ERA Rolling stock fleet study

Final Report – December 2024

EUROPEAN UNION AGENCY FOR RAILWAYS

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Glossary

Abbreviation	Explanation
BEMU	Battery Electric Multiple Unit
BMU	Battery Multiple Unit
DBEMU	Diesel-Battery Electric Multiple Unit
DEMU	Diesel-Electric Multiple Unit
DMU	Diesel Multiple Unit
EMU	Electric Multiple Unit
ERA	European Union Agency for Railways
ERATV	European Register of Authorised Types of Railway Vehicles
ERTMS	European Rail Traffic Management System
ESG	Economic Steering Group
ETCS	European Train Control System
EVN	European Vehicle Number
EVR	European Vehicle Register
HEMU	Hydrogen Electric Multiple Unit Set
HMU	Hydrogen Multiple Unit Set
HS	High-Speed
HS EMU	High-Speed Electric Multiple Unit
ILU	Intermodal Loading Unit
K+	Internal ERA dataset comprising additional characteristics on keepers based on ERA analysis
MT	Management Team of ERA
OS	Open Source
RE	Registration Entity
SWDB	Silent Wagon Database
T+	Internal ERA dataset comprising characteristics on types retrieved from open sources
TKM	Tonnes-kilometre
URL	Uniform Resource Locator
V+	Internal ERA dataset comprising additional characteristics on vehicles retrieved from other and open sources, as well as ERA analysis
VKM	Vehicle Keeper Marking register

1. Introduction

1.1. Problem and objective

The European Union Agency for Railways (ERA or Agency) is tasked to assess the interoperability level of the Union rail system using information included in the Agency registers[1]. Three registers are of particular importance to assess the interoperability of the rolling stock fleet.

- The European Vehicle Register[2] (EVR) is a web-based tool used by Keepers to submit applications for vehicle registration and by Registration Entities (REs) to manage the allocation of vehicle numbers and to record vehicle registrations and their updates.
- The European Register of Authorised Types of Vehicles[3] (ERATV) contains data on the types of vehicles authorised by Member States and the Agency and provides information on (technical) parameters of types.
- The Vehicle Keeper Marking register[4] (VKM) is a joint OTIF/EU register hosted by ERA and provides a list of all registered markings.

These registers are invaluable sources for authorisation and registration processes. Unfortunately, they cannot be easily leveraged to assess the level of interoperability of the Union rail system.

For one, the registers were not primarily designed for analytical purposes but for authorisation and registration needs. This makes that data gaps exist for certain analyses. Secondly, data quality issues exist, meaning that the data needs to be reviewed and interpreted before it can be correctly analysed. Thirdly, ERATV is a comprehensive resource for technical analyses on the interoperability of the European fleet. However, at the point of writing only ~23% of registered vehicles have an ERATV type ID. For older vehicles[5] that are likely to never be reauthorised, there has not been an obligation to make technical information available through ERATV.

This has substantial consequences for decision-making when more detailed data related to vehicles or types are needed. For instance, innovation projects can be hampered by the lack of readily available fleet insights (e.g. DAC, ERTMS), leading to cumbersome and resource intensive efforts to collect vehicle information.

ERA's Economic Steering Group (ESG) and the ERA Management Team (MT) asked the Agency's Analysis Team to perform a study on the European rolling stock fleet covering a wide range of technical and economic topics (see Table 1). ***The main goal of this study is to improve insights into the characteristics of the European rolling stock fleet that impact interoperability by creating enriched vehicle, type and keeper datasets. The subgoals are to provide answers to specific questions regarding the characteristics of the fleet and related aspects (e.g. keeper governance, future fleet needs).***

This report provides an overview of the applied methods and results. Additionally, it identifies methodological, definitional and resource gaps that need to be addressed.

[1] Directive (EU) 2016/797, Art 53(2)
[2] European Vehicle Register (EVR) | European Union Agency for Railways
[3] European Register of Authorised Types of Vehicles (ERATV) | European Union Agency for Railways
[4] Vehicle Keeper Marking register (VKM) | European Union Agency for Railways
[5] E.g. before implementation of Interoperability Directive 2008/57/EC

1.2. Study requests

The report focuses on the analysis requests received early 2024 from the ESG and Agency MT. Table 1 shows the requests, where in the report the results are presented, the scope, and the achieved progress.

Table 1

Part	Requests to analyse	Vehicle scope	Progress
3.1	Number of silent wagons	Wagons	+
3.2	Number of wagons for agricultural transport	Wagons	+
3.3	Number of intermodal wagons	Wagons	++
3.4	Power source trends	Traction vehicles	++
3.5	Number of single and multiple voltage system vehicles	E traction vehicles	++
3.6	Overall tractive effort	Traction vehicles	+
3.7	Number of unique trainsets	Trainsets	+
3.8	Overall seating capacity	Passenger trainsets	+
3.9	ETCS on-board status	Traction vehicles	~
4.1	Vehicles keeper trends	All	++
5.1	Replacement rate and rolling stock needs	All	+

1.3. Disclaimer

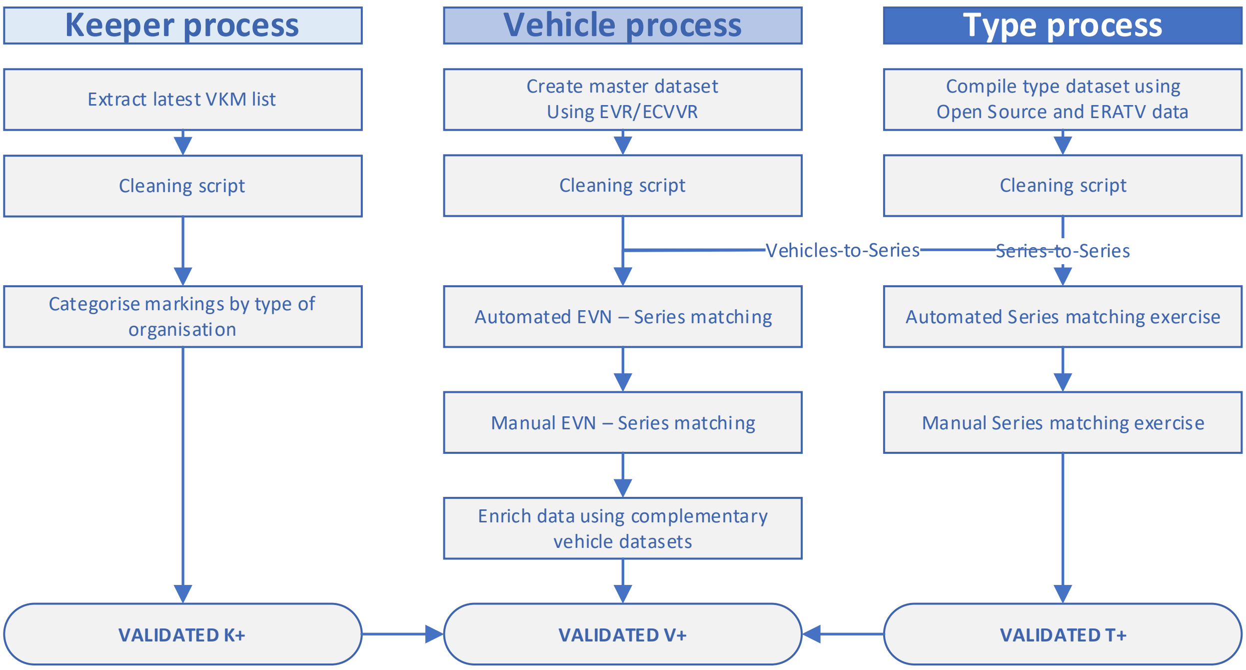
By reading this report the following disclaimer shall be accepted:

- This report is non-legally binding.
- Statistics contained in this report are exclusively aggregated vehicle-related statistics.
- The terms “V+”, “T+”, and “K+” mentioned in this report are not official terms set out in European legislation. They have been produced by the ERA Analysis Team and are used in this report exclusively as informal references.
- The term ‘type’ used in this report with regards to T+ shall not be associated or mixed with the term a “vehicle type” as per Directive (EU) 2016/797, Commission Implementing Regulation (EU) 2018/545 and Commission Implementing Decision 2011/665/EU.
- ERA assumes full responsibility for the integration of Open Source (OS) data in this report and their interpretation.
- Where relevant and feasible, permission to use OS data was sought and granted to the Agency.
- Any use of OS data outside of this report must be explicitly acknowledged. Copyright must be retained by the original source. Any use of data from this report must be done respecting the intellectual property rights vested with such data.
- The results presented in this report are based on a beta version of V+, T+ and K+. These results are meant to showcase the potential of these datasets and should be regarded as indicative.

2. General method and data

The method comprises three flows for vehicle keeper, vehicle, and type datasets as shown below. Additional analyses were performed to determine future rolling stock needs.

Figure 1



2.1. Vehicle Keeper Dataset

Vehicle keeper markings are maintained in a dedicated register. It contains over 4 600 unique markings with organisation name, country, registration status, and URL if available. To determine trends by type of keeper the markings were categorised as follows:

- Lessor
- Maintenance (infrastructure and rolling stock maintenance)
- Manufacturer
- Operator (RUs and IMs)
- Shipper
- Unknown

The parent company (using web search and sector knowledge) was allocated to markings, too. The dataset was linked to the vehicle dataset, as each vehicle has a registered keeper.

