
# Study on the competitiveness of the Rail Supply Industry

Final Report

Written by Ecorys in cooperation with VVA and TNO
*September – 2019*

**EUROPEAN COMMISSION**

Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs
Directorate Industrial Transformation and Advanced Value Chains
Unit C.3 — Advanced Engineering and Manufacturing Systems

*Contact:* Unit C.3 — Advanced Engineering and Manufacturing Systems

*E-mail: grow-c3@ec.europa.eu*

*European Commission*
*B-1049 Brussels*

EUROPEAN COMMISSION

# Study on the competitiveness of the Rail Supply Industry

Final Report

Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs
Directorate Industrial Transformation and Advanced Value Chains
2019

***Europe Direct is a service to help you find answers to your questions about the European Union.***

**Freephone number** (*)**:**

**00 800 6 7 8 9 10 11**

(*) The information given is free, as are most calls (though some operators, phone boxes or hotels may charge you).



Luxembourg: Publications Office of the European Union, 2014

ISBN 978-92-79-86728-6
DOI 10.2873/592269



Printed in [Country]

PRINTED ON ELEMENTAL CHLORINE-FREE BLEACHED PAPER (ECF)

PRINTED ON TOTALLY CHLORINE-FREE BLEACHED PAPER (TCF)

PRINTED ON RECYCLED PAPER

PRINTED ON PROCESS CHLORINE-FREE RECYCLED PAPER (PCF)

# Contents

# EXECUTIVE SUMMARY

## Context of the study and research questions

The European rail supply industry and thereby its competitiveness is very important for Europe's economy. Therefore, the European Parliament adopted a resolution on 9 June 2016 on the Competitiveness of the European Rail Supply Industry (RSI)[1], which was supported by the European Commission in its response on 4 October 2016. The Commission's response stresses the importance of the opportunities provided by:

- improving the single market and encouraging demand for rail products;
- international agreements such as the Government Procurement Agreement (GPA);
- bilateral agreements in the form of Free Trade Agreements;
- renewing the European rail industry's research and innovation agenda;
- protecting European rail technology and its intellectual property rights;
- improving employment and skills for the RSI;
- digital railway applications such as ERTMS;
- EU public procurement rules;
- and boosting investment in rail transport.

In order to monitor the above points as well as other factors influencing the competitiveness of the European RSI, DG GROW established in 2018 an Expert Group on the Competitiveness of the Rail Supply Industry. Furthermore, they requested an independent study analysing the competitiveness of the European Rail Supply Industry. The latest analysis of the sector carried out for the Commission was provided in a Sector Overview and Competitiveness Survey of the Rail Supply Industry in May 2012. During the last seven years, the sector has undergone several changes due to economic and technological evolutions and geopolitical alterations. It is therefore necessary to update the study.

The main objective of the study is to provide an updated overview over the competitiveness of the European RSI and analyse its positioning in the world market including its future trends and opportunities. In particular, the study should explore the decisive factors influencing the competitiveness of the European RSI: its capability to innovate, to adapt to changes, to conquer new markets, trade patterns, global competition as well as the analysis of the main economic factors such as turnover, employment, investment and more.

## Main findings of the study on the economic importance of the EU RSI

The railway supply industry is an important industry sector for Europe, with a turnover of EUR 49.2 billion and a value added of EUR 15.2 billion in 2017.

The segment of manufacture of railway locomotives and rolling stock including repair and maintenance employs almost 200,000 people, with another 97,000 people working in the construction of railways and underground railways (2017 numbers). The **railway supply industry** constituted 0.2% of all enterprises and 0.7% of all persons employed, 0.4% of turnover and 0.7% of the total value added in the EU manufacturing industry. Since 2011, the sector has seen a general growth.

In **production value**, the manufacture of rolling stock and locomotives is the most important segment of the RSI (EUR 31.2 billion) followed by the rail infrastructure segment (EUR 10.2 billion). The segment of signalling and electrification follows at a distance (EUR 1.4 billion). Between 2011 and 2017, the production value increased by approximately 11%. The largest share of the production value can be attributed to the manufacture of locomotive and rolling stock (+15%), followed by signalling and electrification technology (+2%), and rail infrastructure (+0.3%).

The **rolling stock and locomotives segment** employs some 106,000 people in Europe in 2017. A few major players are leaders on the global rolling stock industry market: CRRC (China), Siemens (Germany), Alstom (France) and Bombardier (Canada/Germany). In 2018, there were 1,831 companies active in Europe in the segment of rolling stock and locomotives,

[1] P8 TA(2016)0280.

approximately 16% of which were SMEs. For **rail infrastructure** a high degree of specialisation is encountered. In 2018, there were 350 companies active in Europe with 17% of them being SMEs. A high number of components is being produced locally (e.g. rails, fastenings, sleepers), only high value components are mainly produced in EU. The European market for **signalling and electrification technology** is rather fragmented and served by various companies. Large companies that act on the signalling market include Alstom, Siemens, Thales and Bombardier. In total, 344 companies were active in Europe in 2018; of these 21% were SMEs.

In terms of **international trade** the rolling stock and locomotives market is by far the largest and most globalised market. The sources of imports of the rail products to the EU are highly concentrated in 10 countries (90%): Switzerland, Japan, China, the United States, Ukraine, South Korea, Russia, Norway, Turkey and Serbia. In contrast, exports are less strongly concentrated. The majority of exports (60%) in 2017 went to Switzerland, China, Saudi Arabia, USA, Norway, Turkey, Australia, Russia and Brazil. The total value of exports has been stable over the years and was at about EUR 5,783 million in 2017. The total value of imports, on the other hand, has increased since 2014, reaching around EUR 2,456 million in 2017.

## Main findings of the study on the competitive position of the EU RSI

The **European RSI remains a major player** in the global RSI market, despite slowing down between 2009 and 2013, it recently recovered its growth rate to approximately 5% per year. The manufacture of railway locomotives and rolling stock experienced a growth in enterprises, turnover, value added, and number of persons employed; however, this growth is lower in magnitude when **compared to peer EU transport manufacturing industries**. When compared to other industries, the European RSI lags in terms of export intensity. Furthermore, gross investment per person employed was below the average in EU manufacturing largely due to the long period for return on investment in some RSI products. However, recent trends indicate an increase of R&D investment in the rail sector.

The **EU remains the largest net exporter since 2000**, with the only exception of 2005 in which Japan presented a higher value of net exports. **EU RSI companies are the main foreign suppliers on established RSI markets outside the EU**. European companies Siemens (8 Billion EUR) and Alstom (7 billion EUR) are the worldwide leaders in terms of rail industry turnover, only after Chinese CRRC (30 billion EUR), whose turnover is largely based on its huge domestic market.

In terms of **market shares**, the European RSI has the highest market share among imported products in China, Japan and South Korea and considerable presence in the Russian and USA markets. In China, there was a reduction of imports from all main trade partners. In contrast, in Japan the share of the European locomotives and rolling stock producers increased since 2014. The EU is also a market leader in South Korea, with 30% of the imports having origin in the European RSI; however, Chinese exports to South Korea also increased and it is expected that China might become the main exporter.

However, the **global RSI market is changing.** China started to become a key player. Fuelled by strong internal demand, often of public investment nature, the Chinese RSI has seen its production grow exponentially. Combined with investments in R&D by Chinese companies in the RSI, this indicates a new role for Chinese RSI not only in terms of ability to satisfy the internal demand, but also as a role of exporter. China became a net exporter in 2010 and started gaining international market share ever since, especially in developing countries in south-east Asia and Africa. Japan's RSI is also almost self-sufficient with the share of imports in the consumption representing only 2% of the total. **Trade barriers** in the RSI sector continue to hinder the trade of RSI goods, with the percentage of exports representing only a limited part of the total production for all the major global players.

**Employment** on RSI sector remains overall constant, with the rail supply industry to continue to represent an important source of jobs both for low and high skilled workers. Employment numbers have grown in the EU's locomotive and rolling stock segment by approximately 1% from 2000 to 2017. China, Russia, and India employ by far the largest number of workers, in total more than 1 million people.

**SMEs** continue to represent a fundamental source of **innovation**, know-how, and highly specialised workers in the manufacturing segment. The cooperation between large companies and SMEs increased which can lead to benefits for both parties. Large companies benefit from

SMEs through the innovative solutions they provide and their specific expertise. In contrast, SMEs benefit from access to important projects, contracts, or investments as subcontractors and they can also allow major companies to cover the commercialisation aspects of the new solutions developed, which represents a difficult aspect for SMEs. However, access to finance to promote R&D projects as well as protection of intellectual property rights (IPR) when going abroad, represent two of most critical areas for SMEs. IPR plays an overall important role in the RSI. It is in particular German and French companies which play a major role for the EU when it comes to newly granted patents and registered industrial designs. In a worldwide comparison, Chinese and Japanese companies are the most intensive in IPRs.

**Innovation** remains one of the key elements of success of European RSI. R&D, ad-hoc cooperation projects to share knowledge and capabilities between companies, as in the case of ERTMS, appears to be an excellent way to maintain the innovation. The joint participation of the railway industry in the development of the ERTMS technical solution and standards was essential for its success. Despite the technical standardisation, operation rules remain national based and are still a barrier for seamless cross border rail operations. ERTMS has been successful in its implementation outside Europe, but deployment in the EU remains low due to the additional costs required to ensure compatibility with national legacy systems. Nonetheless, the sector managed to maintain a leading position globally thanks to various initiatives related to stimulation of R&D&I, e.g. by means of the Shift2Rail Joint Undertaking. This investment in R&D&I may be necessary in light of the significant investments taking place in other regions, most notably China. Initiatives in the field of digitalisation will support the RSI in maintaining a leading position in the near future.

**Public investments** in infrastructure, from EU funding instruments—such as EIB's investment, CEF, and the TEN-T programme—as well as national investment allowed under the State aid framework have helped to stimulate demand for RSI products and the industry to remain dynamic. Nonetheless, there is still significant room for additional investment to meet the ambitions set out in plans, such as Rail 2050 vision, the Transport White Paper, TEN-T and the Single European Railway Area. As such, the sector has not received optimal support in the form of public infrastructure investments from all national governments.

Contributing to the overall positive competitive position of the RSI over the past years has been the stimulation of the internal market, by means of **competition** and **public procurement** on the basis of best-quality-price-ratio, also known as the MEAT principle (most economically advantageous tenders). The ambitious design objectives fixed by the procurement tender technical specifications together with MEAT principles incentivises companies interested in participating in the tendering process to develop and propose new technologies and solutions. However, still in 2016 close to 50% of RSI tenders were awarded based on the lowest price, though the numbers are decreasing.

## Future outlook of the EU RSI

There are various factors favouring the future development of the EU RSI. Among these are the advancing **European integration** and **harmonisation of the internal market**. The envisioned Single European Railway Area and its ambition to create by 2020 an interoperable trans-European rail system can boost the RSI by creating more demand, but also by improving the functioning of the internal market. Combined with investments into TEN-T core network corridors and into a single European train control and communication system in the form of ERTMS, this can revitalise Europe's railways and the industry supplying them.

In addition, **climate change** and the challenges related to it pressure Member States and the EU to improve environmental protection and to move towards more energy efficient means of transport. Climate change is high on the political agenda in many states. Already, one can observe countries increasing investments in more sustainable modes of transport, such as rail, and increasing charges for often more convenient but less environmentally friendly modes of transport.

Next to these factors, there are future positive trends affecting the RSI. For example, the rapid **urbanisation** requires cities to update their mass transit systems and invest into metros or light rail systems to avoid traffic backlogs. Similar, an **ageing society** will require more and better public transport infrastructure. Next to buses, rail is well placed to provide this infrastructure. The RSI can benefit from the trend towards to **intermodal transport** by positioning rail into becoming the backbone of future transport concepts by providing central

nodes for both passenger and freight transport. Finally, forecasts expect **continued growth of the global rail supply market** with the highest expected growth rates in Latin America, Africa, and the Middle East, where the EU RSI might find new export opportunities.

There are also several **challenges** ahead of the EU RSI. Some challenges such as interoperability issues due to national legacy systems and lack of public investment in rail infrastructure, seem to be addressed by continued political effort in harmonising the internal market and policy changes due to climate change. However, for others it remains to be seen how they will be addressed.

For example, **international competition** has increased, especially due to China's RSI increasingly exploring export markets. Huge investments by China in its own rail systems especially its high speed network, forced and induced technology transfers have led to China catching up in many RSI technologies. In addition, China's Belt and Road Initiative and the investment it provides into infrastructure development in third countries, show ambitions to gain market shares globally. Moreover, the use of state support and financing, export credits and in some cases development aid, help China's RSI access third markets, including to a limited extent the EU's own internal market. In addition, through foreign direct investment, Chinese companies are creating a foothold in the EU market.

In addition, the world has recently seen a revival of **protectionism** with many countries reducing market access for foreign competitors by either supporting local production (e.g. Buy America rules), implementing requirements for joint ventures with local partners, or by reducing transparency of procurement markets. Overall, a negative trend can be observed with many countries establishing market access barriers and as a consequence, export markets have shifted mainly due to the constantly dropping and currently very low accessibility of the Chinese market to the Middle East, Central Asia and Latin America.

Finally, the rail supply industry already faces a **labour and skills shortage**. Combined with a decreasing workforce due to ageing, perception of an unattractive sector, and changing skill requirements due to the digital transformation, it is expected this shortage could increase in the near future.

## Policy recommendations

The study on the competitiveness of the EU RSI reveals that the position of Europe is strong and as in many other competing countries is fed by high demands from its domestic market. In global trade Europe holds a lead position, especially in the delivery of more complex technological solutions. Key strengths of the European RSI as indicated in the study are its leading position in advanced technologies, the well-developed design and production methods, the high level of quality and quality control processes leading to a high reliability, the ability to smartly integrate services into product delivery, and long experience in general in improving operational and maintenance processes.

In the future, demand may also change. The demand for higher energy efficiency may increase, but also safety and security of transport will receive high and increasing attention. EU RSI have a unique position to profit from this development by further exploiting its technological advanced position.

Thus a number of challenges and opportunities are observed that form the basis for the recommendations. These recommendation address four areas:

- The internal market;
- The global market;
- Innovation and standardisation;
- Labour demand and skills.

***1. Stimulate and strengthen the internal market:***
In order to strengthen and stimulate the internal market for rail supply products, there are a range of policies that could be further enforced. First of all, market demand may be increased by stimulation of public investments into rail infrastructure from Member States and the EU (e.g. Connecting Europe Facility). Secondly, the shift from road and air to rail transport should be further encouraged by promoting it as a sustainable alternative and introducing measures

that aim to internalise the external costs of transport. Promoting the application of the MEAT principle in the domain of railway procurement. This allows the industry to move further away from purely cost-based competition in favour of competition based on broader value-added. The Commission has published guidelines for green procurement and innovation procurement. Another prominent initiative in this field is the development by UNIFE and the European rail community (CER, EIM) of joint sectoral recommendations on best value procurement in the rail sector. The Commission and Member States should further support these guidelines and initiatives. Finally, a more rapid roll-out of ERTMS should be stimulated across Europe's railways. This would also include support of training of the workforce and stronger mandates, and possibly more resources for ERA.

***2. Promote and enforce a level-playing field on the global market:***
With respect to access to foreign markets for EU rail suppliers, the current initiatives of the European Commission should be continued and flanked by additional measures. Monitoring of and acting on barriers to market access, non-tariff barriers, procurement strategies and forced technology transfers, should be continued. Bilateral and multilateral instruments such as free trade agreements (FTAs) and the government procurement agreement (GPA) should be pursued. Here, continued negotiations and implementation of FTAs as well as promoting the accession of third countries to the GPA in order to open up new market opportunities is advised.

As a flanking measure, in order to increase leverage, the concept of reciprocity in access to procurement markets should be enforced, including, if necessary, the possibility of sanctions in case satisfactory market access cannot be achieved by negotiation. The proposal by the European Commission of the International Procurement Instrument (IPI) is considered to be the most effective action available. Continuation of this policy and solving the deadlock in the Council is advised.

Finally, one important factor causing an imbalance in the international level playing field concerns state support and export credits. A reform of the OECD Rail Sector Understanding (RSU) on export credits or at least the introduction of a guarantee mechanism to bridge the gap with non-OECD countries (e.g. increased loan tenure duration, flexibility in applying the rule of minimum national content) should be investigated.

***3. Further support the European RSI's innovation capabilities and promote standardisation:***
Maintaining the technological advanced position of Europe is key in retaining its future competitive positions. Therefore, a continuation of the dedicated collaborative R&D partnership Shift2Rail should be ensured under Horizon Europe. Moreover, instruments facilitating the deployment of the innovative technologies within Shift2Rail should be explored. Here, especially cooperation between SMEs and the promotion of partnerships between SMEs and large companies as well as providing better access to finance should be encouraged. This could lead to more innovation being introduced to the market. The aim should be to build up an effective SME network or cluster, which could increase the sharing of knowledge and increase the visibility of SMEs for potential partnerships and private finance.

In order to make innovations most effective, a leading role of the EU in the standardisation process should be maintained. To this aim, the EU should continue taking the lead in fostering the cooperation between industry players for the development of industry standards when required.

The use of ERTMS in third countries (by promotion) and in the EU (by funding) should be further encouraged. Internally, EU funding schemes can be used as a tool to promote the adoption of common rules of operations across Europe by requiring that beneficiaries of EU funding implement common operating rules across the EU. Finally, progressive regulation can drive innovation and market adoption of innovations in the fields of safety, security, and energy efficiency in rail transport.

***4. Promote the development of skills and safeguard access to skilled labour for the RSI:***
As in most technical engineering sectors, the supply of technical engineers may become a bottleneck in maintaining the competitive position of the EU RSI. Overall, there is a need to continuously promote technical education in engineering and other relevant sciences and to make the sector more attractive, including attempts to increase the share of women in technical professions. The EU Blueprint for Sectoral Cooperation for Skills (launched as part of the New

Skills Agenda) encourages the establishment of frameworks of cooperation between key stakeholders. Recently, the rail supply and transport industry was added as a sector eligible for the 4th wave of the Blueprint project. This framework can provide a forum to better address the skill gaps and promote the RSI as a high-technology and attractive sector for workers, and should therefore be supported. Furthermore, for skill development, the recommendations of the S2R initiative should be taken over. The recommendations with relevance for the RSI include, inter alia:

- Enhance cooperation between vocational education, academia and companies;
- Encourage companies to support higher education (academic) apprenticeships;
- Facilitate the transfer of workforce and labour mobility by supporting the development of alternative learning systems and lifelong learning approaches.

# 1. INTRODUCTION

The European Commission (EC DG GROW) has commissioned ECORYS and VVA under the Multiple framework contract for the procurement of economic studies and analysis related to impact assessments and evaluations (575/PP/2016/FC) to carry out a study describing the current situation and the future outlook of the railway supply industry (RSI), comprising of the manufacturing sector of rolling stock and locomotives, signalling and electrification equipment, and some other components used by railways.

The results presented in this report consists of information from statistical data sources, information from literature, and information from interviews. The final results were validated with a survey. Together, they form the evidence base for the study.

## 1.1. Context and background

The competitiveness of the European rail supply industry is important for the growth of an important European sector. In response to the European Parliament resolution of 9 June 2016 on the Competitiveness of the European Rail Supply Industry (RSI)[2], DG GROW's reply contains the actions that the Commission intends to take to address the challenges faced by the industry.

The latest analysis of the sector carried out on behalf of the Commission was provided in a Sector Overview and Competitiveness Survey of the Rail Supply Industry in May 2012. During the last 7 years, the sector has undergone several changes due to geopolitical alterations, economic and technological evolutions. It is therefore necessary to update the study.

## 1.2. Study Objective

The main objective of the study is to provide the economic and competitiveness overview of the European rail supply industry and analyse its positioning in the world market including its future trends and opportunities. In particular, the study should explore the decisive factors influencing the competitiveness of the European RSI, its capability to innovate, to adapt to changes, to conquer new markets, trade patterns, as well as the analysis of the main economic factors such as turnover, employment, investment, etc.

## 1.3. Structure of this report

The structure of this report is as follows:

- Chapter 2 discusses the RSI sector, its taxonomy and its main sub-segments;
- Chapter 3 presents the economic importance of the RSI;
- Chapter 4 analyses the competitive position of the RSI *vis-à-vis* its main competitors;
- Chapter 5 presents the findings on the regulatory and framework conditions that impact the sector and its competitiveness;
- Chapter 6 presents a strategic outlook for the sector.

The annexes of this report contain supporting information on the implementation of the tasks and the findings.

[2] P8 TA(2016)0280.

# 2. DEFINING THE RAIL SUPPLY INDUSTY (RSI)

## 2.1. Taxonomy of the RSI

In order to be able to arrive at exhaustive definition of railway supply industry, a clear understanding of the stakeholders with their roles and stakes is required. However, specific literature including a definition of railway supply industry – which is the focus of the current study – is scarce.

### 2.1.1. *Definition and segmentations of the RSI*

The starting point for the segmentation in the grouping applies to the previous study on the competitiveness of the Rail Supply Industry: Ecorys (2012). That study groups the railway supply industry into the manufacturers of rolling stock and locomotives, electrification, signalling, telecommunication and track equipment. Ecorys' statistics definition includes the manufacturers of constituents of the railway line, suppliers of telecommunication systems, control command, providers of maintenance for infrastructure, rolling stock and locomotives and other companies in the supply chain of the railway industry (Ecorys, 2012).

Other sources use a similar segmentation. The Railway Supply Institute (US-based) defines the rail supply industry as those companies active in a broad range of products and services, including: freight rail, passenger rail, locomotives, maintenance of way, communication and signalling and equipment leasing. According to Interfleet Technology (2007), the industry can be split into three segments: (1) locomotives and rolling stock, (2) infrastructure and (3) signalling and telecommunications.

One notable source for sector segmentation is UNIFE, which is the representative body for the European Rail Supply Industry. In their 2015 study, they state that the "sector is broadly structured around operators, infrastructure managers and manufacturers", distinguishing four main series of business operations in which utility is added to the goods and services offered:

1. Manufacturers of rail supplies:
   a. Infrastructure (tracks & electrification);
   b. Signalling systems and components;
   c. Rolling stock (trains, locomotives and subcomponents - axles, wheels, interiors, HVAC, energy systems, brakes, doors, bogies, etc…);
   d. Services: engineering and consulting.
2. System integrators (companies that take all the above subcomponents and produce and sell the finalised train set);
3. Passenger and Freight Rail operators (rail operators drive trains, manage passengers, collect fares and handle goods);
4. Infrastructure managers (these companies own the tracks, energy systems and stations, and are responsible for their maintenance).

Building up on the above-mentioned definitions, a consolidated taxonomy of the RSI can be developed. This taxonomy, including definition of sub-segments, is presented in Table 1.

**Table 1 Taxonomy of the Rail Supply Industry**

| Product segment | Sub-segment |
|---|---|
| **1. Infrastructure** | 1.1 Permanent way |
| | 1.2 Civil engineering or designers of the infrastructure |
| | 1.3 Power supply (electrification subsystems) |
| **2. Signalling and control** | 2.1 Electro-mechanical or electrical signalling |
| | 2.2 Safety or equipment for railways or tramways |
| | 2.3 Monitoring tools |
| **3. Rolling stock (incl. locomotives)** | 3.1 (Very) high speed trains |
| | 3.2 Locomotives |
| | 3.3 Multiple units |
| | 3.4 Coaches |
| | 3.5 Freight wagons |
| | 3.6 Metro vehicles |
| | 3.7 Light rail vehicles (incl. tram) |

An important question is the impact of digitalisation on the sector. While digital transformation does lead to some new initiatives (discussed further in sections 2.1.2.3 and 5.7.3), these mainly concern the development of digital versions of existing products and services offered. As such, these initiatives do not form a new segment of the industry, but rather alter the way in which products and services are offered within that segment. As such, they do not lead to significant changes to the taxonomy of the sector as, for example, the taxonomy identified in the previous study (Ecorys 2012).

### 2.1.2. *Description of the RSI segments*

#### 2.1.2.1. The railway infrastructure segment & The signalling, control and electrification segment

Railway infrastructure broadly breaks down into infrastructure and signalling, control and electrification system.

In the infrastructure system, there is one fundamental part: "tracks". The track is the steering base for the train and represents the primary distinction between this form of land transportation and all others in that it provides a fixed guidance system (Railway Technical). The usual track form consists of the two steel rails, secured on sleepers so as to keep the rails at the correct distance apart and capable of supporting the weight of trains. Traditionally, sleepers are wooden, and can be softwood or hardwood (Railway Technical). Nowadays, they are becoming more expensive and other types of materials have appeared, notably concrete and steel (Railway Technical).

Track is the most obvious part of a railway route; however there is a sub-structure supporting the track which is equally important in ensuring the ride for the train. This part consists of two main elements:

1. the formation: it is the ground upon which the track will be laid;
2. the ballast: made up of stones - usually granite or basalt, it provides support, load transfer and drainage to the track and thereby keeps water away from the rails and sleepers.

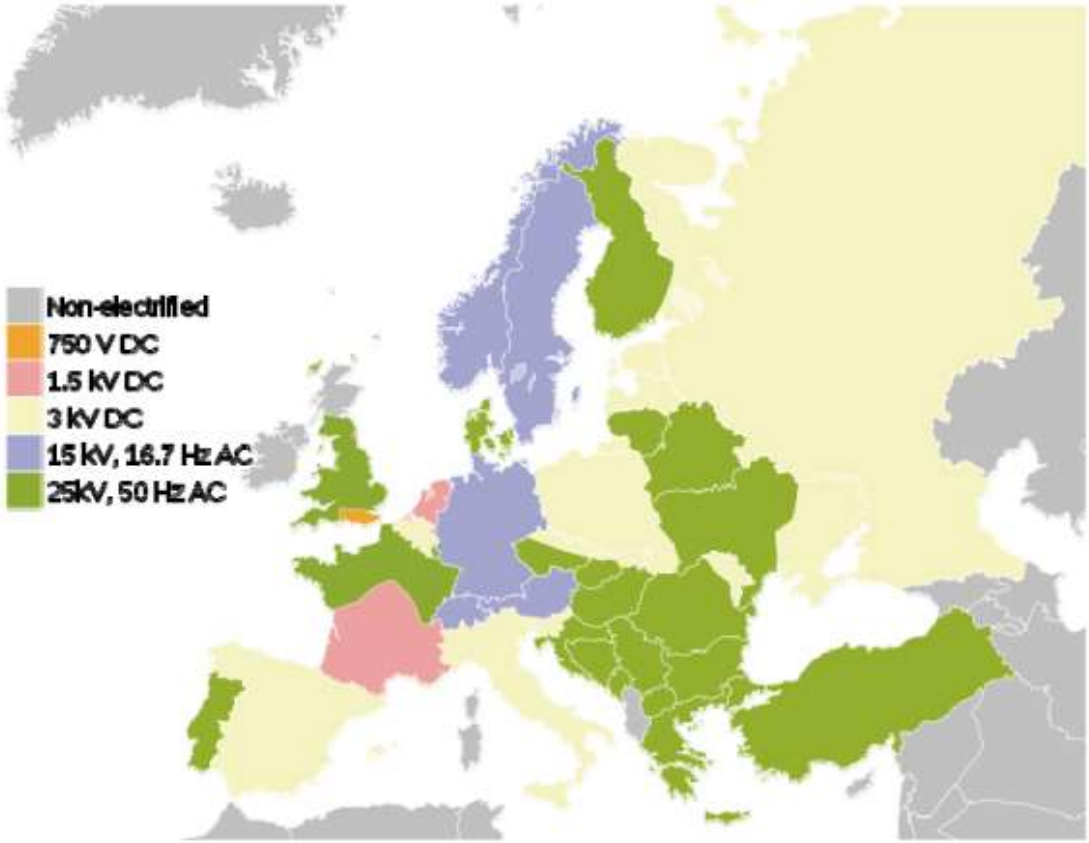
Electrical equipment is needed in both the vehicles and the infrastructure (Ecorys, 2012). Therefore, the signalling and control segment is also closely linked to the rolling stock and locomotives segment. The main sub-systems are electrification and signalling & train control.

Railway electrification provides traction energy to trains, especially to railway trains and trams without an on-board prime mover or local fuel supply. There is a wide variety of electric traction systems around the world, which have been built according to the type of railway, its location and the technology available at the time of the installation (Ecorys, 2012). The energy is usually generated in largescale generating stations and conveyed to the trains by transmission lines to the railway (Ecorys, 2012). The transmission of power is always accessible along the track by means of an overhead wire or at ground level, using an extra, third rail laid close to the running rails (Ecorys, 2012). Through a (continuous) contact, conductor energy can be transferred to trains (Ecorys, 2012).

The main advantage of electric traction is a higher power-to-weight ratio than forms of traction such as diesel or steam that generate power on board (Frey, 2012). Electricity enables faster acceleration and higher tractive effort on steep gradients (Frey, 2012). On locomotives equipped with regenerative brakes, descending gradients require very little use of air brakes as the locomotive's traction motors become generators sending current back into the supply system and/or on-board resistors, which convert the excess energy to heat (Frey, 2012). Other advantages include the lack of exhaust fumes at point of use, less noise and lower maintenance requirements of the traction units (Frey, 2012). Given sufficient traffic density, electric trains produce fewer carbon emissions than diesel trains, especially in countries where electricity comes primarily from non-fossil sources (Frey, 2012).

The main disadvantages are the capital cost of the electrification equipment, most significantly for long distance lines which do not generate heavy traffic (Frey, 2012). Suburban railways with closely-spaced stations and high traffic density are the most likely to be electrified and main lines carrying heavy and frequent traffic are also electrified in many countries (Frey, 2012).

**Figure 1 Classification of electric traction**




Source: Railway Electrification System & Engineering, Sheilah Frey (2012).

Electrification systems are classified by three main parameters (Ecorys, 2012):

1. Voltage: There are many different voltage systems used for railway electrification systems around the world. The permissible range of voltages allowed for the standardised voltages is as stated in standards BS EN 50163 and IEC 60850. These take into account the number of trains drawing current and their distance from the substation:

| Electrification system | Lowest non-permanent voltage | Lowest permanent voltage | Nominal voltage | Highest permanent voltage | Highest non permanent voltage |
|---|---|---|---|---|---|
| 600 V DC | 400 V | 400 V | 600 V | 720 V | 800 V |
| 750 V DC | 500 V | 500 V | 750 V | 900 V | 1 kV |
| 1,500 V DC | 1,000 V | 1,000 V | 1,500 V | 1,800 V | 1,950 V |
| 3 kV DC | 2 kV | 2 kV | 3 kV | 3 kV | 3 kV |
| 15 kV AC, 16.7 Hz | 11 kV | 12 kV | 15 kV | 17.25 kV | 18 kV |
| 25 kV AC, 50 Hz | 17.5 kV | 19 kV | 25 kV | 27.5 kV | 29 kV |

2. Current: Current Electrification systems use either DC (direct current) or AC (alternating current), the former being, for many years, simpler for railway traction purposes, the latter being more effective over long distances and cheaper to install although, until recently, more complicated to control at train level (Ecorys, 2012);

3. Contact System: There are two main contact systems: 1) overhead line (catenary) and 2) third rail and two other less diffused system 3) fourth rail and 4) fifth rail:

   - In the case of overhead systems, the contact conductor is usually a contact wire suspended in a catenary wire system to maintain accurate registration of geometrical position. The trains have a pantograph mounted on the roof, which supports

conducting strips held in contact with the contact wire by a spring system (Ecorys, 2012);
- The third rail system uses a "shoe" to collect the current on the train. Third rail systems can be designed to use top contact, side contact or bottom contact (see figure above). Third rail is more compact than overhead wires and therefore more often used in inner urban areas where part of the track runs underground. AC systems always use overhead wires, DC can use either an overhead wire or a third rail; both are common. Most third rail systems use DC (Ecorys, 2012);
- The fourth rail is an additional rail which carries the electrical return that, on third rail and overhead networks, is provided by the running rails. A heavy "shoe" suspended from a wooden beam attached to the bogies collects power by sliding over the top surface of the conductor rail. The London Underground in England and Milan Metro's line 1 are the few networks that use a four-rail system (Frey, 2012);
- In the case of Scarborough Line 3 in Toronto, the third and fourth rails are outside the track and the fifth rail is an aluminium strip between the running rails.

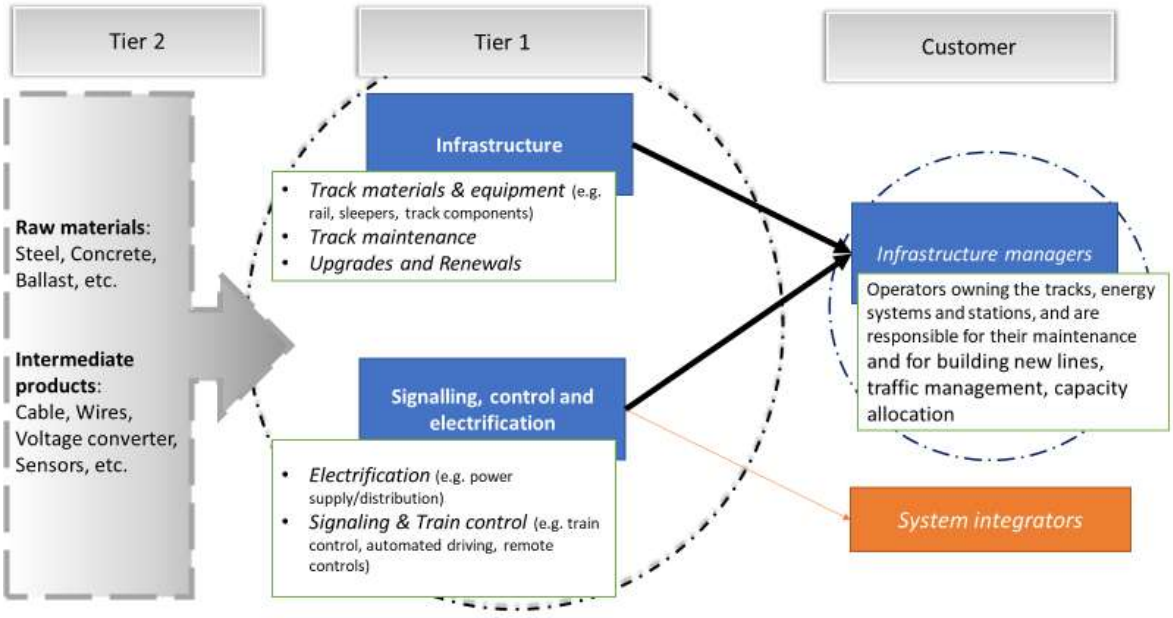
Few companies manufacture solely for the rail industry and solely for electrification (Ecorys, 2012). Some RSI companies in electrification offer complete systems, turn key or BOT (built operate transfer), but act only as a contractor to the client. Components for the whole system might come from smaller companies, specialised in specific products, such as copper cables, transformers, switchgear, poles and other equipment (Ecorys, 2012). These specialised small or medium sized companies usually serve the public power supply market as well, and normally do not show the portion of rail products within their total activity (Ecorys, 2012).

Regarding signalling & train control products, the main sub-systems are: (1) train protection equipment, (2) train operation equipment, and (3) train supervision equipment (Ecorys, 2012). Typical components are now electronic products, including: complex software with high levels of safety integrity; radio-based communications; and advanced forms of display screen used for signalling control, information and communication systems (Ecorys, 2012).

Many of the applications and components used in this segment are also extensively used in other industries, ranging from very high industries to basic industry. However, the high level of safety in addition to the special interface issues associated with railway applications means that despite this there is still a large degree of specialisation (Ecorys, 2012).

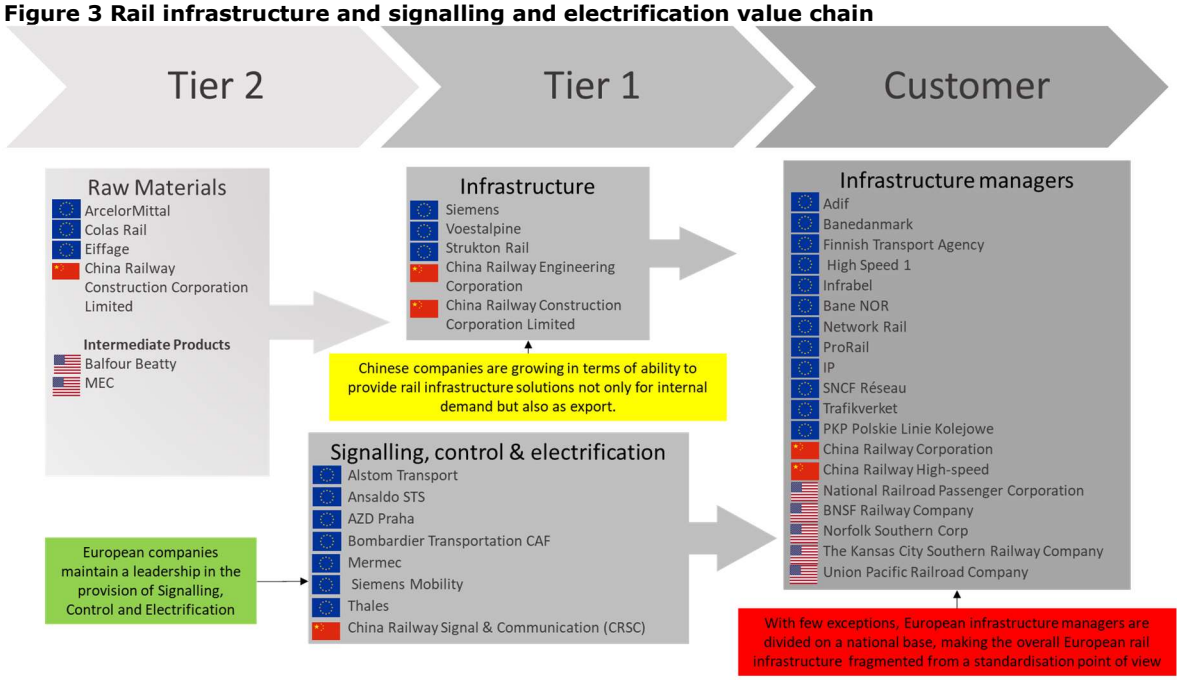
Taking all these elements into account, Figure 2 and Figure 3 show our understanding of the supply chain of the railway infrastructure segment, that includes Tier 2 operators (i.e. suppliers of raw materials and intermediate products), Tier 1 infrastructure operators (i.e. suppliers of track material & equipment, their maintenance and for the construction of civil works and platforms), Tier 1 signalling, control and electrification operators (i.e. suppliers of signalling, control and electrification systems) and Costumer (i.e. infrastructure managers – those operators owning the tracks, energy system and stations and are responsible for their maintenance).

**Figure 2 Railway infrastructure segment**




Source: Ecorys, RailwayDirectory + UNIFE.

**Figure 3 Rail infrastructure and signalling and electrification value chain**




Source: VVA elaboration.

### 2.1.2.2. The locomotive and rolling stock segment

Locomotives and rolling stock are typically complex products containing many thousands of individual components that derive from sophisticated mechanical, electrical and electronic engineering activities (Interfleet Technology, 2007). There is a wide range of types of rolling stock, which can be broken down into various segments (Ecorys, 2012):

- High speed trains are designed to operate regularly at speeds between 220 km/h and 299 km/h and Very High-Speed trains are those which travel at over 300 km/h (UNIFE, 2017). The first country to do this was Japan with their Shinkansen (so-called "Bullet Train) in 1964. The trains can consist of multiple units or can be a single carriage, with a driver's cab at one or both ends;
- Locomotives provide the motive power for a train. Locomotives have no payload capacity of their own, and their sole purpose is to move the train along the tracks. In

contrast, some trains have self-propelled payload-carrying vehicles. A further classification of locomotives is based on their power source, mainly diesel or electricity;
- Multiple Units are self-propelled carriages that consist of more than one carriage, coupling several similar carriages, and are controlled by one driving cab. Multiple units are classified by their power source and are of two main types: electric multiple unit (EMU) or diesel multiple unit (DMU). They are primarily used for passenger transport. Sometimes a further differentiation is based on speed and/or the type of lines they serve (e.g. Intercity, regional, local);
- Coaches are passenger railway vehicles other than passenger railcars, and also include sleeping cars, saloon cars, dining cars, etc.;
- Freight wagons are railway vehicles intended for transport of goods;
- Metro vehicles including two specific types of metro vehicles, those using rubber tyre wheels or steel wheels;
- Light rail vehicles (including trams) including both powered units and trailers.

Unlike cars (or other transport vehicles), there is a significant tendency for most locomotives and rolling stock to be heavily customised. This derives from the fact that the design is much determined by the interface with the infrastructure (which varies considerably between networks) and the relative lack of internationally accepted standards for this industry (Interfleet Technology, 2007). Nevertheless, all rolling stock is built from a series of progressively more complex assemblies and subsystems that may be manufactured in-house or purchased from other railway rolling stock companies (Ecorys, 2012). The typical main subsystems are:

- Body structures: These are typically integral structures optimised so that the mass is as low as possible for the given structural strength and carrying capacity (Interfleet Technology, 2007). Steel remains a major raw material for structures, especially locomotives, wagons and main line rolling stock, although light alloys are used extensively for the lighter rolling stock used for commuter trains and urban rail systems (Interfleet Technology, 2007). Suppliers will use these materials, cutting, shaping and pressing them into the structural members and panels required. For large batch production, technology allows the use of large light alloy extrusions to replace the traditional panelled form of construction (Interfleet Technology, 2007). In all cases, automated welding processes and purpose-built jigs are now the typical form of assembly (Interfleet Technology, 2007). The use of Glass-Reinforced Plastic (GRP) for non-structural elements is important and recently tram and other light vehicle bodies have been built using composite materials with assembly by means of high strength adhesive (Interfleet Technology, 2007);
- Bogies/wheelsets and suspension: the bogies support the mass of the vehicle, use the wheels to guide it along the track and provide some degree of cushioning against the shocks transmitted from the track during motion. The basic production facilities are based around mechanical castings and forgings, to complicated fabricated designs with suspension systems relying on well-engineered rubber components or compressed air bags or some sort of combination (Interfleet Technology, 2007);
- Braking systems: Trains or self-propelled vehicles need to have high performance, safe, self-contained braking systems (Interfleet Technology, 2007). Typically, these will be pressurised air systems, using compressors, reservoirs, brake actuators and the associated pipework and connections. They are therefore are not dissimilar to systems used in the automotive industry. The main differences are the mechanical systems that cause the vehicles to brake, which involve specialised forms of brake block and brake disc, derived from a well-developed technology (Interfleet Technology, 2007);
- Traction equipment: Diesel locomotives and multiple units may be equipped with diesel engines that may have been used in other applications ranging from shipping and power generation to buses, however the transmission and final drive equipment is more specialised (Interfleet Technology, 2007). Electrical locomotives and rolling stock including metro vehicles and trams are based on electrical rather than mechanical engineering and involves the production of specialised motors, inverters, transformers, rectifiers, current collection equipment etc. (Interfleet Technology, 2007);
- Control and diagnostic systems: Electronic controls and diagnostic systems have entered the product range within the lifetime of many existing locomotives and rolling stock (Interfleet Technology, 2007). Although there has been significant technology transfer from other industry into this sub-system area, the key problem of obsolescence has emerged because of the disparity between the long working life of locomotives and rolling stock and the rapid development of electronics and computer technology (Interfleet Technology, 2007).

