale

- Newer DSB data was delivered as the average score on a 10-point scale. These scores were converted to a of “percentage respondents scoring a 7 out of 10 or higher” using a linear regression model based on NS customer satisfaction data from 2005 to 2015 (approximately 800.000 respondents, 2209 scores, R^2= 0,9579).

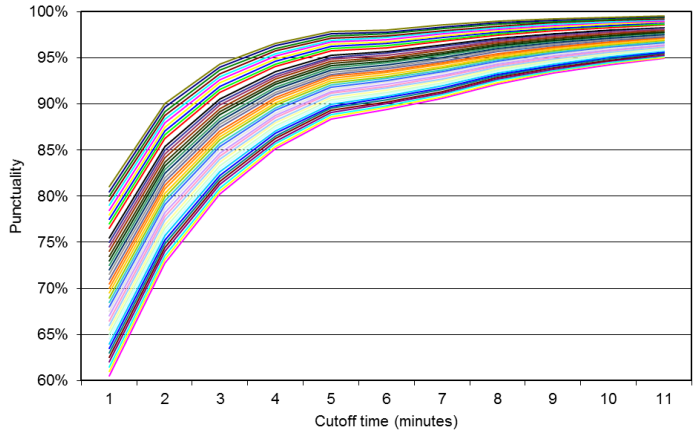


After this harmonization scores were indexed (Average score of 2015 = 100), ranked and harmonized.

Appendix B. Methodology
Harmonization of punctuality data

Punctuality of train arrivals

- Train arrival punctuality is compared based on the NS / ProRail measuring method and definitions; the percentage of trains arriving within 4 minutes 59 seconds from the planned time on the main (34) nodes on the network, excluding cancelled trains
- The effect of measuring on nodes or end points has not been taken into account for this comparison
- Data from peers using different cutoff times for delays is harmonized using a linear regression model of arrivals of NS trains using different cutoff times (n = 3050, R^2= 0,9779)



Passenger punctuality

- Among this peer group passenger punctuality is only measured and/or calculated by DSB, NMBS, NS and SBB
- DSB and SBB calculate passenger punctuality based on a 3 minute cutoff time (2.59). Therefore NS data is recalculated using this cutoff time for comparison.
- NMBS measures punctuality based on a 5 minutes 59 seconds cutoff time. Therefore NMBS data is converted with the linear regression model used for train arrival punctuality.
- Differences of calculation methods (e.g. using smart card passenger counts) are not taken into account for this comparison.

Cancellations

- Cancellations are compared based on the NS calculation of cancelled trains; number of trains passing measurement nodes divided by the planned number of trains to pass these nodes (based on the daily timetable fixed, 48 hours in advance)

Appendix B. Methodology
Ratios used for PPP adjustment

Indicator	Purchasing Power Parities						
Time	2009	2010	**2011**	2012	2013	2014	**2015**
Unit	National currency per US dollar						
Country							
Belgium	0,859	0,854	**0,840**	0,830	0,816	0,821	**0,825**
Denmark	7,840	7,750	**7,600**	7,610	7,420	7,480	**7,500**
France	0,861	0,856	**0,844**	0,848	0,819	0,819	**0,824**
Netherlands	0,842	0,849	**0,830**	0,829	0,808	0,814	**0,827**
Sweden	8,920	8,990	**8,850**	8,710	8,710	8,920	**9,130**
Switzerland	1,520	1,510	**1,430**	1,360	1,320	1,320	**1,280**
United Kingdom	0,656	0,691	**0,700**	0,696	0,692	0,699	**0,693**
United States	1,000	1,000	**1,000**	1,000	1,000	1,000	**1,000**
Euro area (18 countries)	0,794	0,790	**0,780**	0,775	0,760	0,760	**0,767**

Source: OECD stats, Purchasing Power Parities for GDP and related indicators

	Purchasing Power Parities						
	2009	2010	**2011**	2012	2013	2014	**2015**
	National currency per EUR and Dutch price level 2015						
Country							
Belgium	1,039	1,033	**1,016**	1,004	0,987	0,993	**0,998**
Denmark	9,480	9,371	**9,190**	9,202	8,972	9,045	**9,069**
France	1,041	1,035	**1,021**	1,025	0,990	0,990	**0,996**
Netherlands	1,018	1,027	**1,004**	1,002	0,977	0,984	**1,000**
Sweden	10,786	10,871	**10,701**	10,532	10,532	10,786	**11,040**
Switzerland	1,838	1,826	**1,729**	1,644	1,596	1,596	**1,548**
United Kingdom	0,793	0,836	**0,846**	0,842	0,837	0,845	**0,838**
United States	1,209	1,209	**1,209**	1,209	1,209	1,209	**1,209**
Euro area (18 countries)	0,960	0,955	**0,943**	0,937	0,919	0,919	**0,927**

Based on table above, only indexed on NL: 2015 value = 100 for all countries