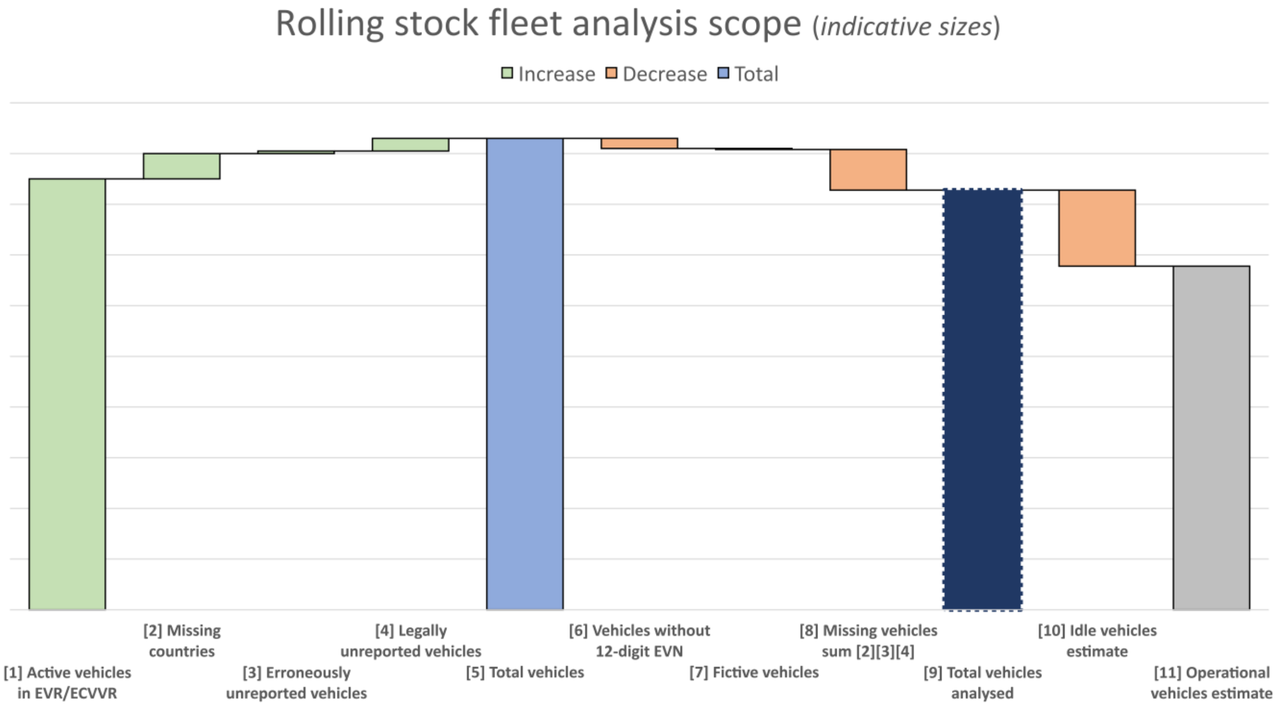
The complete dataset shall be referred to as 'K+'.

2.2. Vehicle Dataset

2.2.1. Vehicle scope

The first step was to extract vehicle information from the EVR. An accurate understanding of what is included in EVR and what not is critical to interpret the results. Figure 2 provides an overview of the factors that influence the scope and what different notions of the European fleet exist.

Figure 2



[5] Total vehicles

[1] Active vehicles in EVR/ECVVR

- Traction vehicles ~130k
- Wagons ~635k
- Special vehicles ~ 18k
- Coaches ~45k
- Total ~835k active vehicles within scope extracted in June 2024

[2] Missing countries

- 24 countries covered
- Hungary, Estonia, Ireland not connected to ECVVR/EVR
- Also note that UK, Western Balkans, Turkey are not included

[3] Erroneously unreported vehicles

- E.g. CH coding error for trainsets in which 1 EVN is given for entire set, rather than each vehicle
- Incompletely registered vehicles, for instance with an erroneous EVN or incorrect withdrawal mode.

[4] Legally unreported vehicles

- Vehicles out of scope of IOD and EVR Decision as specified here EVR GUIDELINES – application guide.pdf

[9] Total vehicles analysed

[6] Vehicles without 12-digit EVN

- E.g. extracted vehicles operating on 1520mm network using legacy Soviet coding scheme (~29k vehicles) or erroneous EVN

[7] Fictive vehicles

- E.g. CH coding error for trainsets in which every vehicle gets 1 EVN **and** one additional EVN for the trainset as a whole

[8] Sum of [2] [3] [4]

- Vehicles that do exist but remain out of sight of EVR could not be analysed

[11] Operational vehicles estimate

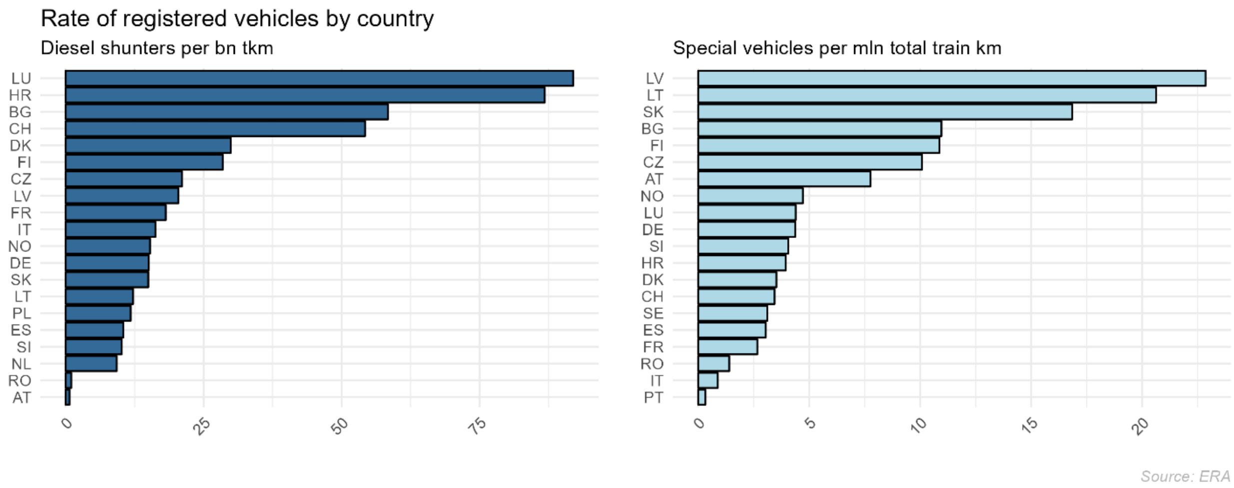
[10] Idle vehicles estimate

- Comprehensive access to train composition data needed. Not available today. Estimates exist that up to 150k wagons not active.

A comparison of the EVR figures with various studies (UNIFE World Rail Market Study, SCI Verkehr, DG MOVE) showed several differences that can be explained by different scopes, definitions, data access, and errors. Based on that analysis, it is believed that this study provides a most comprehensive and accurate insight into the size of the European rolling stock fleet, considering the limitations as shown in Figure 2.

That said, the number of erroneously or legally unreported vehicles is difficult to estimate. Figure 3 shows the rate of registered diesel shunters and special vehicles per country. Some variances can be explained by definitional and methodological aspects. Yet the extent of the divergences suggests there is a high probability that there are different practices in countries as to when a vehicle is registered. This increases the difference between the size of the registered and actual fleet.

Figure 3



2.2.2. *Vehicle analysis*

Various methods were applied to assess the technical characteristics of vehicles.

A first approach was to infer technical details from the vehicle number. The EVR Decision clarifies how to interpret European Vehicle Numbers (EVNs), as shown in Table 2. Through this approach, information on over 100 technical parameters could be retrieved for wagons and for coaches a few dozen.

Table 2

<table>
<tr><th>Rolling stock group</th><th>Interoperability capability and vehicle type [2 figures]</th><th>Country in which the vehicle is registered [2 figures]</th><th>Technical characteristics [4 figures]</th><th>Serial number [3 figures]</th><th>Check digit[1 figure]</th></tr>
<tr><td>Wagons</td><td>00 to 49
80 to 89
[details in part 6]</td><td rowspan="4">01 to 99
[details in part 4]</td><td>0000 to 9999
[details in part 9]</td><td>000 to 999</td><td rowspan="4">0 to 9
[details in part 3]</td></tr>
<tr><td>Hauled passenger vehicles</td><td>50 to 79
[details in part 7]</td><td>0000 to 9999
[details in part 10]</td><td>000 to 999</td></tr>
<tr><td>Tractive rolling stock and units in a trainset in fixed or pre-defined formation</td><td rowspan="2">90 to 99
[details in part 8]</td><td colspan="2">0000000 to 8999999
[the meaning of these figures is defined by the Member States, eventually by bilateral or multilateral agreement]</td></tr>
<tr><td>Special vehicles</td><td>9000 to 9999
[details in part 11]</td><td>000 to 999</td></tr>
</table>

For traction vehicles this approach is hampered by the fact that no common European coding system exists. A review of national coding schemes showed that they are largely unharmonized and incompatible. As a result, information that could be extracted from the national coding scheme was not used in this report.

In addition to EVN deduced information, additional insights were extracted using the Silent Wagon database (see Single-Entry-Point - SEP) and restriction codes in EVR.

The complete dataset shall be referred to as ‘V+’.

2.3. Vehicle Type Dataset

To complement the EVN based analysis, vehicle numbers were linked with types. EVR contains for 23% of the vehicles an ERATV ID reference to the type. For about 50% of the vehicles there was additional information under the 'series' field. Do note that data quality issues exist which means that the vehicles for which there is useful type and series information is substantially lower.

For vehicles for which no type information existed, a new field was introduced. First, using open-source information a parallel type database was created, T+. Table 3 indicates the main parameters that are included for locomotives and trainsets. For wagons and coaches type information was collected to.

Table 3

T+ parameter	Loc	Trainset	T+ Parameter	Loc	Trainset
Series name (unified)	V	V	Power	V	V
Construction year(s)	V	V	Gauge	V	V
Builder (original company)	V	V	Height	V	V
Builder (current owner)	V	V	Length	V	V
Conversion year(s)	V	V	Width	V	V
Propulsion system (E / D / …)	V	V	Axle load	V	V
Voltage	E-locs	E-sets	Wheel arrangement	V	V
Engine	D-locs	D-sets	Wheelbase	V	V
Engine builder	D-locs	D-sets	Wheel diameter	V	V
Max speed	V	V	Cars (motorized/trailers/total)	X	V
Tractive effort	V	V	Seats (2nd / 1st class / total)	X	V

The website *spotlog.org*[6] was instrumental for this part of the exercise. In addition, trainspo.com and Wikipedia were important sources of information to find information on technical parameters and perform data quality checks. ERA wants to explicitly acknowledge the important contributions of the OS community to enable the analyses in this report, while accepting that the responsibility of interpretation and validation lays with the Agency.

Subsequently, the T+ Type ID was linked to 113 000 out of 130 000 traction vehicles in EVR, corresponding to an 87%. The difference is mostly explained by the absence of complete type information for vehicles in some countries and the time needed to perform the matching exercise. However, the large number of successful matches highlights the possibility of matching OS information with EVR.