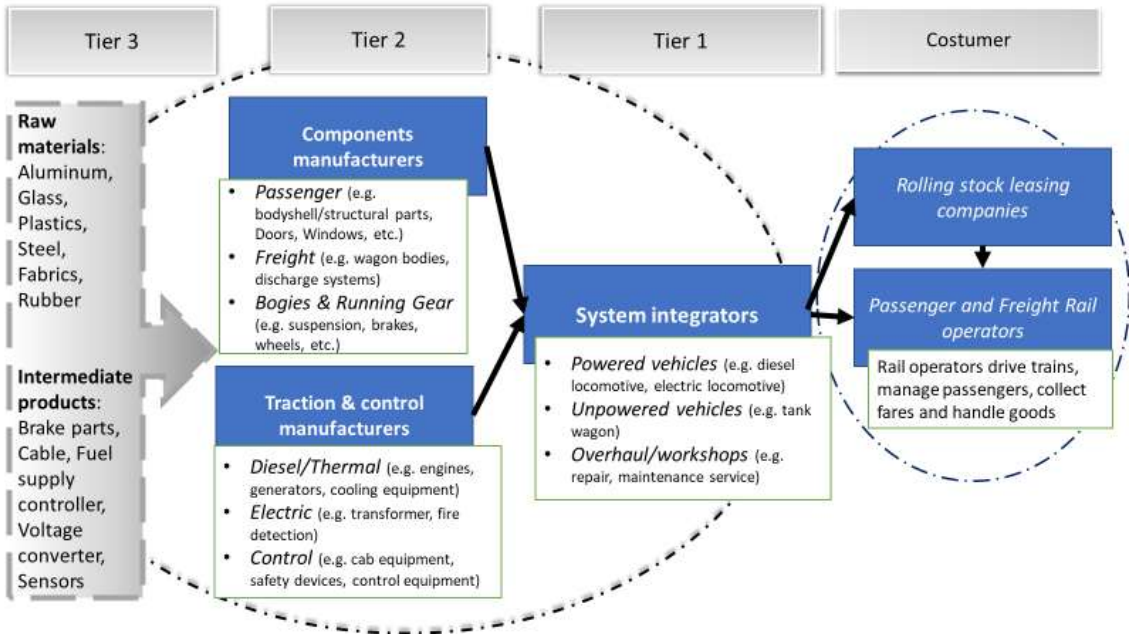
Rail operators traditionally had their own workshops, turning raw materials into the locomotives and rolling stock, signalling equipment, prefabricated building elements, track components and everything else they needed (Interfleet Technology, 2007). Independent manufacturers used to work exclusively for the national railway company, which designed the train and co-ordinated the entire production process (e.g. Ansaldo – Ferrovie dello Stato in Italy). Currently, rail transport operators are more likely to buy locomotives and rolling stock designed by the suppliers, and the companies that supply them in turn are more likely to buy in intermediate products/sub-systems because of the increased complexity and sophistication of these products (Interfleet Technology, 2007).

According to a 2010 study, which mapped out the US value chain, the production of rolling stocks is structured around a three-step tier system:

- Tier 1 suppliers consist OEM firms that provide the shell (body), design, and final assembly of railcars or locomotives. Tier 1 suppliers are assumed to have a central role as assembler of components, playing a pivotal role across the whole supply chain;
- Tier 2 suppliers divided according to the type of products supplied: propulsion, electronics, and body and interior;
- Tier 3 includes firms that supply parts and materials to companies in the top two tiers.

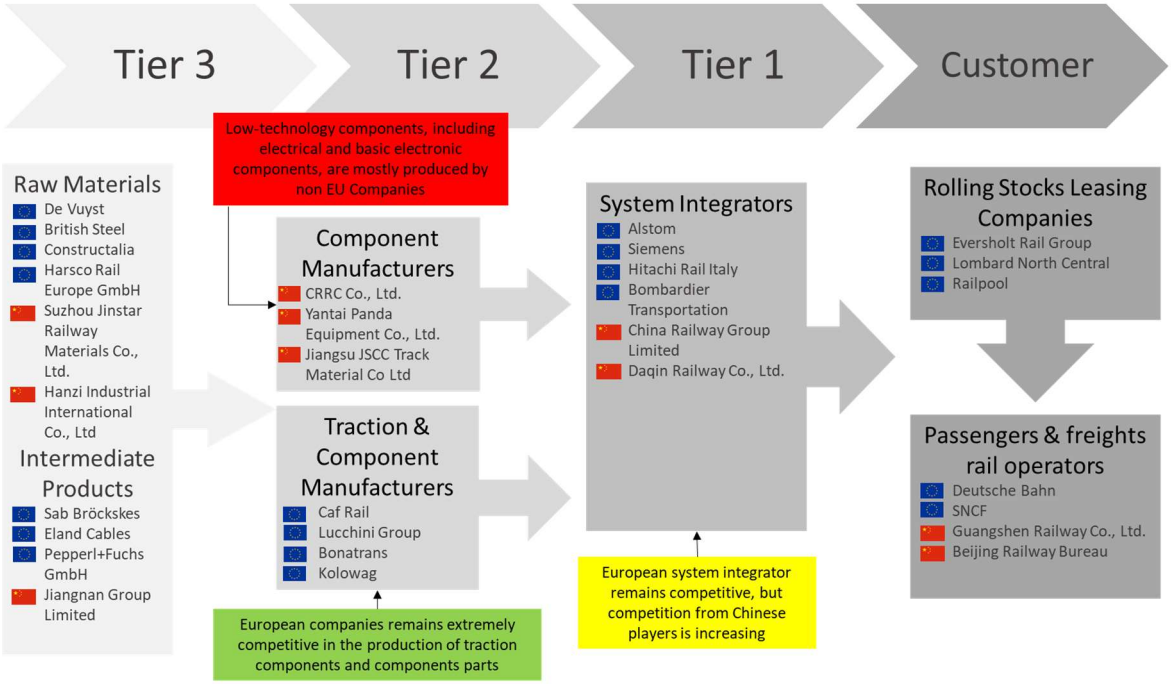
Taking all these elements into account, Figures 2.4 and 2.5 shows our understanding of the supply chain of locomotive and rolling stocks, that includes Tier 3 operators (i.e. suppliers of raw materials and intermediate products), Tier 2 (i.e. manufacturers of components and traction and control goods), Tier 1 (i.e. OEM firms that take all the above subcomponents and produce and sell the finalised train set) and Customers (i.e. rolling stock leasing companies - which then lease to train operating and freight operating companies – or passenger/freight rail operators).

**Figure 4 Locomotive and rolling stock segment**




Source: Ecorys, RailwayDirectory & UNIFE.

**Figure 5 Locomotive and Rolling stocks value chain**




Source: VVA elaboration.

### 2.1.2.3. The digitalisation of the rail supply industry

Digital transformation encompasses the processes by which digital technologies and information are used by business sectors and public administrations to modify their organisational models, improve their performance and create new value (European Parliament, 2019).

The rail supply industry is impacted by the digitalisation, which has enabled a new wide range of potential services and applications, such as (European Parliament, 2019):

- Passenger and freight information services;
- Video surveillance;
- Smart infrastructure;
- Monitoring of assets;
- Signalling systems; and
- Automated train control systems.

According to a research carried out in key sectors of the German and European economies, the rail supply industry sees four main levers driving the digital revolution (Roland Berger, 2017):

1. *Interconnectivity*: interconnected value chains via mobile or fixed-line high-bandwidth telecom networks, which aims at synchronising supply chains and shortening innovation cycles;
2. *Digital data*: better predictions and decision-making by capturing, processing and analysing digital data;
3. *Automation*: autonomous and self-learning cyber-physical systems which increase speed, and reduce error rates and operating costs;
4. *Customer interface*: direct access to customers for new intermediaries through the (mobile) internet which enables companies to offer customers transparency and new services.

These four levers have translated in marked adoption by the industry of the following main technologies and solutions (Shift2Rail, 2018):

1. *Internet of Things* (IoT);
2. *Cloud Computing*;
3. *Big Data Analytics*;
4. *Automation and Robotics*.

As a result, new products and services are becoming an integral part of the operations of railway undertakings, infrastructure managers and manufacturers for the industry (Shift2Rail, 2018). For example, mobile applications, e-ticketing, digital train control, signalling and traffic management, digital platforms for predictive maintenance are considered the key areas of digital transformation of the rail sector and are becoming integral part of the rail supply chain. In particular, the digitalisation of reservation and ticketing (i.e. *e-ticketing*) has already brought many benefits (European Parliament, 2019):

- Passengers gain easier access to their travel details, which can be electronically stored;
- The cost of providing tickets is significantly lowered for operators since they do not have to produce individual disposable tickets for each journey.

According to Roland Berger (2017), the segments in the RSI with the highest potential for digitization are (ranking order):

1. Train control;
2. Maintenance;
3. Infrastructure;
4. Rolling stock.

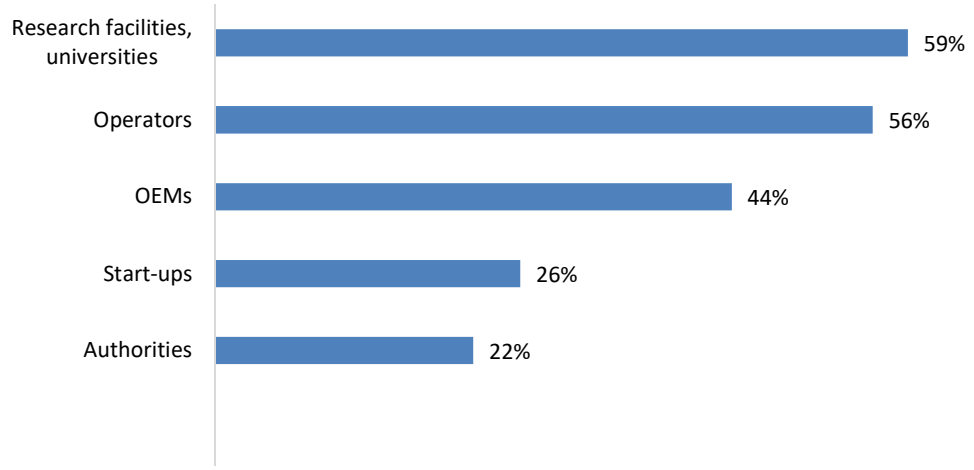
It is expected that the segment train control and maintenance will be the most impacted and less potential is seen for infrastructure and rolling stock (Roland Berger, 2017). In particular, the widespread adoption of the new above-listed technologies will lead to (European Parliament, 2019):

- Train manufacturers to offer new services such as remote monitoring, real-time diagnostics of rolling stock and preventive maintenance;
- Sensors placed on critical train or infrastructure components can send data to detect imminent defects or breakdowns;
- Infrastructure managers will be able to optimise the exploitation of big data obtained for the nowcasting and forecasting of infrastructure conditions and reduce their maintenance costs.

It is likely that digital transformation will further offer new opportunities to rail transport actors, for instance in asset management, operations or the role of users, and contribute to the emergence of new players in the rail market (European Parliament, 2019).

In order to keep the pace with these new technological trends, rail companies and their suppliers have launched investments, start-up incubators and research to develop new digital solutions to run their businesses (Roland Berger, 2017). It results that the cooperation in digital innovation/R&D is happening with the "*usual suspects*": 59% of the respondents to the Roland Berger's survey declared to cooperate with "research facilities, universities", only one fourth of the rail supply industry is already somehow working with start-ups (Roland Berger, 2017).

**Figure 6 Rail supply digitisation – cooperation**




Source: Roland Berger, 2017.

A more in-depth analysis of the (likely) impacts of digitalization on the RSI is presented in section 6.1.1.

## 2.2. A statistical definition for the railway supply industry

One of the main objectives of the study is to define the railway supply industry in economic terms at the most detailed level possible in different EU industry classifications, as well as goods classifications.

In general, the railway supply industry groups the manufacturers of rolling stock and locomotives, electrification, signalling, telecommunication and track equipment. Included are the manufacturers of constituents of the railway line, suppliers of telecommunication systems, control command, providers of maintenance for infrastructure and locomotives and rolling stock and other companies in the supply chain of the railway industry. Operators for rail freight and passenger transport services, companies that provide civil engineering services or designers of the infrastructure, digital services providers etc., are also considered part of the rail industry. However, when using Eurostat databases and nomenclatures such as NACE, and PRODCOM, due to data limitation, companies which do not produce a physical product are excluded. The selection of statistical codes which has been made to capture the railway supply industry, does not capture services.

The following classifications are taken into account:

- CN – Combined Nomenclature: European classification of goods used for foreign trade statistics; 8-digit level;
- PRODCOM: Classification of goods used for statistics on the industrial production in the EU; 8-digit level;
- CPA - European Classification of Products by Activity; 6-digit level;
- NACE - Nomenclature générale des Activités économiques dans les Communautés Européennes: Statistical classification of economic activities in the European Communities; 4-digit level.

Although being different classifications for different purposes, they are interrelated with each other. In general, they rely on a similar structure and are therefore comparable to a high degree.

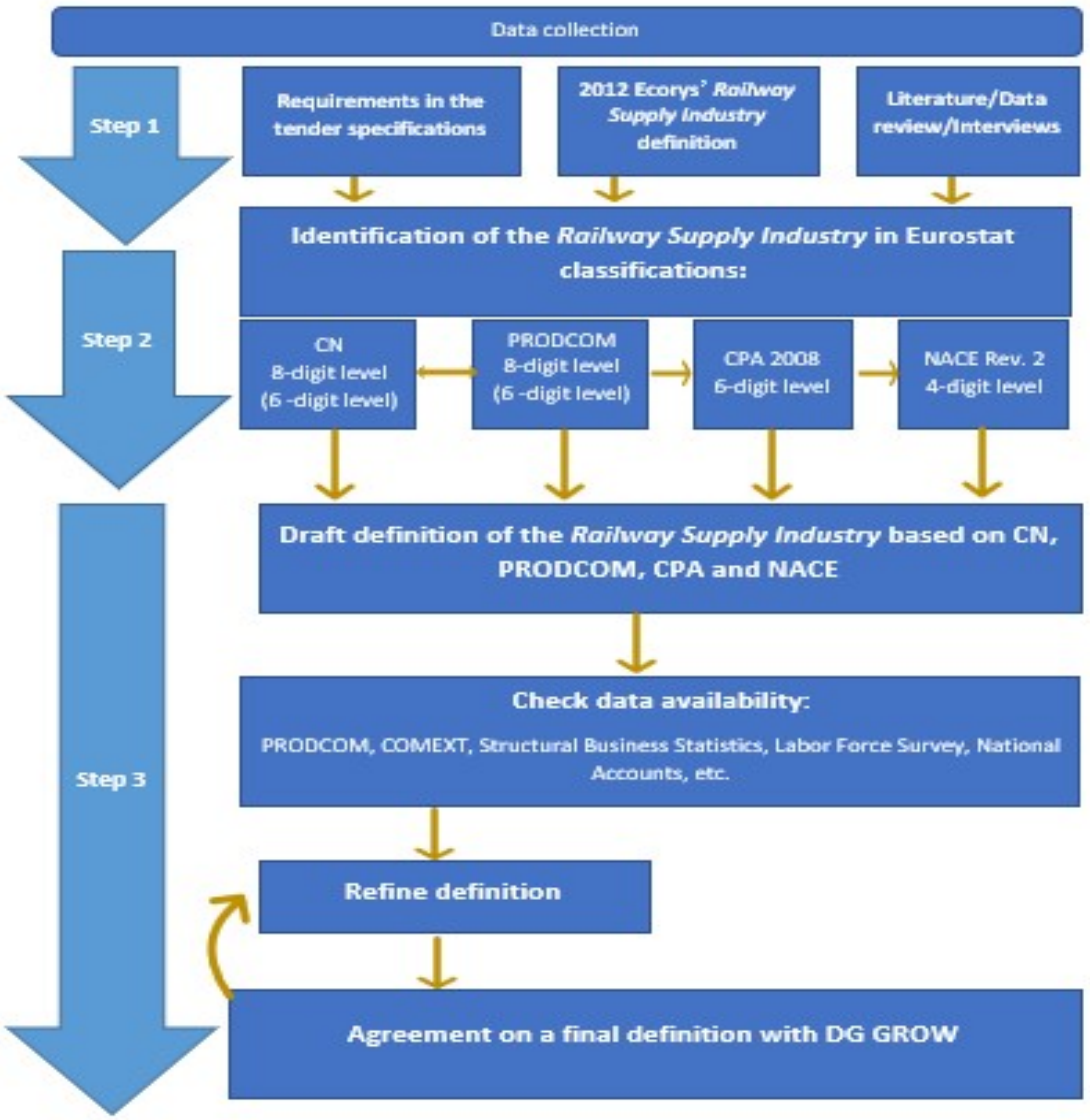
In line with the taxonomy presented in the previous section, the statistical definition of railway industry comprises of suppliers of:

1. Infrastructure (tracks & electrification[3]);
2. Signalling systems and components;
3. Rolling stock (trains, locomotives and subcomponents - axles, wheels, interiors, HVAC, energy systems, brakes, doors, bogies, etc…).

In order to match the information in statistical databases with the sector segmentation presented in the previous section, three different steps are taken (as represented in Figure 7):

- Step 1: Framing the railway supply chain;
- Step 2: Identification of railway goods & services in the classifications;
- Step 3: Draft definition, refinements and agreement on a final definition.

**Figure 7 Process of defining the Railway Supply Industry**




Source: VVA.

### Step 1: Framing the railway supply chain

[3] The distinction between *Signalling System* & *Electrification* has not been consistently possible along the various sections of the report. In fact, Eurostat does only partly allow such distinction. Only when sufficient information was available, secondary data have been applied to estimate what percentage can be labelled as "*Signalling*" or "*Electrification*".

The most important source of information regarding the elements that make up the railway supply industry is the latest Ecorys' (2012) study "*Sector Overview and Competitiveness Survey of the Railway Supply Industry*". Ecorys (2012) considered a "narrow definition" of railway supply based on *NACE Rev. 1 section 35.2 - Manufacture of railway and tramway locomotives and rolling stock,* companies that do not produce a physical product (operators for rail freight and passenger transport services) and companies that provide civil engineering services or designers of the infrastructure, etc. were excluded.

Building up from the statistical "narrow definition" of railway supply, it the so-called "broad definition" was created, which includes products and services which are necessary as inputs for the delivering of *rail transport.*

However, the main difficulty related to this exercise was the fact that codes are disaggregated by materials and technology used to manufacture the goods rather than by the purpose/use. In addition, some inputs (either good or service) are included in codes with a small railway supply industry share. Therefore, Tier 1 and Tier 2 suppliers (where possible data allowing) were then solely considered for this exercise.

**Step 2: Identification of railway goods & services in the classifications**

PRODCOM is the first classification to be considered in the process, as it is the most detailed classification (8-digit-level) and is directly linked to all the other classifications: on the one hand, PRODCOM is to a great extent linked to the NACE classification on a 4-digit-level. On the other hand, there is a thorough conversion table from CN to PRODCOM, but not from CN to NACE or CPA. Step by step, the railway supply industry is first identified in the codes available in CN and PRODCOM, and subsequently also in CPA and NACE.

*Preparation phase: identification of relevant list of codes*

The basis of the identification of codes related to the railway *goods* was based on a *best-fit-approach* on the **PRODCOM 8-digit codes**. All codes including railway were taken into account, regardless of the share of "railway goods" within the codes.

The **CPA 6-digits** and **PRODCOM 6-digits** correspond to each other i.e. the two classifications are identical at the 6-digit level. As a consequence, in order to link CPA 6-digits to the more detailed **PRODCOM 8-digit classification**, it is easy to see which PRODCOM 8-digits are assigned to the respective CPA/PRODCOM 6-digits.

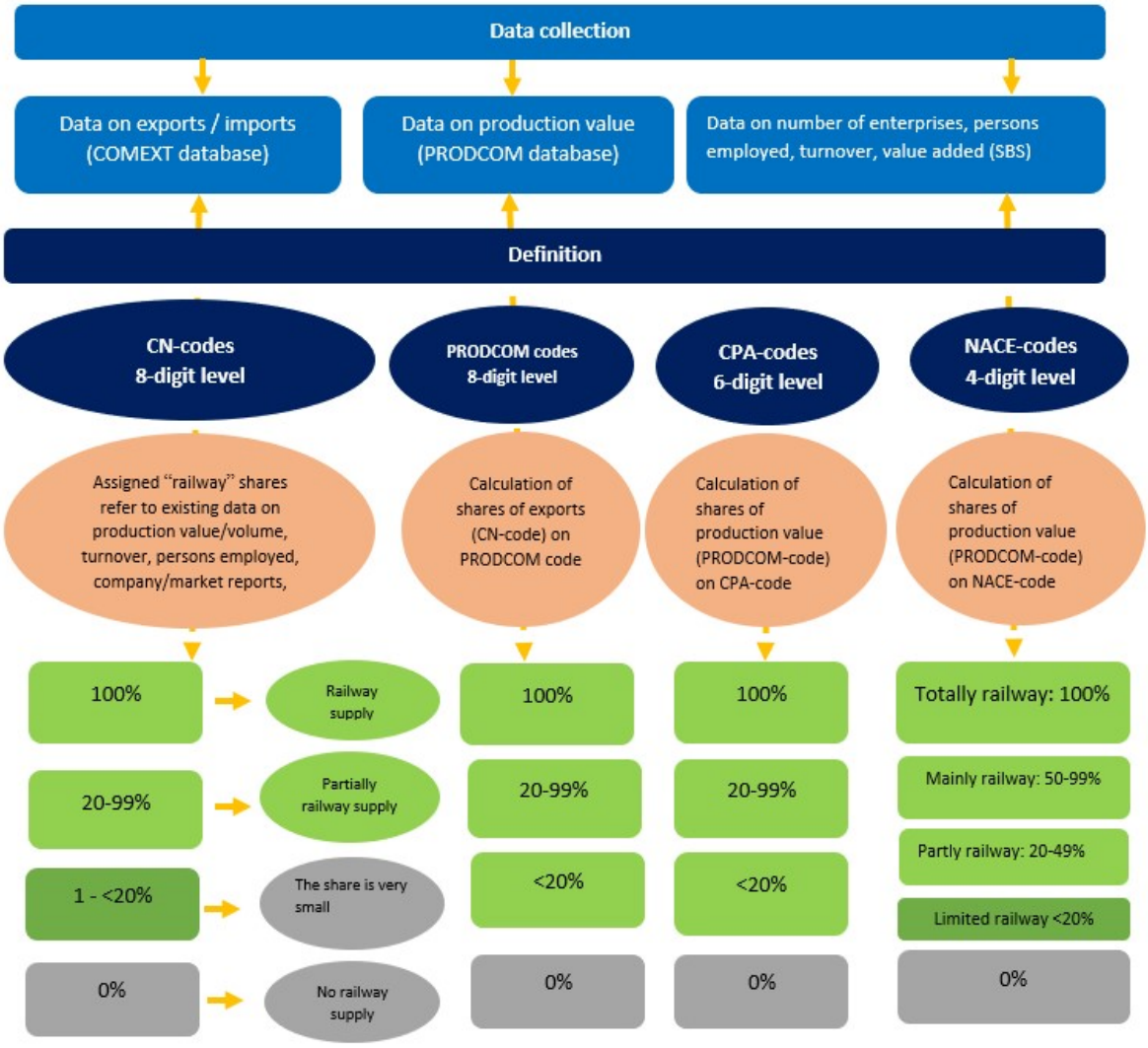
In a next step, the whole **CPA 2008 6-digit level** classification was used to identify further goods and services related to the railway supply industry.

There is a conversion table between **PRODCOM 8-digit codes** and **CN 8-digit codes**. All goods identified in PRODCOM 8-digit codes are also identified in CN 8-digit codes. One single PRODCOM 8-digit code can be assigned to more than one CN 8-digit code, as CN can be more detailed for some goods than PRODCOM.

*Assigning railway supply industry shares to each of the codes*

The preparation phase was followed by the **process of assigning *railway goods* shares to each of the codes** in the different classifications – this process is depicted in more detail in Figure 8. Beginning with the most detailed CN classification, each code in each classification is assigned a specific railway supply share. This share (rounded up or down to the next 10% step) is then taken into account to be applied in the data analysis. Information on the shares were drawn from recent literature / documents / data related to the railway industry.

**Figure 8 Process of identifying codes related to railway supply industry**




Source: VVA.

**Step 3: Draft definition, refinements and agreement on a final definition**

The draft definition of codes related to railway supply industry were discussed with the Commission and the Railway Supply Industry Experts Group in order to arrive on a final definition of railway supply industry in the classifications of CN, PRODCOM, CPA and NACE.

*Data sources*

The latest available and comparable data were collected, covering the EU 28 and a time period from 2011-2016. In particular, the following data sources were used for the data analysis:

- Eurostat: PRODCOM: production of goods related to the railway supply industry;
- Eurostat: COMEXT: international trade (import, exports) of the railway supply industry;
- Eurostat: Structural Business Statistics (SBS): number of enterprises, persons employed, turnover, value added;
- Eurostat: Labour Force Survey (EU-LFS): employment;
- Database of the World Intellectual Property Organization (WIPO): patents, industrial design;
- UN Comtrade Database: international trade (imports, exports) of the railway supply industry.

*Indicator framework*

From these statistics, the following indicators / variables were retrieved in order to analyse the competitive position of the railway supply industry:

- Number of enterprises;
- Persons employed;
- Business performance indicators: turnover, value added (GVA);
- Productivity (GVA per person employed);
- Enterprise size;
- Production value;
- Export and import;
- Intellectual property rights, e.g. patents and industrial design rights.

# 3. ECONOMIC IMPORTANCE OF THE RAILWAY SUPPLY INDUSTRY IN EUROPE

Similar to the 2012 study, due to data limitations, two different 'statistical definitions' of the railway sector are included it in this study.

A first definition of the railway supply industry was constructed in order to describe the EU railway supply industry regarding the structure of the industry as well as the interrelation with third markets through imports and exports. The nomenclatures used to this aim were PRODCOM and NACE. A full description of the product codes, level of disaggregation and the compatibility of the product codes can be found in Annex A.

A second definition of the railway supply industry is used when the EU RSI is compared with the RSI in the US, Japan, Russia, Korea, India and China. The explanation for this second definition stems from the need to find a "global" common definition of RSI. A full description of the data can be found in Annex G.

## 3.1. Overall sector structure

**Box 1 Definition of the railway supply in NACE**

**Totally railway supply (100%):**
- Manufacture of railway locomotives and rolling stock;
- Repair and maintenance of other transport equipment.

**Mainly railway supply (shares 41-99%):**
While the railway supply industry shares can be applied to turnover and valued added, it cannot be applied to the number of enterprises and persons employed due to methodological reasons (please see Annex B - Introductory notes: PRODCOM-CPA-NACE-CN for more details):
- No code identified for this category.

**Partly railway supply (shares 20-40%):**
While the railway supply industry shares can be applied to the indicators turnover and valued added, it cannot be applied to the number of enterprises and persons employed due to methodological reasons (please see Annex B - Introductory notes: PRODCOM-CPA-NACE-CN for more details). Therefore, data on the number of enterprises and persons employed cannot be shown:
- Casting of steel;
- Casting of iron.

**Limited railway supply (shares <20%)**
While the railway supply industry shares can be applied to the indicators turnover and valued added, it cannot be applied to the number of enterprises and persons employed due to methodological reasons (please see chapter Annex B - Introductory notes: PRODCOM-CPA-NACE-CN for more details). Therefore, data on the number of enterprises and persons employed cannot be shown:
- Sawmilling and planning of wood;
- Manufacture of other plastic products;
- Manufacture of basic iron and steel and of ferro-alloys;
- Forging, pressing, stamping and roll-forming of metal; powder metallurgy;
- Machining;
- Manufacture of fasteners and screw machine products;
- Manufacture of other fabricated metal products n.e.c.;
- Manufacture of other fabricated metal products n.e.c.;
- Manufacture of other electrical equipment.

[1] For more information on the definition, please see Annex B- Introductory notes: PRODCOM-CPA-NACE-CN.

In the European Union (EU 28), in 2017, approx. 5,100 enterprises can be assigned to the NACE categories belonging to the *totally Railway Supply Industry*[4] which employ almost 200,000 persons. The turnover of the railway supply industry (totally, partly and limited together) amounts to approx. EUR 49,217 million, while the value added is about EUR 15,220 million. The productivity

[4] These figures refer to NACE 30.20 "Manufacture of railway locomotives and rolling stock" and NACE 33.17 "Repair and maintenance of other transport equipment", according to the NACE Rev. 2 Statistical classification of economic activities in the European Community.

in the totally railway supply industry amounts to approx. EUR 55,000 gross value added by person employed, with the value in the manufacture of railway locomotives and rolling stock (approx. EUR 50,000) being the highest and the productivity in the repair and maintenance of other transport equipment sector being the lowest (approx. EUR 40,000).

**Table 2 Structure of the railway supply industry in the EU 28, 2017**

| | Enterprises | Persons employed | Turnover in € million | Value added in € million | Productivity in € 1.000[2] |
|---|---|---|---|---|---|
| | | | | | *Totally Railway Supply Industry* |
| Manufacture of railway locomotives and rolling stock | 832 | 106,357 | 23,752 | 6,529 | 61 |
| Repair and maintenance of other transport equipment | 4,267 | 92,815 | 9,874 | 3,417 | 38 |
| Sub-Total | 5,099 | 199,172 | 33,626 | 9,945 | |
| | | | | | *Partly Railway Supply Industry[1]* |
| Casting of steel | n/a | n/a | 1,720 | 589 | n/a |
| Casting of iron | n/a | n/a | 2,817 | 883 | n/a |
| | | | | | *Limited Railway Supply Industry[1]* |
| Sawmilling and planning of wood | n/a | n/a | 393 | 81 | n/a |
| Manufacture of other plastic products | n/a | n/a | 172 | 57 | n/a |
| Manufacture of basic iron and steel and of ferro-alloys | n/a | n/a | 1,394 | 242 | n/a |
| Forging, pressing, stamping and roll-forming of metal; powder metallurgy | n/a | n/a | 1,877 | 563 | n/a |
| Machining | n/a | n/a | 4,411 | 1,887 | n/a |
| Manufacture of fasteners and screw machine products | n/a | n/a | 365 | 128 | n/a |
| Manufacture of other fabricated metal products n.e.c. | n/a | n/a | 456 | 163 | n/a |
| Manufacture of other electrical equipment | n/a | n/a | 1,988 | 683 | n/a |
| **Total Railway Supply Industry** | **n/a** | **n/a** | **49,217** | **15,220** | **n/a** |
| | | | | | *Works (totally railway)* |
| Construction of railways and underground railways | 4,730 | 96,692 | 25,778 | 6,849 | 73 |
| | | | | | *Services (partially railway)* |
| Engineering activities and related technical consultancy | n/a | n/a | 56,422 | 26,812 | 74 |
| **Total Railway works/supplies/services** | **n/a** | **n/a** | **131,417** | **44,880** | **n/a** |

Note: Data are based on the NACE-classification and railway supply industry as defined in the frame of the present study.
[1] Data on turnover and value added are presented according to the "rail" shares of the industries belonging to the partly/limited railway supply. Due to methodological reasons, the shares cannot be applied to the number of enterprises and persons employed (see Annex A).
[2] Productivity is defined as gross value added per person employed (=apparent labour productivity according to Eurostat). Value =2016.
Source: VVA, Eurostat, Structural Business Statistics (sbs).

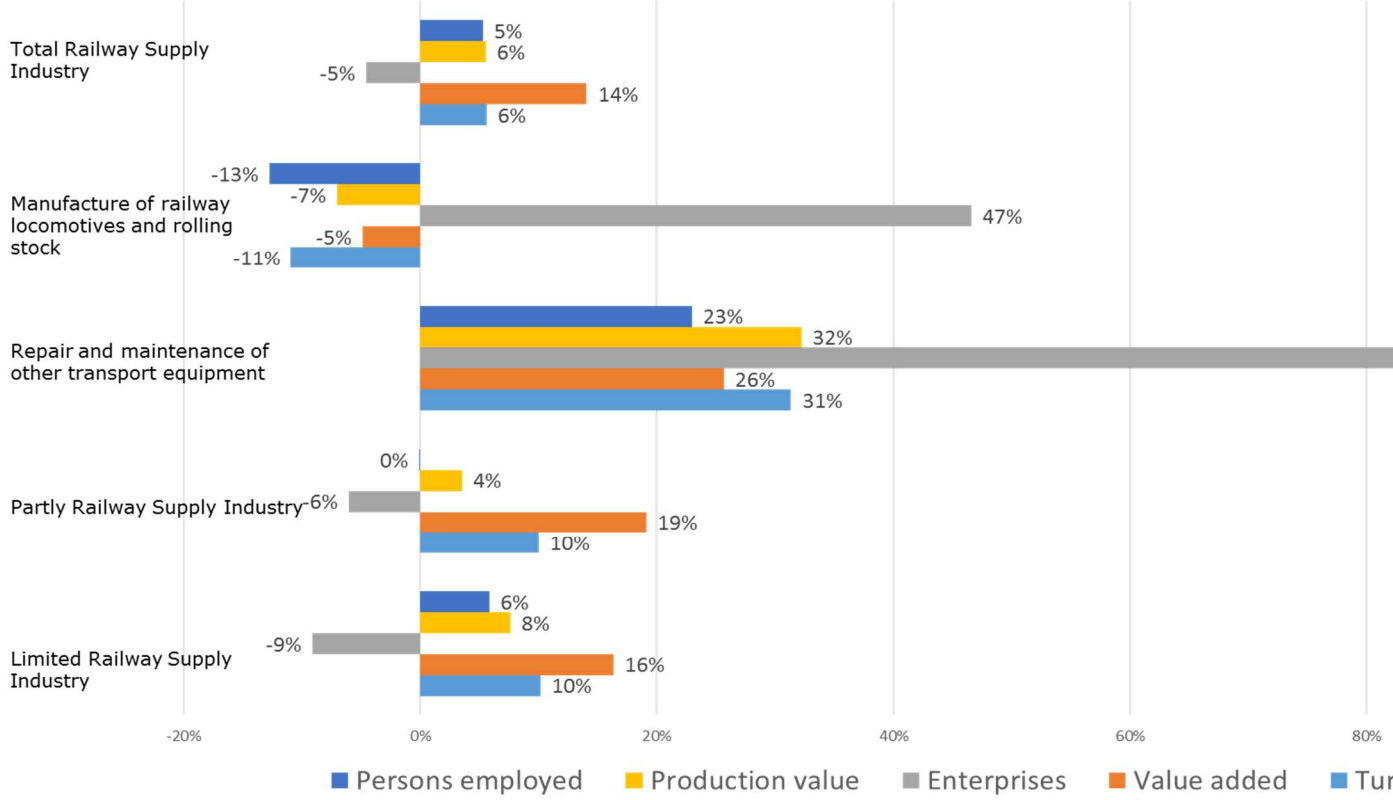
The development of the totally, partly and limited railway supply industries differ from each other:

- The analysis of the development between 2011 and 2017 of the **totally Railway Supply Industries** show that the number of enterprises increased by 68%, the number of persons employed by 10%, the turnover grew by 16% and the value added by 21%. In relative terms, most of growth is driven by 'Repair and maintenance of other transport equipment' which shows a considerable growth (even though, in total repair and maintenance counts less in terms of turnover and person employed). The sector

'Manufacturing of locomotive and rolling stocks' also shows growth in all indicators compared to the 2011 (base level), but moderately compared to the other industry;

- The **partly railway supply industries** – consisting of casting of steel and iron - show decreasing turnover and value added;
- The sectors assigned to **limited railway supply industries** show an increased in both turnover and value added.

**Figure 9 Total growth from 2011 (baseline) to 2017 – Railway Supply Industry**




Source: VVA, Eurostat, Structural Business Statistics (sbs).

### 3.1.1. *Locomotive and rolling stocks*

The largest sector by far within the railway supply industries in the European Union is the **Manufacture of railway locomotives and rolling stock**. The manufacture of rolling stocks and locomotives makes up 832 enterprises and 106,357 persons employed. As shown in Table 2, 53% of the persons employed in railway supply industries in the European Union can be assigned to the manufacture of railway locomotives and rolling stock. This industry is also the main contributor to the total turnover (71%) and to the value added (66%).

According to 2017 Eurostat data, the total number of enterprises operating in the manufacturing of locomotive and rolling stocks has increased by 6% compared to 2011. There is a prevalence in UK, Germany, Poland, Spain, Czech Republic, France, Romania and Sweden, jointly accounting for 67% of the total European locomotives and rolling stock enterprises. Furthermore, it is noted that for Italy no official data has been published since 2014. In that year however it had the largest number of companies in the EU. Among the leading countries, United Kingdom (+190%)[5],Germany (+21%) and Sweden (+13%) experienced a positive growth rate in number of

[5] According to the opinion of a European industry association representing the rail supply industry, this growth rate in the number of companies in the UK could be driven by the two big infrastructure projects running in the country (i.e. High Speed 2 and Cross Rail London) which might have led companies to establish a branch/subsidiary in the UK.

enterprises, whereas Poland (-29%), France (-22%), Romania (-22%) and Spain (-5%) show a decline compared to 2011.

Another result that emerges from the Eurostat's Structural Business Statistics is that Cyprus, Luxembourg and Malta do not have any company active in manufacturing of railway locomotives and rolling stock, and that the Estonian industry has disappeared.

**Table 3 Number of enterprises in railway, tramway locomotive and rolling stock by Member State**

| GEO/YEAR | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | Growth 2011 to 2017 | CAGR |
|---|---|---|---|---|---|---|---|---|---|
| European Union | 782 | 794 | 714 | 780 | 816 | 856 | 832 | 6% | 1% |
| Austria | 10 | 7 | 9 | 10 | 8 | 9 | 9 | -10% | -2% |
| Belgium | : | : | : | 9 | 9 | : | 9 | #VALUE! | #VALUE! |
| Bulgaria | 13 | 13 | 12 | 12 | 13 | 12 | 10 | -23% | -4% |
| Croatia | 14 | 13 | 11 | 12 | 12 | 13 | 12 | -14% | -3% |
| Czech Republic | : | : | : | 49 | 52 | 57 | 60 | #VALUE! | #VALUE! |
| Denmark | 4 | 5 | 4 | 5 | 5 | 6 | 6 | 50% | 7% |
| Estonia | 3 | 1 | 0 | 0 | 0 | 1 | 1 | -67% | -17% |
| Finland | 3 | 3 | 2 | 2 | 2 | 1 | 1 | -67% | -17% |
| France | 41 | 72 | 28 | 39 | 42 | 39 | 32 | -22% | -4% |
| Germany | 75 | 82 | 81 | 68 | 100 | 102 | 91 | 21% | 3% |
| Greece | 6 | : | : | : | 4 | 5 | 4 | -33% | -7% |
| Hungary | 44 | 42 | 38 | 37 | : | : | : | | |
| Italy | : | : | : | 132 | : | : | : | | |
| Latvia | 4 | 5 | 5 | 7 | 10 | 8 | 8 | 100% | 12% |
| Lithuania | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 100% | 12% |
| Netherlands | 17 | 15 | 16 | 15 | 18 | 15 | 18 | 6% | 1% |
| Poland | 137 | 114 | 82 | 106 | 93 | 100 | 97 | -29% | -6% |
| Portugal | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 33% | 5% |
| Romania | 54 | 50 | 48 | 49 | 42 | 44 | 42 | -22% | -4% |
| Slovakia | 15 | 14 | 13 | 13 | 11 | 8 | 9 | -40% | -8% |
| Slovenia | 4 | 4 | 3 | 3 | 2 | 2 | 2 | -50% | -11% |
| Spain | 82 | 80 | 55 | 81 | 70 | 77 | 78 | -5% | -1% |
| Sweden | 32 | 34 | 37 | 39 | 40 | 37 | 36 | 13% | 2% |
| United Kingdom | 41 | 52 | 65 | 83 | 106 | 119 | 119 | 190% | 19% |

Source: VVA, Eurostat, Structural Business Statistics (sbs).

The total number of employees in the locomotive and rolling stock segment equals approx. 106,357. The overall figure has increased with some 1% between 2011 and 2017. For those countries for which data are available, the growth patterns differ between countries, with some countries (e.g. Germany, Spain, Poland, United Kingdom) showing growth in employment whereas other (e.g. France, Romania, Bulgaria, Croatia, Latvia, Slovakia and the Netherlands) show clear decreases.