Also note that OS type data was to be used when no information could be retrieved from ERATV itself. Hence, T+ is primarily used for vehicles that have been authorised before the fourth railway package came into force.

The complete dataset shall be referred to as 'T+'.

2.4. Price analysis

To determine the price of vehicles, the analysis utilised data from specialised and online journals on rail transport. The methodology involved creating a database of European rolling stock purchase prices by compiling information from international and national specialised press outlets and briefings. The data

[6] Website available at: Home Page - SpotLog.

collection process excluded articles that lacked clear cost information, were incomplete, only included bids, had delivery dates beyond 2026, or pertained to rail vehicles for local services. This large review exercise took place on over 15 800 newspaper articles from 11 different sources (Table 4).

Customised to the specific webpage structure, a script was used to filter articles with price information and manual validation took place to identify 92 articles with information on prices for wagons, coaches, DMUs, EMUs, and HS EMUs (and additional vehicle categories not included in these first results).

The list of retrieved information is the following: total purchase price of the rolling stock, number of vehicles, manufacturer(s), buyer, country, type of vehicles, information about the maintenance[7].

To try to ensure comprehensive geographical representation of the collected data, a broader range of journals was considered, some of which cover all of Europe.

Table 4

Number of scrapped articles		
N.	**Press name**	**N. Of scrapped articles**
1	**Railwaypro.com**	783 articles
2	**Railway-news.com**	155 articles
3	**Railmagazine.com**	4,072 articles
4	**Railway.supply/en/news-en/** (Industry publication for railway transport specialists)	5,813 articles
5	**News.railbusinessdaily.com** (Rail Business Daily)	76 articles
6	**Railmarket.com** (Largest database and news for rail business / Railvis.com)	125 articles
7	**Railtech.com** (Rolling stock dedicated section)	121 articles
8	**Globalrailwayreview.com**	426 articles
9	**Railwaygazette.com** (International)	39 articles
10	**Railwaymagazine.co.uk** (The railway hub)	3,489 articles
11	**Blog.tuttotreno.it** (Italy)	744 articles
		15,842 articles identified and scrapped

2.5. Data quality

Beyond the completeness checks as described under section 2.1.2.1., data quality was assessed in several other ways.

First, besides the automated matching of vehicle to T+ type ID, a manual validation exercise was applied to 113 000 tractive vehicles.

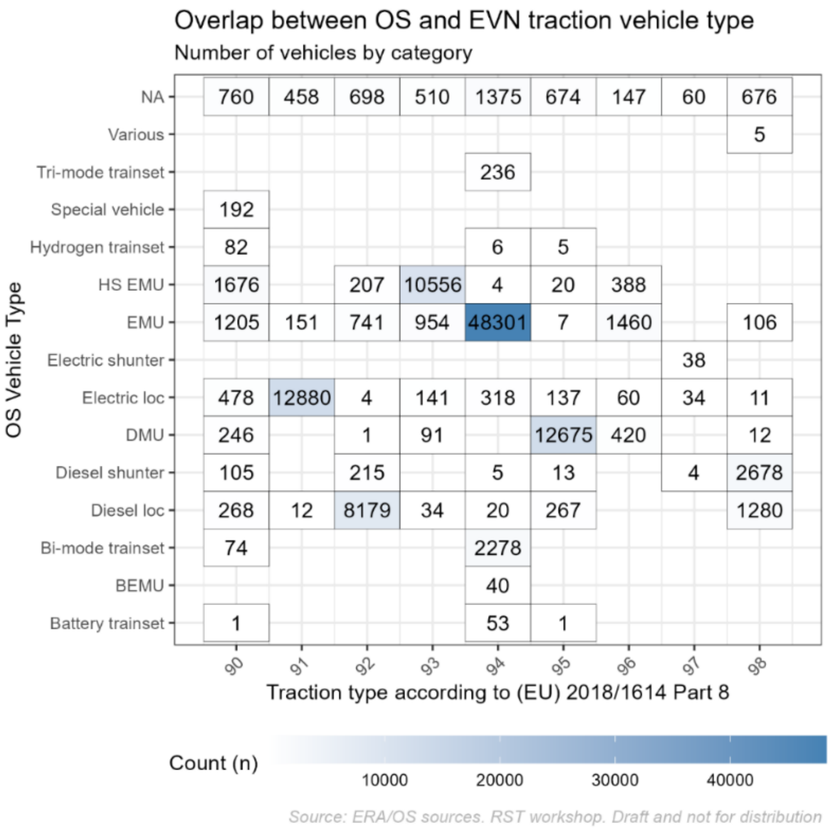
Second, the consistency between various OS repositories was checked and inconsistencies were reported to the source websites.

Third, the consistency between technical information inferred from EVNs was compared with information retrieved from OS data. Figure 4 shows the link between the vehicle category by EVN (x-axis) and OS data (y-axis). Checks found that in OS data was considerably more reliable for certain traction types. It questions to

[7] In some articles the total purchase price includes the cost for maintenance.

some extent the value of an 'intelligent' EVN number if it is not consistently assigned. The implications are part of the discussion chapter.

Figure 4



Based on the validated V+, T+, and K+ the report could perform the analyses as requested by the ESG, as provided in the next chapters.

2.6. Workshop

The method and results as presented in this report were presented and thoroughly discussed during a hybrid workshop on 20 November 2024, with a range of ESG representatives. The workshop feedback has been integrated in the comments and discussion sections of this report.

3. Technical analysis

The developed databases can be used for a range of analyses. This section specifically describes the requests that were filed to the Agency by the ESG (see Table 1). For each request the method, results and comments are discussed. The comments section provides feedback from the Agency on how to interpret the charts and includes feedback received from sector experts that participated in the dedicated technical workshop.

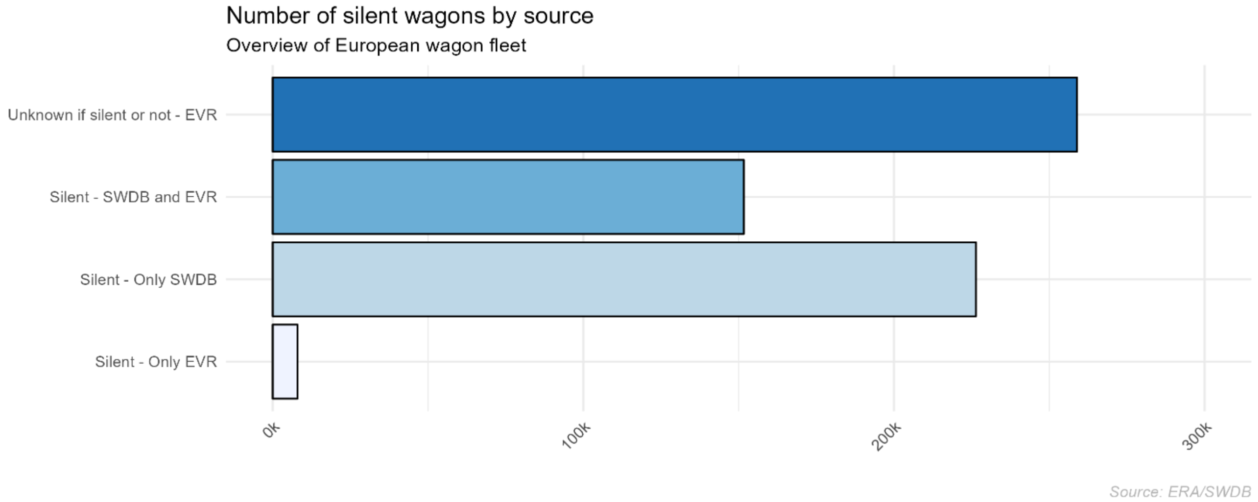
3.1. Silent wagons

3.1.1. Method

EVR contains restriction codes per vehicle. These restriction codes define additional technical characteristics of a vehicle that are important to determine compatibility with the network. However, it is believed that gaps exist and it has so far not been assessed how accurate the data is. In order to cross-check the accuracy of restriction codes on silent wagons, the silent wagon database (SWDB) was consulted. This database was set up by four organisations to coordinate funding procedures and determine network access rights on silent routes (Single-Entry-Point - SEP). SWDB receives data from operators and RSRD[2] and contains information on the types of fitted brake blocks. The two data sources were linked by EVN number.

3.1.2. Results

Figure 5



3.1.3. Comments

The results show that for only ~8 thousand vehicles EVR provided information that was not present in SWDB. The SWDB provided information on over 220 thousand wagons that was not embedded in EVR restriction codes. For about 260 thousand wagons there is no information in both EVR and SWDB.

It can be concluded that EVR restriction codes do not suffice to assess the level of silent wagons in Europe. Also, SWDB may have some gaps considering the large number of vehicles not included. These may however largely be vehicles that are not operational or used on silent routes.

It can be concluded that a large part of the European wagon fleet has been (retro)fitted with silent brake blocks.