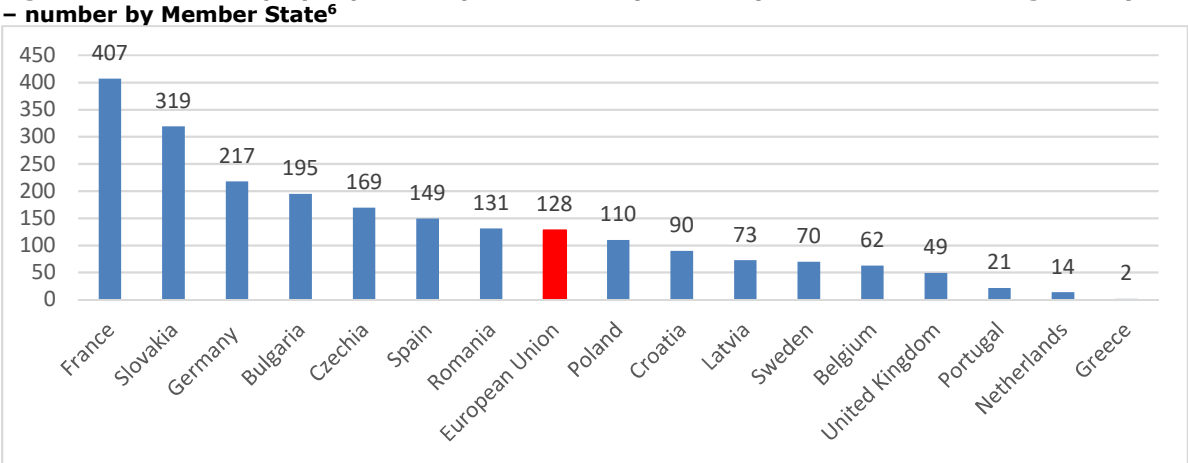
**Table 4 Number of persons employed in railway, tramway locomotive and rolling stock by Member State**

| GEO/TIME | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | Growth 2011 to 2017 | CAGR |
|---|---|---|---|---|---|---|---|---|---|
| European Union | 106,342 | 107,580 | 107,903 | 108,952 | 107,538 | 105,086 | 106,357 | 0% | 0% |
| Belgium | : | : | : | 766 | 689 | : | 562 | | |
| Bulgaria | 2,135 | 2,311 | 2,156 | 2,057 | 1,954 | 2,028 | 1,948 | -9% | -2% |
| Czechia | : | : | : | 10,410 | 10,393 | 10,356 | 10,146 | | |
| Germany | 19,400 | 20,198 | 21,034 | 21,780 | 22,124 | 20,620 | 19,785 | 2% | 0% |
| Greece | 9 | : | : | : | 9 | 11 | 6 | -33% | -7% |
| Spain | 11,148 | 11,078 | 11,089 | 10,852 | 10,832 | 11,302 | 11,639 | 4% | 1% |
| France | : | 14,857 | 14,990 | 14,768 | 14,068 | 13,047 | 13,018 | | |
| Croatia | 1,126 | 618 | : | 571 | 650 | 1,088 | 1,080 | -4% | -1% |
| Italy | : | : | : | 10,745 | : | : | : | | |
| Latvia | 1,090 | 1,165 | 1,176 | 1,201 | 1,043 | 749 | 582 | -47% | -10% |
| Hungary | 3,633 | 3,259 | 2,960 | 3,372 | : | : | : | | |
| Netherlands | 351 | 305 | 306 | 317 | 256 | 253 | 248 | -29% | -6% |
| Poland | 10,078 | 10,135 | 11,271 | 11,182 | 11,207 | 10,814 | 10,657 | 6% | 1% |
| Portugal | : | : | : | 79 | 73 | 76 | 85 | | |
| Romania | 7,756 | 7,265 | 6,351 | 6,534 | 5,981 | 5,531 | 5,511 | -29% | -6% |
| Slovakia | 3,207 | 3,305 | 3,160 | 3,439 | 3,346 | 2,918 | 2,873 | -10% | -2% |
| Sweden | : | : | : | 2,203 | 2,806 | 2,685 | 2,515 | | |
| United Kingdom | 5,035 | 4,878 | 4,773 | 4,731 | 5,064 | 5,877 | 5,877 | 17% | 3% |

Source: VVA, Eurostat, Structural Business Statistics (sbs).

The average number of employees per enterprise for the EU28 equals 132 (134 in 2007). Large differences exist between countries.

**Figure 10 Persons employed per enterprise in railway, tramway locomotive and rolling stock (2017) – number by Member State[6]**




Source: VVA, Eurostat, Structural Business Statistics (sbs).

The above employment figures clearly reflect the location of the large production locations of Europe's main players. The data also shows that production locations are often spread across

[6] No data available for: Austria, Denmark, Finland, Hungary, Italy, Lithuania, Slovenia.

different European countries, whereas in a number of competing countries often production is more concentrated in a number of large manufacturing plants.

### 3.1.2. *Repair and maintenance*

Eurostat does not offer specific information on the two other main segments identified in our taxonomy, "railway infrastructure" and "signalling, control and electrification". Rather, it presents as second largest sector within the railway supply industries in the European Union Repair and maintenance of other transport equipment. According to the NACE Rev. 2 classification this class includes: "repair and maintenance of locomotives and railroad cars (except factory rebuilding or factory conversion)". We interpret this category as the industry involved in the "spare parts". Indeed, products in the locomotive and rolling stock market may consist both of final-end products and individual components. According to the 2012 report,[7] this market is substantial: railway operators spend up to 30% of their annual budgets on spare parts (Ecorys, 2012).

Although not the specific focus of this study, the following paragraphs provide more information about the performance of "spare parts industry" in the EU between 2011 and 2017.

According to Eurostat's Structural Business Statistics, in 2017 the total number of enterprises operating in the repair and maintenance of other transport equipment has increased by 65% compared to 2017. There is a prevalence in UK and Germany, jointly accounting for 52% of the total European enterprises in this subsector.

Between 2011 and 2017, most Member States experienced a positive annual growth rate in the number of enterprises, except from Estonia, (-1%), Romania (-1%) and Denmark (-7%).

**Table 5 Number of enterprises in repair and maintenance of other transport equipment by Member State**

| GEO/TIME | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | Total growth 2011 to 2017 | CAGR |
|---|---|---|---|---|---|---|---|---|---|
| European Union | 2,259 | 2,668 | 2,956 | 3,100 | 3,700 | 3,900 | 4,267 | 89% | 11% |
| Austria | 7 | 11 | 16 | 16 | 16 | 16 | 33 | 371% | 29% |
| Belgium | 20 | 14 | 11 | 27 | 23 | 32 | 35 | 75% | 10% |
| Bulgaria | 132 | 158 | 176 | 188 | 214 | 218 | 234 | 77% | 10% |
| Croatia | 13 | 12 | 16 | 13 | 14 | 14 | 15 | 15% | 2% |
| Czechia | : | : | : | : | 234 | 264 | 338 | | |
| Denmark | 20 | 27 | 19 | 19 | 17 | 13 | 13 | -35% | -7% |
| Estonia | 22 | 27 | 22 | 25 | 23 | 20 | 21 | -5% | -1% |
| Finland | 10 | 10 | 14 | 12 | 13 | 16 | 16 | 60% | 8% |
| France | 79 | 73 | 131 | 120 | 99 | 113 | 94 | 19% | 3% |
| Germany | 469 | 510 | 527 | 458 | 898 | 849 | 975 | 108% | 13% |
| Greece | 9 | 9 | 11 | 13 | 9 | 10 | 86 | 856% | 46% |
| Hungary | 62 | 68 | 66 | 73 | 89 | 83 | 79 | 27% | 4% |
| Italy | 132 | 126 | 123 | 122 | 129 | 133 | 133 | 1% | 0% |
| Latvia | 37 | 51 | 61 | 71 | 71 | 78 | 82 | 122% | 14% |
| Lithuania | 27 | 29 | 32 | 37 | 45 | 53 | 56 | 107% | 13% |
| Netherlands | 23 | 48 | 100 | 115 | 138 | 143 | 147 | 539% | 36% |
| Poland | 248 | 259 | 288 | 276 | 256 | 299 | 289 | 17% | 3% |
| Portugal | 85 | 89 | 96 | 99 | 104 | 100 | 102 | 20% | 3% |
| Romania | 81 | 83 | 83 | 90 | 81 | 77 | 76 | -6% | -1% |

[7] Ecorys (2012 'Sector Overview and Competitiveness Survey of the Railway Supply Industry'.

| GEO/TIME | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | Total growth 2011 to 2017 | CAGR |
|---|---|---|---|---|---|---|---|---|---|
| Slovakia | 10 | 11 | 12 | 10 | 12 | 11 | 12 | 20% | 3% |
| Slovenia | 9 | 10 | 16 | 20 | 20 | 20 | 19 | 111% | 13% |
| Spain | 46 | 42 | 39 | 76 | 48 | 48 | 109 | 137% | 15% |
| Sweden | 47 | 49 | 54 | 55 | 60 | 68 | 74 | 57% | 8% |
| United Kingdom | 545 | 795 | 858 | 958 | 1,099 | 1,252 | 1,252 | 130% | 15% |

Source: VVA, Eurostat, Structural Business Statistics (sbs).

The total number of employees in the repair and maintenance of other transport equipment segment equals approx. 92,815[8]. The overall figure has increased with some 23% between 2011 and 2017. Almost half of the Member States (whose data are available in Eurostat) experienced a growth in employment between 2011 and 2017. In particular, Spain and UK experienced growth in the number of persons employed and, to a lesser extent, Greece, Lithuania, Finland and Germany. In contrast, especially Hungary, Romania and Croatia lost employment in repair and maintenance of other transport equipment.

**Table 6 Number of persons employed in repair and maintenance of other transport equipment by Member State**

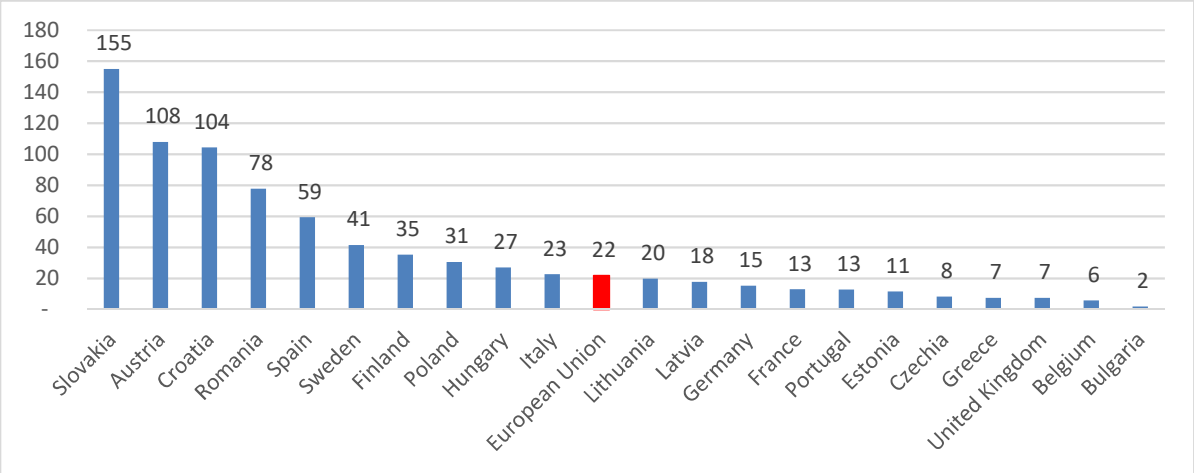
| GEO/TIME | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | Total growth 2011 to 2017 | CAGR |
|---|---|---|---|---|---|---|---|---|---|
| European Union | 75,473 | 76,325 | 75,326 | 117,038 | 93,771 | 75,154 | 92,815 | 23% | 4% |
| Austria | 3,510 | 3,473 | 3,429 | 3,415 | 3,415 | 3,479 | 3,562 | 1% | 0% |
| Belgium | 147 | 193 | 225 | 204 | 227 | 191 | 198 | 35% | 5% |
| Bulgaria | 463 | 572 | 578 | 570 | 453 | 547 | 407 | -12% | -2% |
| Croatia | 2,832 | 2,661 | 2,378 | 2,012 | 1,724 | 1,626 | 1,565 | -45% | -9% |
| Czechia | : | : | : | 2,158 | 2,158 | 2,576 | 2,744 | | |
| Estonia | : | : | 337 | 360 | 360 | 266 | 241 | | |
| Finland | 84 | 83 | 42 | 47 | 44 | 564 | 564 | 571% | 37% |
| France | 2,061 | 1,544 | 1,724 | 1,724 | 1,778 | 1,778 | 1,207 | -41% | -9% |
| Germany | 14,314 | 14,632 | 14,777 | 14,261 | 14,980 | 13,814 | 14,788 | 3% | 1% |
| Greece | 38 | 15 | 17 | 634 | 540 | 624 | 636 | 1574% | 60% |
| Hungary | 5,750 | 6,001 | 5,824 | 1,343 | 1,334 | 1,721 | 2,136 | -63% | -15% |
| Italy | 2,928 | 2,442 | 2,794 | 2,595 | 2,888 | 3,001 | 3,001 | 2% | 0% |
| Latvia | 1,844 | 1,976 | 2,019 | 2,051 | 1,680 | 1,532 | 1,444 | -22% | -4% |
| Lithuania | 589 | 611 | 613 | 620 | 586 | 528 | 1,104 | 87% | 11% |
| Poland | 9,214 | 9,583 | 7,925 | 8,772 | 8,440 | 7,994 | 8,829 | -4% | -1% |
| Portugal | 1,570 | 1,338 | 1,285 | 1,285 | 1,236 | 1,271 | 1,303 | -17% | -3% |
| Romania | 7,078 | 7,232 | 7,565 | 7,162 | 6,425 | 5,919 | 5,907 | -17% | -3% |
| Slovakia | 1,995 | 2,075 | 2,058 | 2,131 | 2,114 | 2,016 | 1,858 | -7% | -1% |
| Spain | 2,985 | 2,746 | 2,622 | 6,094 | 6,199 | 6,279 | 6,464 | 117% | 14% |
| Sweden | 3,127 | 3,121 | 2,991 | 3,000 | 2,850 | 2,841 | 3,060 | -2% | 0% |
| United Kingdom | 5,228 | 5,242 | 6,013 | 6,255 | 6,499 | 9,243 | 9,243 | 77% | 10% |

[8] Caveat: this figure includes the number of persons employed in NACE "33.17 Repair and maintenance of other transport equipment" as defined by the NACE Rev. 2 statistical classification of economic activities in the European Community. However, stakeholders commented that the big railway undertaking often internalize the maintenance (e.g. SNCF). If this part of maintainace employment does not appear in these numbers.

Source: VVA, Eurostat, Structural Business Statistics (sbs).

The average number of employees per enterprise in repair and maintenance of other transport equipment for the EU28 is 36. Large differences exist between countries. Figure 11 Persons employed per enterprise in repair and maintenance of other transport equipment – number by Member State, 2017suggests that in Slovakia, Austria, and Croatia, the spare parts industry is more concentrated in a number of larger manufacturing companies.

**Figure 11 Persons employed per enterprise in repair and maintenance of other transport equipment – number by Member State, 2017[9]**




Source: VVA, Eurostat, Structural Business Statistics (sbs).

## 3.2. RSI according to company size - SME check

Although being the most comprehensive source of information at European level, *Eurostat's structural business statistics* do not capture in full the different facets of the rail supply industry. In fact, the classification is organised in terms of economic activities, not in terms of technology and/or product destination. In addition, Eurostat does not provide data about company size at NACE four-digit level, making the identification of SMEs impossible.

In order to overcome these data limitation, we provide a complementary analysis based on Orbis (for the manufacture of locomotive and rolling stocks) and on *Railway Directory* (for the suppliers of infrastructure materials and for the suppliers of signalling and electrification), the supplier's database provided by *Railway Gazette International*.[10]

The online catalogues were web-scrapped in order to obtain a comprehensive list of companies active in the railway supply chain. Following this process, the companies were matched in Orbis, in order to determine their shareholders structure and check their SME status.[11]

### 3.2.1. *Locomotive and rolling stocks*

The locomotives and rolling stock market is worldwide lead by 30 to 40 and locomotives and rolling stock manufacturers, which cover more than two third of the whole and locomotive and rolling stock production (Ecorys, 2012).

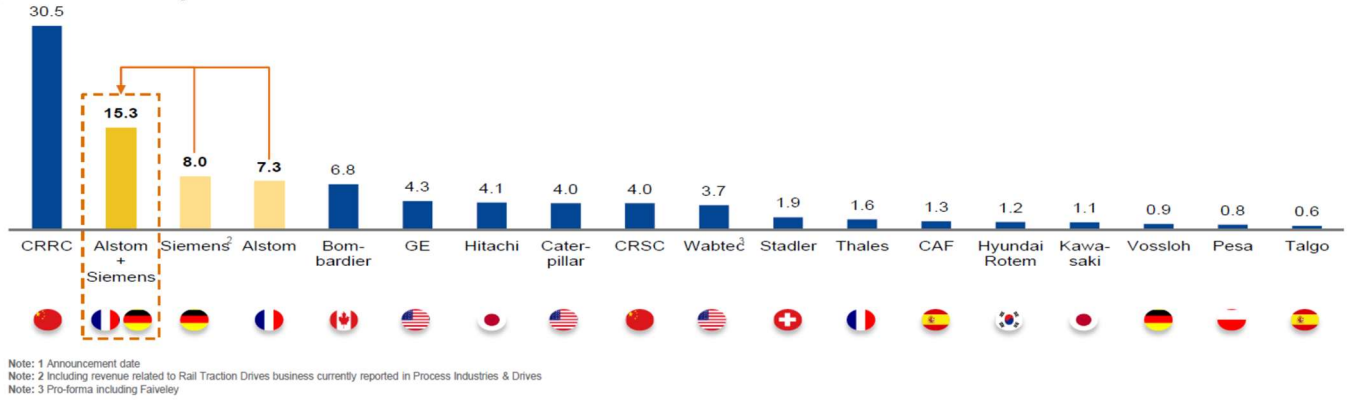
[9] No data available for: Estonia, Denmark, France, Ireland, Cyprus, Luxembourg, Netherlands, Malta, Slovenia.

[10] Railway Directory is the international rail industry reference work, covering operators, statutory bodies, manufacturers, suppliers and services. Railway Gazette International is the parent publication, owned by DVV Media UK Ltd Source: http://www.railwaydirectory.net/.

[11] EU SME Definition was used to perform this exercise. Source: http://ec.europa.eu/growth/smes/business-friendly-environment/sme-definition_en.

According to 2016 industry data Figure 12 the largest groups by turnover are CRRC (China), Siemens (Germany), Alstom (France) and Bombardier (Canada).

**Figure 12 Leading rolling stock manufacturers in 2017, by revenue of rail activities (in billion euros)**




Source: Alstom, 2018.

According to *ORBIS*[12], in total 1.831 companies are active in Europe in the field of '*Manufacture of railway locomotives and rolling stock'*.[13] Out of these 1831 companies, 541 are based in UK[14], followed by Germany (369) and Poland (196).

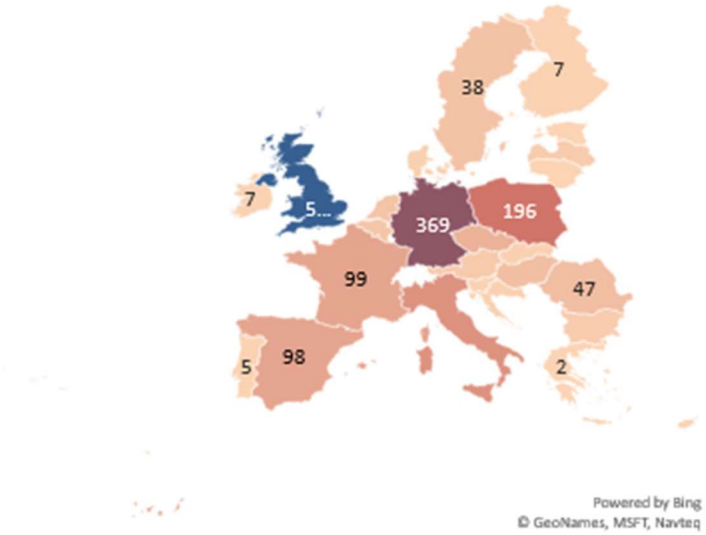
[12] Data as of September 30th, 2018. The differences between Orbis and Eurostat are due to different sampling techniques/methodologies. The Annual Enterprises Statistics in Eurostat's SBS gathers data in terms of number of enterprises (i.e. a count of the number of enterprises active during at least a part of the reference period). Orbis/Amadeus includes over 30 million ownership/subsidiary links. Therefore, the data relate to the count of legal units (an enterprise or part thereof - e.g. a workshop, factory, warehouse, office, depot, etc…- where at or from this place, economic activity is carried out and for which one or more persons work) active during at the reference period.

[13] Caveat: part of these companies is also involved in other segments of the supply chain and/or are branch/subsidiaries of other groups. at the bets of our knowledge, the format of the data does not allow to split the figures into manufacturing and/or supply of a specific segment only.

[14] According to the opinion of a European industry association representing the rail supply industry, the high number of companies in the UK could be driven by the two big infrastructure projects running in the country (i.e. High Speed 2 and Cross Rail London) which might have led companies to establish a branch/subsidiary in the UK and/or by the fact that the liberalization of the UK market translated into a dynamic environment with a lot of freight operators which also provide maintenance and related services for locomotive and rolling stocks. According to the knowledge of the association, Germany and France are the two countries where most of the enterprises active in the manufacturing of locomotives and rolling stocks are based.

**Table 7 Locomotives and rolling stock suppliers – geographical distribution – top 10**

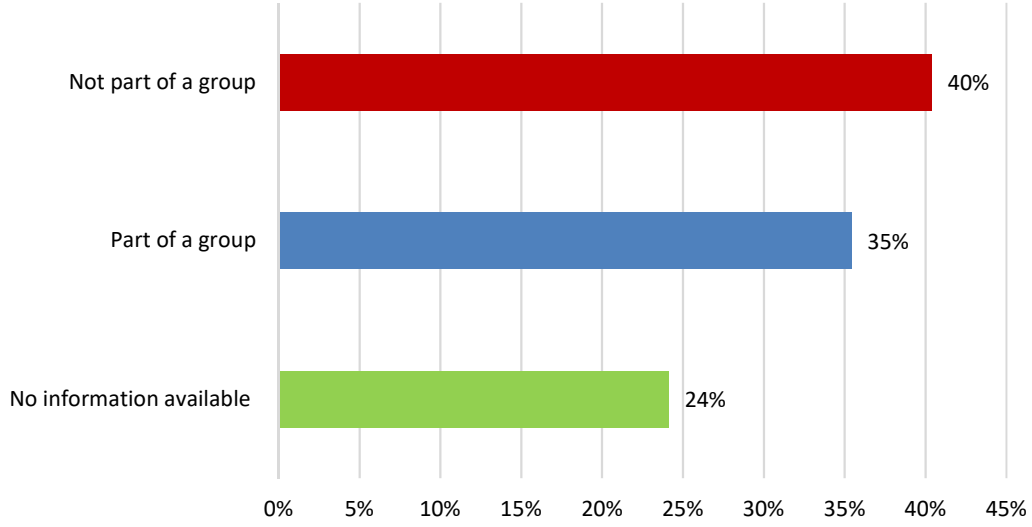
| Country | Nr of companies |
|---|---|
| UK | 541 |
| Germany | 369 |
| Poland | 196 |
| Italy | 135 |
| France | 99 |
| Spain | 98 |
| Czech Republic | 72 |
| Romania | 47 |
| Hungary | 46 |
| Sweden | 38 |




Source: VVA, Orbis.

However, considering that a limited number of large companies are leading the market (Ecorys, 2012), the number of enterprises alone only partially sets the scene, as these enterprises may be part of a larger company. Hence, the shareholder composition of these companies was checked. The results of this exercise (Figure 13) show that 35% belong to a group (i.e. they are subsidiary/branch of another company) and 40% of them are privately owned (note: no information available about the shareholder structure for 24% of the companies).

**Figure 13 Share of suppliers that are part of a group in manufacture of locomotives and rolling stocks sub-sector**

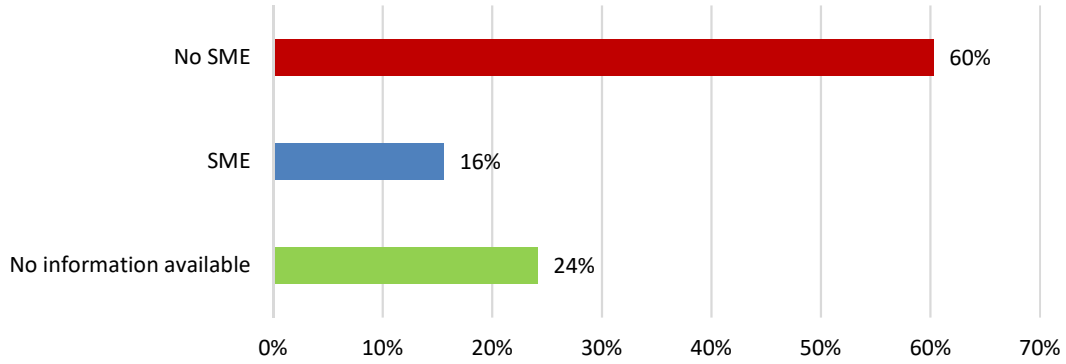



Source: VVA, Orbis.

By applying the SME definition of the European Commission to the sample, the result is that only 16% of the companies in the list (ca. 285) can be categorized as SMEs.[15]

[15] A cluster organization interviewed commented that the manufacture of locomotive and rolling stock is a multi-tier supply chain and there is a large number of European SMEs involved as Tier 2/Tier 3 suppliers. According to stakeholders, the picture represents more the reality of the OEM/Tier 1 firms, which is much more concentrated around large industry groups.

**Figure 14 Share of SMEs in the manufacture of locomotives and rolling stocks sub-sector**




Source: VVA, Orbis.

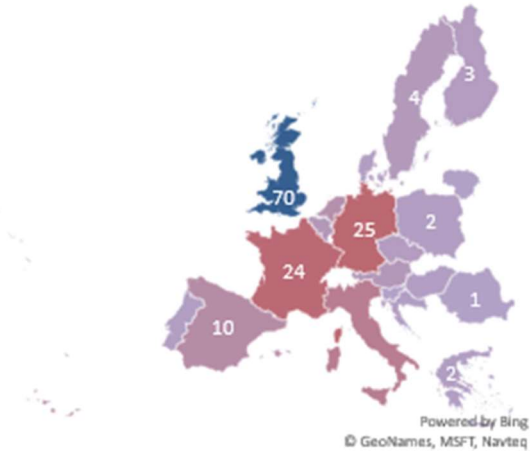
### 3.2.2. *Signalling and electrification*

According to data from *Railway Directory*[16], in total 344 companies are active in Europe as suppliers in the segment of signalling and electrification. This macro category is further subdivided in signalling and train control companies (187)[17] and electrification companies (157). Out of these 344 companies, 150 are privately owned whereas 186 belong to a group.[18]

There are 187 companies active as suppliers of signalling & train control equipment suppliers. According to the information retrieved, 97 are privately owned whereas 97 belong to a group. In terms of geographical distribution, 70 are based in UK, followed by Germany (25) and France (24).

**Table 8 Signalling and train control equipment suppliers – geographical distribution – top 10**

| Country | Nr of companies |
|---|---|
| UK | 70 |
| Germany | 25 |
| France | 23 |
| Italy | 16 |
| Spain | 10 |
| Netherlands | 8 |
| Austria | 5 |
| Belgium | 5 |
| Sweden | 4 |
| Czech Republic | 3 |




Source: VVA, Railway Directory.

[16] As of September 30th, 2018. Caveat: European associations representing the rail supply industry commented that as per their knowledge, the German, French and Italian industry are much bigger in size compared to the UK one. Discrepancies between the data obtained and the opinions of the European associations could be due to the fact that: 1) Railway Directory is a service provided by Railway Gazette (UK based) which may explain the bias towards the UK, 2) Two big infrastructure projects are running in the UK (i.e. High Speed 2 and Cross Rail London) which might have led companies to establish a branch/subsidiary in the country.

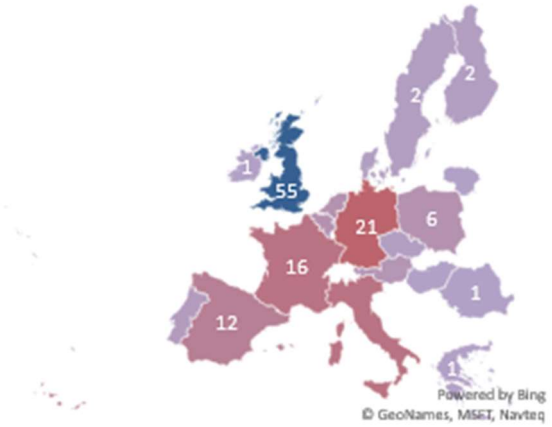
[17] Caveat: part of these companies is also involved in other segments of the supply chain. Therefore, it is difficult to split the figures due to manufacturing or supply of a specific segment only.

[18] For 8 companies we did not find any information about the shareholders structure.

A total of 159 companies are active as electrification equipment suppliers. According to the information retrieved, 75 are privately owned whereas 82 belong to a group. In terms of geographical distribution, 55 are based in UK, followed by Germany (21) and France (16).

**Table 9 Electrification equipment suppliers – geographical distribution – top 10**

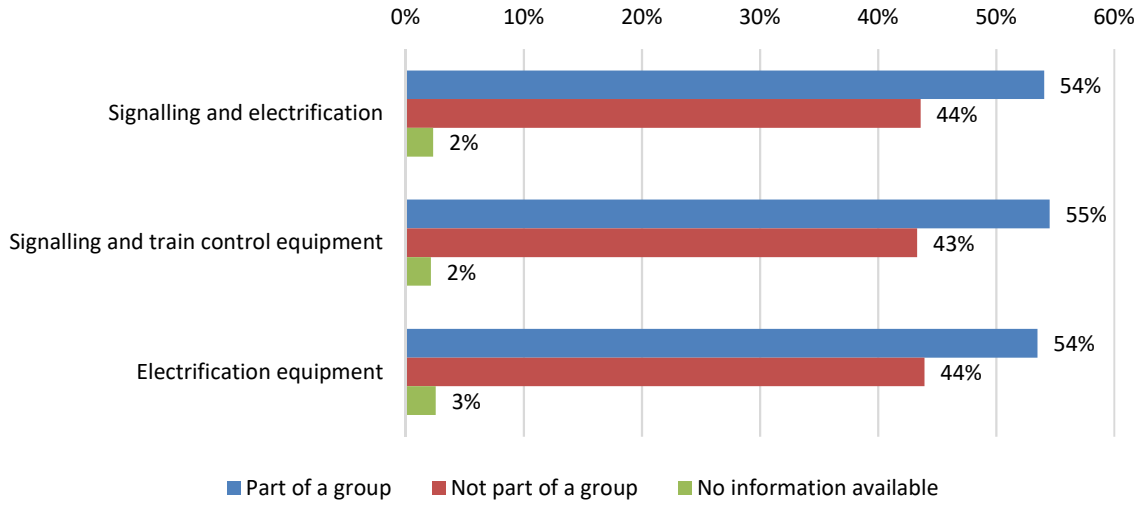
| Country | Nr of companies |
|---|---|
| UK | 55 |
| Germany | 21 |
| France | 17 |
| Italy | 15 |
| Spain | 12 |
| Belgium | 6 |
| Netherlands | 6 |
| Poland | 6 |
| Austria | 5 |
| Portugal | 3 |




Source: VVA, Railway Directory.

Based on the data available on Orbis, the majority of companies are part of a group (54%). This was also the case for the electrification equipment suppliers, as 84 of all 157 suppliers were part of a group (54%). Slightly more train control equipment suppliers were part of a group: a total of 102 of 187 (55%).

**Figure 15 Share of suppliers that are part of a group in the signalling and electrification sub-sector**



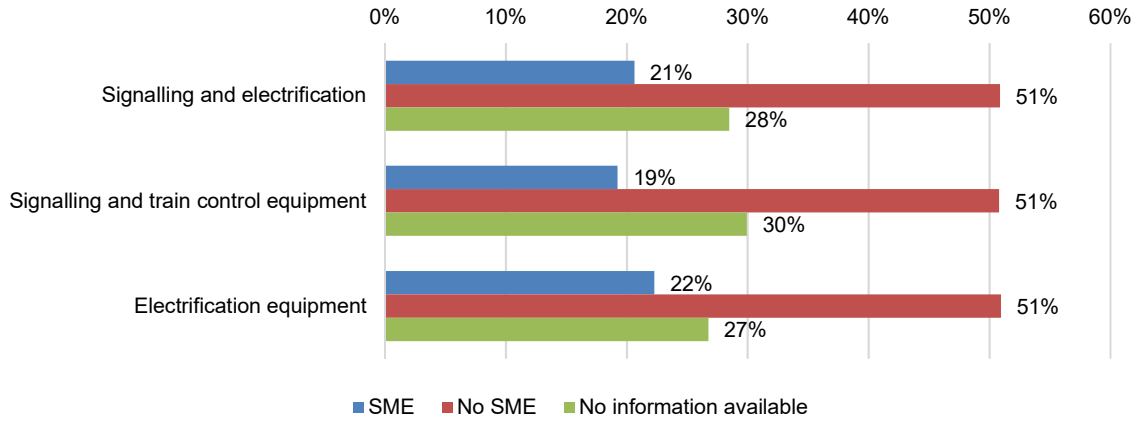

Source: VVA, Orbis.

Based on the European Commission's SME definition[19], a total of 71 SMEs were active in the RSI's signalling and electrification sub-sector (21%). 35 of the 157 electrification equipment suppliers (22%) were SMEs, while only 19 of the 187 signalling and train control equipment suppliers (19%).[20]

[19] To be classified as an SME, the company must be privately owned, have no more than 250 employees and a turnover of maximum EUR 50 million / balance sheet of EUR 43 million.

[20] Stakeholders interviewed commented that the signalling and electrification sector is very concentrated around few players, as it is not a multi-tier supply chain.

**Figure 16 Share of SMEs in the signalling and electrification sub-sector**




Source: VVA, Orbis.

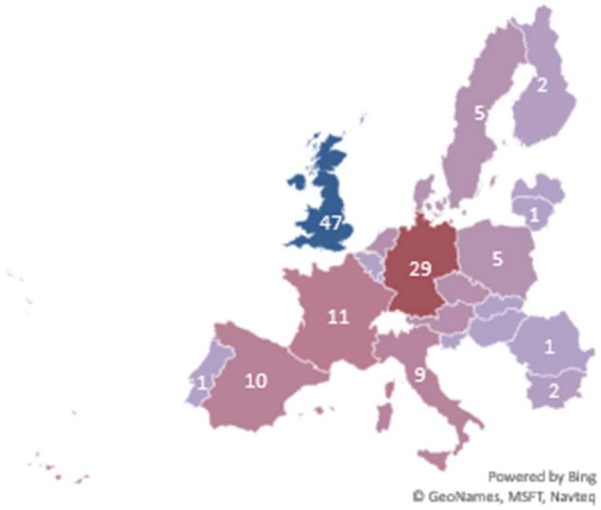
### 3.2.3. *Rail infrastructure*

According to data from *Railway Directory*[21], a total of 350 companies are active in Europe as suppliers of track materials and equipment and track maintenance.[22]

Out of these 350, 152 companies are active as suppliers of track materials and equipment. These companies trade in various products, such as: rail, sleepers, fastenings/spike, track components, etc. In terms of geographical distribution, 47 are based in UK,[23] followed by Germany (29) and France (11).

**Table 10 Track materials and equipment suppliers – geographical distribution – top 10**

| Country | Nr of companies |
|---|---|
| UK | 47 |
| Germany | 29 |
| France | 11 |
| Spain | 10 |
| Italy | 9 |
| Austria | 6 |
| Czech Republic | 6 |
| Netherlands | 6 |
| Denmark | 5 |
| Poland | 5 |




Source: VVA, Railway Directory.

[21] As of September 30th, 2018.

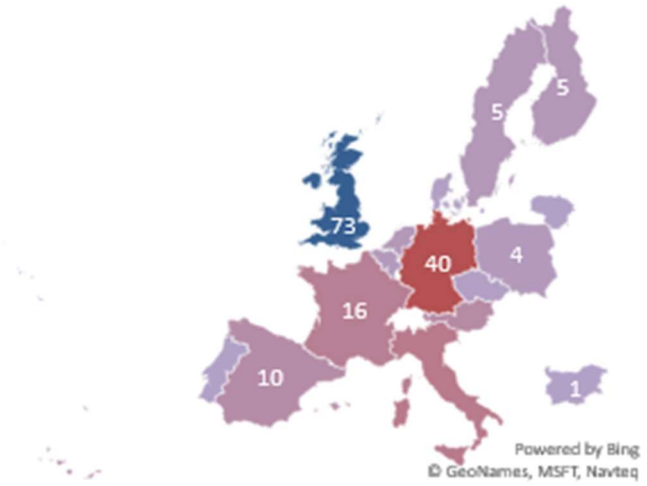
[22] Caveat: part of these companies is also involved in other segments of the supply chain. Therefore, it is difficult to split the figures due to manufacturing or supply of a specific segment only.

[23] Caveat: European associations representing the rail supply industry and associations representing the infrastructure managers commented that as per their knowledge, the German, French and Italian industry are much bigger in size compared to the UK one. Discrepancies between the data obtained and the opinions of the European associations could be due to the fact that: 1) Railway Directory is a service provided by Railway Gazette (UK based) which may explain the bias towards the UK, 2) Two big infrastructure projects are running in the UK (i.e. High Speed 2 and Cross Rail London) which might have led companies to establish a branch/subsidiary in the country.

In addition, 198 companies are active as suppliers of track maintenance. These companies provide services such as: maintenance machines, ballast cleaners, on-site welding, etc. According to the information retrieved, 73 are based in UK, followed by Germany (40) and Italy (18).

**Table 11 Track Maintenance suppliers – geographical distribution – top 10**

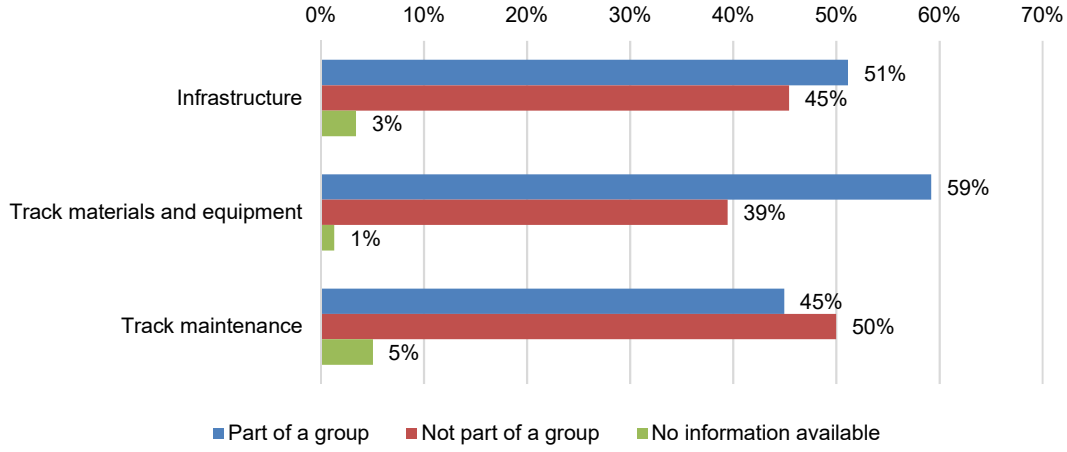
| Country | Nr of companies |
|---|---|
| UK | 73 |
| Germany | 40 |
| Italy | 18 |
| France | 16 |
| Austria | 11 |
| Spain | 10 |
| Finland | 5 |
| Netherlands | 5 |
| Sweden | 5 |
| Belgium | 4 |




Source: VVA, Railway Directory.

A total of 179 companies in the infrastructure sub-segment were part of a group (51%). Compared to the other suppliers' categories, less than half of the track maintenance suppliers belonged to a group (89 of 198; 45%). On the other hand, the majority of the track materials and equipment suppliers were part of a group (90 of 152; 59%).

**Figure 17 Share of suppliers that are part of a group in the infrastructure sub-sector**

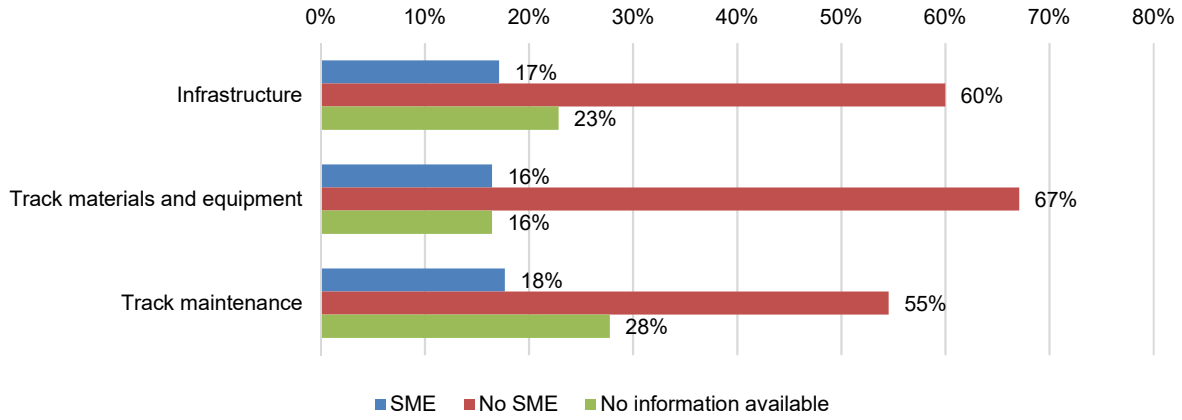



Source: VVA, Orbis.