3.2. Wagons for agricultural transport

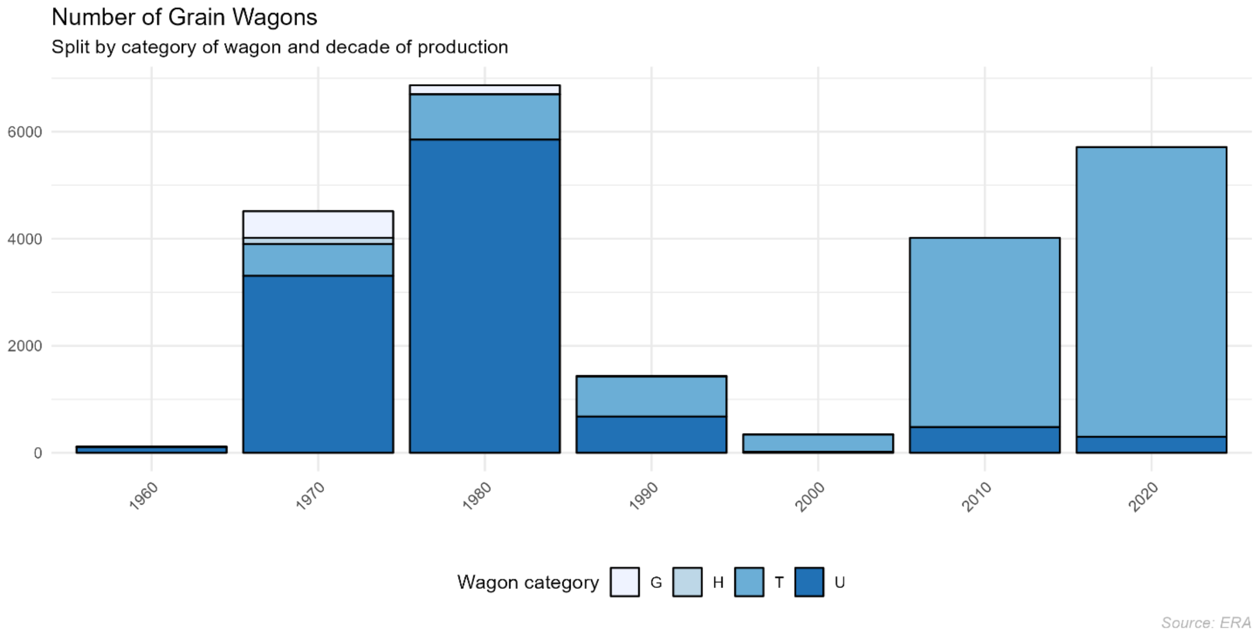
3.2.1. Method

The ESG requested an analysis on the number of agricultural wagons. The only available approach at scale was to analyse the EVNs and associated index letters, as certain letters are designated for grain, fruit & vegetable, fish, and meat transport.

After an initial screening it was concluded that only for grain wagons a sufficient number existed to analyse.

3.2.2. Results

Figure 6



3.2.3. Comments

The results show that the manufactured number of grain wagons has fluctuated considerably over time.

It is also noted that identifying which wagons are designated for specific food transport by their index letters is limited, as these wagons can also be used for other (food) products. Conversely, wagons not specifically designated for grain transport can still carry grain. For example, specialised containers for grain transport have been developed, so any wagon capable of carrying containers could in principle be considered a 'grain wagon'. Therefore, the wagon numbers mentioned above should be considered as indicative.

A deep operational analysis is needed to determine more precisely the number of wagons for different types of agricultural transport.

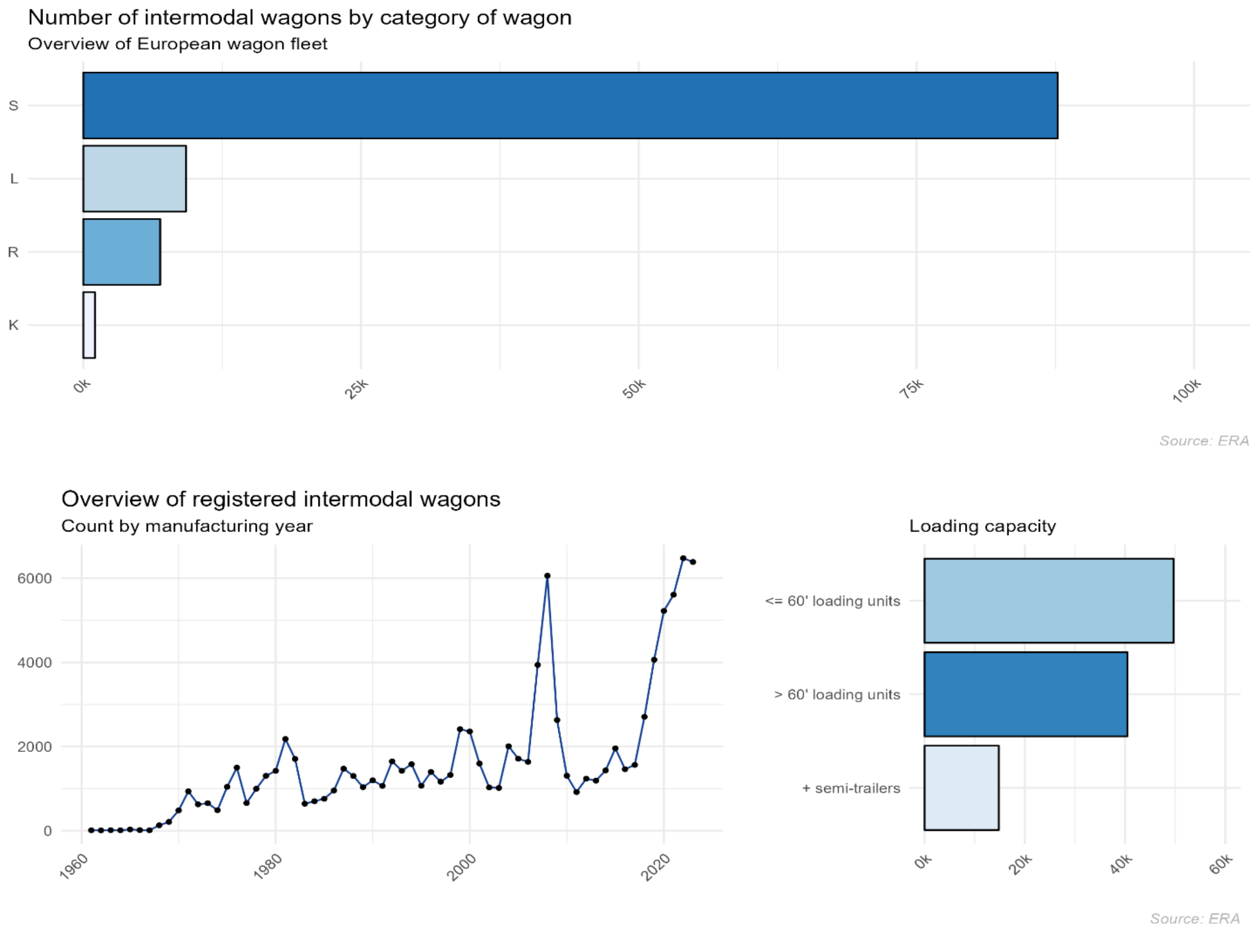
3.3. Intermodal wagons

3.3.1. Method

Intermodal wagons were identified through the EVN and associated index letter. The letters indicate if a wagon is capable of transporting an intermodal loading unit. To be more precise, appendix 6 part 12 of the EVR Decision specifies if a wagon is capable of transporting containers and swap bodies smaller or larger than 60 feet. It also specifies if a wagon is fitted to transport semi-trailers. It is possible to break the analysis on intermodal vehicles further down by sub class (e.g. by count of Sdggmrss, Sggmrss, etc.).

3.3.2. Results

Figure 7



3.3.3. Comments

The chart shows the number of wagons per category, which together are about 105 000 wagons. Further disaggregation by capability to carry different types of Intermodal Loading Unit (ILU) and size are possible.

The main point for discussion is whether wagons capable for intermodal transport are actually used for intermodal transport. Workshop participants suggested that an analysis of operational data would enable a better distinguish intermodal wagons used for actual intermodal transport from those that in theory could be used for intermodal transport but are not in practice.

One way to do so is to analyse the extent to which the wagons in scope are travelling between container terminals. This would enable to determine the difference between the 'actual' from the 'hypothetical' intermodal fleet.

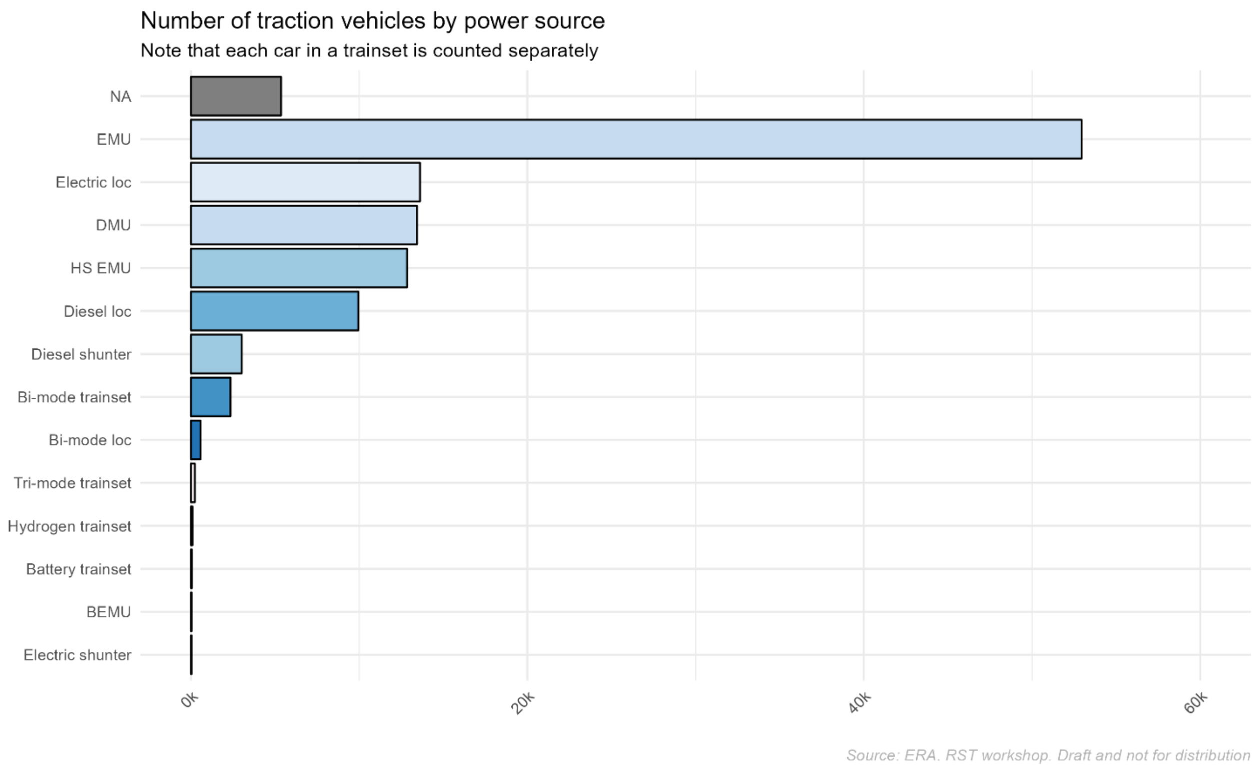
3.4. Power system

3.4.1. Method

The ESG was interested in getting more accurate numbers on the number of vehicles with alternative traction. OS data was primarily used to identify the power system as EVNs provide partial information on the technical characteristics of traction vehicles and, as shown in Figure 4, suffers from data quality issues.