A total of 60 SMEs[24] were active in the infrastructure sector (17%). Slightly more SMEs were in the subcategory of track maintenance (35 of 60; 18%) than in the track materials and equipment subcategory (25 of 60; 16%).

[24] To be classified as an SME, the company must be privately owned, have no more than 250 employees and a turnover of maximum EUR 50 million / balance sheet of EUR 43 million.

**Figure 18 Share of SMEs in the infrastructure sub-sector**

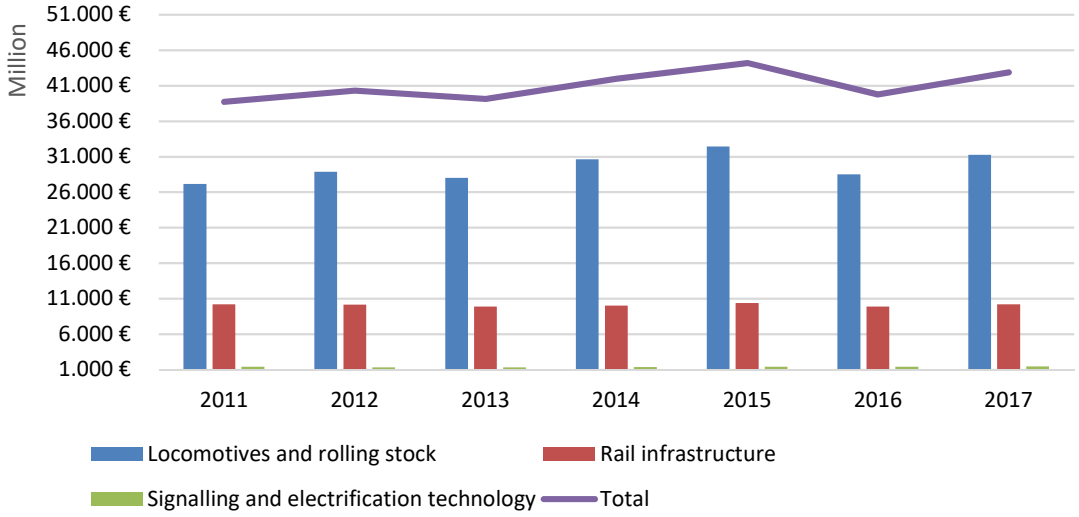



Source: VVA, Orbis.

## 3.3. Production in the RSI

This section provides an overview of the total production value in the EU's RSI with a focus on the three main sub-segments. The total production value in RSI has increased 11% in the years (2011 baseline). Regarding this increase in value, the biggest contribution to the growth was recorded in the locomotive and rolling stock sub-segment (15%). The rail infrastructure sub-segment did not experience any change (0%), while the signalling and electrification technology subsector grew 2%. Not only did the locomotive and rolling stock subsector contribute to the largest share of the industry growth, but its production value was also the highest of the three sub-segments (72% on average). The production of rail infrastructure amounted to around one fourth of the total value, while the total production value for signalling and electrification technology accounted only for 3% of the total RSI production value on average. The figure below (Figure 19) shows the production value of the EU's RSI and its sub-segments from 2011 to 2017.

**Figure 19 Production value RSI, EU28, 2011-2017**




Source: VVA, PRODCOM.

### 3.3.1. *Locomotive and rolling stock*

The locomotive and rolling stock sub-sector is comprised of 13 individual classifications of manufactured goods, following the PRODCOM codes (Table 12 The largest growth in production value was recorded in the production of i) mechanical or electromechanical signalling, safety or traffic control equipment for roads, inland waterways, parking facilities, port installations or

airfields (+814%) and ii) diesel-electric locomotives (+341%).[25] The greatest decrease in production value was measured in i) other rail locomotives; locomotive tenders (-65%); ii) rail locomotives powered from an external source of electricity (-21%) and iii) reconditioning of railway and tramway locomotives and rolling-stock (-20%).

**Table 12 Production of segment 'Locomotives and rolling stock' in EU28 markets**

| Locomotive and rolling stock | PRODCOM code | Aggregated production 2011 – 2017 in (in thousand €) | Total growth from 2011 (baseline) to 2017 |
|---|---|---|---|
| Rail locomotives powered from an external source of electricity. | 30201100 | 9,632,756.63 € | -21% |
| Diesel-electric locomotives. | 30201200 | 3,008,340.19 € | 341% |
| Other rail locomotives; locomotive tenders. | 30201300 | 779,625.68 € | -65% |
| Self-propelled railway or tramway coaches, vans and trucks, except maintenance or service vehicles. | 30202000 | 39,790,332.88 € | 21% |
| Railway or tramway maintenance or service vehicles (including workshops, cranes, ballast tampers, track-liners, testing coaches and track inspection vehicles). | 30203100 | 4,288,159.25 € | 33% |
| Rail/tramway passenger coaches; luggage vans, post office coaches and other special purpose rail/tramway coaches excluding rail/tramway maintenance/service vehicles, self-propelled. | 30203200 | 24,729,200.77 € | 0% |
| Railway or tramway goods vans and wagons, not self-propelled. | 30203300 | 5,336,765.67 € | 22% |
| Parts of locomotives or rolling-stock. | 30204030 | 46,445,095.07 € | 10% |
| Mechanical or electromechanical signalling, safety or traffic control equipment for roads, inland waterways, parking facilities, port installations or airfields. | 30204050 | 1,536,296.99 € | 814% |
| Mechanical signalling, safety or traffic control equipment for railways or tramways; parts of mechanical (including electromechanical), signalling, safety or traffic control equipment for railways, tramways, roads, inland waterways, parking facilities, port installations or airfields. | 30204060 | 3,320,824.77 € | 78% |
| Reconditioning of railway and tramway locomotives and rolling-stock. | 30209100 | 6,217,277.61 € | -20% |
| Repair and maintenance of railway and tramway locomotives and rolling-stock and of mechanical (and electro-mechanical) signalling, safety or traffic control equipment. | 33171100 | 54,131,251.22 € | 9% |
| Railway or tramway track fixtures and fittings (excluding sleepers of wood, concrete or steel, sections of track and other track fixtures not yet assembled and railway or tramway track construction | 399900Z5 | 7,545,972.65 € | 94% |

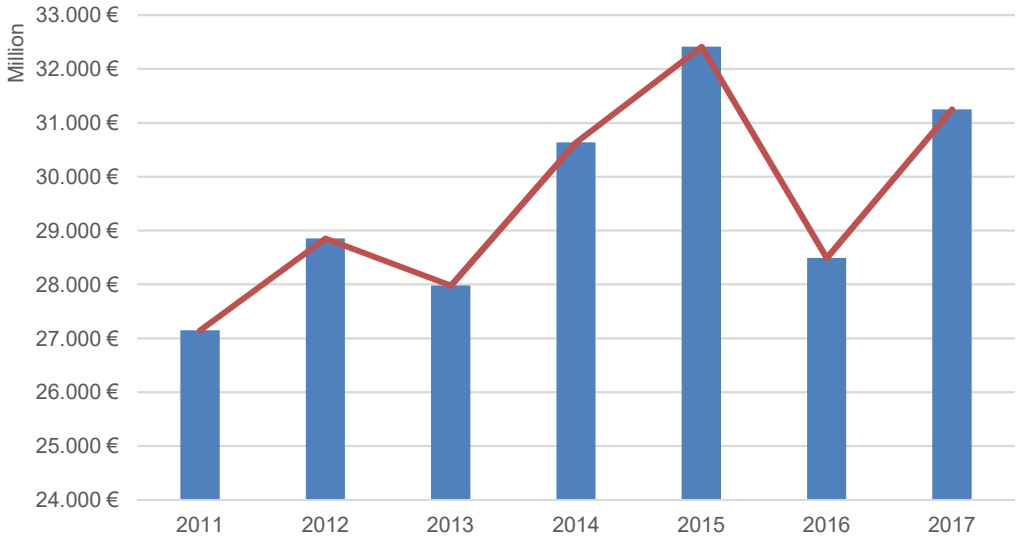
[25] According to the information provided by a European rail industry association, locomotives in the world are mostly powered by diesel engines – of the total number of locomotives currently in service 61% are diesel-powered. This is due to the dominant role of locomotives in freight haulage, particularly in marge freight markets such as United States, Canada, Brazil, Australia and Russia.

| Locomotive and rolling stock | PRODCOM code | Aggregated production 2011 – 2017 in (in thousand €) | Total growth from 2011 (baseline) to 2017 |
|---|---|---|---|
| material); mechanical, including electromechanical, signalling, safety or traffic control equipment for railways, tramways, roads, inland waterways, parking facilities, port installations or airfields; parts of the foregoing. | | | |
| Total | | 206,761,899.37 € | 15% |

Source: VVA, PRODCOM.

Nevertheless, the highest production value was recorded in the repair and maintenance of railway and tramway locomotives and rolling stock and of mechanical (and electromechanical) signalling, safety or traffic control equipment. This is followed by the production of i) parts of locomotives or rolling stock; ii) self-propelled railway or tramway coaches, vans and trucks (except maintenance or service vehicles) and iii) rail/tramway passenger coaches; luggage vans, post office coaches and other special purpose rail/tramway coaches.

**Figure 20 Production value of the locomotive and rolling stock sub-segment, 2011-2017**




Source: VVA, PRODCOM.

### 3.3.2. *Signalling and electrification products*

The products in the signalling and electrification sub-segment only comprises two categories of manufactured goods, according to the PRODCOM codes (see Table 13). Overall, the production value of those categories, as well as the total production value of signalling and electrification technology has remained stable over the years; with a slight increase (+2%).

**Table 13 Production of "signalling and electrification technology" in EU28 markets**

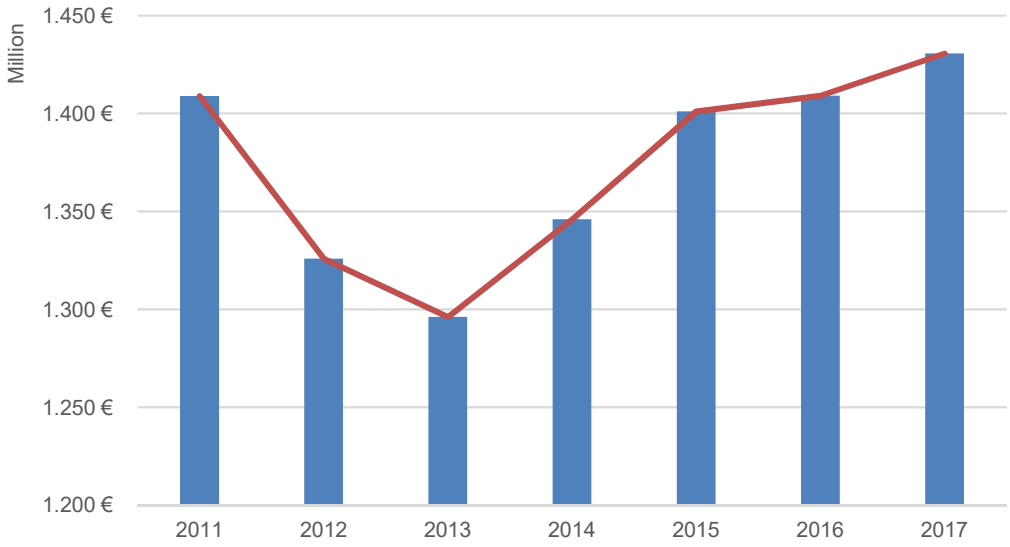
| Signalling and electrification technology | PRODCOM code | Aggregated production 2011 – 2017 in (in thousand €) | Total growth from 2011 (baseline) to 2017 |
|---|---|---|---|
| Parts of electrical signalling, safety or traffic control equipment for railways, tramways, | 27903330 | 225,926.18 € | -3% |

| Signalling and electrification technology | PRODCOM code | Aggregated production 2011 – 2017 in (in thousand €) | Total growth from 2011 (baseline) to 2017 |
|---|---|---|---|
| roads, inland waterways, parking facilities, port installations and airfields. | | | |
| Electrical signalling, safety or traffic control equipment for railways or tramways. | 27907010 | 9,391,650.99 € | 2% |
| **Total** | | **9,617,577.17 €** | **2%** |

Source: VVA, PRODCOM.

While the sub-segment experienced slight growth over the full observed time period, it had decreased until 2013 (- 8%; 2011 baseline). From that point onwards, the production value picked up again to surpass 2011 levels by 2017 (see Figure 21).

**Figure 21 Production value in the RSI sub-segment signalling and electrification systems, 2011-2017**




Source: VVA, PRODCOM.

### 3.3.3. *Rail infrastructure*

The production of rail infrastructure records the second-highest total value of production in the EU's RSI. Nevertheless, the levels have remained stable since 2011 (+0.3%). The sub-segment is comprised of 11 individual categories of manufactured goods, following the PRODCOM codes (see Table 14). In comparison to the locomotive and rolling stock sub-sector, only four recorded a growth in the time period observed: i) screws and bolts for fixing railway truck construction material, iron or steel (+25%), ii) turned metal parts for articles of HS 7326, 7419, 7616; turned metal parts for vehicles and apparatus for fixing railway track of HS 86 (+24%), iii) railway or tramway track fixtures and fittings and parts thereof (+14%); and iv) plastic parts for locomotives or rolling stock, railway or tramway track fixtures and fittings, mechanical signalling, safety or traffic control equipment (+3%). The remaining experienced a decrease in production value[26], amongst which the highest decrease was recorded in the production of grey iron castings for locomotives/rolling stock/parts, used other than in land vehicles, bearing housings, plain shaft bearings, piston engines, gearing, pulleys, clutches, machinery (-21%).

[26] Exception: railway or tramway sleepers (cross-ties) of wood, not impregnated.

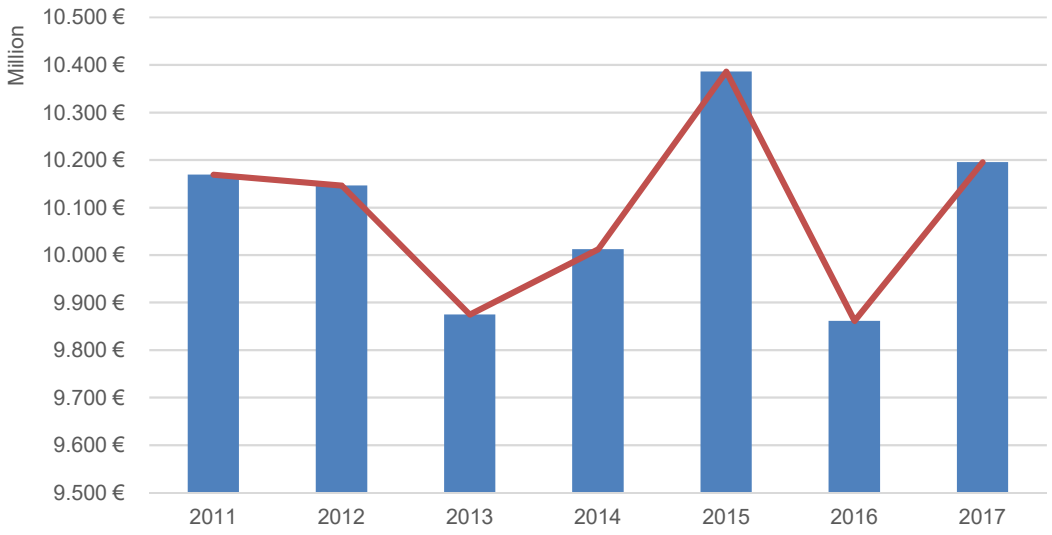
**Table 14 Production of segment 'Rail infrastructure ' in EU28 markets**

| Rail infrastructure | PROD-COM code | Aggregated production 2011 – 2017 in (in thousand €) | Total growth from 2011 (baseline) to 2017 |
|---|---|---|---|
| Railway or tramway sleepers (cross-ties) of wood, not impregnated. | 16101300 | 156,391.12 € | / |
| Railway or tramway sleepers (cross-ties) of impregnated wood. | 16103200 | 573,788.78 € | -1% |
| Plastic parts for locomotives or rolling stock, railway or tramway track fixtures and fittings, mechanical signalling, safety or traffic control equipment. | 22299150 | 1,664,986.97 € | 3% |
| Railway material (of steel). | 24107500 | 15,099,928.06 € | -13% |
| Ductile iron castings for locomotives/rolling stock/parts, used other than in land vehicles, bearing housings, plain shaft bearings, piston engines, gearing, pulleys, clutches, machinery. | 24511290 | 7,946,854.22 € | -5% |
| Grey iron castings for locomotives/rolling stock/parts, used other than in land vehicles, bearing housings, plain shaft bearings, piston engines, gearing, pulleys, clutches, machinery. | 24511390 | 7,048,779.64 € | -21% |
| Steel castings for locomotives/rolling stock/parts, use other than in land vehicles, bearing housings, plain shaft bearings, piston engines, gearing, pulleys, clutches, machinery. | 24521090 | 9,881,880.47 € | -19% |
| Drop forged steel parts for locomotives or rolling stock, aircraft, spacecraft, electrical machinery and equipment, optical, photographic, cinematographic, measuring, checking or precision apparatus. | 25501280 | 202,069.10 € | -12% |
| Turned metal parts for articles of HS 7326, 7419, 7616; turned metal parts for vehicles and apparatus for fixing railway track of HS 86. | 25621013 | 23,373,553.51 € | 24% |
| Screws and bolts for fixing railway truck construction material, iron or steel. | 25941115 | 1,817,021.35 € | 25% |
| Railway or tramway track fixtures and fittings and parts thereof. | 25992910 | 2,879,350.97 € | 14% |
| Total | | 70,644,604.19 € | 0.3% |

Source: VVA, PRODCOM.

In this case, the highest production value was recorded for the production of turned metal parts for articles of HS 7326, 7419, 7616; turned metal parts for vehicles and apparatus for fixing railway track of HS 86; followed by the production of railway material (steel).

**Figure 22 Production value in the categories of the manufactured goods in the rail infrastructure sub-segment, 2011-2017**




Source: VVA, PRODCOM.

## 3.4. Gross investments in tangible goods

The level and intensity of private investments conducted in the railway supply industry, were measured by using Eurostat's *gross investment in tangible goods*, which includes spending on land improvement, plant, machinery and equipment purchases.[27]

The objective of this analysis is to provide an indication of the productivity of capital for the industries under analysis. From an economic perspective, improved capital goods (i.e. better capital equipment) increase labour productivity.

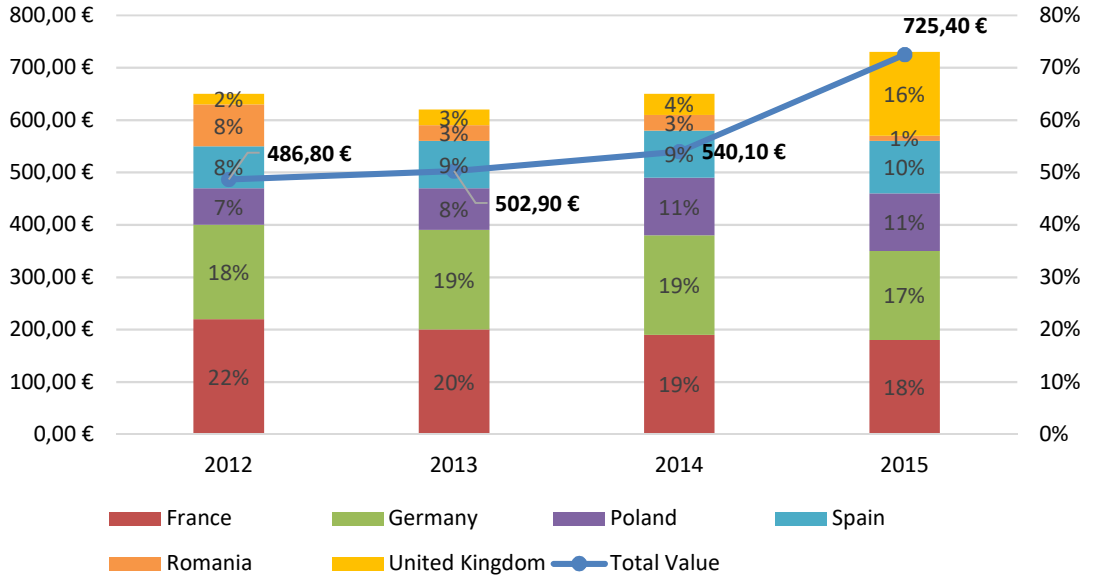
This analysis is limited to the *totally Railway Supply industries,* due to the specification of the industry thought NACE codes.[28] However, caution should be used in interpreting the results. In fact, Eurostat provides data about *gross investments* which include investments for new capital formation (e.g. the acquisition of new machineries) and investment to cover the annual deprecation costs.

Figure 23 shows the total gross investments in tangible goods made by the European manufacturing of locomotives and rolling stocks industry. The investment in tangible goods have increased from 486.8 million € in 2012 (no data is available for the year 2011) to 725.4 million € in 2015, experiencing a compound average annual growth rate (CAGR) of about 10%.

[27] Gross investment in tangible goods is defined as investment during the reference period in all tangible goods. Included are new and existing tangible capital goods, whether bought from third parties or produced for own use (i.e. capitalised production of tangible capital goods), having a useful life of more than one year including non-produced tangible goods such as land. Investments in intangible and financial assets are excluded It does not account for the consumption (depreciation). Source: https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Gross_investment_in_tangible_goods_-_SBS.

[28] In structural data according to NACE (e.g. Structural Business Statistics), a company, and thus their persons employed, turnover, value added, etc., is allocated to the industry in which is the main activity of the company. This means that indicators / data include also activities of the company that may have been accomplished in other sectors.

**Figure 23 Gross investment in tangible goods in million €, manufacturing of locomotives and rolling stocks period 2012-2015**

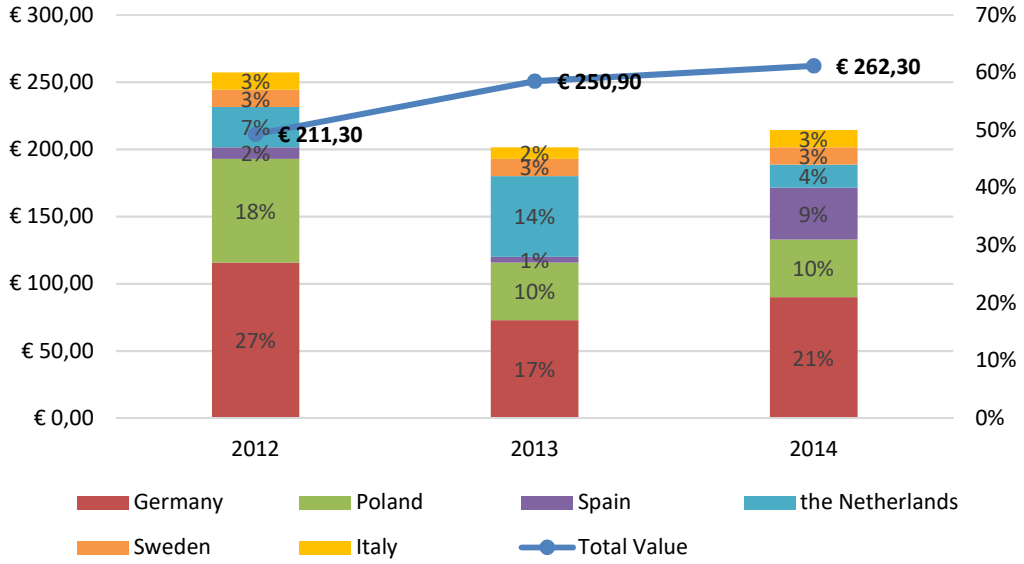



Source: VVA, Eurostat, Structural Business Statistics (sbs).

According to the data available, 6 countries (France, Germany, Poland, Romania, Spain and United Kingdom) contributed to generate 67% (on average) of the total amount invested by the industry at aggregate European level.[29]

Figure 24 shows the total gross investments in tangible goods made by the European repair and maintenance of other transport equipment (i.e. 'spare parts' industry). The investment in tangible goods have increased from 211.3 million € in 2012 (no data is available for the year 2011) to 262.3 million € in 2014 (latest year available), experiencing a compound average annual growth rate (CAGR) of about 7%.

**Figure 24 Gross investment in tangible goods in million €, repair and maintenance of other transport equipment period 2012-2014**




Source: VVA, Eurostat, Structural Business Statistics (sbs).

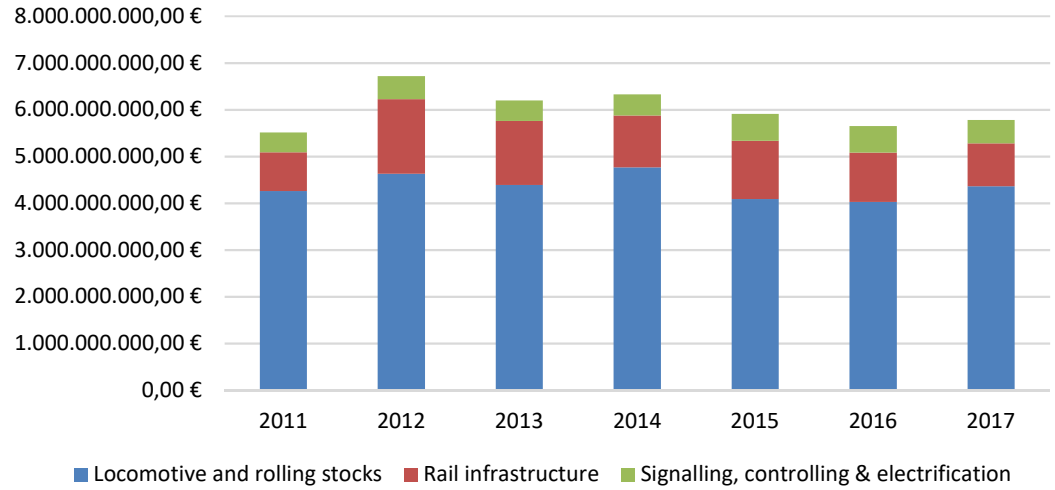
[29] Caveat: data are not available for all Member States and/or present gaps in the time series.

According to the data available, 6 countries (Germany, Poland, Spain, the Netherlands, Sweden and Italy) contributed to generate 52% (on average) of the total amount invested by the industry at aggregate European level.[30]

## 3.5. International trade (CN Codes)

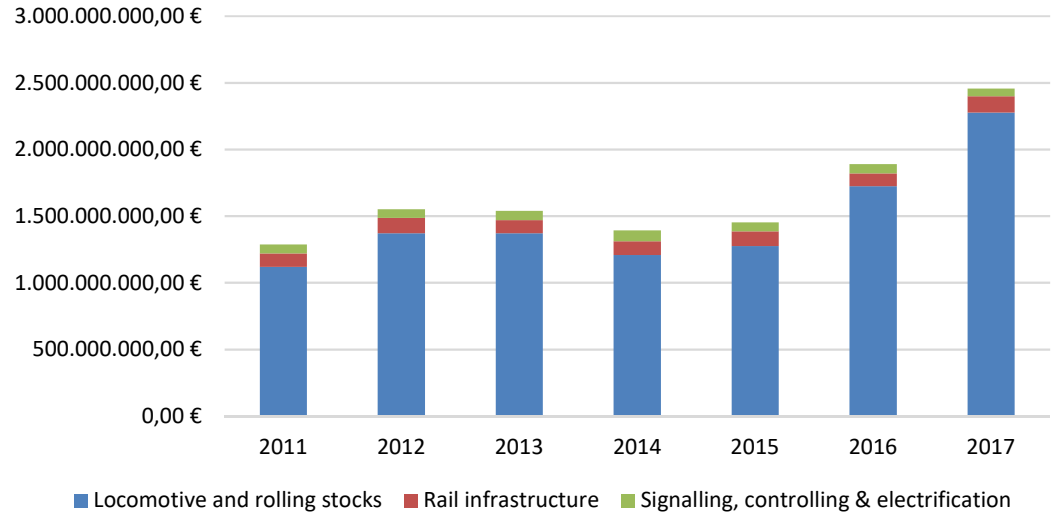
This section provides a description of the recent international trade patterns for the EU. A detailed overview by the three sub-segments follows the short introduction of the total RSI market. The figures below (see Figure 25 and Figure 26 show the total trade patterns in the EU's RSI industry from 2011 to 2017. Overall, the total value of exports was stable over the years, with a peak of over EUR 6,720 million in 2012. The total value of imports, on the other hand, has increased since 2014, reaching around EUR 2,456 million in 2017. Overall, the locomotive and rolling stock sub-segment has contributed to the largest share of the total value, both regarding exports but particularly imports.

**Figure 25 Total value of exports extra-EU, million €, period 2011-2017**




Source: VVA, COMEXT.

**Figure 26 Total value of imports extra-EU, million €, period 2011-2017**

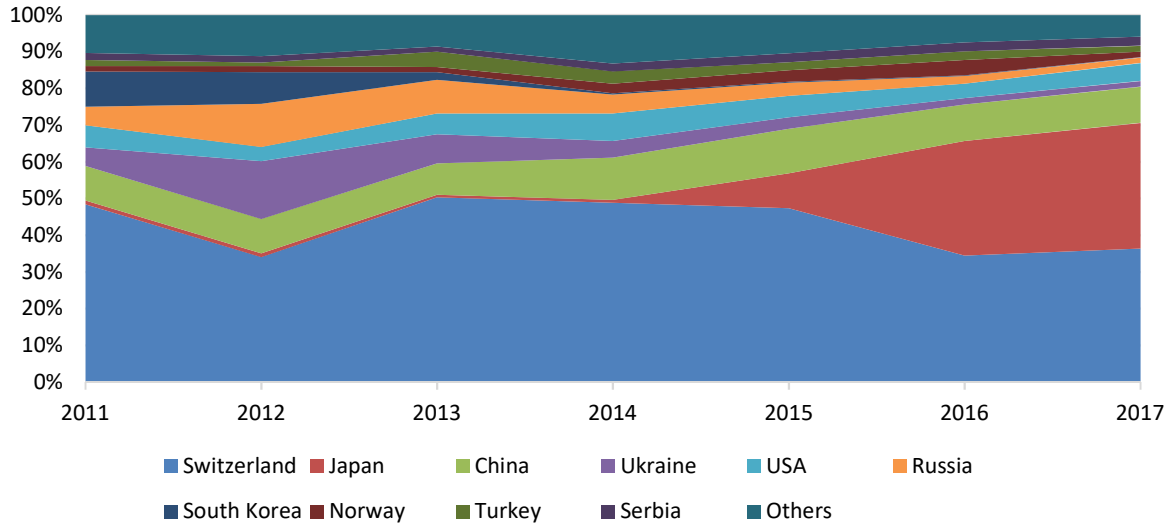



Source: VVA, COMEXT.

[30] Caveat: data are not available for all Member States and/or present gaps in the time series.

The source of imports for EU RSI is highly concentrated on 10 countries: Switzerland, Japan, China, the United States, Ukraine, South Korea, Russia, Norway, Turkey and Serbia. These ten countries amount for over 90% of the total import value in the EU's RSI (see Figure 27).

**Figure 27 Extra-EU imports by country, total RSI, period 2011-2017**




Source: VVA, COMEXT.

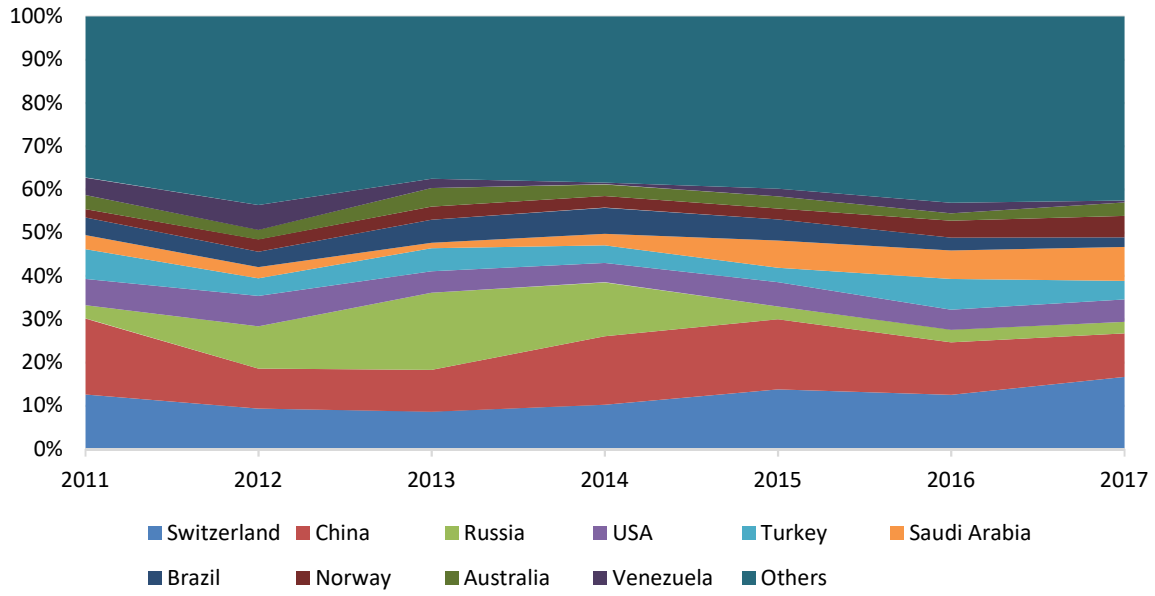
**Table 15 Extra-EU imports by country, total RSI, EUR Million, period 2011-2017**

| Country | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| Switzerland | 622,32 | 527,41 | 773,73 | 679,94 | 687,59 | 650,51 | 892,44 |
| Japan | 13,47 | 15,94 | 10,26 | 10,42 | 138,42 | 589,41 | 842,25 |
| China | 121,53 | 145,18 | 131,39 | 160,62 | 176,17 | 188,64 | 241,72 |
| Ukraine | 65,57 | 244,04 | 121,94 | 63,21 | 45,57 | 31,51 | 39,05 |
| USA | 77,30 | 60,39 | 87,94 | 105,49 | 84,43 | 74,30 | 119,95 |
| Russia | 65,67 | 181,43 | 141,17 | 71,18 | 51,75 | 40,46 | 35,63 |
| South Korea | 123,38 | 134,14 | 31,19 | 5,29 | 4,76 | 3,65 | 4,02 |
| Norway | 19,40 | 24,76 | 22,43 | 36,05 | 45,81 | 78,62 | 36,14 |
| Turkey | 20,74 | 16,07 | 63,72 | 47,01 | 30,83 | 43,71 | 39,79 |
| Serbia | 25,03 | 26,53 | 21,84 | 29,99 | 35,17 | 46,33 | 60,81 |
| ***Subtotal*** | ***1.154,41*** | ***1.375,90*** | ***1.405,61*** | ***1.209,18*** | ***1.300,51*** | ***1.747,14*** | ***2.311,80*** |
| ***Others*** | ***133,34*** | ***174,13*** | ***132,63*** | ***184,20*** | ***152,48*** | ***141,80*** | ***145,00*** |

Source: VVA, COMEXT.

The destination of EU exports in RSI (outside of the EU itself) is not as strongly concentrated on a few countries as the imports. The top ten receiving countries are Switzerland, the United States, Brazil, Saudi Arabia, Russia, Canada, Turkey, China, South Africa and Norway. Around 60% of the exports of EU RSI go to these countries (see Figure 28).

**Figure 28 Extra-EU exports by country, total RSI, period 2011-2017**




Source: VVA, COMEXT.

**Table 16 Extra-EU exports by country, total RSI, EUR Million, period 2011-2017**

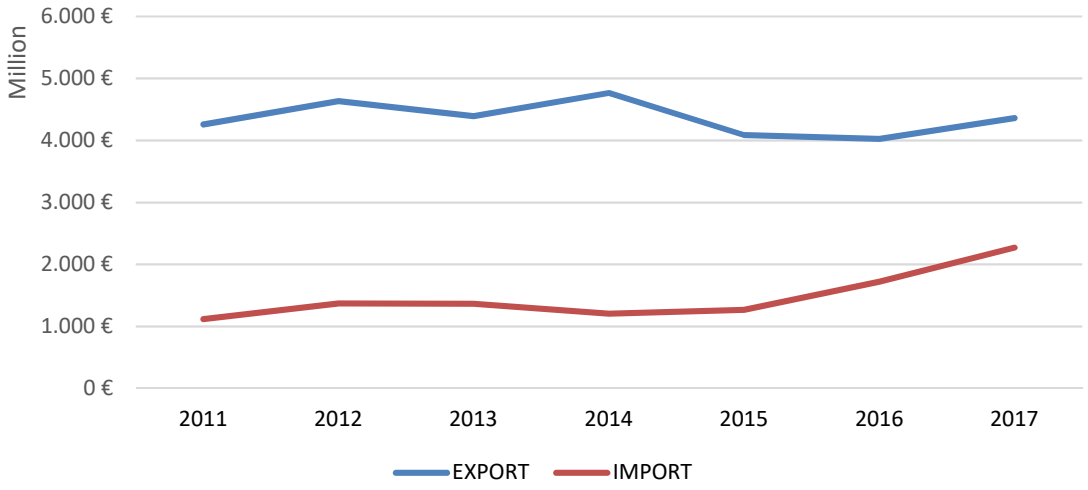
| Country | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| Switzerland | 692,20 | 627,11 | 535,21 | 648,53 | 810,91 | 707,24 | 964,21 |
| China | 971,36 | 622,51 | 600,10 | 1.002,28 | 958,12 | 685,93 | 580,07 |
| Russia | 168,49 | 655,52 | 1.103,58 | 788,25 | 174,74 | 164,27 | 155,90 |
| USA | 333,55 | 472,23 | 307,00 | 284,33 | 335,85 | 261,39 | 297,00 |
| Turkey | 380,73 | 274,73 | 329,82 | 256,57 | 196,36 | 402,94 | 249,80 |
| Saudi Arabia | 179,20 | 172,79 | 80,29 | 170,56 | 370,64 | 369,51 | 453,11 |
| Brazil | 223,29 | 240,48 | 326,90 | 381,21 | 286,74 | 168,26 | 127,33 |
| Norway | 108,48 | 190,33 | 191,40 | 170,06 | 149,04 | 219,03 | 289,42 |
| Australia | 178,58 | 149,81 | 266,59 | 170,76 | 169,07 | 99,12 | 177,03 |
| Venezuela | 222,06 | 384,16 | 130,21 | 25,59 | 101,36 | 135,42 | 24,99 |
| ***Subtotal*** | ***3.457,93*** | ***3.789,67*** | ***3.871,10*** | ***3.898,14*** | ***3.552,84*** | ***3.213,12*** | ***3.318,86*** |
| ***Others*** | ***2.055,02*** | ***2.931,29*** | ***2.328,51*** | ***2.432,83*** | ***2.354,90*** | ***2.436,05*** | ***2.464,18*** |

Source: VVA, COMEXT.

### 3.5.1. *Locomotive and rolling stock*

Since 2011, the EU has increased its total trade of locomotive and rolling stock. Overall, the value of exports was stable over the years of scope. The level of import, on the other hand, has increased, especially since 2015 (total increase of 103% from 2011 to 2017) (see Figure 29).

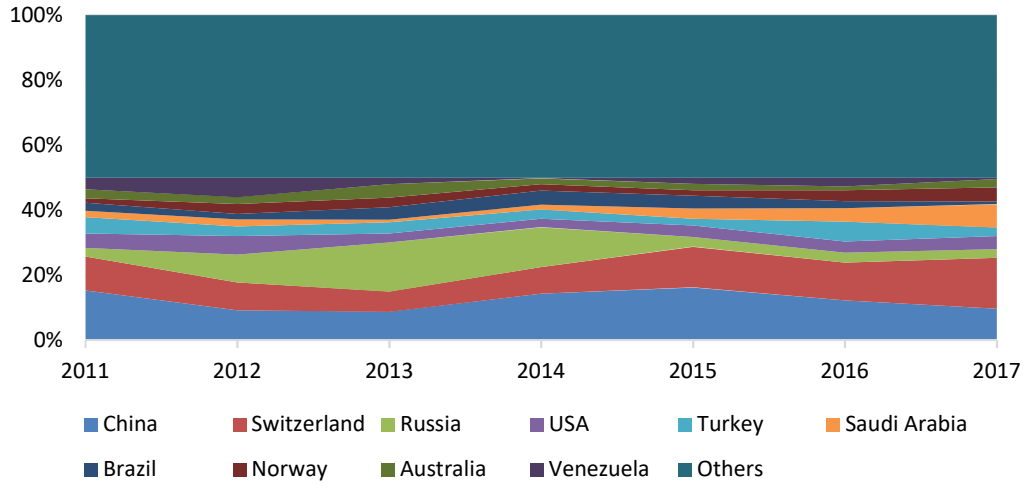
**Figure 29 EU external trade in locomotive and rolling stock, total value € million, period 2011-2017**




Source: VVA, COMEXT.

Around half of all exports of locomotive and rolling stock goes to ten countries: Switzerland, China, Saudi Arabia, Norway, the United States, Mexico, Peru, Russia, Turkey and India. In comparison to the total top receiving countries, Mexico, Peru and India make the top list, suggesting that the demand for locomotive and rolling stock is higher in these countries than in other RSI sub-segments (see Figure 30).

**Figure 30 EU exports in locomotive and rolling stock by destination outside of the EU**




Source: VVA, COMEXT.