3.4.2. Results

Figure 8



3.4.3. Comments

The chart shows the number of vehicles by power source. Experts commented that the current categorisation is open for improvement. For trainsets the following could be used: DMU / DEMU / EMU / HMU / HEMU / BMU / BEMU / DBEMU.

For HS trains it was recommended to categorise the vehicles by their maximum design speed, splitting high-speed (i.e. 200 km/h to 249 km/h) from very high-speed trains (i.e. >250 km/h). It was noted that but in OS data and based on EVN categorisation, each country applies a different definition of HS EMUs. In some countries an EMU that travels at 220 km/h is considered a HS EMU while in others not. This definitional variance explains some difference in statistics.

A final comment is that there is no harmonised approach how diesel locs are distinguished from diesel shunters. One suggestion is to split these categorise based on the power output, with shunters being vehicles with a power of 1000 kW or less. The need to distinguish between tilting and non-tilting EMUs for statistical purposes was not acknowledged by most workshop participants.

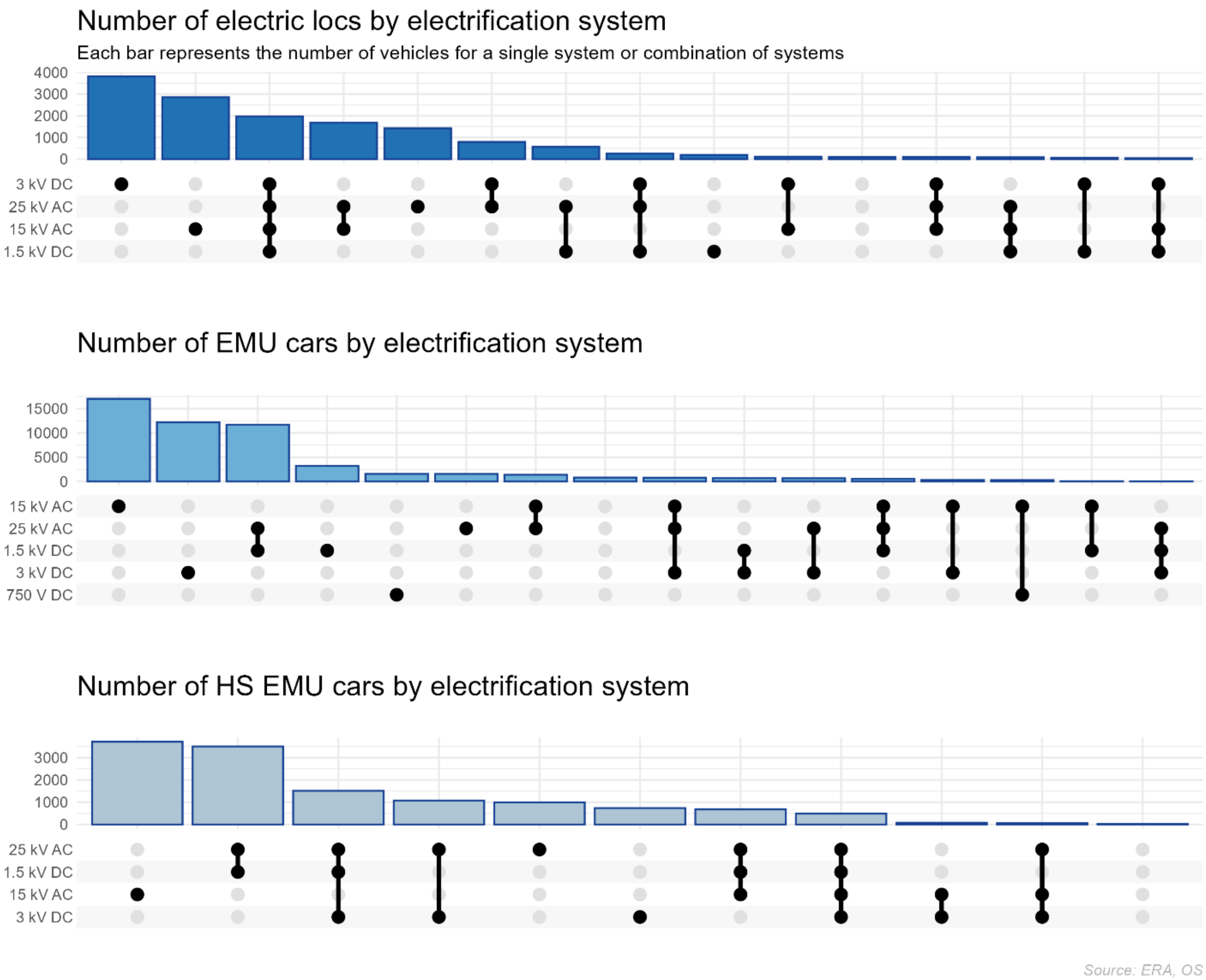
3.5. Electrification system

3.5.1. *Method*

For each electric locomotive or trainset the electrification system was determined using OS data. Subsequently, the number of vehicles that run on each system were counted.

3.5.2. *Results*

Figure 9



3.5.3. *Comments*

Each bar represents the count of vehicles per unique single system or combination of systems on which the vehicles can run. Please note that the numbers for EMUs and HS EMUs concern the number of cars, not the number of unique trainsets. This analysis provides an insight into the pervasiveness of multi-system vehicles and the capability to cross countries with different electrification systems.

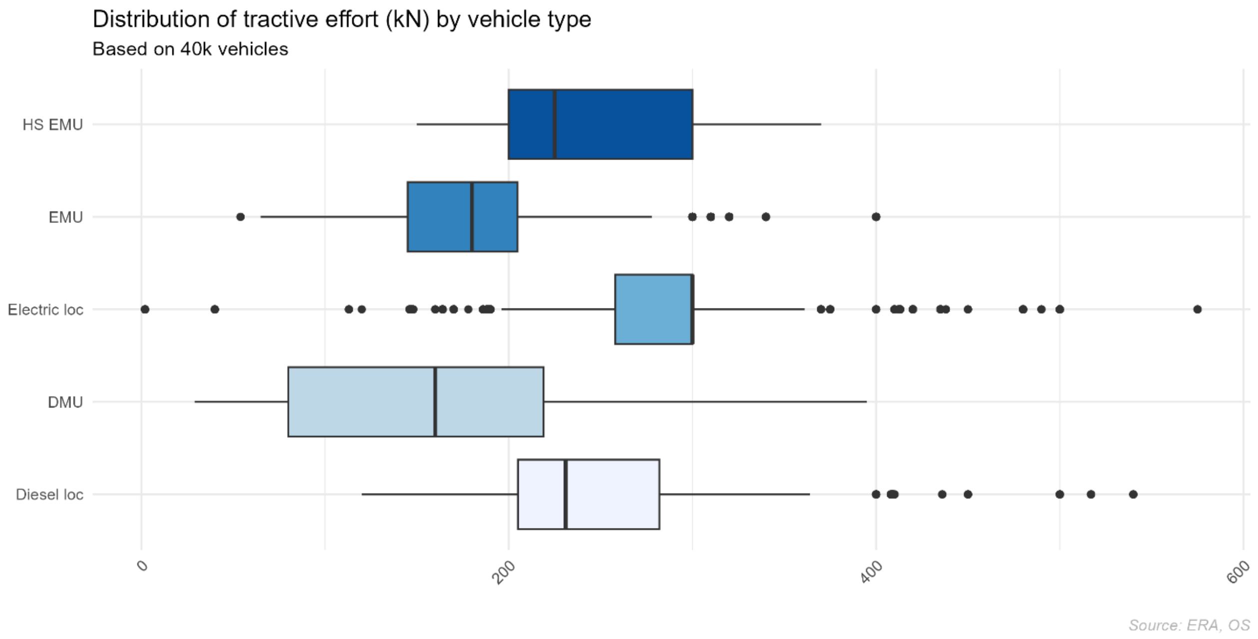
3.6. Tractive effort

3.6.1. Method

OS data was used to determine the tractive effort of vehicles. For about 40 000 vehicles information could be found.

3.6.2. Results

Figure 10



3.6.3. Comments

The exercise showed that for a sizeable number of vehicles the information could be derived from open sources.

At the same time, the usefulness of this variable for statistical purposes was questioned by workshop participants, particularly whether this was useful for trainsets. For other specialised analyses the data could be of use.

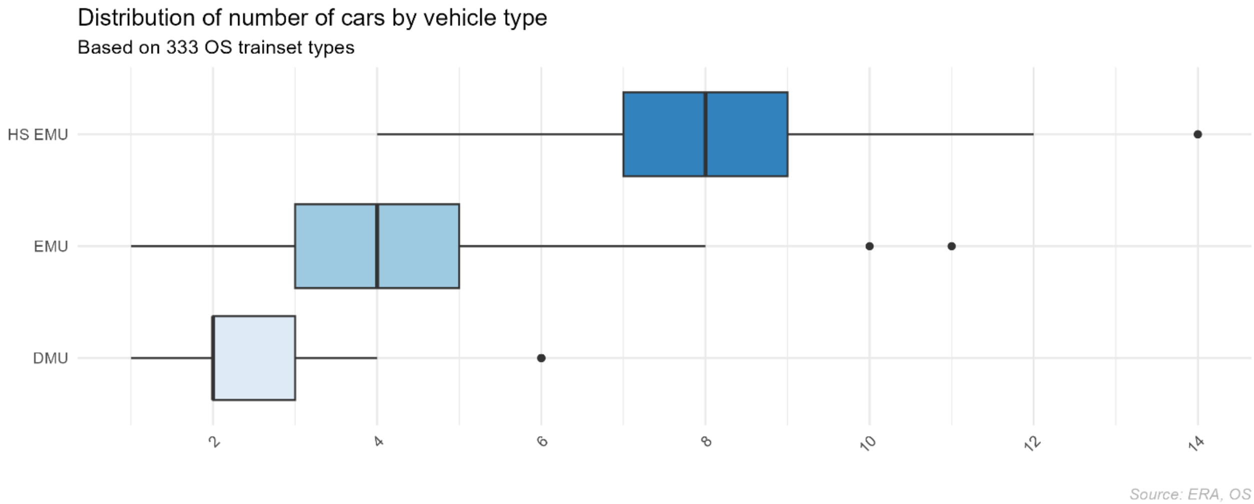
3.7. Trainsets

3.7.1. *Method*

EVR contains no information on which vehicle belongs to which trainset. Each country has moreover its own logic to encode trainsets. For instance, Switzerland was found to apply five different coding methods for trainsets. This makes it cumbersome to define trainsets based on EVN information alone. Instead, OS data was used to understand out of how many cars each type should exist. The number of vehicles per type was then divided by that number of cars. The distribution is shown using boxplots.

3.7.2. *Results*

Figure 11



3.7.3. *Comments*

The results provide an approximation of the number of cars per type of trainset. About 50 000 vehicles could be assigned to 333 T+ types with composition information. This translated into 13 100 actual trainsets. Given the scope and the plausibility of the figures, workshop participants believed that the numbers could for statistical purposes be extrapolated to estimate the number of trainsets per country.

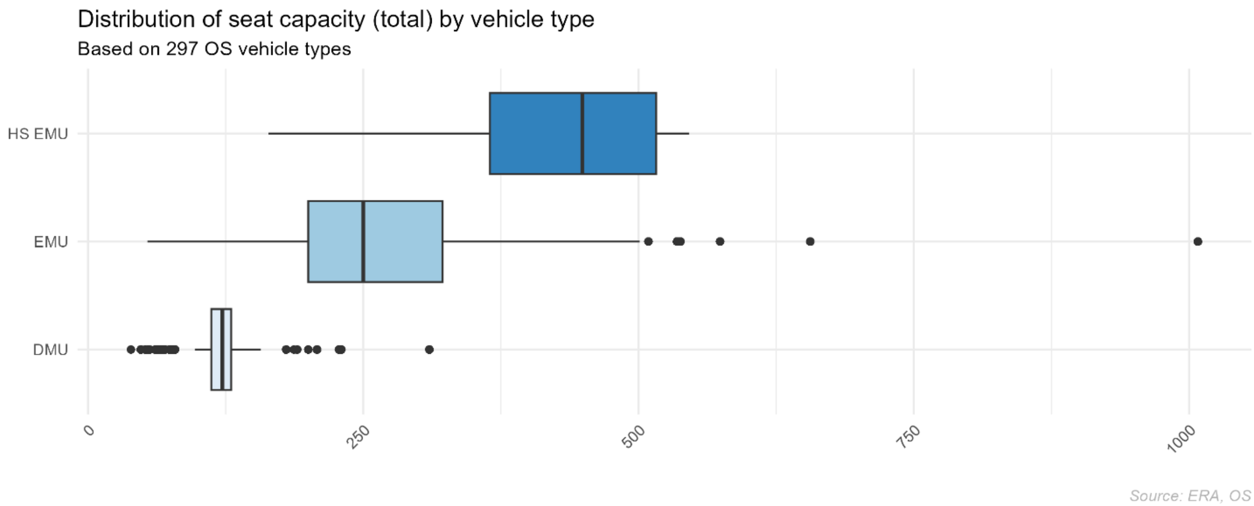
3.8. Seating capacity

3.8.1. Method

OS data was used to determine the seating capacity of trainsets, meaning the total number of seats rather than seats by car. For about 297 T+ types information could be found.

3.8.2. Results

Figure 12



3.8.3. Comments

Similarly to tractive effort, the usefulness of this variable for statistical purposes was questioned by workshop participants. For other specialised analyses the data could be of use.

The main proposal was to change the statistics from number of seats per trainset to number of seats per car.

3.9. ETCS

3.9.1. Method

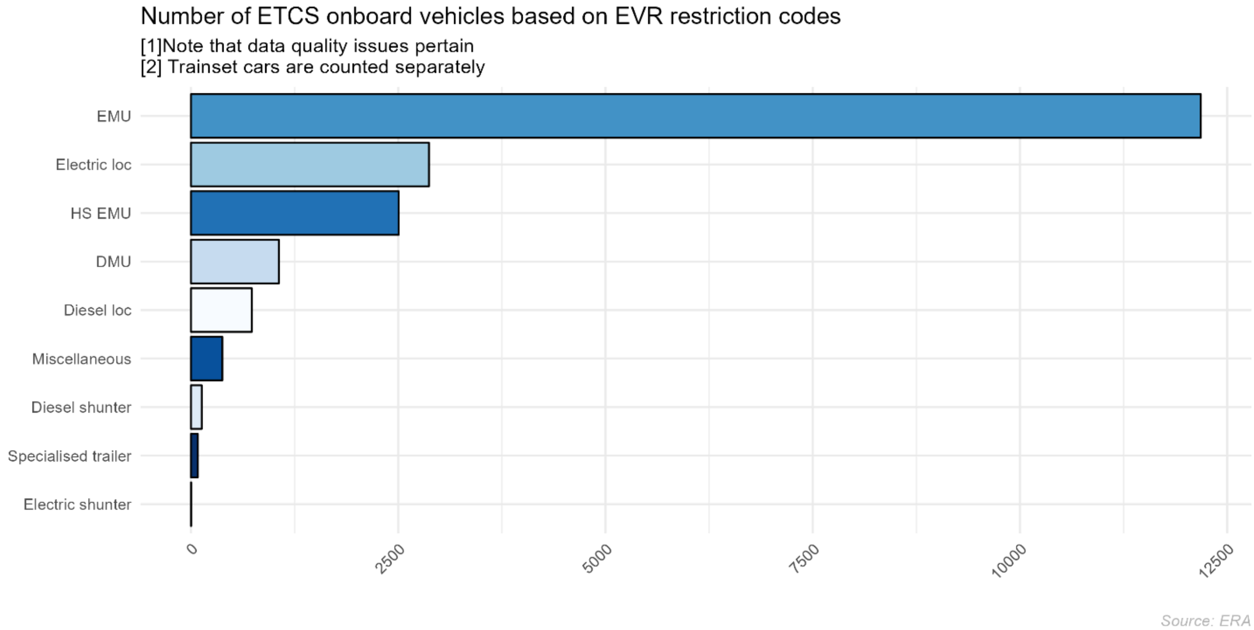
There is a consistently high interest in understanding the level of ETCS implementation. Despite long term efforts to map the status on a European level the results remain incomplete. Unfortunately, OS data provides insufficient insights into this variable and EVR can be used only to a limited extent.

The way how EVR can be used is by analysing the vehicles' restriction codes. Restriction codes are used to indicated if there is ETCS on-board, but do not provide information on the level. The results of this analyses are found in the figure below. Do note that restriction codes are not consistently provided by all registration entities (RE) and, in some cases, may not be up to date.

The analysis could be completed by providing ETCS level information by linking ERATV type information. While that would be valuable it would not lead to a complete overview on ETCS implementation as not all vehicles with ETCS onboard have an ERATV type ID.

3.9.2. Results

Figure 13



3.9.3. Comments

The current data collection efforts on ETCS need to be optimised. Several respectable but cumbersome efforts are undertaken to collect ETCS information by aggregating national and news outlet sources. Yet this makes tracking arduous and carries the risk of double counting.

Workshop participants emphasized the utmost urgency to monitor ETCS implementation. For recent and future vehicles, the link can be made with ERATV type ID information to determine the ETCS level. For vehicles that are not identified through EVR and ERATV yet, it was proposed to contact REs to provide all EVNs for vehicles with ETCS, including information on the ETCS level.

An additional way to collect these data emerged during the workshop consisting in a dedicated survey to RUs with a limited and agreed set of information.

4. Vehicle keeper analysis

4.1. Vehicle keepers

4.1.1. Method

As indicated in section 2.1.1., vehicle keepers were assigned to six types. By linking the VKM types to each vehicle an analysis can be made on the share of the fleet kept by each type and the trend over time.

The type 'Maintenance' includes organisation involved in infrastructure and vehicle maintenance. The 'Operator' type covers railway undertakings and infrastructure managers. The reason was that in some cases there was unclarity if holdings apply a clear split between VKMs used on vehicles for passenger and infrastructure operations.

Some organisations perform multiple activities, such as wagon leasing and maintenance. In those cases, one type was chosen based on the presumed main type of activity.