**Table 17 Extra-EU exports of in locomotive and rolling stock, by main source country, EUR Million**

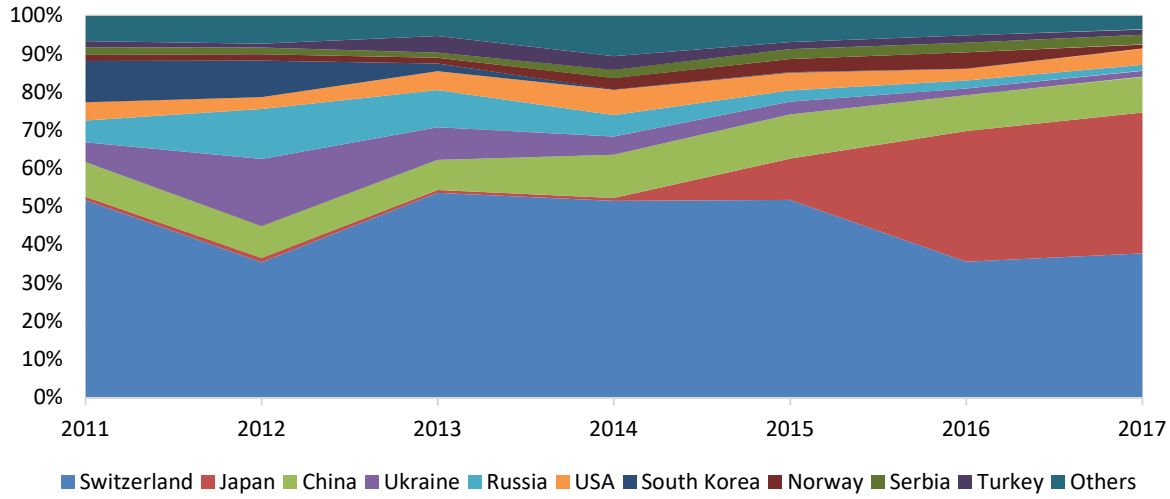
| Country | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| China | 865,86 | 495,09 | 490,42 | 885,17 | 856,20 | 595,63 | 505,06 |
| Switzerland | 591,24 | 465,20 | 347,67 | 504,88 | 656,94 | 566,13 | 814,02 |
| Russia | 150,14 | 465,79 | 843,26 | 761,91 | 156,64 | 150,77 | 142,36 |
| USA | 253,34 | 309,45 | 153,95 | 159,67 | 185,27 | 167,73 | 208,86 |
| Turkey | 286,16 | 160,54 | 196,16 | 177,53 | 109,50 | 294,30 | 137,12 |
| Saudi Arabia | 111,52 | 115,62 | 42,98 | 91,39 | 165,80 | 201,71 | 374,06 |
| Brazil | 138,35 | 91,23 | 212,73 | 267,11 | 207,11 | 107,12 | 41,37 |
| Norway | 77,43 | 163,88 | 166,44 | 122,04 | 89,06 | 160,64 | 228,96 |

| Country | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| Australia | 157,03 | 114,90 | 229,33 | 114,06 | 104,72 | 57,31 | 133,45 |
| Venezuela | 201,84 | 324,50 | 114,04 | 10,13 | 99,62 | 133,26 | 21,79 |
| ***Subtotal*** | ***2832,91*** | ***2706,20*** | ***2796,98*** | ***3093,90*** | ***2630,85*** | ***2434,61*** | ***2607,05*** |
| ***Others*** | ***1427,02*** | ***1926,53*** | ***1594,24*** | ***1672,49*** | ***1457,10*** | ***1590,96*** | ***1756,19*** |

Source: VVA, COMEXT.

The top ten importing non-EU countries of locomotive and rolling stock, however, amount for around 90% of all imports and are: Switzerland, Japan, China, the United States, Serbia, Ukraine, Russia, Turkey, Norway and India (see Figure 31). Of these countries, Japan and Switzerland contribute to around half of all imports of rolling stock and locomotives in the EU (66% on average).

**Figure 31 Extra-EU imports of locomotive and rolling stock by main source country**




Source: VVA, COMEXT.

**Table 18 Extra-EU imports of in locomotive and rolling stock, by main source country, € Million**

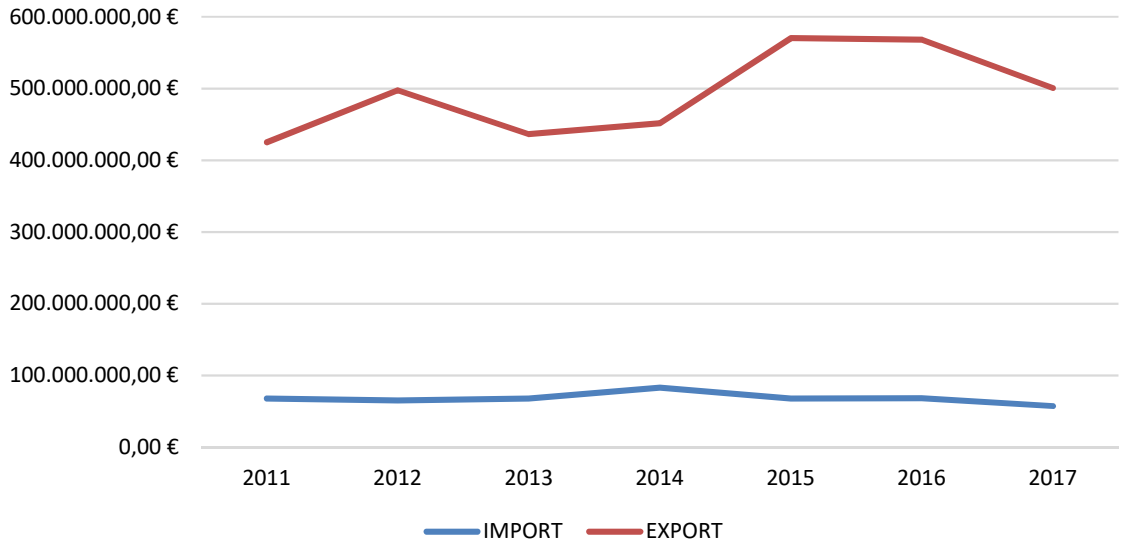
| Country | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| Switzerland | 578,88 | 485,66 | 734,70 | 621,58 | 659,53 | 614,31 | 859,82 |
| Japan | 10,15 | 15,48 | 9,77 | 9,80 | 137,88 | 588,77 | 839,15 |
| China | 101,23 | 114,94 | 107,86 | 136,72 | 147,14 | 162,57 | 212,62 |
| Ukraine | 58,22 | 240,21 | 117,05 | 56,75 | 42,75 | 29,32 | 35,99 |
| Russia | 63,64 | 178,79 | 133,52 | 68,25 | 37,72 | 36,67 | 35,03 |
| USA | 54,04 | 42,94 | 67,64 | 80,20 | 59,40 | 52,28 | 96,47 |
| South Korea | 120,51 | 130,20 | 27,02 | 1,46 | 1,52 | 0,99 | 0,97 |
| Norway | 18,01 | 23,77 | 21,45 | 35,28 | 44,16 | 73,50 | 23,90 |
| Serbia | 22,60 | 24,10 | 17,73 | 26,75 | 32,49 | 43,55 | 57,55 |
| Turkey | 17,06 | 13,13 | 59,62 | 42,60 | 24,43 | 33,69 | 32,31 |
| ***Subtotal*** | ***1044,33*** | ***1269,21*** | ***1296,36*** | ***1079,38*** | ***1187,02*** | ***1635,64*** | ***2193,81*** |
| ***Others*** | ***75,23*** | ***100,97*** | ***73,70*** | ***128,30*** | ***87,99*** | ***89,16*** | ***81,77*** |

Source: VVA, COMEXT.

### 3.5.2. *Signalling and electrification products*

The total value of international trade of EU signalling and electrification products has remained stable over the years. The value of exports has recorded a slight increase over the years (+18%), whilst the value of imports increased half-way while decreasing again since 2014 (-16% from 2011 to 2017) (see Figure 32). Overall, the total value of international trade in signalling and electrification systems is the lowest compared to the other RSI sub-segments.

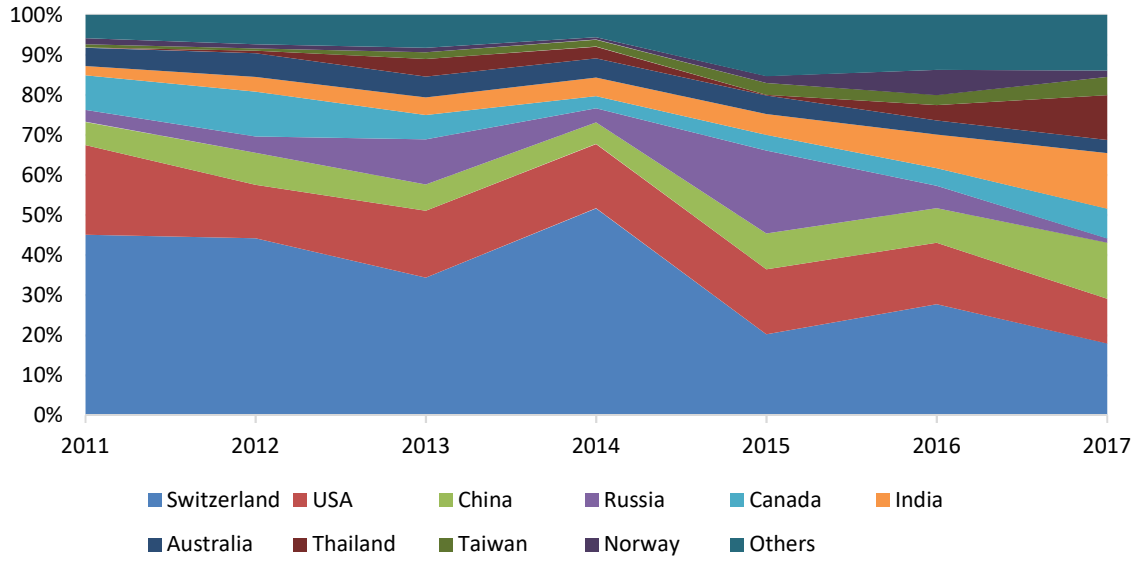
**Figure 32 EU external trade in signalling and electrification systems, Total value (€)**




Source: VVA, COMEXT.

Similar to the other RSI sub-segments, the imports from non-EU countries in signalling and electrification systems is highly concentrated on a few countries (average of 89%). The top ten importing non-EU countries are: Switzerland, United States, China, Russia, Canada, India, Australia, Thailand, Taiwan and Norway. While the US and Switzerland amounted for over 60% of the total value of imports in 2011, his share has nearly halved by 2017 (32% of the import value) (see Figure 33).

**Figure 33 Extra-EU imports of signalling and electrification systems, by main source country**




Source: VVA, COMEXT.

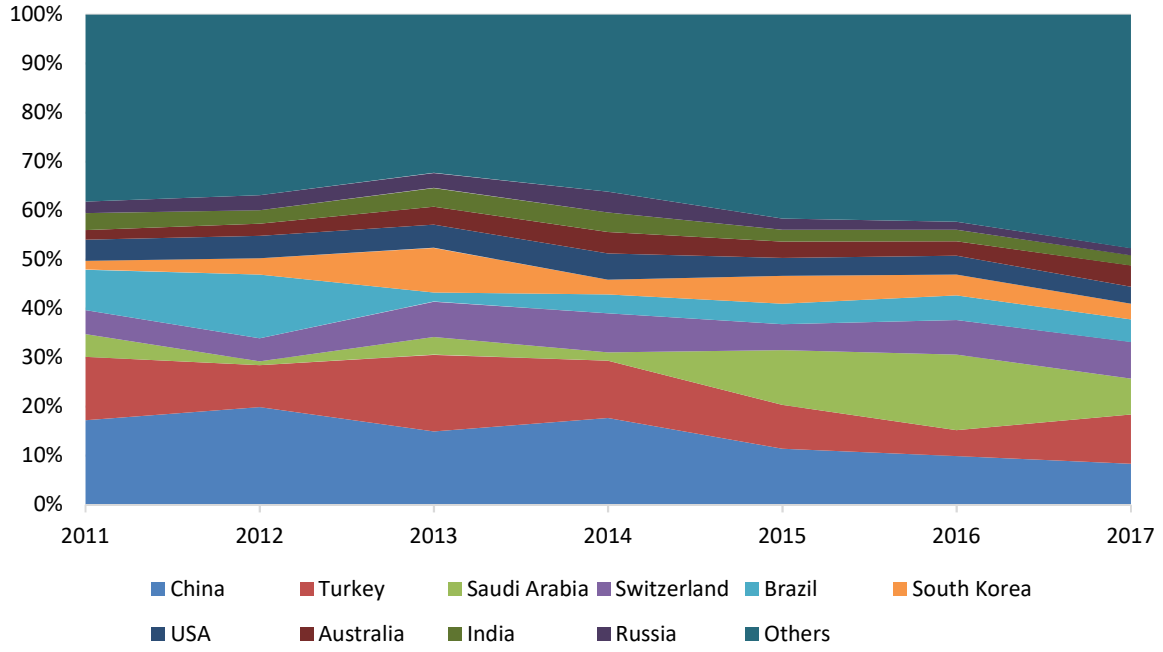
**Table 19 Extra-EU imports of signalling and electrification systems, by main source country,**

| Country | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| Switzerland | 30,58 | 28,70 | 23,29 | 42,93 | 13,69 | 18,93 | 10,29 |
| USA | 15,23 | 8,70 | 11,34 | 13,37 | 11,01 | 10,43 | 6,39 |
| China | 3,92 | 5,20 | 4,47 | 4,47 | 6,10 | 5,91 | 8,03 |
| Russia | 2,03 | 2,64 | 7,64 | 2,93 | 14,03 | 3,79 | 0,60 |
| Canada | 5,86 | 7,27 | 4,13 | 2,53 | 2,64 | 3,00 | 4,27 |
| India | 1,59 | 2,43 | 2,99 | 3,81 | 3,54 | 5,76 | 7,94 |
| Australia | 3,13 | 3,81 | 3,52 | 4,00 | 3,13 | 2,38 | 1,89 |
| Thailand | 0,02 | 0,43 | 2,94 | 2,43 | 0,13 | 2,62 | 6,38 |
| Taiwan | 0,51 | 0,34 | 1,18 | 1,45 | 2,01 | 1,72 | 2,63 |
| Norway | 1,04 | 0,68 | 0,72 | 0,53 | 1,17 | 4,30 | 0,92 |
| ***Subtotal*** | ***63,90*** | ***60,21*** | ***62,22*** | ***78,45*** | ***57,45*** | ***58,84*** | ***49,34*** |
| ***Others*** | ***4,01*** | ***4,82*** | ***5,62*** | ***4,65*** | ***10,39*** | ***9,38*** | ***7,98*** |

**€ Million**
Source: VVA, COMEXT.

Again, the share of the value of exports of signalling and electrification systems outside the EU is less highly concentrated on top countries as the imports. On average, 61% of the total export value was recorded in the top 10 receiving countries (a comparable number to the other sub-segments). The share of other countries receiving EU exports has increased over the years as well. Nevertheless, the top ten countries are largely the same countries as in the other sub-segments: China, Turkey, Saudi Arabia, Switzerland, Brazil, South Korea, United States, Australia, India and Russia (see Figure 34).

**Figure 34 Extra-EU exports of signalling and electrification systems, by main source country**




Source: VVA, COMEXT.

**Table 20 Extra-EU exports of signalling and electrification systems, by main source country, € Million**

| Country | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| China | 73,13 | 99,07 | 65,28 | 79,71 | 65,01 | 56,38 | 41,86 |

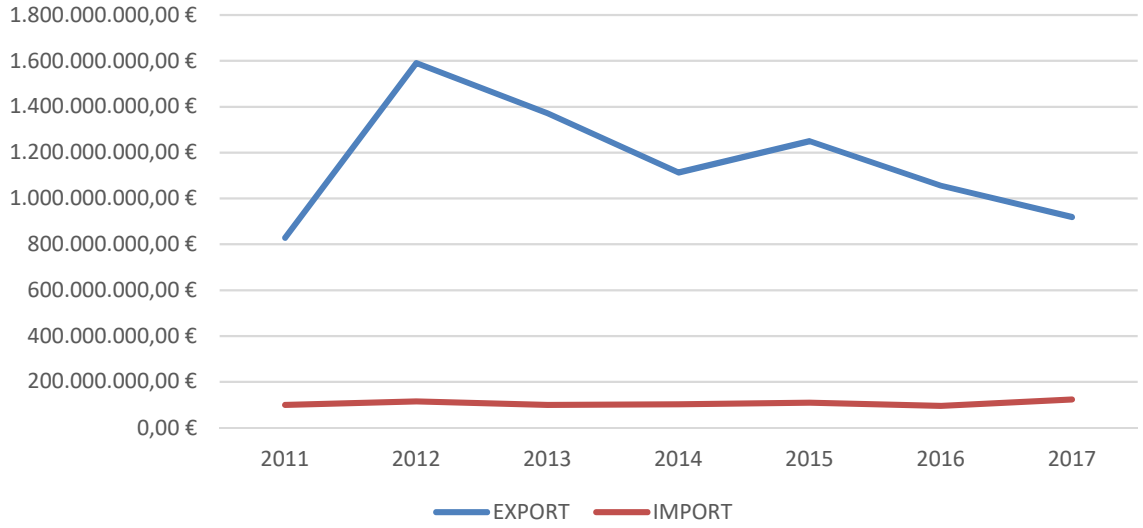
| Country | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| Turkey | 55,03 | 42,30 | 68,31 | 53,01 | 51,09 | 30,05 | 50,17 |
| Saudi Arabia | 19,69 | 4,16 | 15,70 | 7,61 | 63,54 | 87,32 | 36,83 |
| Switzerland | 20,66 | 23,29 | 31,64 | 36,02 | 30,23 | 40,17 | 37,47 |
| Brazil | 35,32 | 64,71 | 7,93 | 17,34 | 23,82 | 28,54 | 23,06 |
| South Korea | 7,61 | 16,38 | 39,86 | 13,48 | 32,60 | 24,00 | 15,94 |
| USA | 18,22 | 22,79 | 20,76 | 24,28 | 20,59 | 22,14 | 17,38 |
| Australia | 8,28 | 12,42 | 16,01 | 19,82 | 19,28 | 16,54 | 21,76 |
| India | 14,79 | 13,51 | 16,66 | 17,81 | 13,68 | 13,24 | 10,54 |
| Russia | 10,02 | 15,49 | 13,39 | 19,25 | 13,06 | 9,44 | 7,22 |
| ***Subtotal*** | ***262,75*** | ***314,12*** | ***295,55*** | ***288,33*** | ***332,91*** | ***327,82*** | ***262,23*** |
| ***Others*** | ***162,30*** | ***183,43*** | ***141,12*** | ***163,32*** | ***237,40*** | ***240,19*** | ***238,77*** |

Source: VVA, COMEXT.

### 3.5.3. *Rail Infrastructure*

The external trade of railway infrastructure in the EU has decreased since 2012 (-39% to 2017). This is particularly driven by the decreasing levels of export since 2012 (-42% to 2017), while not yet fully reaching the 2011 levels. The level of imports, on the other hand, has remained stable over the years, with a slight increase overall since 2011 (+11%) (see Figure 35).

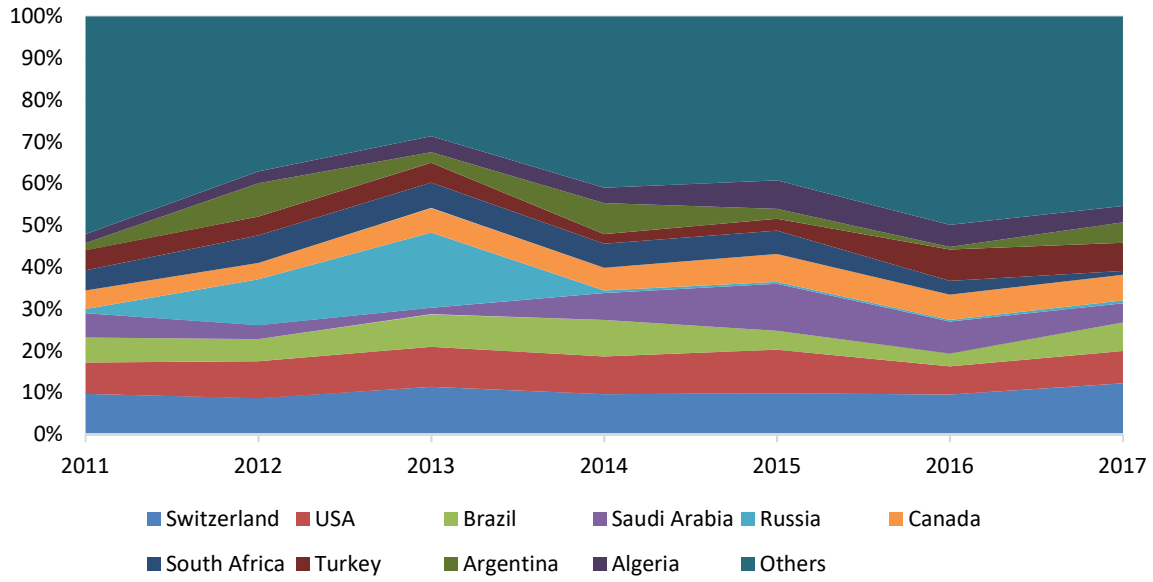
**Figure 35 EU external trade in infrastructure, Total value (€)**




Source: VVA, COMEXT.

In comparison to locomotive and rolling stock export outside of the EU discussed later, the share of exports of railway infrastructure to a few countries is smaller, yet still highly concentrated (58% on average goes to ten countries). Among the top receiving countries are: Switzerland, United States, Brazil, Saudi Arabia, Russia, Canada, South Africa, Turkey, Argentina and Algeria (see Figure 36).

**Figure 36 Extra-EU export of railway infrastructure by main source country**




Source: VVA, COMEXT.

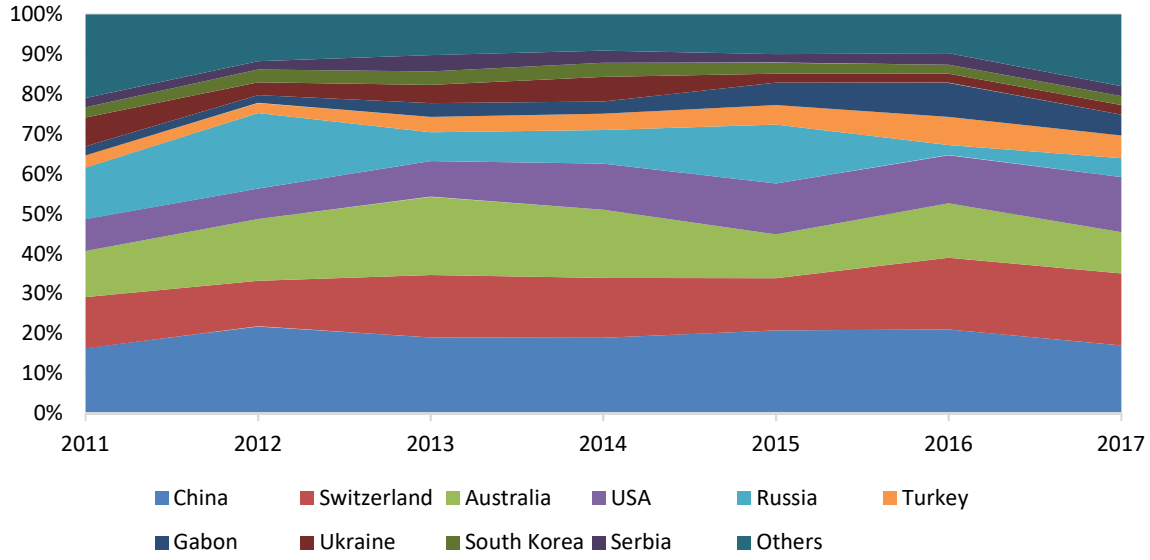
**Table 21 Extra-EU export of railway infrastructure by main source country, € Million**

| EXPORT | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| Switzerland | 80,30 | 138,62 | 155,90 | 107,64 | 123,73 | 100,95 | 112,72 |
| USA | 61,99 | 139,99 | 132,30 | 100,37 | 129,99 | 71,52 | 70,76 |
| Brazil | 49,62 | 84,54 | 106,24 | 96,75 | 55,82 | 32,59 | 62,89 |
| Saudi Arabia | 47,99 | 53,02 | 21,61 | 71,56 | 141,30 | 80,48 | 42,22 |
| Russia | 8,33 | 174,24 | 246,93 | 7,09 | 5,04 | 4,06 | 6,33 |
| Canada | 37,14 | 62,75 | 80,08 | 60,85 | 83,78 | 63,62 | 55,93 |
| South Africa | 39,88 | 104,50 | 83,52 | 63,21 | 69,47 | 34,85 | 8,26 |
| Turkey | 39,55 | 71,88 | 65,34 | 26,03 | 35,76 | 78,59 | 62,52 |
| Argentina | 14,19 | 126,15 | 34,41 | 82,06 | 29,36 | 7,24 | 44,49 |
| Algeria | 17,84 | 45,02 | 52,33 | 41,61 | 84,96 | 55,48 | 36,38 |
| ***Subtotal*** | ***396,82*** | ***1.000,71*** | ***978,64*** | ***657,16*** | ***759,23*** | ***529,37*** | ***502,50*** |
| **Others** | ***431,15*** | ***589,98*** | ***393,08*** | ***455,78*** | ***490,25*** | ***526,21*** | ***416,31*** |

Source: VVA, COMEXT.

The overall import of railway infrastructure from non-EU countries is also highly concentrated on ten countries (86% on average): China, Switzerland, Australia, United States, Russia, Turkey, Gabon, Ukraine, South Korea and Serbia (see Figure 37). Of these countries, Switzerland, the US, Russia and Turkey are also among the top receiving countries of railway infrastructure. Therefore, these countries appear to be the most important trade partners outside of the EU regarding this RSI sub-segment.

**Figure 37 Extra-EU imports of infrastructure by main source country**




Source: VVA, COMEXT.

**Table 22 Extra-EU imports of infrastructure by main source country, € Million**

| Country | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|
| China | 16,39 | 25,05 | 19,06 | 19,43 | 22,93 | 20,16 | 21,07 |
| Switzerland | 12,86 | 13,06 | 15,75 | 15,43 | 14,37 | 17,26 | 22,32 |
| Australia | 11,56 | 17,80 | 19,70 | 17,47 | 12,13 | 13,07 | 12,88 |
| USA | 8,03 | 8,76 | 8,96 | 11,92 | 14,01 | 11,59 | 17,09 |
| Russia | 12,96 | 21,78 | 7,21 | 8,62 | 16,26 | 2,44 | 5,83 |
| Turkey | 3,11 | 2,89 | 3,90 | 4,20 | 5,41 | 6,71 | 7,05 |
| Gabon | 2,22 | 2,29 | 3,44 | 3,10 | 6,13 | 8,25 | 6,48 |
| Ukraine | 7,24 | 3,65 | 4,58 | 6,33 | 2,55 | 2,19 | 2,99 |
| South Korea | 2,59 | 3,68 | 3,41 | 3,63 | 3,04 | 2,18 | 2,79 |
| Serbia | 2,33 | 2,41 | 4,10 | 3,15 | 2,30 | 2,76 | 3,07 |
| ***Subtotal*** | ***79,29*** | ***101,35*** | ***90,11*** | ***93,28*** | ***99,13*** | ***86,61*** | ***101,58*** |
| ***Others*** | ***21,00*** | ***13,49*** | ***10,24*** | ***9,33*** | ***11,00*** | ***9,31*** | ***22,31*** |

Source: VVA, COMEXT.

## 3.6. Labour competitiveness

Cost and price competitiveness are major drivers of sector performance (Ecorys, 2012) and the productivity of capital and labour is, in turn, an important underlying factor behind costs and prices (Krugman, 1994).

In this section of the report, we analyse three dimensions of labour competitiveness:

1. **Labour productivity growth**: growth rate in gross value added per persons employed;

2. **Labour utilisation growth**: growth rate in the hours worked per persons employed;[31]

3. **Unit labour cost growth**: growth rate in wage-adjusted labour productivity (i.e. ratio of labour costs to labour productivity).

For these indicators, an (average) growth rate[32] with respect to the previous year is provided, as the development over the years is more important than the absolute values, which to a certain extent, may be misleading.

This analysis is limited to the *totally Railway Supply industries* due to the specification of the industry thought NACE codes[33] and the geographical coverage varies according to the data availability (at least two consecutive years):

- NACE 30.20 Manufacture of locomotive and rolling stocks: 13 Member States + Turkey;[34]
- NACE 33.17 Repair and maintenance of other transport equipment: 18 Member States + Norway and Turkey.[35]

Labour productivity is a crucial factor for cost competitiveness, and its growth rate is a key dimension of economic performance and an essential driver of changes in living standards. In fact, high labour productivity growth in combination with lower labour utilisation rate can reflect greater use of capital, and/or a decrease in the employment of low-productivity workers, or general efficiency gains and innovation.

Figure 38 presents the comparison of the two indicators (i.e. Labour Utilization Growth and Labour Productivity Growth) for the NACE 30.20 *Manufacture of locomotive and rolling stocks*:[36]

[31] Hours worked is the number of hours actually worked, defined as the sum of all periods spent on direct and ancillary activities to produce goods and services. Source: https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Hours_worked.

[32] Disclaimer: the rates are presented as average according to the time series available. However, caution should be used in the interpretation of the results as the available time series vary between countries and the averages do not refer to the same time period (not all Member States have data for the period 2010-2016).Please refer to Annex E for a full overview of the data available by country.

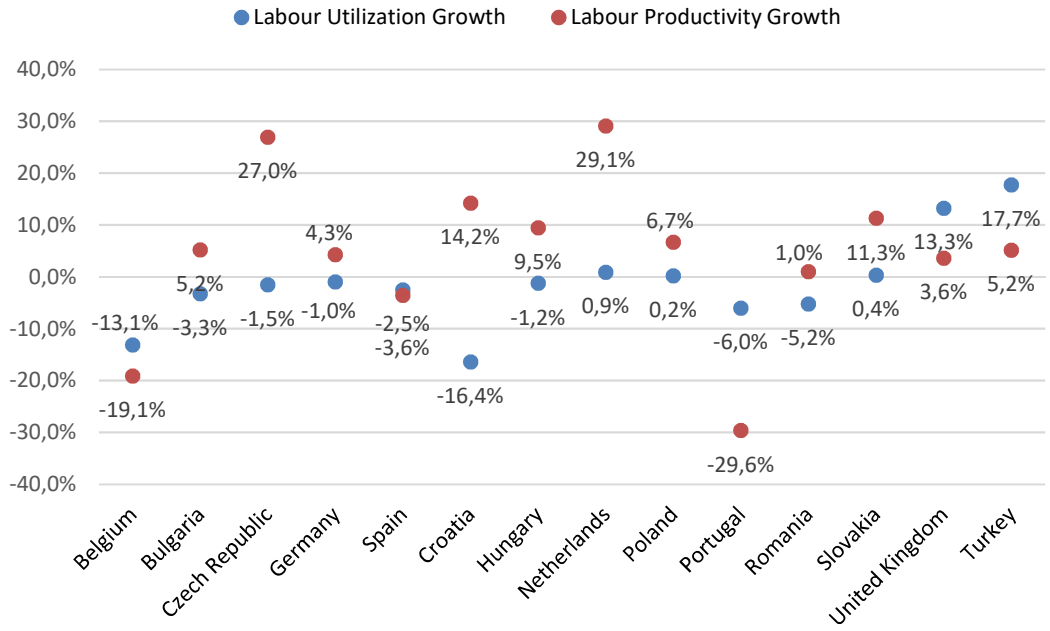
[33] In structural data according to NACE (e.g. Structural Business Statistics), a company, and thus their persons employed, turnover, value added, etc., is allocated to the industry in which is the main activity of the company. This means that indicators / data include also activities of the company that may have been accomplished in other sectors.

[34] The focus on these Member States was driven by data availability in Eurostat (SBS): Bulgaria, Belgium, Czech Republic, Germany, Spain, Croatia, Hungary, the Netherlands, Poland, Portugal, Romania, Slovakia, UK and Turkey are the only countries which provided the necessary inputs in SBS for at least two consecutive years.

[35] The focus on these Member States was driven by data availability in Eurostat (SBS): Bulgaria, Belgium, Czech Republic, Germany, Greece, Spain, Croatia, Italy, Lithuania, Hungary, Austria, Poland, Portugal, Romania, Slovakia, Finland, Sweden, UK, Norway and Turkey are the only countries which provided the necessary inputs in SBS for at least two consecutive years.

[36] Disclaimer: the rates are presented as average according to the time series available. However, caution should be used in the interpretation of the results as the available time series vary between countries and the averages do not refer to the same time period (not all Member States have data for the period 2010-2016). Please refer to Annex E for a full overview of the data available by country.

**Figure 38 NACE 30.20, labour utilization growth (avg.) & labour productivity growth (avg.) – Member States overview**



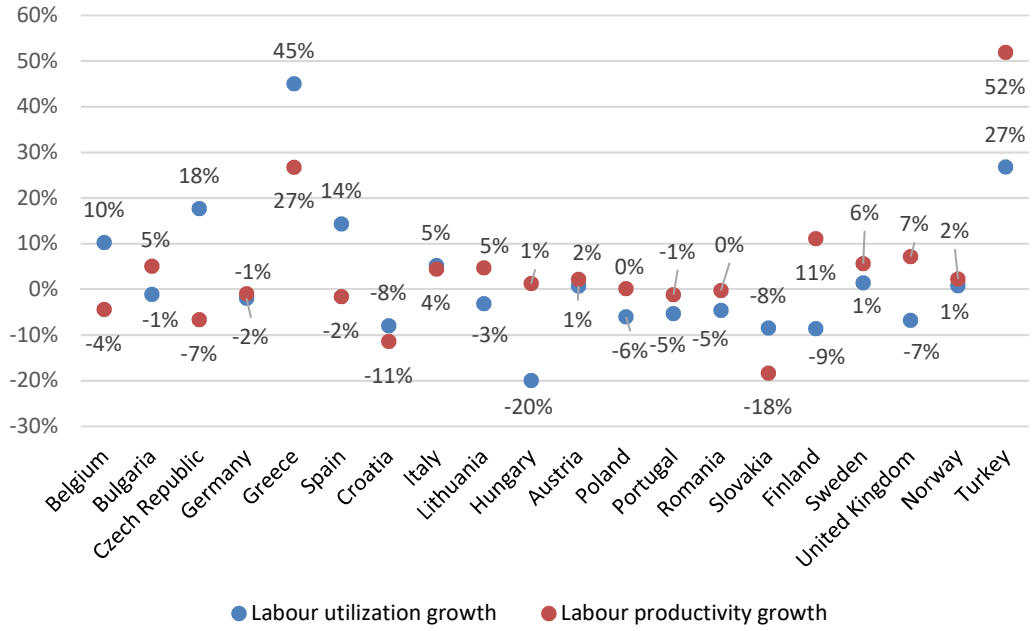

Source: VVA, Eurostat, Structural Business Statistics (sbs).

Among the countries under analysis, productivity growth rates remained high and labour utilisation decreased (negative rates) in Bulgaria, Czech Republic, Germany, Croatia, Hungary and Romania. In addition, three countries (Poland, Slovakia and the Netherlands) experienced a positive growth rate in terms of productivity and a slight increase in terms of labour utilisation (less than 1% on average). In contrast, the United Kingdom (and Turkey) experienced a higher level of labour utilisation (on average) compared to productivity growth rate achieved (on average).

Figure 39 presents the results for the 'spare parts' industry (i.e. NACE 33.17 – Repair and Maintenance of Other Transport Equipment):[37]

[37] Disclaimer: the rates are presented as average according to the time series available. Caution should be used in the interpretation of the results as the available time series vary between countries and the averages do not refer to the same time period (not all Member States have data for the period 2010-2016). Please refer to Annex E for a full overview of the data available by country.

**Figure 39 NACE 33.17, labour utilization growth (avg.) & labour productivity growth (avg.) – Member States overview**




Source: VVA, Eurostat, Structural Business Statistics (sbs).

Among the countries under analysis, productivity growth rates remained high and labour utilisation decreased (negative rates) in Bulgaria, Spain, Lithuania, Hungary, Finland and the UK. In addition, Poland and Romania experienced a decrease in labour utilisation to achieve the same level of productivity. In contrast, Belgium, Czech Republic, Greece, Italy and Austria experienced a labour utilization growth rate that is higher that the growth rate of productivity per person employed achieved.

In order to provide a full picture about labour competitiveness, the following graphs put in comparison labour productivity with labour cost, measured in Unit Labour Cost that is calculated as the ratio of labour costs to labour productivity. In order to eliminate periodic fluctuations and seasonality, we provide an (average) growth rate of this indicator.[38]

Unit labour cost should be interpreted as the general indicator of cost competitiveness, with respect to labour costs. On the level of enterprises, an increase in unit labour cost would cut profits, if enterprises did not shift the burden of growing labour costs onto consumers/end users or, in other words, if they did not raise the prices of goods and services (ILO, 2000).

It is generally believed that unit labour cost should not increase rapidly and that the changes in productivity have to be in line with the changes in labour costs in order to maintain competitiveness (ILO, 2000). If labour costs grow faster than labour productivity, the cost competitiveness of the industry could suffer, unless this is compensated for by simultaneously reducing other costs (ILO, 2000).

Labour costs and productivity are generally in balance if there is sufficient demand in the labour market (ILO, 2000). If labour costs grow slower than productivity, an employer can recruit employees for slightly higher wages and still make a profit. If labour costs grow faster than productivity, employers will let employees go (ILO, 2000). Therefore, changes in labour costs

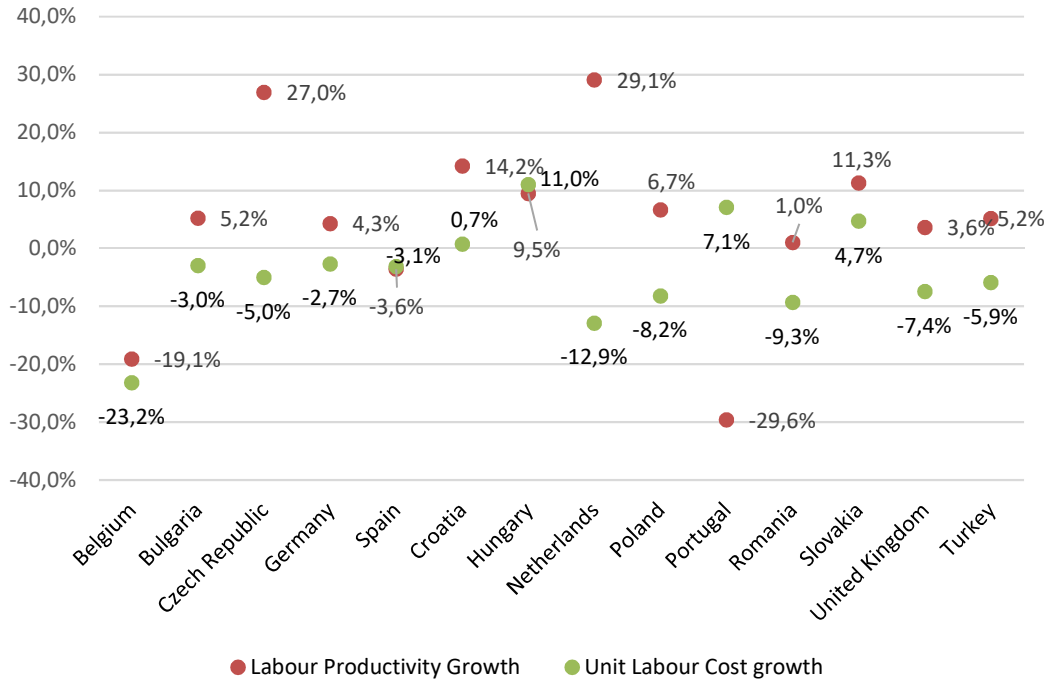
[38] Disclaimer: the rates are presented as average according to the time series available. Caution should be used in the interpretation of the results as the available time series vary between countries and the averages do not refer to the same time period (not all Member States have data for the period 2010-2016). Please refer to Annex E for a full overview of the data available by country.

follow changes in productivity (ILO, 2000). However, in some countries, labour costs may grow much faster than productivity, simply because these were at a low level to begin with (ILO, 2000).

In general, countries with a relatively low level of unit labour cost may be regarded as competitive. Unit labour cost shows that a country can improve its cost competitiveness by either decreasing labour costs or increasing productivity (ILO, 2000).

Figure 40 presents the comparison of the two indicators (i.e. Unit Labour Cost and Labour Productivity Growth) for the NACE 30.20 *Manufacture of locomotive and rolling stocks*:[39]

**Figure 40 NACE 30.20, unit labour cost growth (avg.) & labour productivity growth (avg.) – Member States overview**




Source: VVA, Eurostat, Structural Business Statistics (sbs).

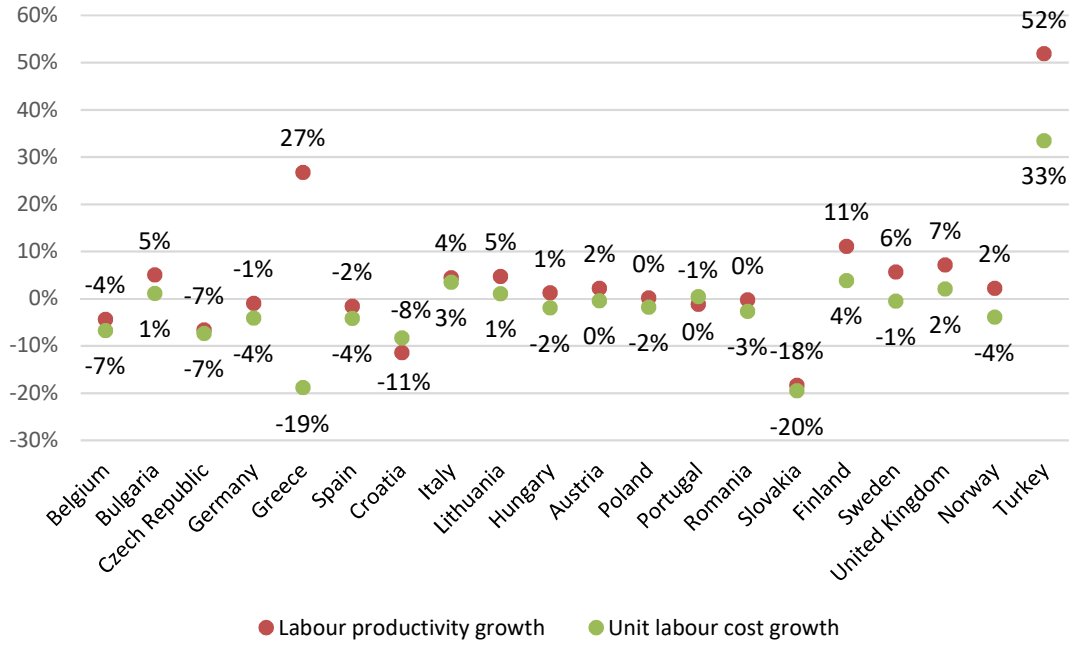
Among the countries under analysis, productivity growth rates remained high and unit labour cost decreased (negative rates) in Bulgaria, Czech Republic, Germany, the Netherlands, Poland, Portugal, Romania and the United Kingdom (+ Turkey). In addition, Croatia experienced a low increased in unit labour costs to achieve a high level of productivity. In contrast, Portugal experienced a labour cost growth rate that is higher that the growth rate of productivity per person employed achieved.

Figure 41 presents the results for the 'spare parts' industry (i.e. NACE 33.17 – Repair and Maintenance of Other Transport Equipment):[40]

[39] Disclaimer: the rates are presented as average according to the time series available. However, caution should be used in the interpretation of the results as the available time series vary between countries and the averages do not refer to the same time period (not all Member States have data for the period 2010-2016). Please refer to Annex E for a full overview of the data available by country.

[40] Disclaimer: the rates are presented as average according to the time series available. However, caution should be used in the interpretation of the results as the available time series vary between countries and the averages do not refer to the same time period (not all Member States have data for the period 2010-2016). Please refer to Annex E for a full overview of the data available by country.

**Figure 41 NACE 33.17, unit labour cost growth (avg.) & labour productivity growth (avg.) – Member States overview**




Source: VVA, Eurostat, Structural Business Statistics (sbs).

Among the countries under analysis, productivity growth rates remained high and unit labour cost decreased (negative rates) in Greece, Hungary and Sweden (+ Norway). In addition, Poland and Romania experienced a decrease in unit labour cost and a zero-growth rate in productivity. In the spare parts industry, none of the country under analysis experienced a labour cost growth rate that is higher than the productivity per person employed.

Overall, taking into account the overall results in the dimensions under analysis, in details:

1. high and positive labour productivity growth accompanied by a negative (or constant) labour utilization growth; and
2. A unit labour cost growth rate lower than the labour productivity growth rate.

It is possible to conclude that between 2011 and 2016, the following countries have ranked high in terms of labour competitiveness:

- NACE 30.20 *Manufacture of locomotive and rolling stocks*: Bulgaria, Czech Republic, Germany, Croatia, Romania and the Netherlands;
- NACE 33.17 Repair and Maintenance of Other Transport Equipment: Hungary, Poland and Romania.

It must be said that labour competitiveness is only one dimension of an industry competitiveness which is also determined by the ability to set prices, the ability of the firm to supply with a unique product, through branding and product differentiation, and the market power exercised by the firm (Ecorys, 2012). In addition, capital costs (which are not taken into account in unit labour cost), for instance, are also relevant when it comes to cost competitiveness, especially in developed countries (ILO, 2000).

## 3.7. Procurement trends

This section analyses the procurement trends in the railway supply industry, 2014-2016. The results are based on the contract awards published in the Tenders electronic daily (TED) database.

Before conducting the analysis, cancelled contracts were excluded from the data. It is important to note that in some instances the value of the contract was not recorded. TED disclaims that the

quality of (value) data submitted by contracting authorities is often low. Thus, it is important to be cautious when interpreting the results of the 'total value' and to be taken as a base line.

The analysis of the procurement trend follows the following steps:

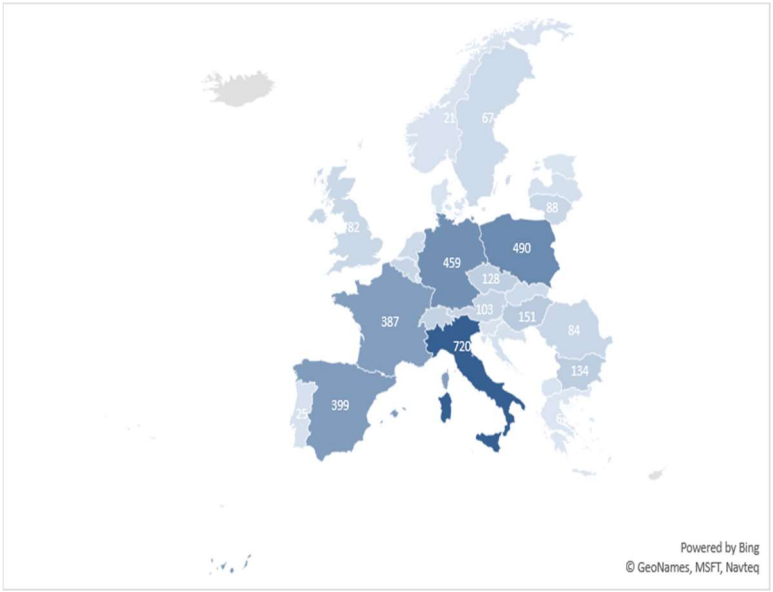
- Step 1: Cleaning of the data by excluding cancelled notices;
- Step 2: Categorising CPV values according to the CPVs of relevance to the RSI in order to identify the notices of interest to the study. The list of selected CPVS is found in Annex C;
- Step 3: Analysis of the data;
- Step 4: In-depth analysis of the top 20 tenders per year in terms of value and the winning companies as well as share of procurements from domestic or cross-border companies[41].

### 3.7.1. *Number of tenders and value of awards per country*

Considering the nature of products under analysis, **the Market demand** at the European level was recorded as the number of the tenders published by each EU member state per country and sub-sector of the RSI (locomotives and rolling stock; signalling, controlling, and electrification; and infrastructure). Double tenders were excluded. Overall, the highest numbers of tenders for the RSI was recorded in Italy, Poland and Germany.

**Figure 42 Number of tenders in RSI by contracting country, 2014-2016**

| Country | Nr of tenders |
|---|---|
| IT | 720 |
| PL | 490 |
| DE | 459 |
| ES | 399 |
| FR | 387 |
| HU | 151 |
| BG | 134 |
| CZ | 128 |
| AT | 103 |
| BE | 98 |
| LT | 88 |
| RO | 84 |
| UK | 82 |
| NL | 77 |
| SK | 67 |
| SE | 67 |
| FI | 41 |
| LV | 36 |
| HR | 35 |
| SI | 25 |
| PT | 25 |
| LU | 23 |
| DK | 23 |
| IE | 21 |
| EE | 17 |
| GR | 6 |




Source: VVA, TED database.

This is hardly surprising as the largest countries tend to have a larger railway industry than smaller countries, while some countries like Cyprus and Iceland do not have a railway at all. In terms of value of tenders, the results are similar.[42] Larger countries are in top positions, including

[41] It is important to note that those tenders have been excluded from the top 20 list if the value was not recorded.

[42] Value of tenders based on results from the TED database. The total value is underestimated as there are missing values when the quality of the reported values was not sufficient, according to the database.

Italy, France and Spain. However, other countries show larger total values of tenders, especially Belgium and the Netherlands.

**Table 23 Total value of tenders (2014-2016)**

| Country | Total value of awards (sum of the period 2014-2016) |
|---|---|
| IT | 8,265,090,585.76 € |
| BE | 3,491,931,341.16 € |
| FR | 2,541,874,391.97 € |
| NL | 1,632,141,562.54 € |
| ES | 1,624,942,652.39 € |
| PL | 1,112,522,130.13 € |
| UK | 1,014,891,593.52 € |
| DE | 692,914,728.72 € |
| SE | 610,437,848.76 € |
| CZ | 558,051,102.52 € |
| HU | 464,108,843.17 € |
| BG | 276,569,755.43 € |
| SK | 180,341,055.35 € |
| FI | 135,287,645.00 € |
| RO | 106,069,293.41 € |
| AT | 105,242,471.82 € |
| DK | 101,759,993.63 € |
| HR | 75,485,237.75 € |
| PT | 61,817,815.27 € |
| LT | 49,586,617.82 € |
| LV | 21,526,136.45 € |
| SI | 19,862,669.53 € |
| EE | 12,783,449.00 € |
| LU | 2,497,196.23 € |
| GR | 2,393,048.40 € |
| IE | 1,388,780.49 € |
| **Total value** | **23,161,517,946.22 €** |

Source: VVA, TED database.

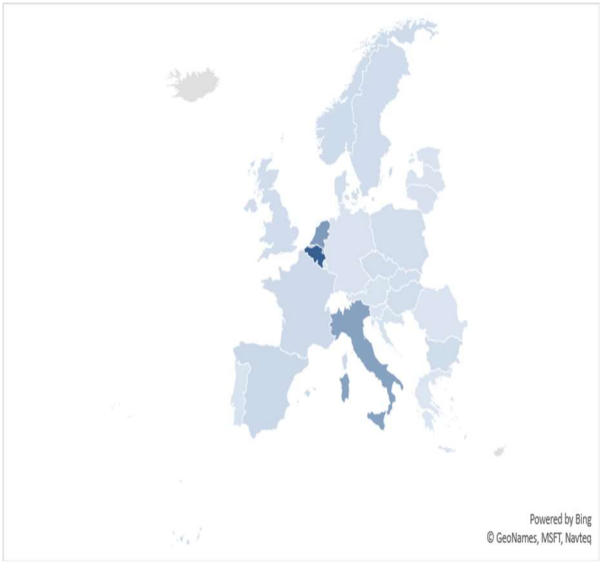
The number of tenders and their value is only a broad approach towards the demand of countries in RSI. In order to reflect the differences in country size, the total value of awards were normalised by the total km of railway in the country. The aim is to assess the award value per km of railway. The data on the km of railway are taken from the World Bank[43].

In terms of award value per km of railway in each country 2014 to 2016, Belgium recorded the highest number, followed by the Netherlands and Italy (see Figure 43).

[43] For missing data, the number from the previous year has been used.

**Figure 43 Total value of award over km of railway by country, 2014-2016**

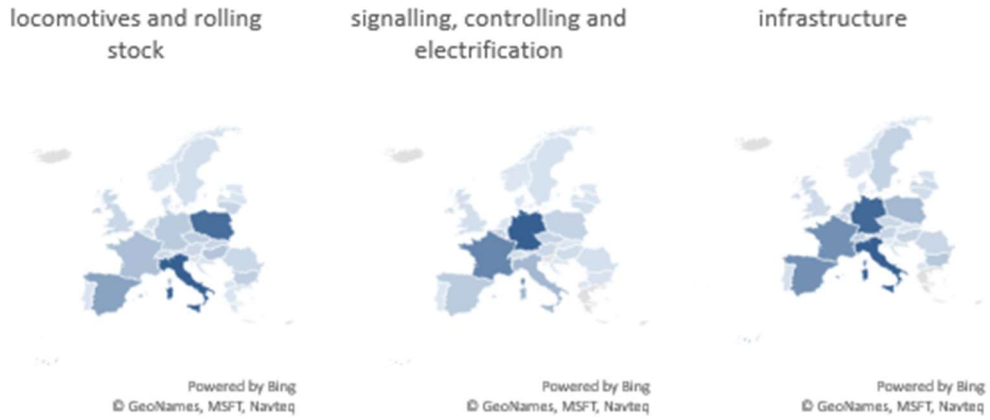
| Country | Total value of awards over km of railway |
|---|---|
| BE | 969,414.14 € |
| NL | 541,161.00 € |
| IT | 492,894.55 € |
| ES | 103,660.36 € |
| FR | 84,692.45 € |
| BG | 68,788.68 € |
| SE | 62,957.39 € |
| UK | 62,489.09 € |
| PL | 60,185.61 € |
| HU | 59,272.08 € |
| CZ | 58,958.80 € |
| SK | 49,730.31 € |
| DK | 47,752.23 € |
| HR | 28,983.23 € |
| LT | 26,235.27 € |
| PT | 24,211.20 € |
| FI | 22,835.07 € |
| AT | 21,385.59 € |
| DE | 20,765.18 € |
| SI | 16,428.45 € |
| EE | 11,831.93 € |
| LV | 11,575.68 € |
| RO | 9,850.58 € |
| LU | 9,080.71 € |
| GR | 1,068.33 € |
| IE | 707.35 € |




Source: VVA, TED database.

In terms of sub-sectors, the total number of tenders for locomotives and rolling stock was highest in Poland and Italy, followed by Spain. Most tenders for signalling, controlling and electrification, on the other hand, were published by Germany and France. Finally, the number of tenders in infrastructure was highest in Italy and Germany, followed by France and Spain (see Figure 44).

**Figure 44 Number of tenders by sub-sector and country**




Source: VVA, TED database.

**Table 24 Number of tenders by subsector and country 2014-2016, EU-28**

| Country | Locomotive and rolling stock | Signalling and electrification technology | Railway infrastructure |
|---|---|---|---|
| AT | 51 | 16 | 36 |
| BE | 30 | 24 | 44 |
| BG | 73 | 4 | 57 |
| CY | 47 | | |
| CZ | 77 | 20 | 31 |
| DE | 87 | 145 | 227 |
| DK | 14 | 1 | 8 |
| EE | 3 | 1 | 13 |
| ES | 214 | 29 | 156 |
| FI | 20 | 5 | 16 |
| FR | 126 | 104 | 157 |
| GR | 6 | | |
| HR | 21 | 2 | 12 |
| HU | 103 | 11 | 37 |
| IE | 5 | 2 | 14 |
| IT | 427 | 50 | 243 |
| LT | 59 | 8 | 21 |
| LU | 2 | 16 | 5 |
| LV | 9 | 2 | 25 |
| MT | | | |
| NL | 28 | 3 | 46 |
| PL | 384 | 21 | 85 |
| PT | 8 | 1 | 16 |
| RO | 45 | 7 | 32 |
| SE | 23 | 5 | 39 |
| SI | 20 | | 5 |
| SK | 58 | 1 | 8 |
| UK | 50 | 8 | 24 |

Source: VVA, TED database.

In terms of value of awards per km in the country and for each sub-sector, the highest value of locomotives and rolling stock awards per km was recorded in Belgium, the Netherlands and Italy. The value of the awards per km in signalling, controlling and electrification was highest in Italy, Spain and Belgium. Italy also had by far the largest value of awards per km in infrastructure (see Figure 45). On average, the highest valued tenders were recorded for locomotives and rolling stock. The value is almost 8 times higher than for the tenders in the railway infrastructure, which in turn is over double as high than the value in the signalling and electrification technology, on average (see Table 25).

**Figure 45 Locomotives and rolling stock - total value of awards over km of railway by country, 2014-2016**


Source: VVA, TED database.

**Table 25 Total value of awards over km of railway by country per subsector 2014-2016, EU-28 (Value in EUR)**

| Country | Locomotive and rolling stock | Signalling and electrification technology | Railway infrastructure |
|---|---|---|---|
| AT | 15,768.00 € | 3,001.00 € | 2,617.00 € |
| BE | 938,062.00 € | 18,558.00 € | 12,794.00 € |
| BG | 62,117.00 € | 462.00 € | 6,209.00 € |
| CY | | - | - |
| CZ | 46,150.00 € | 6,141.00 € | 6,668.00 € |
| DE | 594.00 € | 691.00 € | 19,480.00 € |
| DK | 33,050.00 € | | 14,702.00 € |
| EE | 1,253.00 € | 380.00 € | 10,199.00 € |
| ES | 57,747.00 € | 22,917.00 € | 22,995.00 € |
| FI | 430.00 € | 533.00 € | 21,872.00 € |
| FR | 79,131.00 € | 904.00 € | 4,657.00 € |
| GR | 1,068.00 € | - | - |
| HR | 16,419.00 € | 640.00 € | 11,924.00 € |
| HU | 48,645.00 € | 449.00 € | 10,178.00 € |
| IE | 160.00 € | 3,001.00 € | 547.00 € |
| IT | 394,934.00 € | 28,609.00 € | 69,352.00 € |
| LT | 21,091.00 € | 1,364.00 € | 3,781.00 € |
| LU | | 9,081.00 € | - |
| LV | 3,139.00 € | - | 8,437.00 € |

| Country | Locomotive and rolling stock | Signalling and electrification technology | Railway infrastructure |
|---|---|---|---|
| MT | | - | - |
| NL | 531,801.00 € | 1,364.00 € | 9,360.00 € |
| PL | 37,669.00 € | 2,059.00 € | 20,457.00 € |
| PT | 3,810.00 € | 309.00 € | 20,092.00 € |
| RO | 4,339.00 € | 3,786.00 € | 1,725.00 € |
| SE | 48,373.00 € | 3,243.00 € | 11,341.00 € |
| SI | 14,215.00 € | - | 2,214.00 € |
| SK | 44,365.00 € | - | 5,365.00 € |
| UK | 57,361.00 € | 2,367.00 € | 2,761.00 € |

Source: VVA, TED database.

Regarding the public procurement per year and subsector, the demand for locomotives and rolling stock in terms of number of notices appears largest in Poland over all three time periods, followed by Italy, Spain and France (growing tendency over the three years) (see Figure 46).

**Figure 46 Number of tenders for locomotives and rolling stock by country, 2014-2016**


Source: VVA, TED database.

**Table 26 Number of tenders in locomotive and rolling stock per year 2014-2016, EU-28**

| Country | 2014 | 2015 | 2016 |
|---|---|---|---|
| AT | 21 | 11 | 19 |
| BE | 13 | 6 | 11 |
| BG | 19 | 24 | 30 |
| CY | | | |
| CZ | 12 | 32 | 33 |
| DE | 19 | 36 | 32 |
| DK | | 7 | 7 |
| EE | 1 | 1 | 1 |
| ES | 63 | 65 | 86 |
| FI | 9 | 6 | 5 |
| FR | 48 | 33 | 45 |
| GR | | 1 | 5 |
| HR | 10 | 6 | 5 |
| HU | 12 | 51 | 40 |
| IE | | 1 | 4 |
| IT | 129 | 147 | 151 |
| LT | 16 | 23 | 20 |
| LU | | 1 | 1 |

| Country | 2014 | 2015 | 2016 |
|---|---|---|---|
| LV | 3 | 2 | 4 |
| MT | | | |
| NL | 7 | 8 | 13 |
| PL | 137 | 139 | 108 |
| PT | 6 | | 2 |
| RO | 18 | 9 | 18 |
| SE | 6 | 6 | 11 |
| SI | 3 | 4 | 13 |
| SK | 12 | 23 | 23 |
| UK | 13 | 14 | 23 |

Source: VVA, TED database.

Again, the total value of awards per km of railway was highest in Belgium, followed by Italy. (see Figure 47 and Annex C).

**Figure 47 Total value of awards for locomotives and rolling stock by country, 2014-2016**


Source: VVA, TED database.

The number of tenders in signalling, controlling and electrification, on the other hand, is largest in Germany and France (see Figure 48 and Annex C)).

**Figure 48 Number of tenders for signalling, controlling and electrification by country, 2014-2016**


Source: VVA, TED database.

**Table 27 Number of tenders in signalling and electrification technology per year 2014-2016, EU-28**

| Country | 2014 | 2015 | 2016 |
|---|---|---|---|
| AT | 1 | 6 | 9 |
| BE | 4 | 7 | 13 |
| BG | 1 | 1 | 2 |
| CY | | | |
| CZ | 8 | 9 | 3 |

| Country | 2014 | 2015 | 2016 |
|---|---|---|---|
| DE | 25 | 25 | 95 |
| DK | | | 1 |
| EE | | 1 | |
| ES | 5 | 11 | 13 |
| FI | 1 | 3 | 1 |
| FR | 32 | 42 | 30 |
| GR | | | |
| HR | 2 | | |
| HU | 6 | 2 | 3 |
| IE | | 2 | |
| IT | 10 | 26 | 14 |
| LT | 3 | 1 | 4 |
| LU | 5 | 3 | 8 |
| LV | 2 | | |
| MT | | | |
| NL | 1 | 1 | 1 |
| PL | 5 | 8 | 8 |
| PT | | 1 | |
| RO | 2 | 2 | 3 |
| SE | 1 | 3 | 1 |
| SI | | | |
| SK | 1 | | |
| UK | 1 | 3 | 4 |

Source: VVA, TED database.

However, the value of awards per km was highest in Italy in 2014 and 2015 and second highest in 2016 (following Spain) (see Figure 49).

**Figure 49 Signalling, controlling and electrification - total value of awards over km of railway by country, 2014-2016**


Source: VVA, TED database.

Finally, the highest number of tenders for infrastructure were recorded in Germany and Italy, followed by France, Spain and Poland (see Figure 44). Changes were rarely noted. One exception is France, which shows a decrease in numbers of published tenders in infrastructure over the three years (see Figure 50 and Annex C).

**Figure 50 Number of tenders for infrastructure by country, 2014-2016**


Source: VVA, TED database.

However, in terms of value of the awards per km, Italy's values have increased over the years, recording the highest value in 2016. An increase of value per km was recorded in the Balkans (see Figure 51 and Annex C).

**Figure 51 Infrastructure - total value of awards over km of railway by country, 2014-2016**


Source: VVA, TED database.

## Type of procedure

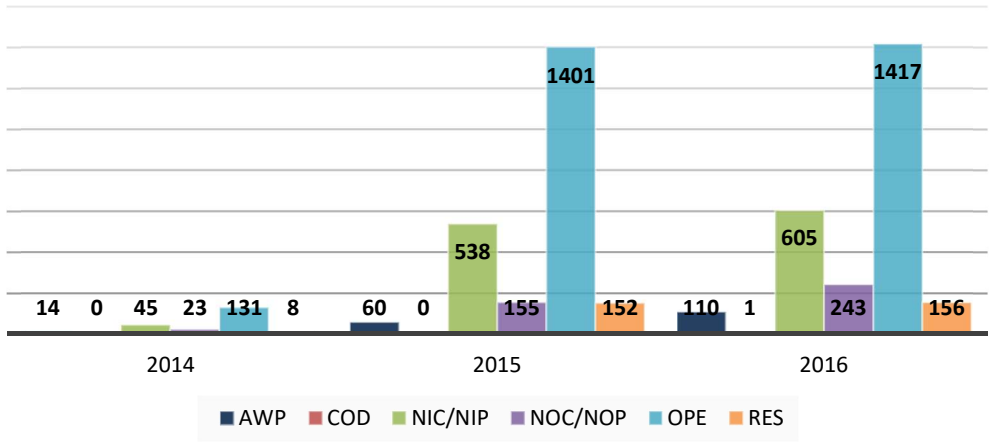
TED categorises five types of procedure followed by the award notices[44]:

- AWP: "award without prior publication of a contract notice";
- COD: "competitive dialogue";
- NOC/NOP: "negotiated without a call for competition";
- NIC/NIP "negotiated with a call for competition";
- OPE "open";
- RES "restricted".

Overall, the most common type of procedure was open procedures, followed by negotiated procedures with a call for competition. There was only one procedure in 2016 that followed the competitive dialogue approach. Over the three years, the share of negotiated procedures with a call for competition (NIC/NIP) increased.

[44] Source: http://data.europa.eu/euodp/repository/ec/dg-grow/mapps/TED(csv)_data_information.pdf.

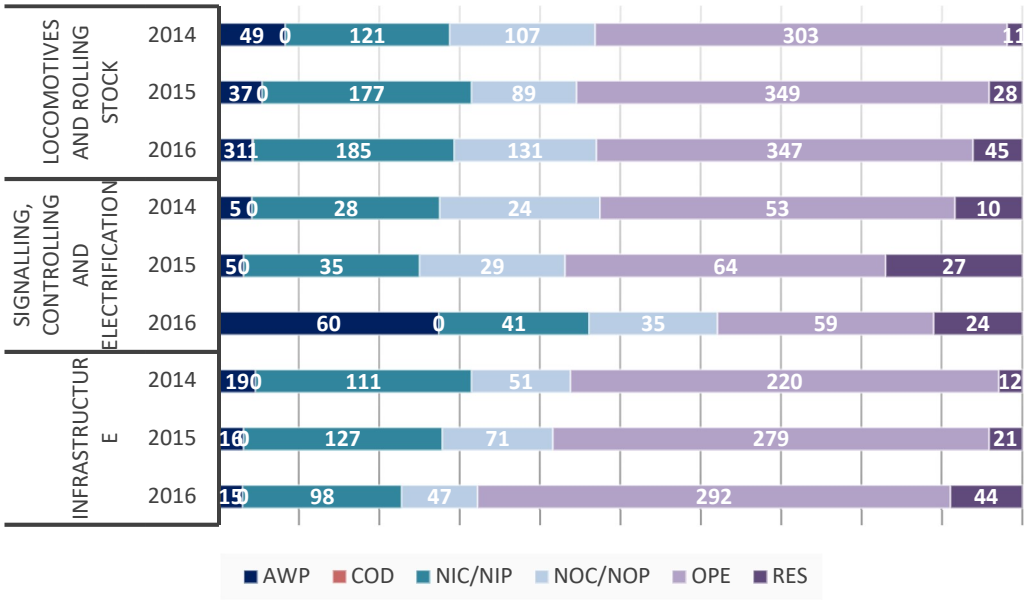
**Figure 52 Number of notices by type of procedure, 2014-2016**




Source: VVA, TED database.

Regarding sub-sectors of the RSI, there is no difference recognisable, the majority of tenders are open competition in every sub-sector, followed by NIC/NIP. While the majority of tenders are open competition in infrastructure, its share has increased over time. On the other hand, the share of AWP procedures in signalling, controlling, and electrification was comparably high in 2016 (see Figure 53).

**Figure 53 Share of type of procedure by sub-sector of RSI and year**




Source: VVA, TED database.

## 3.7.2. *Winning criteria*

The TED database, in many instances, also provides information on the reason for why the award was given to a specific tenderer. The two criteria used are:

- Lowest price (L);
- Most economically advantageous tender (M).

While the lowest price is given to one criterion only, the most economically advantageous tender is often further specified and comprised of multiple criteria. These include, amongst others, a

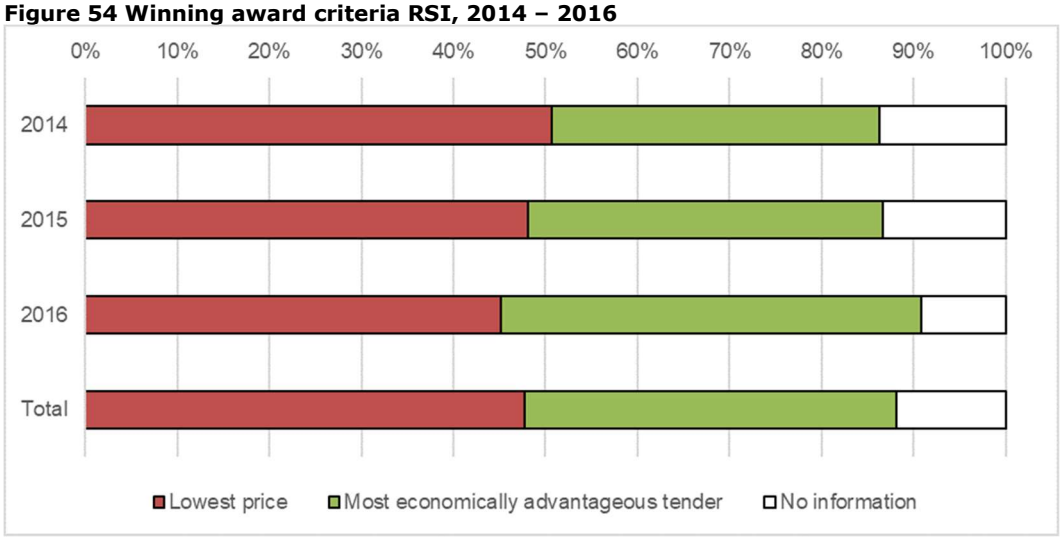
combination of criteria of price and technical value. Other possible criteria include schedule, warranty, or environment.

In order to classify a procurement as "green", we selected the following award criteria:

- Special requirements for materials disposal;
- Special environmental criteria, e.g. "Performance in terms of environmental protection assessed against the "environmental leaflet", "environmental management", but often addressed as 'environment' or 'environmental approach' only;
- Sustainability, e.g. sustainable development approach;
- Energy efficiency.[45]

In general, the number of tenders awarded for either top criteria (Lowest price or Most economically advantageous) is relatively balanced. Slightly more tenders were awarded on the base of lowest price (47.8%), followed by most economically advantageous tender (40.3%). There was no information on around every tenth tender award (11.9%) (see Figure 54).

**Figure 54 Winning award criteria RSI, 2014 – 2016**




Source: VVA, TED database.

Regarding the tenders awarded based on the most economically advantageous offer, in the three years under analysis a total of 34 had criteria of environmental performance. A total of 23 were awarded in France, followed by Norway (5). Other countries that awarded tenders based on the subcategory sustainability were Switzerland, Germany, Finland, Ireland, the Netherlands and Portugal (each 1).[46]

### 3.7.3. *Top winning companies*

The TED database also records the names of the winning companies of the notices. We have selected the top 20 tenders in terms of value (variable VALUE_EURO_FIN_2) in each sub-sector and year. According to the winning companies, four different types of procurements exist:

- Direct domestic: These are companies that are the same country as the awarding authority of the tender;
- Indirect domestic: These are companies that are headquartered outside of the country of procurement notice but have a branch in the country of tender. It is considered an indirect domestic procurement when the branch in the country has won the award;

[45] Source: https://ec.europa.eu/energy/intelligent/projects/en/projects/ecorails.

[46] Disclaimer: we recognize the limitation that a 3-years time series analysis cannot provide a full overview of the European procurement trends. For instance, a European infrastructure mangers association commented that the use of MEAT criteria in public procurement have been systematically used in Germany in the last decade, but this cannot be fully captured by observing the last three years.

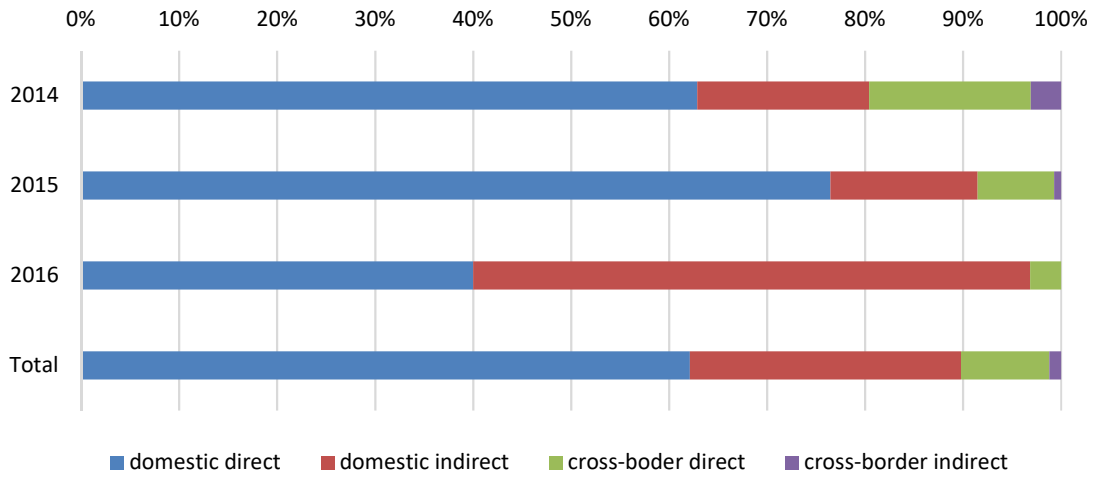
- Direct cross-border: Companies that are headquartered outside of the country of the awarding authority and have won the tender;
- Indirect cross-border: Companies that are located outside of the country of procurement notice and have a branch in another country outside of the granting authority's country. It is considered an indirect cross-border procurement when the branch in the third-country has won the award.

In order to identify the type of procurement, the names of the successful bidder were first cleaned to remove additional space or symbols. The winning companies were then searched for online, to identify the country of origin and whether they had a parent company. If yes, the country of the parent company was identified.

We have then created a dummy for each type of procurement, based on the search results. As the TED database lists tenders multiple times when multiple partners are involved, we also have created a share for each type of procurement. The share was calculated as the AWARD_VALUE_EURO_FIN_1 divided by the VALUE_EURO_FIN_2. This is because the first variable lists the full value of the tender, while the award value records the sum that the winning company receives. The share was 1 if only one company was the successful bidder.

The majority of awards, both in terms of numbers of awards won and the value of the awards, were direct domestic procurements in 2014 and 2015, while in 2016 it was mostly indirect domestic procurements (see Figure 55).

**Figure 55 Average share of procurement type in RSI by year**




Source: VVA, TED database.

The top 5 winning bidders in all three years and all sub-sectors were Alstom, Siemens, Bombardier, Thales and Ansaldo (see Table 28). These companies had either won the award individually, in a group, or through either of all types of procurement.

**Table 28 Top 5 successful bidders**

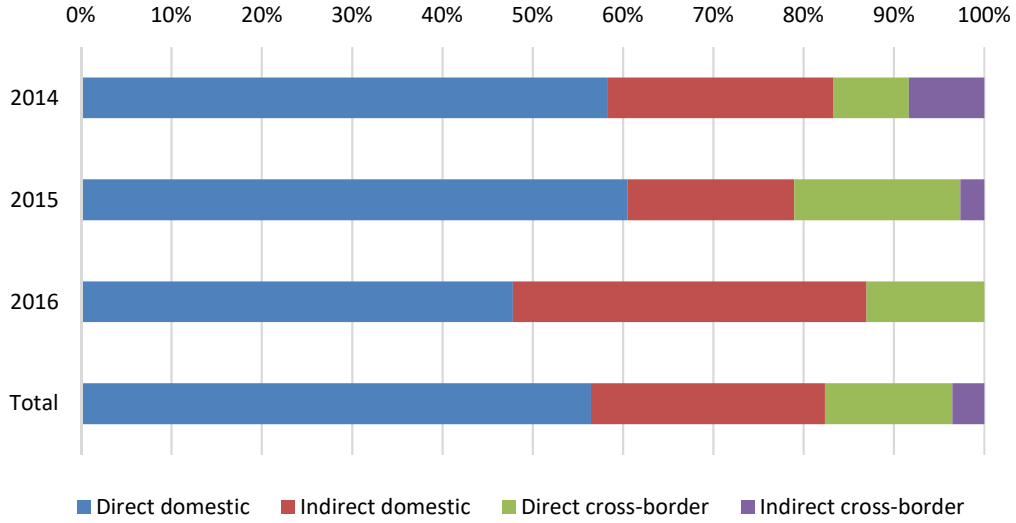
| Name | Number of awards |
|---|---|
| Alstom | 25 |
| Siemens | 20 |
| Bombardier | 16 |
| Thales | 16 |
| Ansaldo | 10 |

Source: VVA, TED database.

Most successful bidders in the sub-sector signalling, controlling and electrification were in the same country as the contracting authority and are either headquartered there or represented

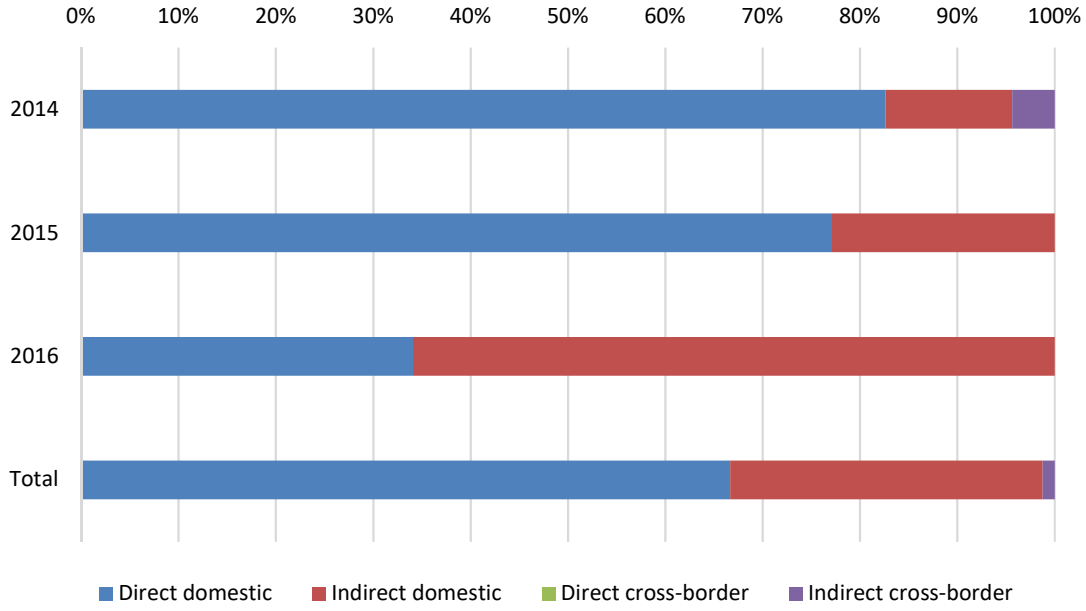
through a branch. No award was won by a direct cross-border bidder. Infrastructure awards, on the other hand, were not one by any indirect cross-border bidders. In general, few tenders were won by cross-border bidders (around 15%). Comparing the three sub-sectors, cross-border bidders seem to be more successful in the locomotives and rolling stock subsector (see Figure 56, Figure 57, Figure 58).

**Figure 56 Average share of procurement type in locomotives and rolling stock awards by year**



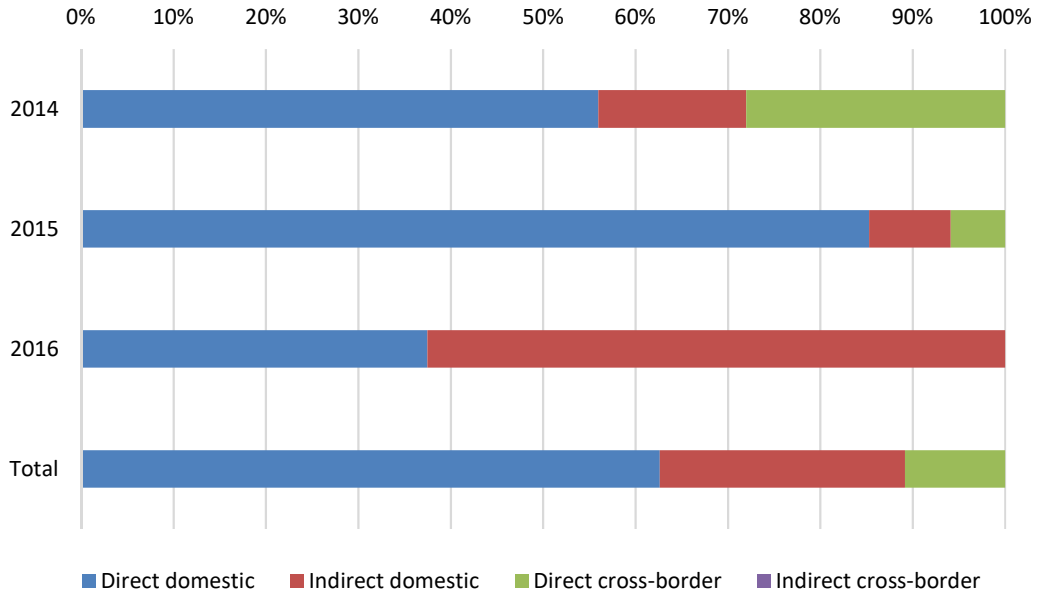

Source: VVA, TED database.

**Figure 57 Average share of procurement type in signalling, controlling and electrification awards by year**




Source: VVA, TED database.

**Figure 58 Average share of procurement type in infrastructure awards by year**




Source: VVA, TED database.

In terms of value, the tendency follows the results of the share of procurement types, meaning that the highest values are usually given to direct domestic bidders, followed by indirect domestic bidders in 2014 and 2015, and vice versa for 2016. Two exemptions are found. In 2016, for instance, the value of procurements won by direct cross-border bidders was higher than the value of procurements won by direct domestic bidders in the locomotives and rolling stock sub-sector. This is the same case, even though with less difference, in the infrastructure sub-sector, for 2016.

## 3.8. Findings on the economic importance of the RSI in Europe

In the European Union (EU 28), in 2017, approx. **5,099** enterprises can be assigned to the **railway supply industry**[47,48]. They employ approx. **199,172** persons. The turnover of the railway supply industry amounts to approx. EUR 49 billion, while the value added is about EUR 15 billion (in 2017). The **railway supply industry** constituted 0.2% of all enterprises and 0.7% of all persons employed, 0.4% of turnover and 0.7% of the total value added in the EU manufacturing industry. Since 2011, the sector has seen a general growth.

The largest sector by far[49] within the **railway supply industry** in the European Union is the **Manufacture of railway locomotives and rolling stock**. Another large sector in terms of turnover and value added is the **Repair and maintenance of other transport equipment** ("spare parts" industry).

A limited number of large groups are leading the RSI market. By applying the SME definition of the European Commission to the data available, it results that only 16% of the companies can be categorised as SMEs in the segment "manufacture of railway locomotives and rolling stock", 17% in the segment "infrastructure", and 22% in the segment "electrification equipment" and 19% in the segment "signalling and train control equipment". According to the opinion of stakeholders

[47] Based on the definition of sporting goods in NACE-codes in the present study (please see Annex B for more details).
[48] Source: Eurostat, Structural Business Statistics.
[49] According to NACE.

interviewed, the RSI is a multi-tier supply chain where OEM/Tier 1 suppliers are indeed concentrated around large industry groups, SMEs are mainly involved as Tier 2/Tier 3 suppliers.[50]

According to PRODCOM data on **industrial production**, in 2017, the production value of the railway supply industry[51] of the 28 EU countries amounted to EUR 287 billion for the overall period 2011-2017. Since 2011, the production value increased by approx. 11%. The largest share of the production value can be attributed to the manufacture of locomotive and rolling stock (+15%), followed by signalling and electrification technology (+2%) and rail infrastructure (+0.3%).