4.1.2. Results

Figure 14

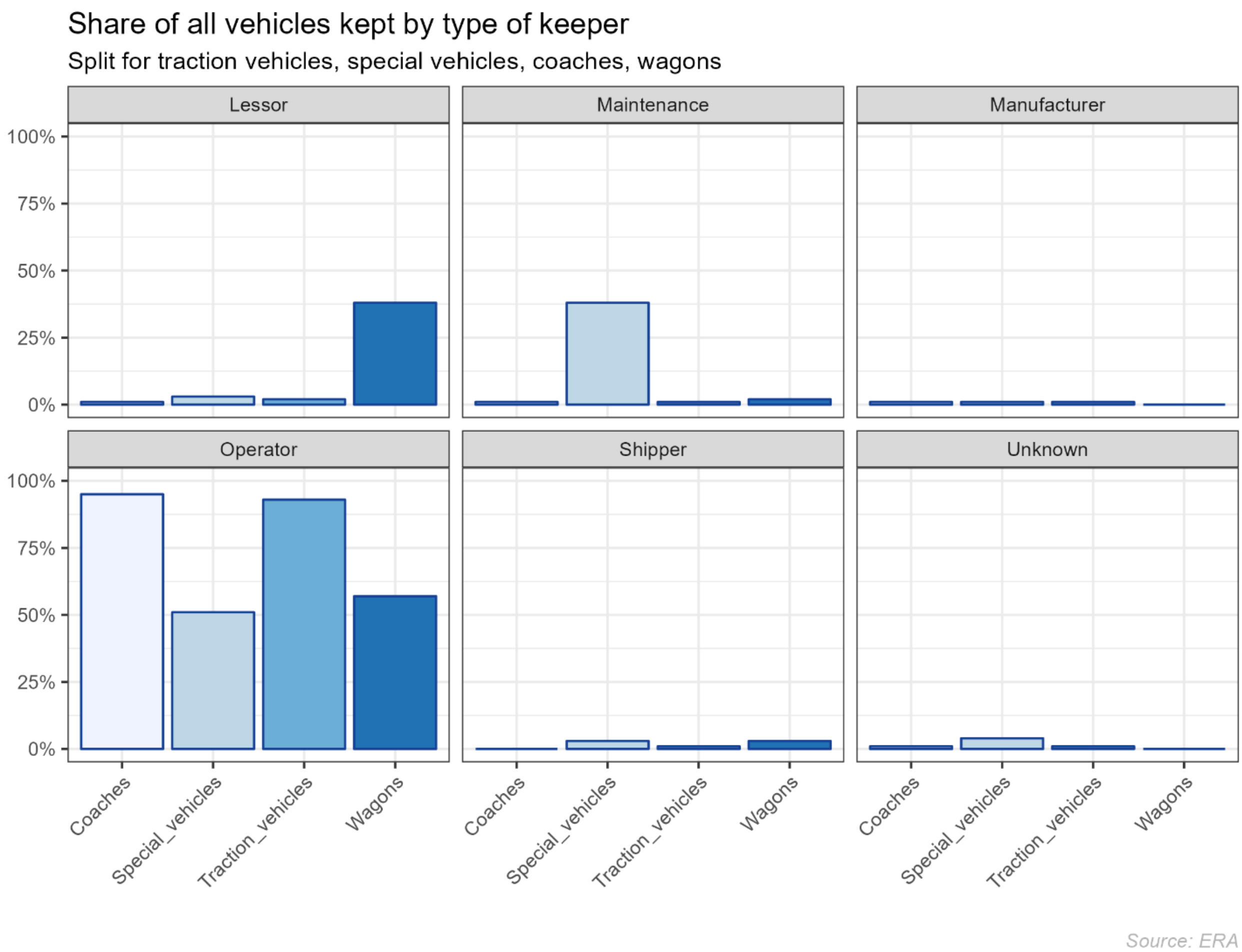
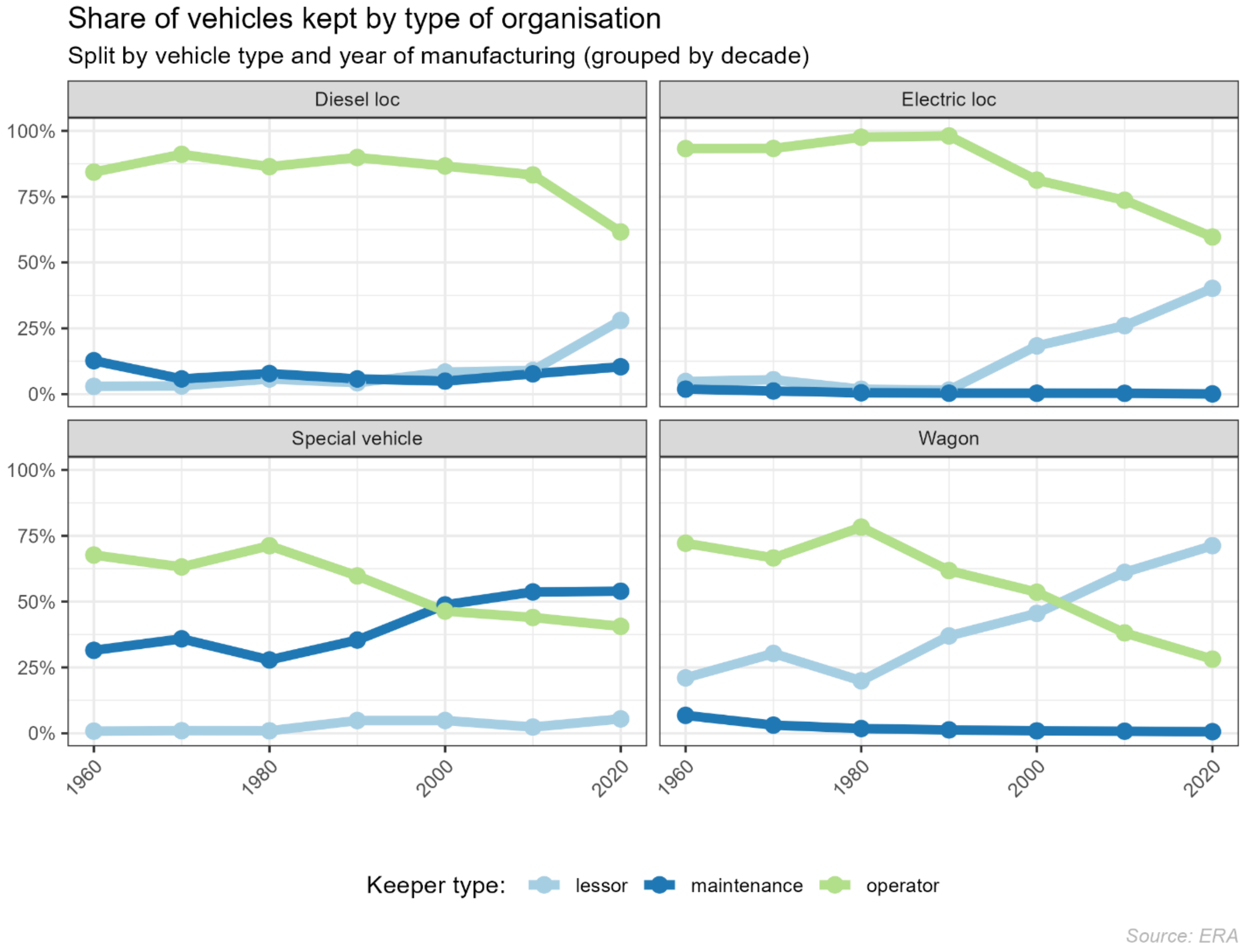


Figure 15



4.1.3. Comments

The figures show that operators still keep the largest share of the fleet. This holds particularly true for coaches and traction vehicles. Yet lessors are increasing their share. Already over 38% of the wagon fleet is kept by lessors, and modern electric and diesel locomotives are also increasingly kept by lessors. This shows a fundamental shift in the keepers of the European wagon fleet, with consequences for how the fleet operates and how it is financed.

Workshop participants asked the Agency to build on these findings and further assess how the fleet is managed in terms of ownership and maintenance.

5. Rolling stock needs analysis

5.1. Rolling stock needs

5.1.1. Method

The ESG requested if an estimate could be made on future vehicle needs and the financing implications. This is particularly relevant in light of the European ambition to double rail freight and triple high-speed passenger transport by 2050. This request is challenging and requires a dedicated study. This report can however contribute by providing initial insights into three aspects, namely:

- *Vehicle age*
  EVR was filtered for vehicles with withdrawal code "33", meaning that they have been scrapped. The age at scrapping was determined for about 154 000 vehicles. The distribution by vehicle category was subsequently plotted.
- *Vehicle utilisation*
  This analysis is based on wagon number statistics from EVR for the EU and AAR for the USA. The tkm statistics were received from Eurostat and the US Bureau of transport statistics.
- *Vehicle prices*
  The method to assess vehicle prices is described in section 2.1.4.

Acknowledging that fleet demand is influenced by a wide range of other factors, the analysis does provide insights, points to knowledge gaps, and advances ideas for a future rolling stock needs analysis.