With regard to **international trade**, overall, the total value of exports was stable over the years, with a peak of over EUR 6,720 million in 2012. The total value of imports, on the other hand, has increased since 2014, reaching around EUR 2,456 million in 2017. Overall, the locomotive and rolling stock sub-segment has contributed to the largest share of the total value, both regarding exports but particularly imports. The source of imports for EU RSI is highly concentrated on 10 countries: Switzerland, Japan, China, the United States, Ukraine, South Korea, Russia, Norway, Turkey and Serbia. These ten countries amount for over 90% of the total import value in the EU's RSI. The destination of EU exports in RSI (outside of the EU itself) is not as strongly concentrated on a few countries as the imports. The top ten receiving countries are Switzerland, the United States, Brazil, Saudi Arabia, Russia, Canada, Turkey, China, South Africa and Norway. Around 60% of the exports of EU RSI go to these countries. The use of international transparent standards is discussed in the next Chapter.

Considering the nature of the products under analysis, the **Market demand** at the European level is measured in terms of value of **public procurement**. In terms of award value per km of railway in each country 2014 to 2016, Belgium recorded the highest number, followed by the Netherlands and Italy. In terms of sub-sectors, the total number of tenders for locomotives and rolling stock was highest in Poland and Italy, followed by Spain. Most tenders for signalling, controlling and electrification, on the other hand, were published by Germany and France. Finally, the number of tenders in infrastructure was highest in Italy and Germany, followed by France and Spain.

The majority of awards, both in terms of numbers and value were direct domestic procurements (i.e. domestic companies) in 2014 and 2015, while in 2016 it was mostly indirect domestic procurements (i.e. foreign companies which have subsidiary in the country of the bid). The top 5 winning bidders between 2014 and 2016 and all sub-sectors were Alstom, Siemens, Bombardier, Thales and Ansaldo.

[50] However, due to data limitation, the analysis was limited to the first category of suppliers/companies which self-classified themselves as RSI suppliers in Railway Directory.

[51] Based on the definition of sporting goods in PRODCOM-codes in the present study (please see Annex B for more details).

# 4. THE COMPETITIVE POSITION OF THE EUROPEAN RSI

The present chapter will assess the position of European Rail Supply Industry in the European and global market, presenting the results of the analysis which used publicly available sectoral data, including data from World Bank Database - Development Indicators- and COMEXT as well as data provided by specialised business data providers, specifically Euromonitor International.

The chapter is organised as follows:

**Section 4.1.** evaluates how European RSI compares with other European industries (specifically the shipbuilding and the heavy road vehicles sector) on international markets, comparing their export/import performances. The goal of the section is to investigate the potential causes of the differences across the different industries and to provide targeted best practices to policymakers operating in the sectors.

**Section 4.2** presents the position of European RSI in the global market, benchmarking the performances of the European sector in relation to other major global economies, including traditional players such as Russia and USA, and emerging players such as China, India and South Korea.

**Section 4.3.** presents three different case studies describing the excellence of some European projects, companies and or technological innovations implemented in the European RSI. Based on data gathered through stakeholder consultation and desk research, the case studies present examples on how the European RSI can promote innovation, sustainability while remaining competitive globally.

Finally, **section 4.4** presents the main findings of the section.

## 4.1. European RSI in comparison with other European industries

This section compares the performance of the EU rail supply industry with other European transport manufacturing industries[52], in terms of[53]:

- *Economic performance* (i.e. productivity, number of enterprises, persons employed, turnover, value added) based on data from Eurostat;
- *Gross investments in tangible goods* based on data from Eurostat*;*
- *Trade performance* based on data collected from the Euromonitor International Passport Industrial, 2018 Edition*.*

Due to the limited availability of detailed data for rail signalling and infrastructure, this section will only cover railway **locomotives and rolling stock**.[54]

### 4.1.1. *Economic performance*

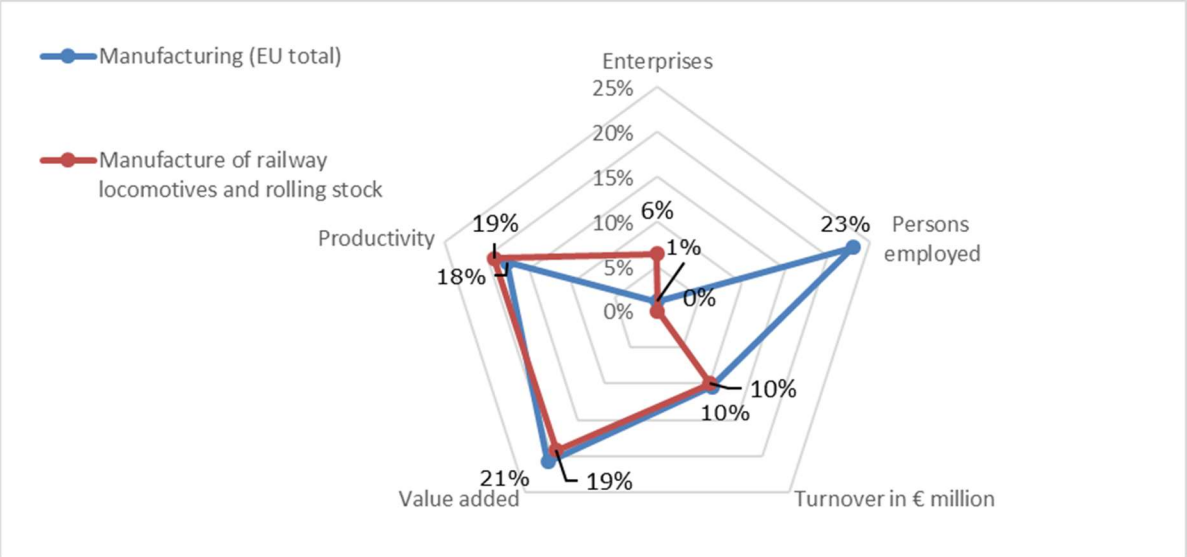
In terms of economic performance (i.e. productivity, number of enterprises, persons employed, turnover, value added) growth in the manufacturing of locomotives and rolling stocks sector was similar to that in the aggregate manufacturing industry in the EU, except for the growth in enterprises and persons employed. Whereas the number of enterprises grew faster in the locomotives and rolling stocks sector, growth in the number of persons employed stayed well behind that in the overall manufacturing industry, with growth rates of respectively 0% and 23%.

[52] And against the EU total manufacturing sector, when data are available.

[53] The use of different sources is driven by the comparability of the data and the explanatory power of the datasets.

[54] The Euromonitor International Passport Industrial, 2018 edition database, includes in the segment *locomotives and rolling stock* the following categories of products: 1) rail locomotives, 2) coaches, vans and trucks 3) other rolling stock. Annex G presents a methodological note regarding the use of the Euromonitor International data.

**Figure 59 Total growth from 2011 to 2017 – Manufacture of railway, locomotives and rolling stock**




Source: VVA, Eurostat, Structural Business Statistics (sbs).

As the data about the EU manufacturing sector encompasses different industries (ranging from manufacture of food products to manufacture of electrical equipment), to provide a more insightful performance comparison, we also focus on specific industries that are similar in terms of:

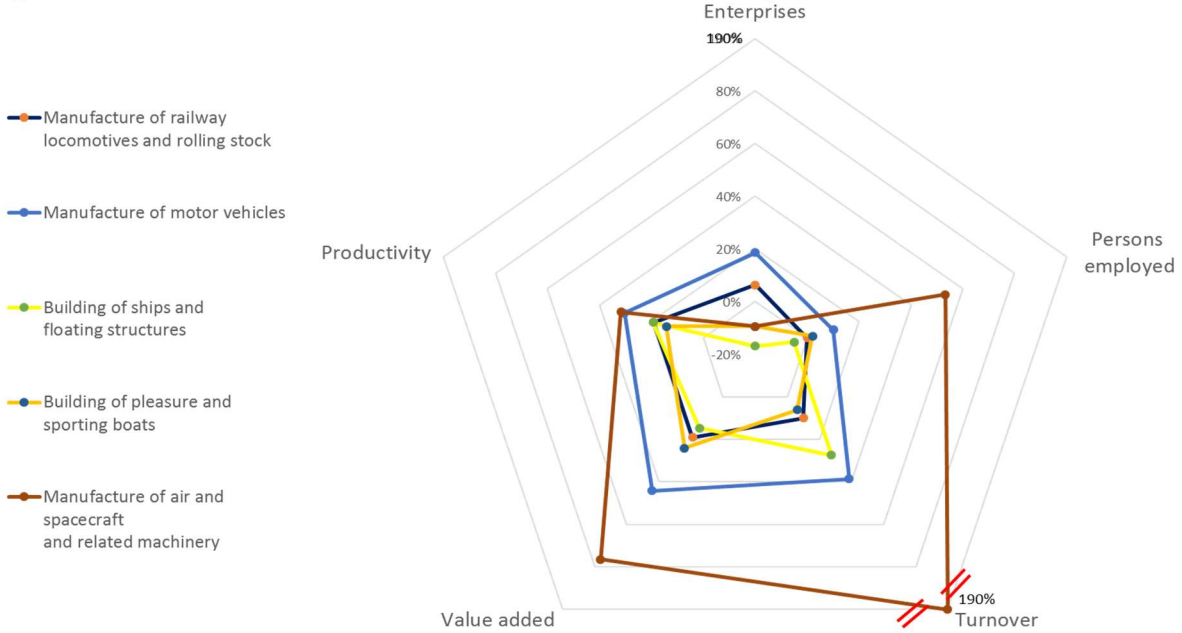
- the character of the goods and services produced;
- the uses to which the goods and services are put; and
- the inputs, the process and the technology of production.

By following this approach, the main industries that "*NACE 30.20 Manufacture of railway locomotives and rolling stock*" can be compared with, are:

- "NACE 29.11 Manufacture of motor vehicles";
- "NACE 30.11 Building of ships and floating structures";
- "NACE 30.12 Building of pleasure and sporting boats"; and
- "NACE 30.30 Manufacture of air and spacecraft and related machinery".

Figure 60 shows the comparison of these sectors:

**Figure 60 Total rowth from 2011 to 2017 – manufacture of transport vehicles industries**



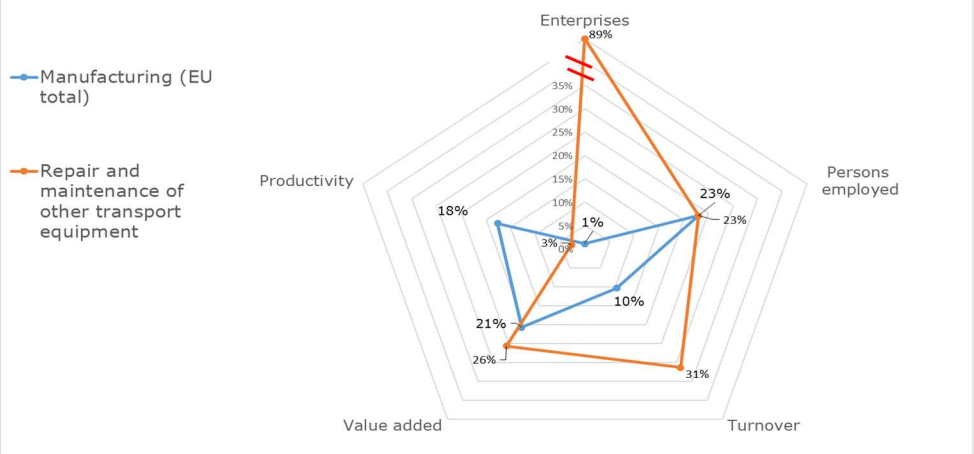

Source: VVA, Eurostat, Structural Business Statistics (sbs).

The comparison with the selected transport vehicles manufacturing industries shows that, in terms of growth rate, the EU manufacture of locomotives and rolling stocks grew faster on almost all creteria than the EU manufacture of ships (both 'Building of ships and floating structure' and 'Building of pleasure and sporting boats'). Only in value added and employment, 'locomotives and rolling stocks manufacturing' grew slightly less than the 'Building of pleasure and sporting boats' sector. However, in comparison with the 'manufacture of motor vehicles' and with the 'manufacture of air- and spacecraft', the industry experienced a lower growth rate.

## Repair and maintenance of other transport equipment

In terms of economic performance (i.e. productivity, number of enterprises, persons employed, turnover, value added), the 'repair and maintenance of other transport equipment segment' outperformed in four out of five indicators compared to the growth registered in the aggregate manufacturing industry in the EU. In particular, in terms of growth in the number of enterprises and turnover, the repair and maintenance of other transport equipment segment grew much faster in comparison to the aggregate manufacturing industry. Only in productivity, the growth in the 'repair and maintenance of other transport equipment segment' (3%) lagged behind that of the overall manutacturing sector.

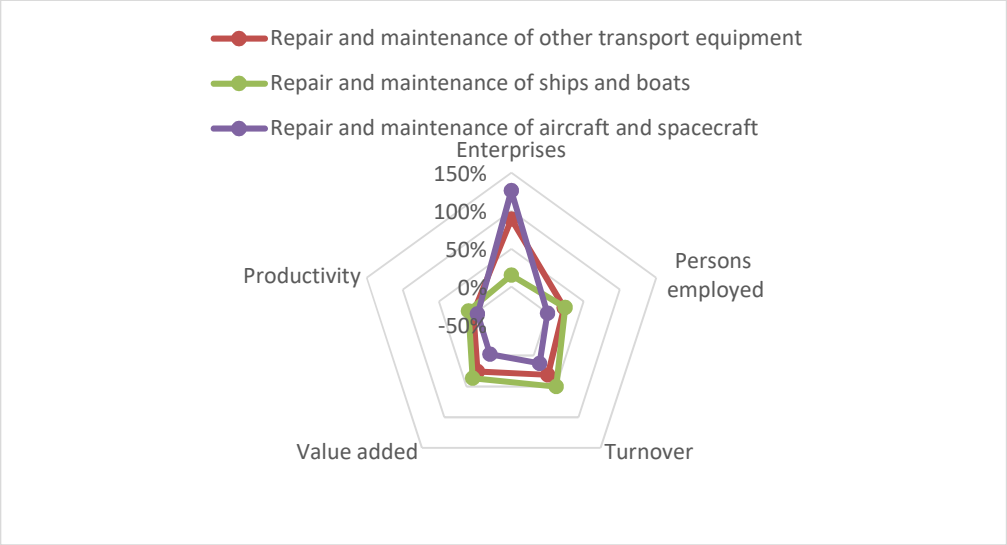
**Figure 61 Total growth from 2011 to 2017 – repair and maintenance of other transport equipment**




Source: VVA, Eurostat, Structural Business Statistics (sbs).

Given that at the data about the EU manufacturing sector encompasses different industries (ranging from manufacture of food products to manufacture of electrical equipment), in a similar fashion to the previous exercise, we provide a more insightful performance comparison with industries that are similar in terms of character/uses of the goods and services produced:

**Figure 62 Total growth from 2011 to 2017 – repair and maintenance of transport vehicles**



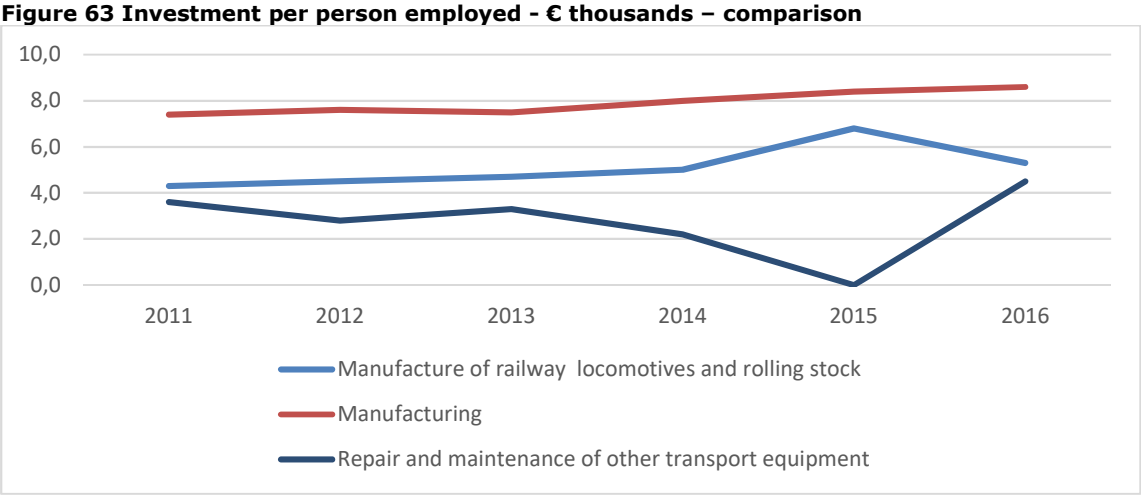

Source: VVA, Eurostat, Structural Business Statistics (sbs).

The comparison with the selected repair and maintenance of transport vehicles industries shows that, in terms of growth rate, the 'repair and maintenance of other transport equipment' outperformed in four indicators compared to 'Repair and maintenance of aircraft and spacecraft'. In contrast, 'Repair and maintenance of ships and boats' showed higher growth than repair and maintenance of transport vehicles industries on all indicators but on enterprises.

### 4.1.2. *Gross investments in tangible goods performance*

The investment intensity of the total railway supply industries is measured in terms of investments per person employed. The indicator *"investments per person employed"* looks at total amount invested per employees in each industry, in order to account for the effect of industry size. Figure 63 shows the intensity of the totally railway supply industries and compares them to the total EU manufacturing.

**Figure 63 Investment per person employed - € thousands – comparison**



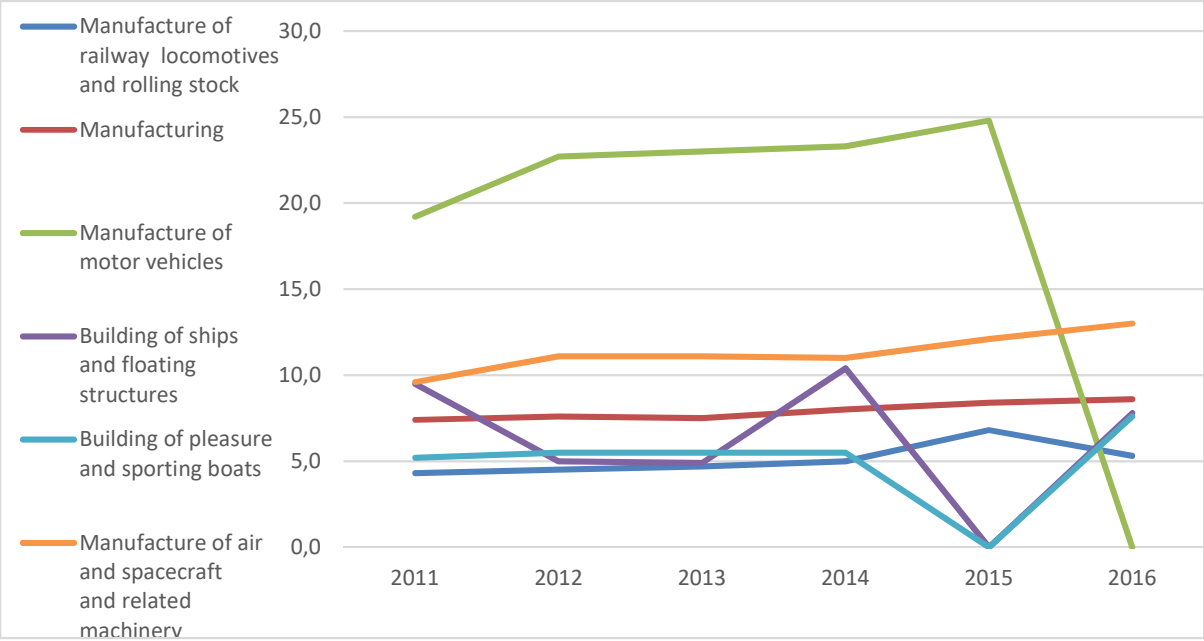

Source: VVA, Eurostat, Structural Business Statistics (sbs).

The two industries showed an investment per person employed below the EU total manufacturing, between 2011 and 2016. This trend is in contrast with the definition of "capital intensive industry". Especially the manufacturing of locomotives and rolling stocks, it is usually referred to be '*capital intensive*' requiring large amounts of investments in fixed assets to produce goods and being marked by high levels of depreciation.

The fact that the intensity is lower than the total EU manufacturing (avg.) between 2011 and 2016 could be explained by the industries just investing to cover their depreciation costs (i.e. replacing old machineries and equipment) and only investing limitedly in new capital formation.[55] However, it should be also considered that, from a methodological perspective, the EU averages include other high capital-intensive industries such as automobile manufacturing, oil production and refining, steel production, and telecommunications which may have biased the EU averages between 2011 and 2016.

In comparison to the data above, the highest investment per person employed (ppe) was recorded in the "*manufacturing of motor vehicles*", followed by "*manufacture of air and spacecraft and related machinery*". The level of investments in these industries (ppe) were also above the average level of investments in the total EU manufacturing. The investment level in the "*building of ships and floating structures*" (until 2015), "*the building of pleasure and sporting boats*" and in the "*manufacture of railway locomotives and rolling stock*" were, instead, below the average level of investments in the total EU manufacturing (see Figure 64).

**Figure 64 Investment per person employed - € thousands – comparison**




Source: VVA, Eurostat, Structural Business Statistics (sbs).

Industry stakeholders interviewed commented that the rail industry is still much project-based. Hence there is a focus on project-specific investment rather than general CAPEX. As a result, the trend of having an investment rate lower than the manufacturing sector as a whole is not necessarily surprising.

The growth rate, however, shows both that the industry is slowly changing its focus which explains a sort of "catch up" with the manufacturing industry average and also may be linked to specific projects won by European RSI companies that would trigger significant investment. Another industry stakeholder commented that the industry is subjected to "boom and bust' and (in the UK) in 2012 was the beginning of a period of rail franchise awards that led to new rolling stock order.

[55] Further analysis would be needed in order to confirm the trend.

A cluster organisation confirmed the upward trend in investment in tangible assets observed since the year 2015, which was driven by investments to upgrade in terms of "*smart factory*" and "*interconnection*" (Internet-of Things) by the main players in the manufacturing of locomotive and rolling stocks.

### 4.1.3. *Trade performance*

The following section presents, based on data collected from the Euromonitor International industrial statistics database, a comparison between three of the major transport-related supply industry, namely motor vehicles and commercial vehicles.

The following categories of products were included in the analysis, in addition to the ones presented in the precedent sections:

- **Motor Vehicles:** this category includes manufacture of passenger cars, commercial vehicles, buses, trolley-buses and coaches, motor vehicle engines, chassis fitted with engines, other motor vehicles such as snowmobiles, golf carts, amphibious vehicles, fire engines, street sweepers, travelling libraries, armoured cars;
- **Motor Vehicle Bodies**: this category includes bodies for motor cars and other motor vehicles principally designed for the transport of persons (including for golf cars and similar vehicles), bodies for lorries, vans, buses, coaches, tractors, dumpers and special-purpose motor vehicles;
- **Trailers and Semi-trailers**: this category include outfitting of all types of motor vehicles, trailers and semi-trailers and manufacture of trailers and semi-trailers; manufacture of containers for carriage by one or more modes of transport;
- **Parts and Accessories**: this category includes manufacture of diverse parts and accessories for motor vehicles such as brakes, gearboxes, axles, road wheels, suspension shock absorbers, radiators, silencers, exhaust pipes, catalysers, clutches, steering wheels, steering columns and steering boxes, safety belts, airbags, doors, bumpers. This category also includes manufacture of inlet and exhaust valves of internal combustion engines and maintenance and repair of containers and shipping drums;
- **Commercial Vessels and Ships**: this category includes the building and repairing of ships including building of commercial vessels, warships, fishing boats and fish-processing factory vessels. This category also includes construction of hovercraft, drilling platforms, construction of floating structures.

While strong differences persist in terms of reference market, type of customers, and business models; comparisons between different European manufacturing industries can help understand how exogenous impacts, such as the economic crisis, the economic slowdown during the aftermath of the crisis, and the subsequently recovery impacted the different sectors.

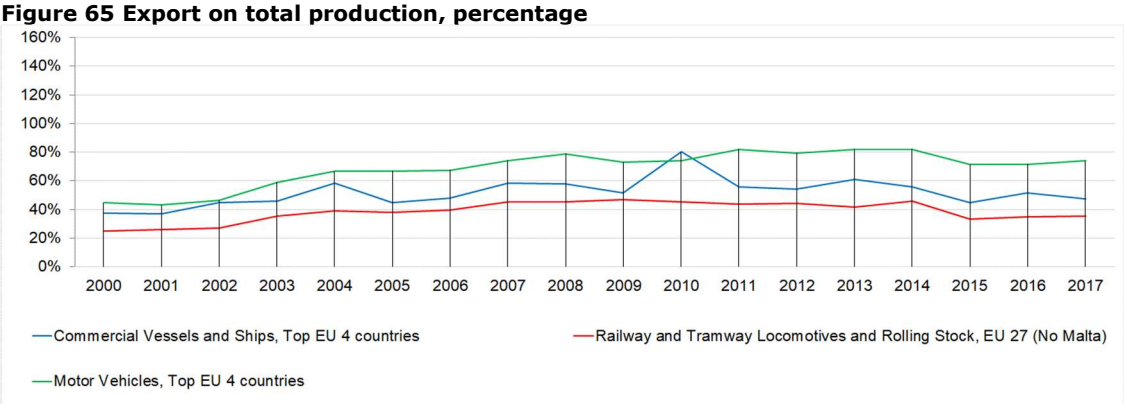
#### Motor, commercial vessels, and railway industry: export, import and consumption performances

The motor and commercial vessels sectors were selected for comparison because all three industries require extensive plants, have high investment costs, are capital intensive, and all three sectors are affected, in a relatively similar manner, by macroeconomic shocks including economic crisis or increase of raw material or energy costs.

Nevertheless, the sectors also present important differences, that are worth keeping in consideration when comparing the three sectors: first, the road sector, that includes in the present analysis passenger cars, lorries, tractors, motorcycles, trailers, parts and accessories of motor vehicles, is characterised by a much larger client base, with an annual turnover close to EUR 520 billion in 2017, compared to the EUR 23 billion of commercial vessels and ship and the EUR 34 billion of the rail supply industry. Furthermore, the lifetime of the typical car is usually much shorter than the one for trains and ships that increases exponentially the replacement rate of the different products. Nevertheless, this element is partially compensated by the higher initial price of ships and rail products compared to the motor one.

For this reason, it is interesting to look at the comparison between the different sectors from a relative point of view, analysing for example the rate of export on total production for the three different industries.

**Figure 65 Export on total production, percentage**

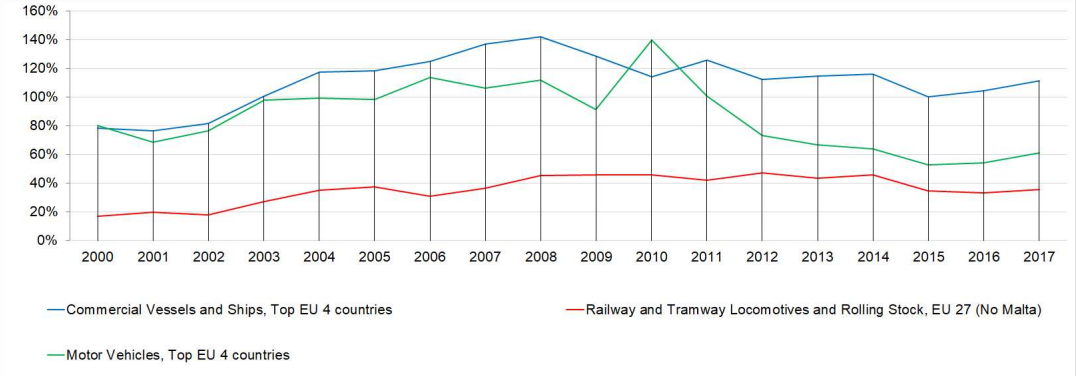



Source: VVA elaboration on Euromonitor International data.

All three industries are export oriented. The motor vehicles peak at rates close to 80% of exported products on total production. The commercial vessels oscillate between 40% to 80% (probably as the effect of the business model of the industry). The rail supply industry is the least export oriented with an average rate of export on total production for the period 2000 to 2017 averaging around 38%. This is in line with the results of the analysis reached in the previous section, and that will be further extended in the next chapter on regulatory challenges and access to foreign market.

Regarding the demand side of these three industries, a similar situation is reflected in the import share on total production, as represented in the figure below.

**Figure 66 Import on total production, percentage**




Source: VVA elaboration on Euromonitor International data.

Looking at the role of import on the total production of the different sectors, the motor vehicles sector is characterised by an elevated rate of import on total production, thus indicating a certain degree of openness of the market to foreign producers. On the contrary, the rail segment is characterised by a limited rate of import on production. The next chapter discusses market accessibility in more detail, focusing on international market access barriers.

To conclude, the European RSI appears affected by a limited openness of the global market, with an impact on export and import share both relatively smaller when compared to the ones of other industries. This fact supports the preliminary observations reached in the previous section on the limited accessibility to foreign market for the RSI, due to regulatory and commercial policy. The next chapter will investigate further the causes of this limited accessibility and the potential way forward.

## 4.2. European RSI evolution and trends in the global context

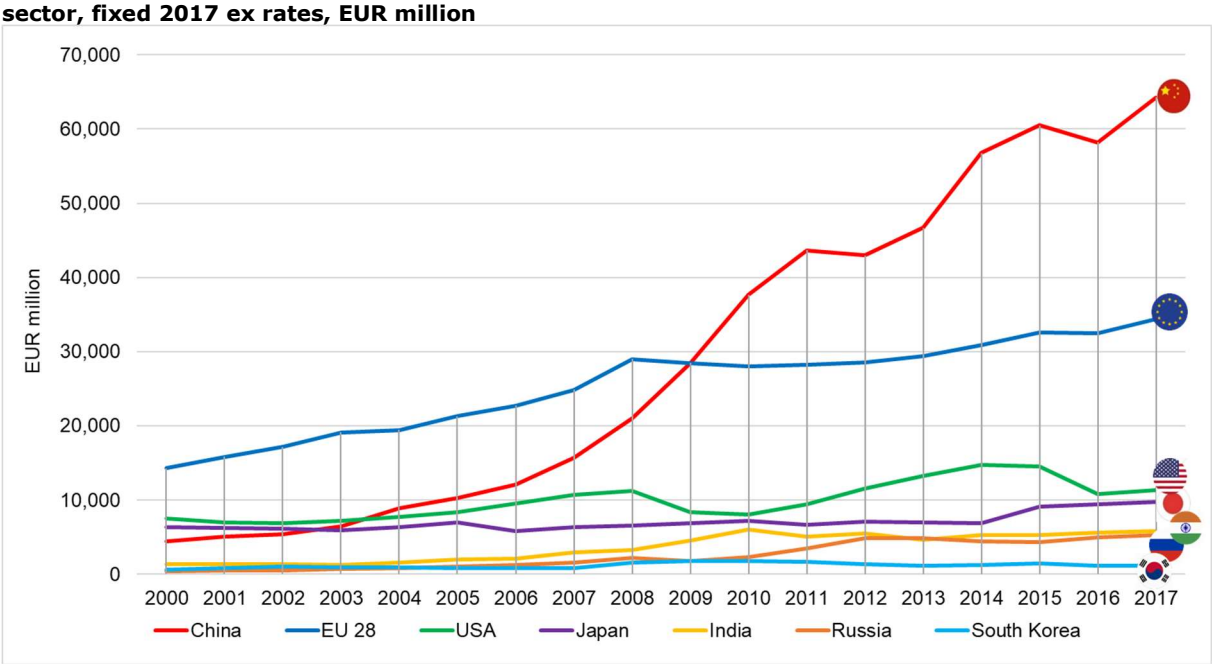
The present chapter will compare the performances of European RSI in the period from 2000 to 2017 with the RSI sectors of traditional and emerging global competitors, including the USA, Japan, South Korea, India and, most notably, China. As a matter of fact, both in the present

section and following sections, particular attention will be committed to the analysis of Chinese performances in the past decade, to analyse and potentially understand the reason behind its dramatic transformation from a relatively minor player in the global rail supply industry to a top player in less than 15 years.

### 4.2.1. *Production*

As presented in section 3.3, production refers to the turnover[56] year by year of the companies located in the market of reference (RSI). Due to the limited availability of comparable international data[57] for signalling and infrastructures, this report only refers to the segment **locomotives and rolling stock** of EU 28, excluding Malta and to the key global non-EU international countries, namely China, India, Japan, Russia, South Korea, and the USA.

**Figure 67 RSI production, locomotives and rolling stock, major global economies active in the sector, fixed 2017 ex rates, EUR million**




Source: VVA elaboration on Euromonitor International data.

The figure above shows that, up to 2009, the EU railway supply industry production was higher than the production of the main international players. In particular, the EU RSI production in the selected period was approximately 50% higher compared to the major competitor's RSI production. In terms of growth rate, the EU figure shows that, apart from a slight decrease between 2008 and 2012, RSI rolling stock production is almost constantly growing in Europe. It is also significant to point out that the Asian countries (i.e. China, Japan, and India) seem to have reacted better to the financial crisis of 2008 as none of them present significant losses over those years.

China's fast growth has its roots back in 2002 along with massive investments in infrastructure projects in China. Following those investments, China also started to invest in several domains such as high-speed trains (2008) and Belt and Road Initiative (2013). This led China to overtake, and to almost double, the EU in terms of production. In addition, government support and advantages in price are some of the key success factors for Chinese rail manufacturers, as most of the contracts won by Chinese suppliers include relevant investment programmes set by the government and financial guarantees that broaden their market. Moreover, under the 12th Five-Year Plan (2011-2015), the Chinese government increased the overall investment in rail fixed

[56] Turnover in terms of manufacturer selling price, fixed 2017 exchange rate.
[57] Euromonitor International Passport Industrial, 2018 edition database, is the main data source.

assets to CNY 3.4 trillion (EUR 430 billion), 42% more than the investment of CNY 2.4 trillion (EUR 310 billion) during the 11th Five Year Plan (2006-2010). Under the 13th Five-Year Plan (2016-2020), official announcements indicate an investment in fixed assets far above CNY 2.8 trillion (EUR 360 billion) and it could reach CNY 3.8 trillion (EUR 490 billion)[58].

### 4.2.2. *Exports*

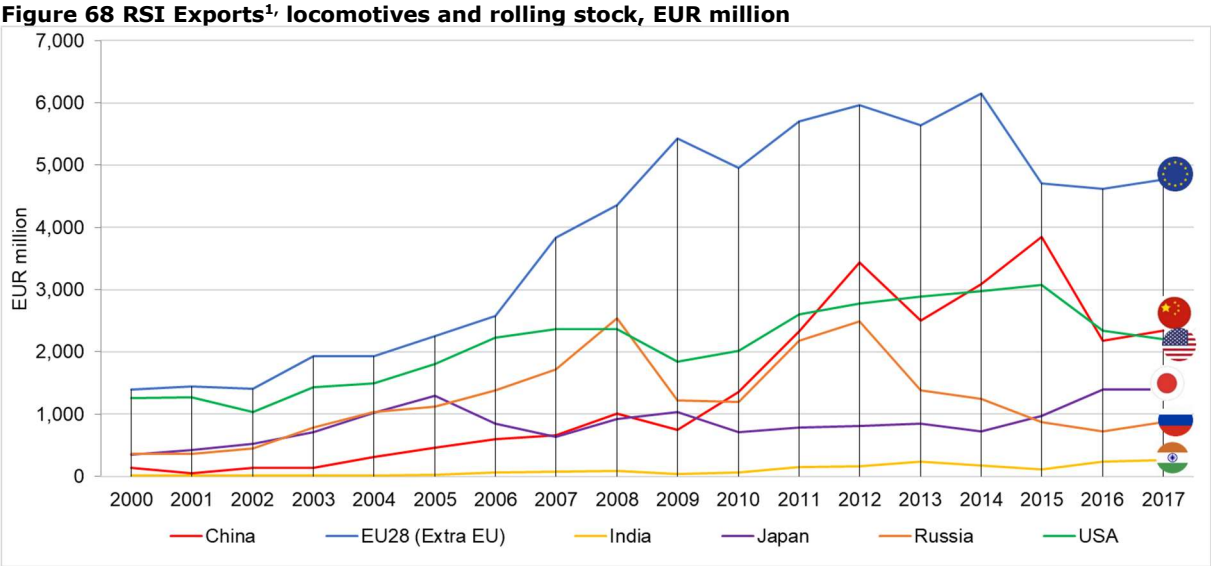
The EU RSI is a global leader on **exports**[59] [60] on **locomotives and rolling stock** and its value has grown more than four times since 2000 to reach EUR 4.8 billion in 2017. China and the USA were in second and third positions, respectively, each of them with less than half of EU exports.

China has demonstrated a stable growth in exports since 2001, reaching an average growth of 24.1% in period from 2000 to 2008. Between 2009 and 2012, China's exports presented a remarkable average growth rate of 46.1% per year, reaching more than EUR 3.4 billion in 2012. Since then, the Chinese exports have not been constant but presented an overall decrease in relation to 2012's value, reaching EUR 2.3 billion in 2017.

From 2000 to 2008, the USA presented a compound average growth of 7.3% per year. From 2009, there was an intensive growth in the exports until 2015, however, with a decline in the exports until 2017. From 2009 to 2017, the average growth rate was 2.0% per year.

The increase of the market shares of China, the USA, and Japan contributed to the downtrend for EU exports between 2014 and 2015.

**Figure 68 RSI Exports[1,] locomotives and rolling stock, EUR million**




Source: VVA elaboration on Euromonitor International and COMEXT data.
[1)] Extra-EU values estimated based on estimation from COMEXT data.

#### 4.2.2.1. Export Intensity

We define export intensity as the degree of exporting activities measured as the percentage of exports relative to production. This parameter is important to understand the importance of exports in relation to total sales for each country or region.

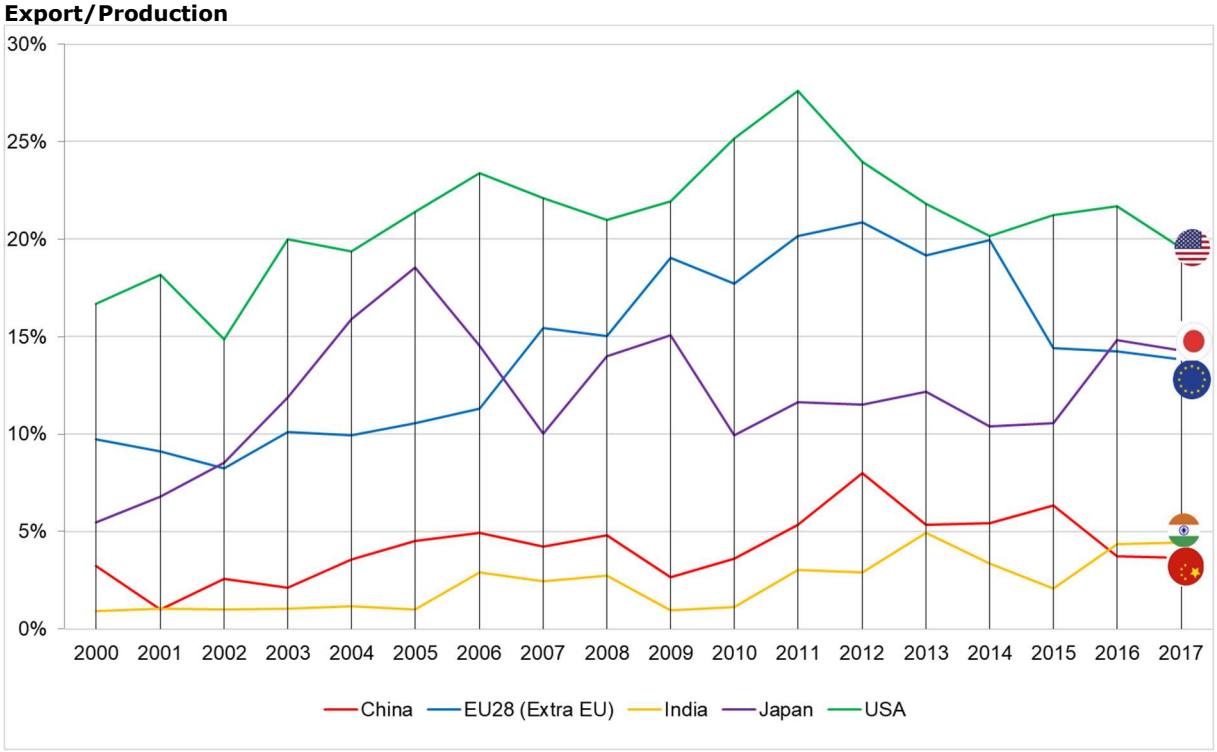
[58] https://www.sci.de/fileadmin/user_upload/Flyer_MC_China_dt.pdf.
[59] Export is defined as the value of goods exported to foreign countries, including all production and other costs incurred up until the goods are placed on board the international carrier for export, yet excluding international insurance and further transportation costs.
[60] The analysis is based on Euromonitor Industrial data and COMEXT data was used to estimate the percentage of exports intra and extra EU.

$$Export\ Intensity = \frac{Export}{Production}$$

The figure below shows that exports represent an important share of the RSI sales in the USA, varying between 15% and 27% in the period analysed. Even if there is a steady production growth of locomotives and rolling stock in the EU (as presented in section 4.2.1), the export intensity has declined since 2012, indicating that the additional production was absorbed by the internal EU demand.

Despite the large production in China, its exports represent less than 5% of its total production (EUR 2.3 billion in 2017) indicating that the internal market in the country holds strong. However, the saturation of the internal market and large infrastructure programs financed by China for South-East Asia and Africa might contribute to the growth of exports in the near future.