5.1.2. Results

Figure 16

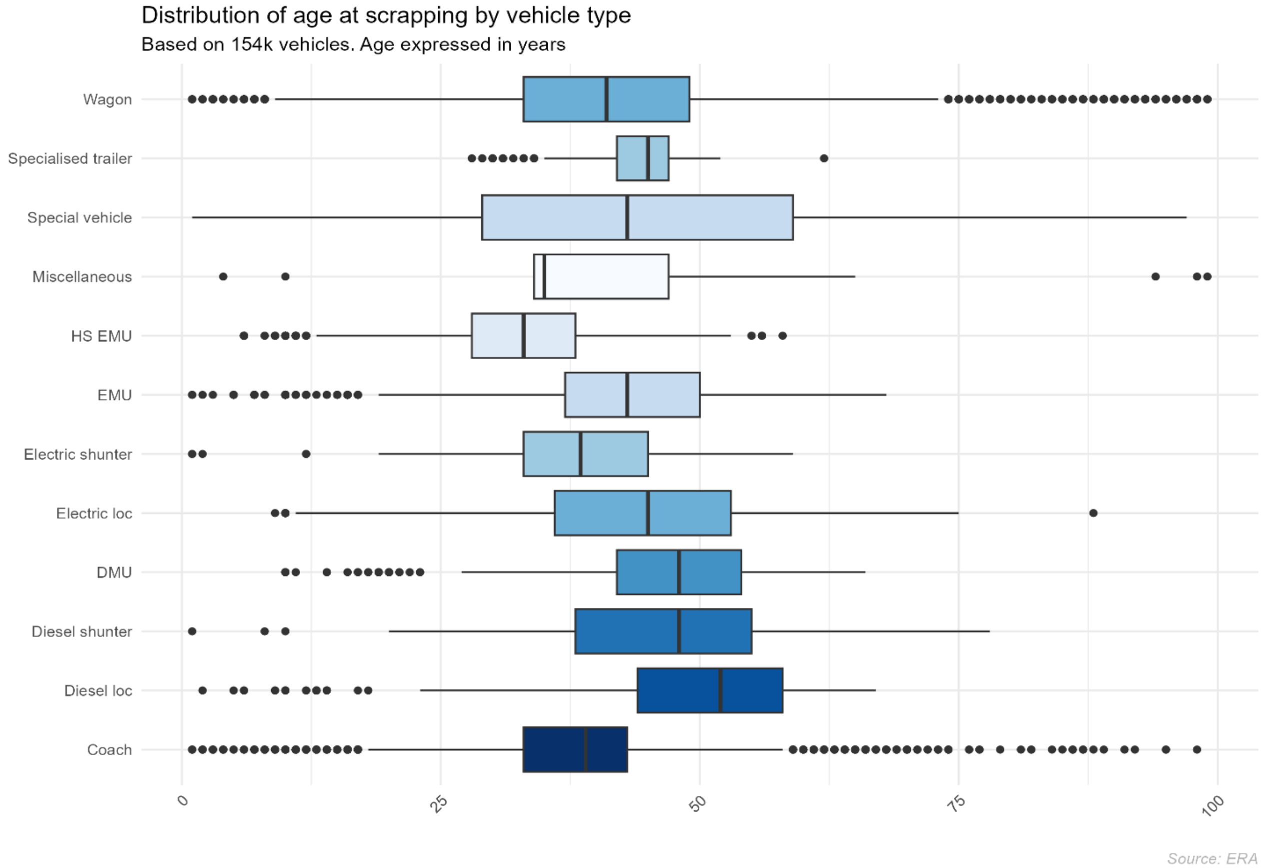


Figure 17

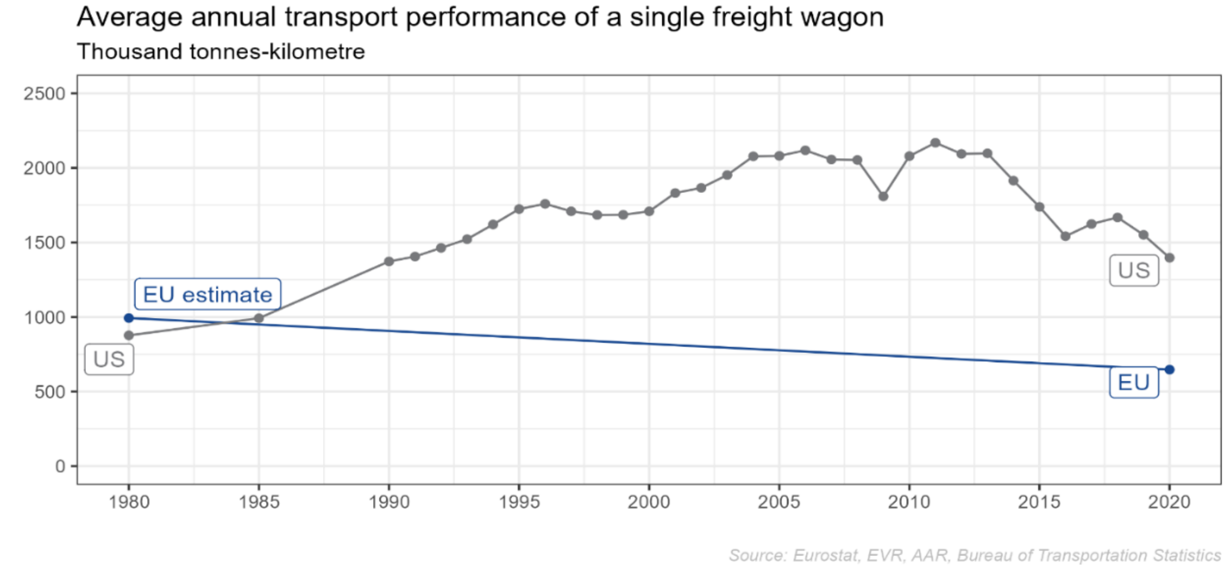
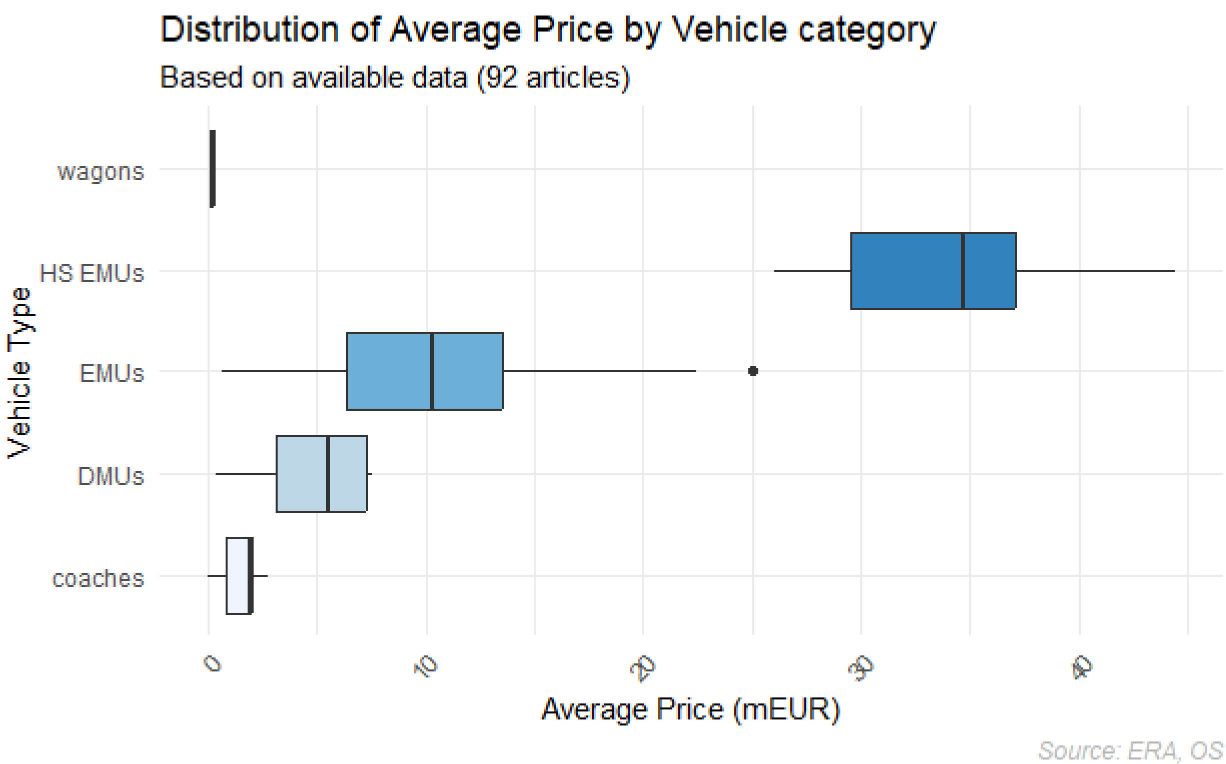


Figure 18



5.1.3. Comments

In order to determine the European rolling stock and financing needs till 2050 several additional analyses are needed. Below several considerations are shared.

First a better understanding is needed on which vehicles are actually running. The tonnes-km performance per wagon was developed based on the total number of wagons in EVR. However, it is believed that many vehicles are standing idle. A pan-European analysis of operational train composition data would enable to determine this.

Second, Figure 16 indicates the age distribution when vehicles are scrapped. It does not provide information on how much each vehicle is running at different stages of its lifetime. Linked to the previous point, a wagon may be used for 40 years after which it stands idle for 5 more. Extensive operational vehicle data is needed to determine this on a European scope.

Third, the utilisation analysis needs to be expanded to other vehicle types and it should be discussed what the most appropriate utilisation indicator is. For instance, Figure 17 uses tkm as a normaliser. But in light of a shift from heavy bulk goods to containers it is questionable whether tkm per wagon is an appropriate indicator to define and compare vehicle utilisation in the future. Workshop participants suggested that explanatory statistics for utilisation, like average operational speed, should be thoroughly analysed, too.

Fourth, it needs to be assessed what the future utilisation rates shall be considering investments in infrastructure, improved interoperability and changes to the European legislative framework on railways. In light of these changes the expected prices of vehicles should be assessed, too.

Finally on the price analysis, results revealed that HS EMUs were the most expensive vehicle category, followed by EMUs, which were more costly than DMUs. Regarding the price for HS EMUs, it was noted that the higher price can be largely explained by the greater number of cars compared to DMUs[8]. Workshop participants added that it would be valuable to present the figures per car, seat and meter. That said, the prices both in terms of differences between vehicle categories and of magnitude were believed to be very plausible.

The price analysis could be further enriched by: 1) providing additional statistics related to prices by regions, by year etc. extracting more detailed information from the researched articles; 2) including additional vehicles categories (e.g. locomotives etc.); 3) complementing transaction costs with additional data sources (including second-hand rolling stock); and 4) providing statistics at car-level, linking the extracted price information with EVNs.

[8] Note that on average DMUs are half the size of EMUs (2 cars versus 4 cars). The number of cars should be considered for future extensions of the current analysis.

6. Discussion

6.1. Observations

Based on the study the following observations can be shared.

There is a significant amount of OS data available, and numerous parallel vehicle registers have been identified. Notably, a large volume of vehicle data to which access is restricted under the EVR Decision is freely accessible on the internet.

For this study OS data was thoroughly analysed and scripts were created to unlock knowledge embedded in ERA Registers. By doing so ***this study improves the insights into the interoperability of the European railway system and V+, T+ and K+ can be leveraged to strengthen policy and financing decisions,*** for instance for topics where the retrofitting of the fleet is analysed like DAC and ETCS*.* Additionally, the study helps to assess the data quality of ERA registers and can inform data cleaning activities.

Despite the added value of V+, T+ and K+ and the insights that were derived from these sources, it should be emphasized that this is only a partial solution. The OS based improvements are limited by data availability and accuracy. Leveraging OS data is moreover a cumbersome and time-consuming exercise. Additionally, OS data focuses mostly on the mechanical characteristics of vehicles, while signalling characteristics are less readily available.

For future vehicles the default linking between EVN and ERATV ID will ensure that relevant information on the interoperability of the European fleet is largely known. For legacy vehicles an alternative approach, like the one developed in this report, would need to be considered and further implemented.

Importantly, despite the novel insights, this study provides a stark reminder that the current level of fleet insights for railways is significantly lower than that for maritime, inland waterway transport and aviation.

This divergence can be linked to different approaches to fleet data access rights and the persistence of data silos. As a case in point, passenger train location data is increasingly shared via national access points. Yet the information is typically not linked to a specific vehicle(s) but to a timetable service number. Moreover, freight train information is largely absent through public portals. This contrasts with what can be seen in aviation (e.g. flightradar24.com) and maritime (e.g. marinetraffic.com), where technical and operational information are accessible to the general public. Greater and simpler data availability enables better analyses and novel applications that benefit the sector.

6.2. Proposals

The following proposals for the Agency are put forward:

1. Collaborate with sector players to improve technical information on vehicle types that are unlikely to receive an ERATV ID through (re)authorisation.
2. Leverage V+, T+ and K+ internally at ERA for higher quality Impact Assessments.
3. Build on the study insights to review data quality of the applicable registers.
4. Evaluate how the updates of restriction codes in EVR can be improved.
5. Use the study insights to improve the statistics for the ERA Railway Factsheets and resolve erroneous EVN based statistics. These statistics could inform EUROSTAT, too.
6. Provide feedback to the OS community on observed inconsistencies and suggest improvements.