**Figure 69 Export Intensity[1, 2], locomotives and rolling stock, percentage defined as Export/Production**




Source: VVA elaboration on Euromonitor International data.
[1)] Extra-EU values estimated based on estimation from COMEXT data.
[2)] Russia has been excluded from the graph because exports values were higher than the total production for some years (2003 – 2008), which might be due to some underreporting of production data for the country in that period.

### 4.2.3. *Imports*

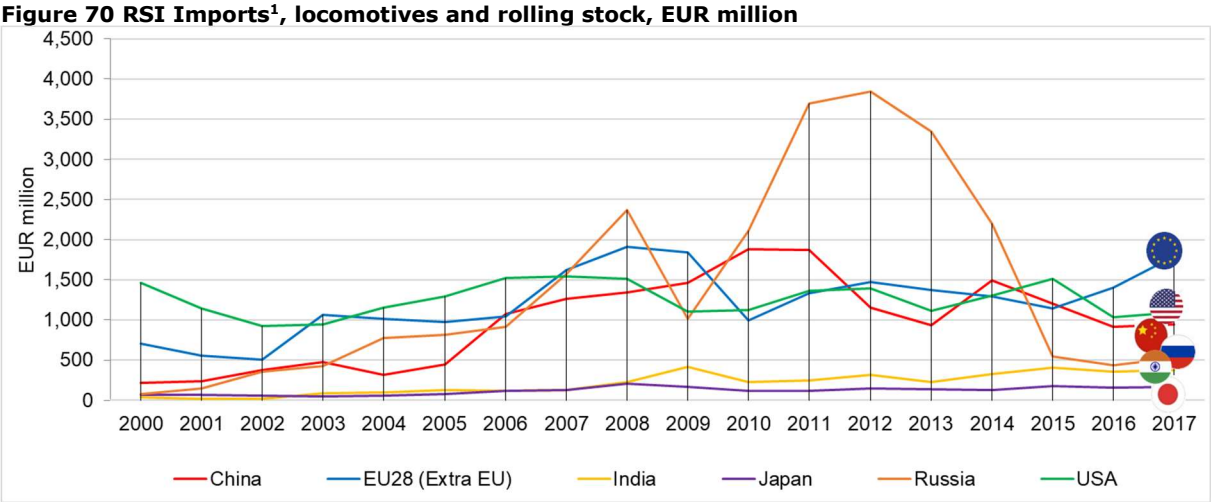
EU **imports[61] [62]of locomotives and rolling stock** supplies from non-EU countries account for EUR 1.5 billion on average per year, the largest globally followed by the USA and China.

A common trend between the different countries analysed is that the imports seem to be seasonal. This might be explained by the fact that the rail supply demand is linked to the infrastructure investment programmes in the countries which can be affected by political cycles, government's priority changes, and the occurrence of major events. As an example, Russia's investment in the

[61] Import is defined as value of goods delivered at the frontier of the importing country, including any freight, insurance and other costs incurred during transportation of goods from the port of origin, yet before the payment of any import duties or other taxes within the country, including re-exports.
[62] The analysis is based on Euromonitor Industrial data and COMEXT data was used to estimate the percentage of exports intra and extra EU.

railway network in preparation for the Sochi Olympic Games seems to be reflected in the increased demand for imports of rail supply in the period preceding the Games.

**Figure 70 RSI Imports[1], locomotives and rolling stock, EUR million**




Source: VVA elaboration on Euromonitor International and COMEXT data.
[1)] Extra-EU values estimated based on estimation from COMEXT data.

#### 4.2.3.1. Import Penetration

Import penetration is defined as a measure of the importance of imports in the domestic economy, either by sector or overall. It is calculated as the value of imports divided by the value of apparent consumption.

$$Import\ Penetration = \frac{Import}{Consumption}$$

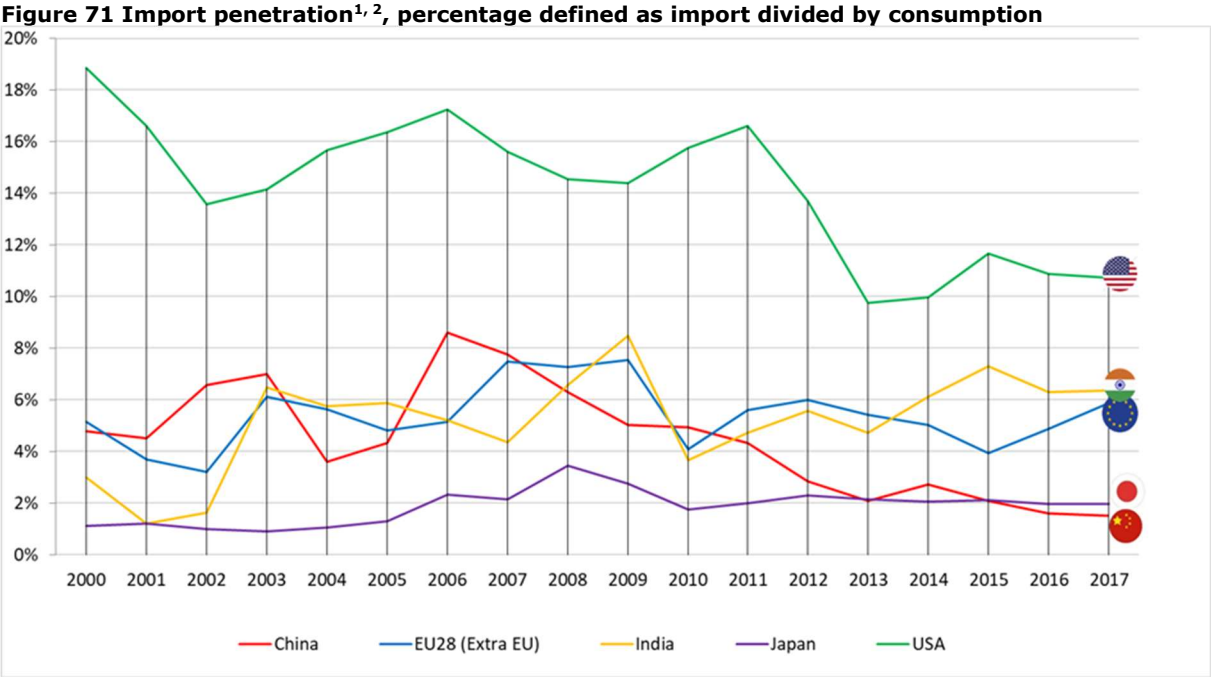
The figure below shows that the USA's imports represented more than 14% of its consumption between 2003 and 2012, with values between EUR 1 – 2 billion per year over the last decade. Since 2012, the trend is the contrary which suggests a reduction on dependency of the USA on foreign RSI products.

For all other countries analysed, the share of imports in the consumption tend to stay below 10%. This is partially explained by the fact that the international industry leaders have production plants spread across the globe and are therefore present in different markets to provide locally produced products. In Europe, Chinese suppliers set a long-term strategy to access new markets and to acquire more and more market share. These actions are taken within the "One Belt One Road" initiative that links Europe and China and ultimately seeks a gateway to the EU.

In the EU, the share of imports in the consumption has remained stable around 5% in the last two decades. The situation is similar in Japan, but the share of imports is less than 2%, showing the strong self-sufficiency of RSI in the country.

China, on the other hand, has considerably decreased its dependency on external rail supplies since 2006 from 8% to less than 2% in 2017. This indicates that the capacity of the RSI in the country has strengthened over the period 2000 and 2017, making the country almost self-sufficient. The decrease, however, also appears to be related to the low accessibility of Chinese market.

**Figure 71 Import penetration[1, 2], percentage defined as import divided by consumption**




Source: VVA elaboration on Euromonitor International data and COMEXT data.
[1)] Extra-EU values estimated based on estimation from COMEXT data.
[2)] Russia has been excluded from the graph because import values were higher than the total consumption for some years (2003 – 2008), which might be due to some underreporting of production data for the country in that period.

### 4.2.4. *Consumption*

Consumption[63] indicates the apparent internal demand of the country for RSI products. The analysis in this chapter focuses on **locomotives and rolling stock.** It is calculated by the sum of production and imports minus the total export in a given year, see equation below.

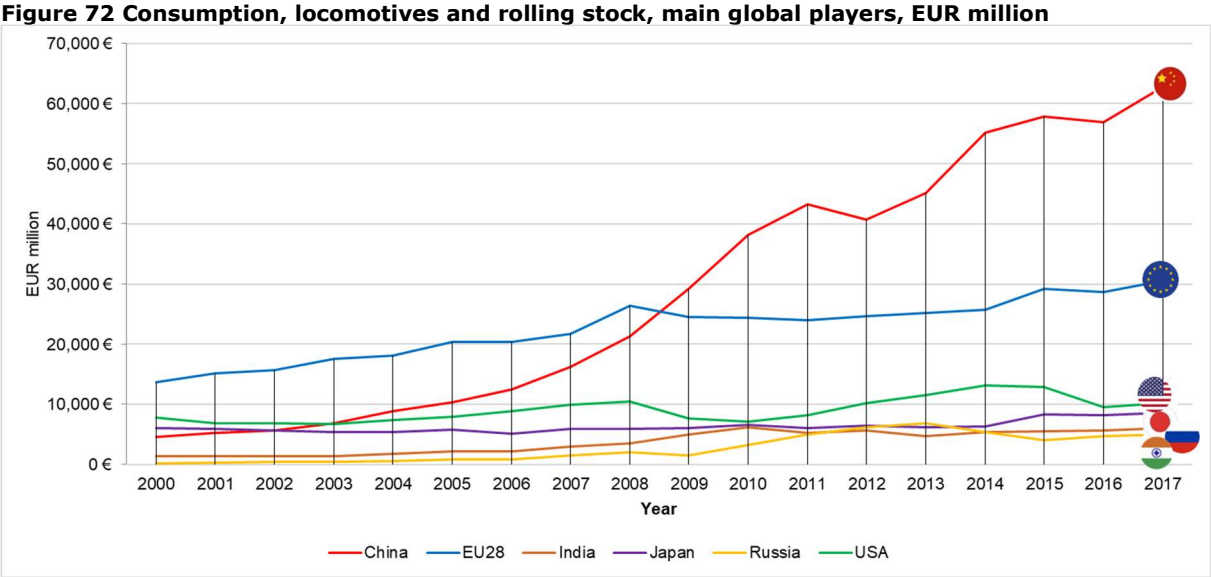
$$Consumption = (Production + Import) - Export$$

In the global context, China experienced a large consumption growth since 2000, mostly led by the huge investment plans set by the government and reflected on the production increase year after year (as presented in section 4.2.1). China's consumption overtook the European absolute value from 2009 onward.

EU production and consumption in the locomotives and rolling stock segment has also grown since 2000. Exports value of the EU RSI industry grew between 2000 and 2011, until it reached almost four-times the value of exports of 2000. After 2011, the exports value remains quite constant, with slight increases.

[63] Consumption was calculated based on data from Euromonitor International Passport Industrial, 2018 edition database, on production, export and import of locomotives and rolling stock. Comparable international data for other railway segments is not available.

**Figure 72 Consumption, locomotives and rolling stock, main global players, EUR million**




Source: VVA elaboration on Euromonitor International data.

### 4.2.5. *Balance of Trade*

The balance of trade (BoT) is the difference between the value of a country's imports and exports for a given period. The balance of trade is the largest component of a country's balance of payments. Economists use the BoT to measure the relative strength of a country's economy. A positive balance of trade reflects a net exporter status, while a negative BoT means that the country is a net importer for a certain good.

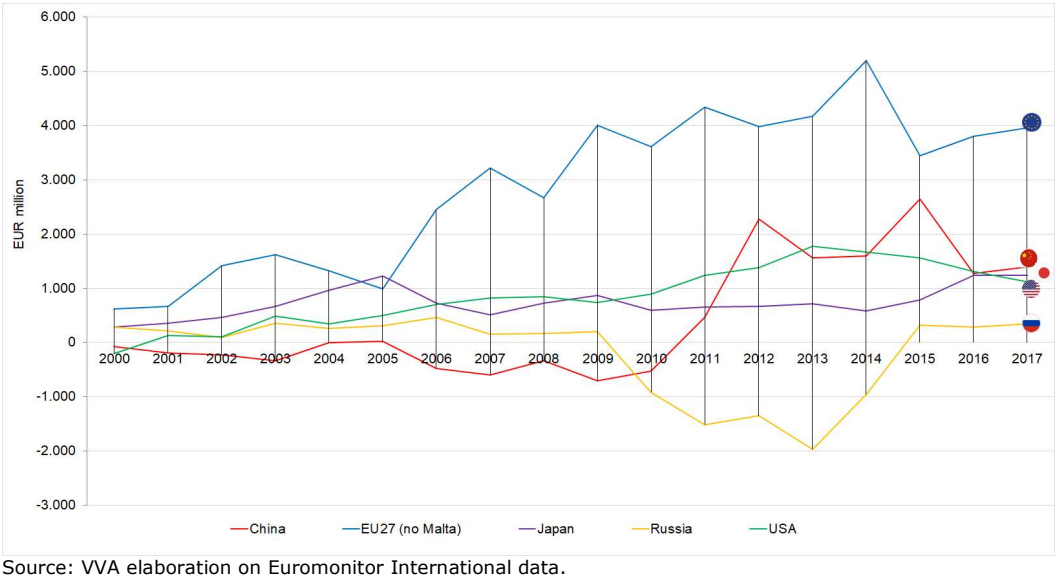
Understanding the significance of a deficit or surplus is the subject of ongoing debate because groups and individuals are affected differently by deficits and surpluses: economic analysis can help better understand the practical implications of various configurations in the balance of trade.

Traditionally, trade surplus was strongly supported by actors who believe that a country/region should always export more merchandise and services than it imports. This trade imbalance results when the goods and services are competitive and desired in world markets and foreigners are willing to invest in the country's products. This is, for example, the situation with high technology content products exported in countries that do not have the knowledge to produce equally competitive products. On the other side, trade deficit could be the result of two main situations: first, in the case of imported goods being cheaper than the domestically produced ones. Second, imported goods being of better quality/higher technology content than the goods produced domestically.

As presented in the figure below, between 2010 and 2013, China and Russia have opposite balance of trade trends. Russia reported a negative balance of trade due to increased imports while Chinese reported a positive BoT due to increased exports. The overall picture says that EU is the best net exporter since 2000, with the only exception in 2005 in which Japan presents a higher value of net exports compared to the European value of the same year. Typically, production, import and export values are concretely influenced by trade agreements put in place in a specific timespan, policy strategies, state aids (outside of EU), legal, financial and non-tariff barriers to international trade and by important long-term railway projects.

Notably, China is the international player that has significantly increased its role in the global market, moving from a status of net importer in the year 2000 to 2010 to a status of net exporter starting from 2011. This important milestone, especially if considered the short timeframe in which it was achieved, is the result of a massive investment in the rail sector by the Chinese government, including the optimisation of national companies – as the merge of the two biggest Chinese rail manufacturers into the new China Rail Rolling Stock (CRRC Corporation) and the development of an infrastructure investment plan known as the Road and Belt Initiative. The topic will be analysed in more detail in the next sections.

**Figure 73 Balance of trade, net export, locomotives and rolling stock, main global players, EUR million**




Source: VVA elaboration on Euromonitor International data.

## 4.2.6. *Market share of the European RSI in other markets worldwide*

The following three sections present in detail the market share of the European RSI in other markets worldwide by analysing the main origin and destination markets of imports and exports (between 2014 and 2018) for China, Japan, Russia, and the USA and their evolution thereof (i.e. growth in exported/imported value between 2014-2018 in %). For South Korea there is only limited data available for the locomotive and rolling stock segment and the infrastructure sub-segment of railway or tramway track construction material of iron or steel. Due to its limited availability this data is presented separately in the following sections.

Data presented were retrieved from the UN Comtrade Dataset[64], and are broken down by:

- Locomotive and rolling stocks (code 86 Railway or tramway locomotives, rolling stock and parts thereof; railway or tramway track fixtures);
- Signalling and electrification goods (code 853010 Electrical signalling, safety or traffic control equipment for railways or tramways);
- Rail infrastructure goods (code 7302 Railway or tramway track construction material of iron or steel & code 4406 Railway or tramway sleepers "cross-ties" of wood).

### 4.2.6.1. Locomotive and rolling stock

As presented in chapter 4.2.2, the European RSI is the lead exporter of locomotives and rolling stock worldwide. In 2018, the European RSI had the highest market share among imported products in China and Japan with considerable presence also in the Russian and USA markets, as presented in Figures 4.16 to 4.21.

In China, 69% of the imported locomotives and rolling stock products are from the EU and the reduction of imports from all main trade partners also impacted the EU. On the other hand, there has been a growth in China's exports to EU countries between 2014 and 2017 from EUR 137 million to EUR 213 million (see Section 3.5.1). In 2018, exports to EU countries represented 13% of China's exports in this segment. The most popular destination of China's exports (27% of the Chinese exports) is the USA, representing 42% of the total imports of the USA. However, the value of the exports to the country has decreased approximately 7% a year in the last 5 years. One of the main companies behind the Chinese success abroad is the CRRC, which has the largest share

64 https://comtrade.un.org/

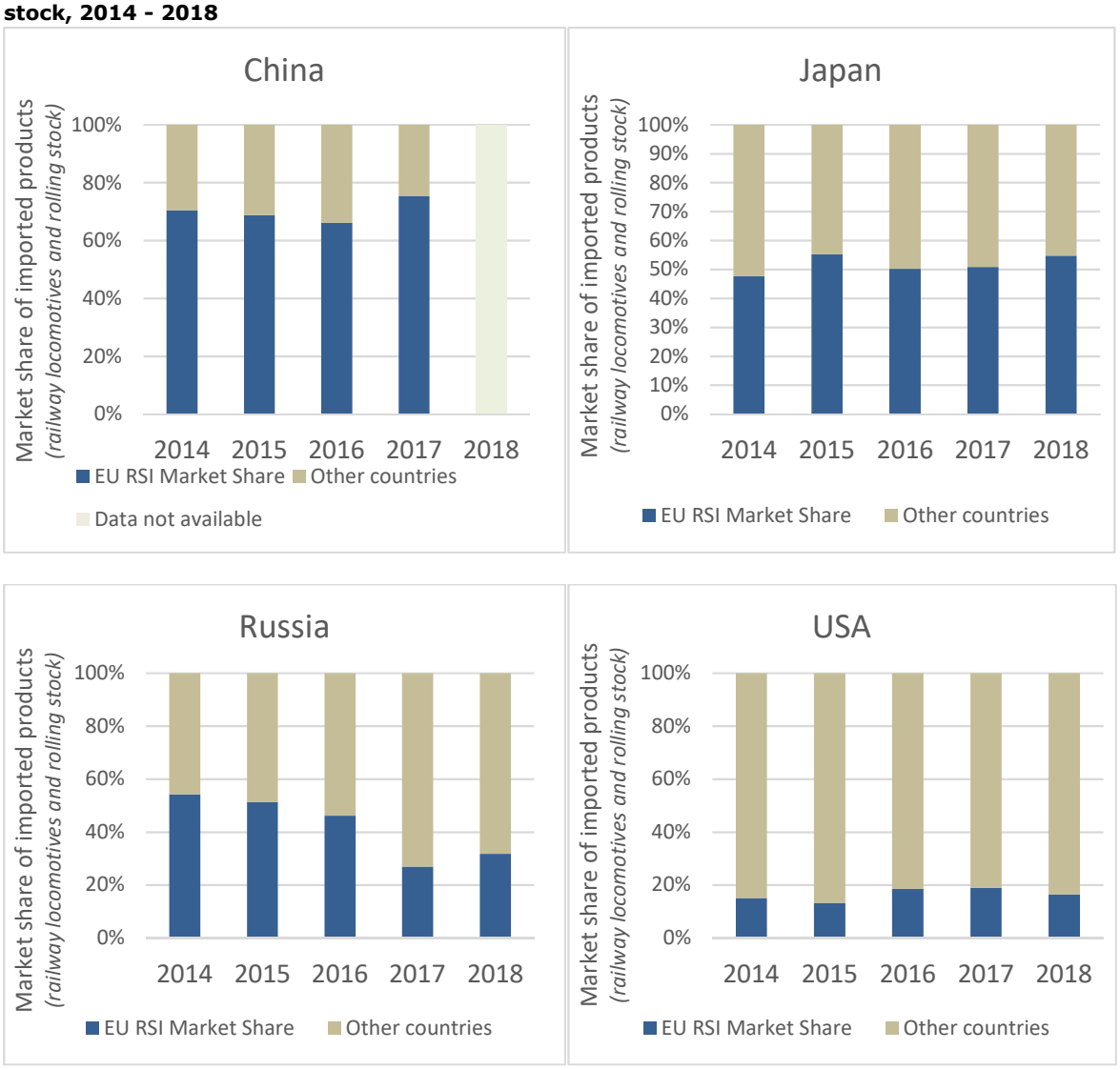
of the worldwide market (30 billion EUR), followed by Siemens (8 Billion EUR), and Alstom (7 billion EUR) (see Figures 4.22 and 4.24).

The penetration of the European locomotives and rolling stock products into Japan has increased since 2014 and it currently represents 49% of the total imports of this segment to the country. The EU is also an important trade partner in relation to Japan's exports, which in 50% of the cases have the EU as its destination.

The market share of the European RSI in Russian's imports is 30%, the second highest share after Ukraine (35%), followed by China (14%).

The EU is also a market leader in South Korea (Figure 77), with 30% of the imports having origin in the European RSI in 2018. However, China's export to South Korea has also increased at an average rate of 24% per year from 2014 and 2018, now representing a share of 29% of total imports of South Korea and it is expected that it might become the main exporter to South Korea.

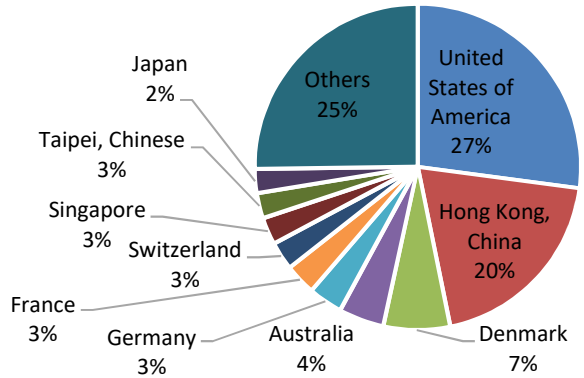
**Figure 74 European RSI market share of imported products in global players, locomotive and rolling stock, 2014 - 2018**



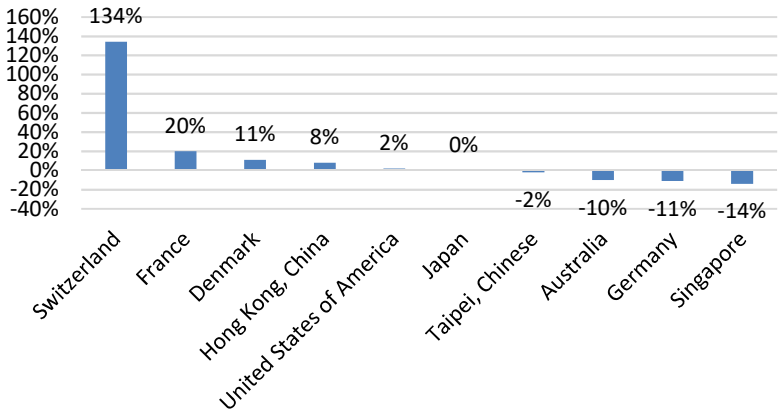

Source: UN COMTRADE.

**Figure 75 China - Product: 86 Railway or tramway locomotives, rolling stock and parts thereof; railway or tramway track fixtures...**

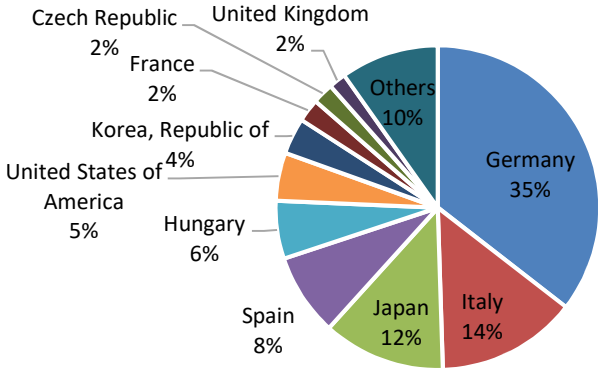
**% exported in 2018**



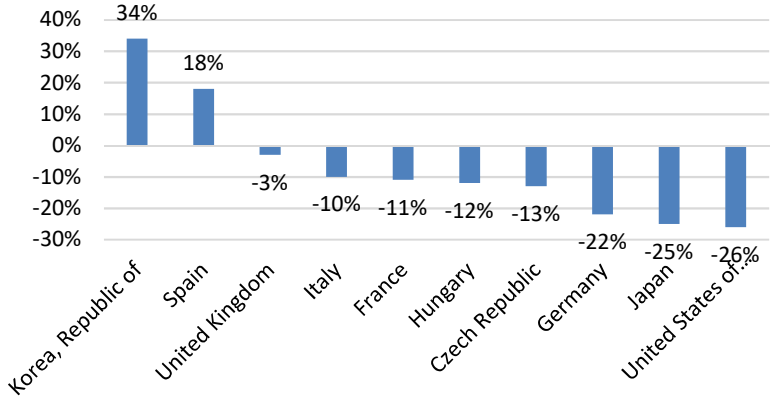

**Growth in exported value between 2014-2018 (%, p.a.)**




**% imported in 2018**



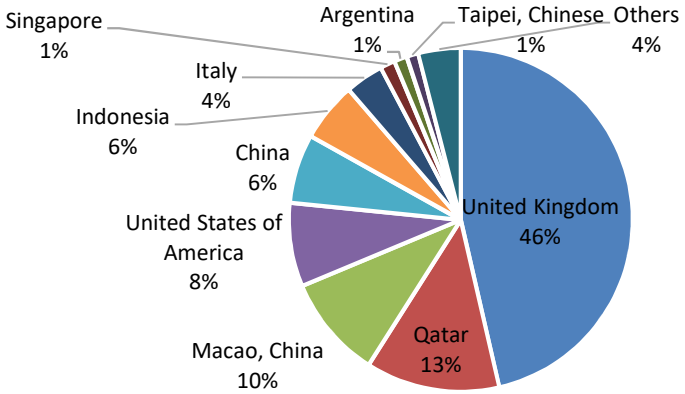

**Growth in imported value between 2014-2018 (%, p.a.)**



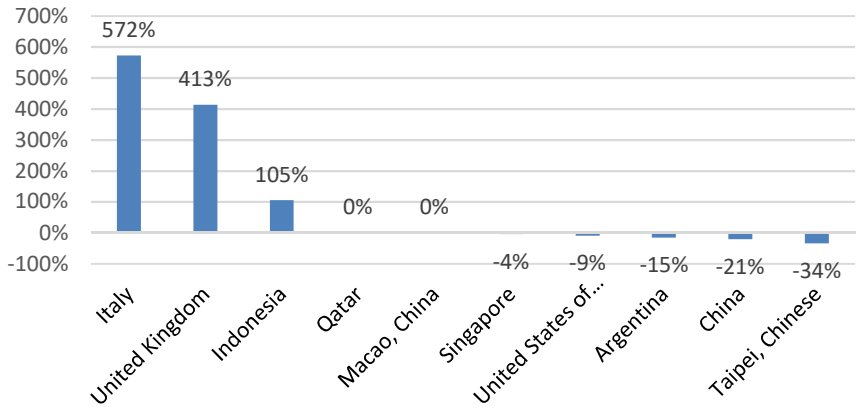

Source: UN COMTRADE

**Figure 76 Japan - Product: 86 Railway or tramway locomotives, rolling stock and parts thereof; railway or tramway track fixtures …**

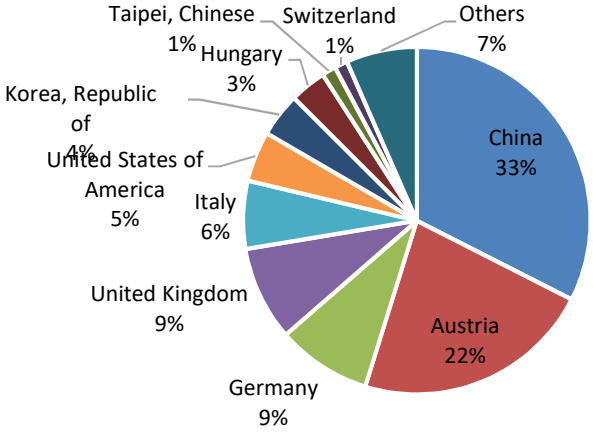
**% exported in 2018**



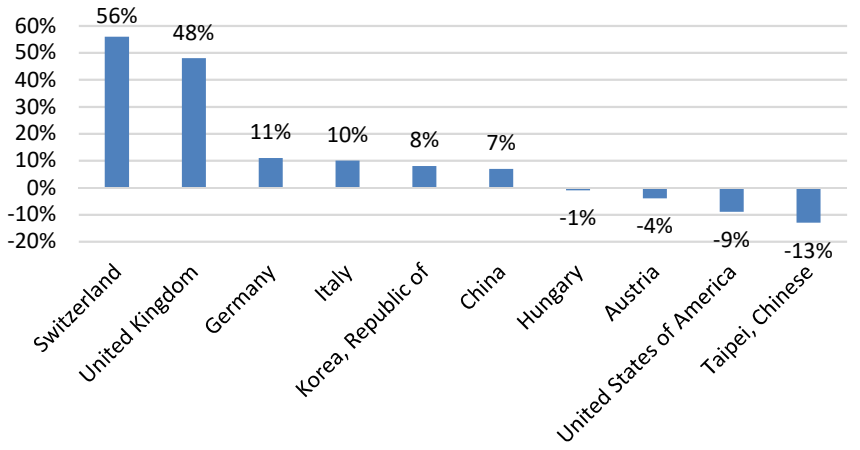

**Growth in exported value between 2014-2018 (%, p.a.)**




**% imported in 2018**



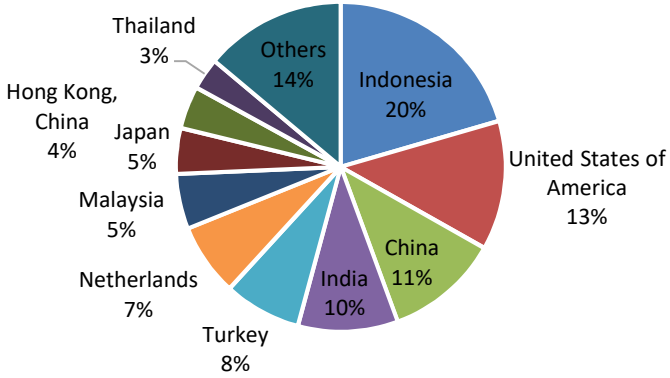

**Growth in imported value between 2014-2018 (%, p.a.)**



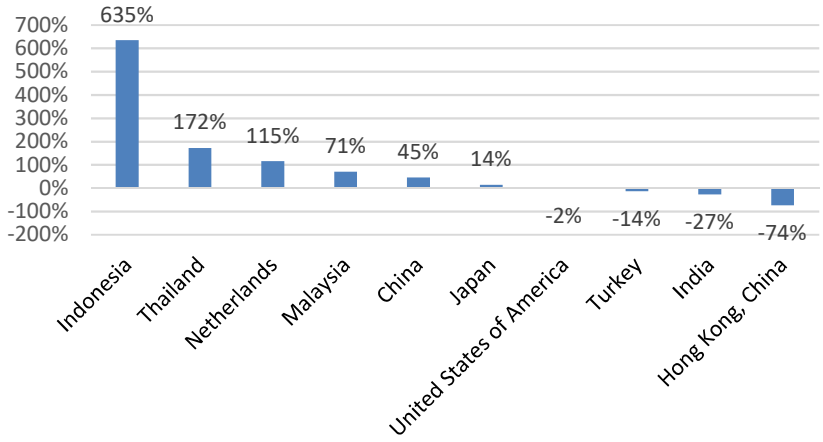

Source: UN COMTRADE.

**Figure 77 South Korea - Product: 86 Railway or tramway locomotives, rolling stock and parts thereof; railway or tramway track fixtures ...**

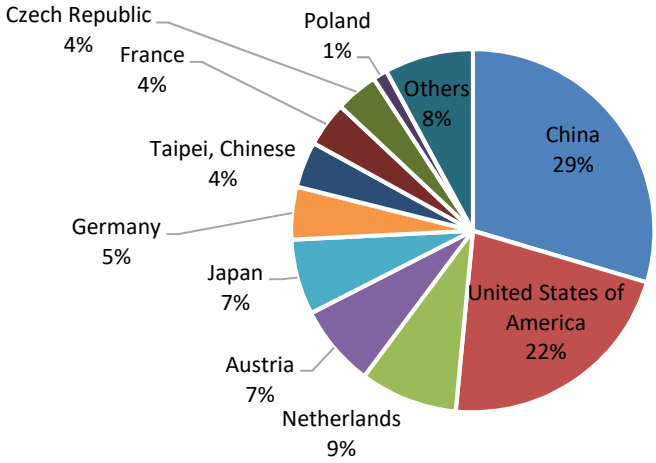
**% exported in 2018**



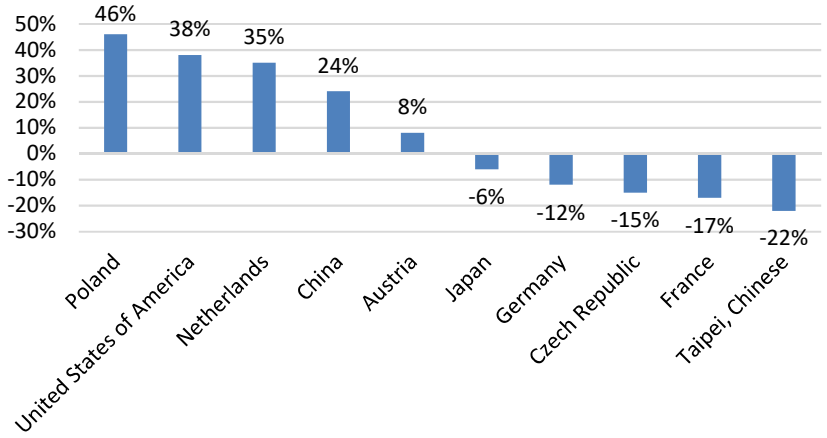

**Growth in exported value between 2014-2018 (%, p.a.)**




**% imported in 2018**



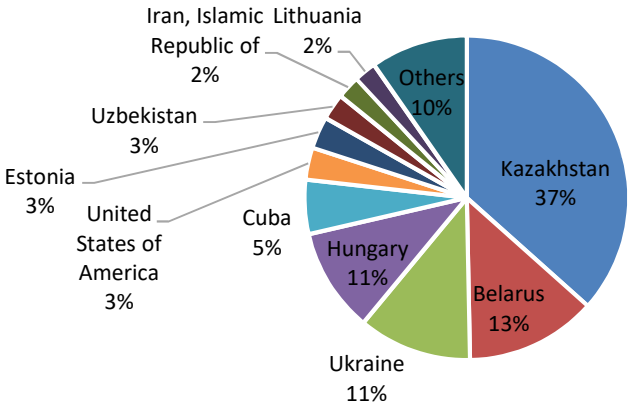

**Growth in imported value between 2014-2018 (%, p.a.)**



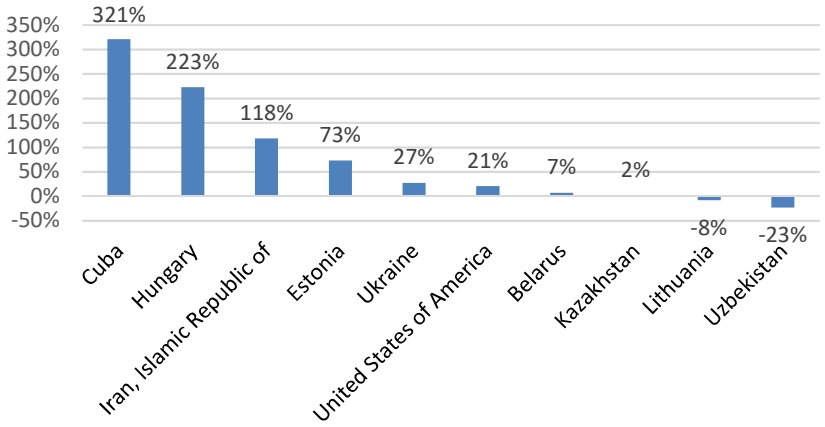

Source: UN COMTRADE.

**Figure 78 Russia - Product: 86 Railway or tramway locomotives, rolling stock and parts thereof; railway or tramway track fixtures ...**

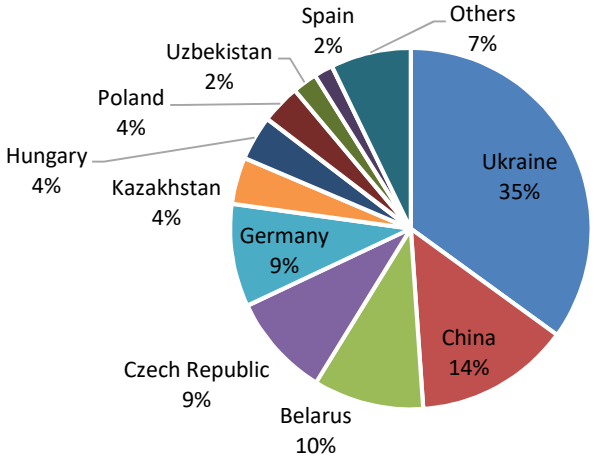
**% exported in 2018**



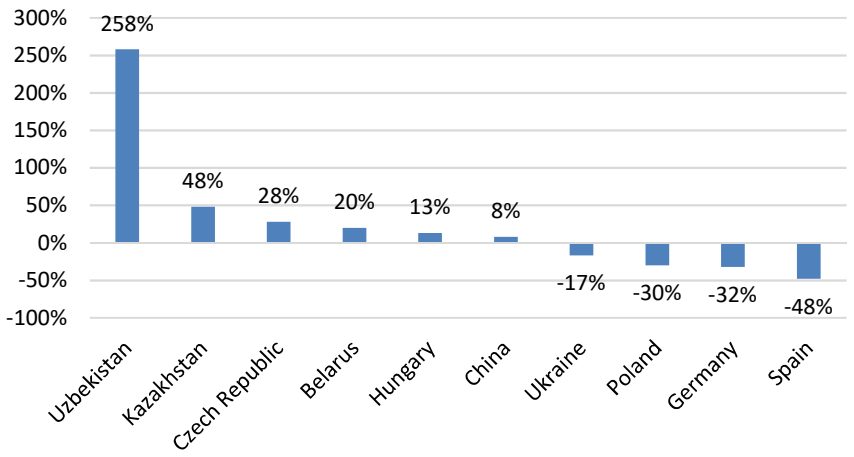

**Growth in exported value between 2014-2018 (%, p.a.)**




**% imported in 2018**



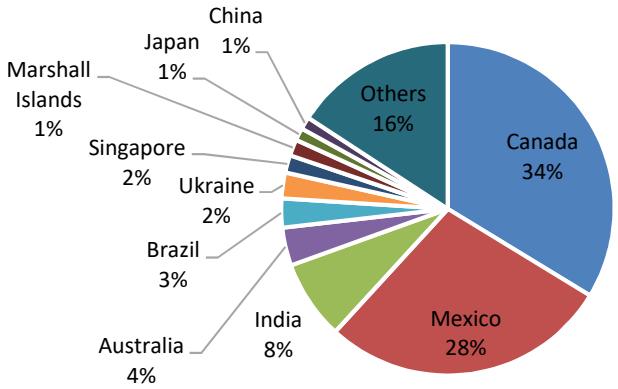

**Growth in imported value between 2014-2018 (%, p.a.)**



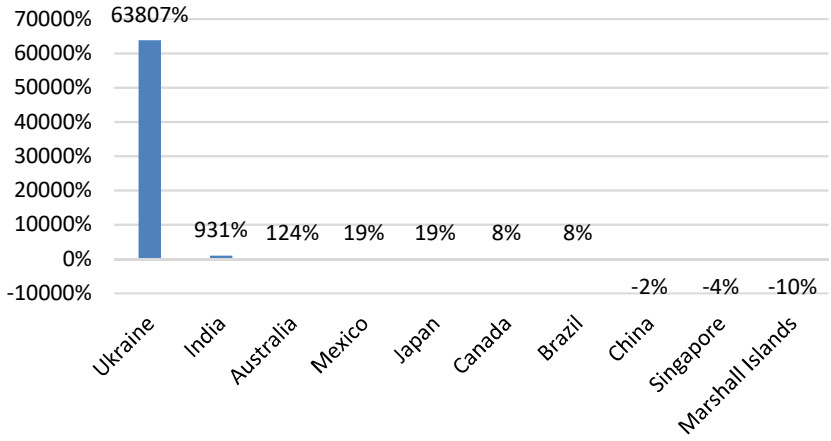

Source: UN COMTRADE.

**Figure 79 USA - Product: 86 Railway or tramway locomotives, rolling stock and parts thereof; railway or tramway track fixtures ...**

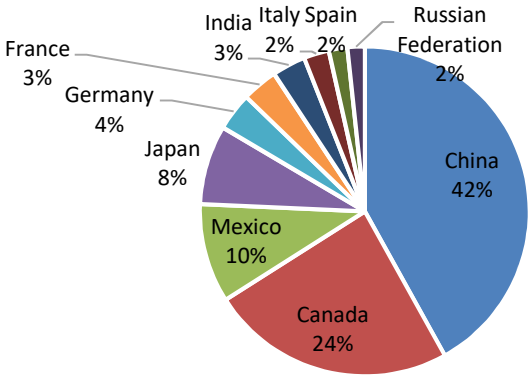
**% exported in 2018**



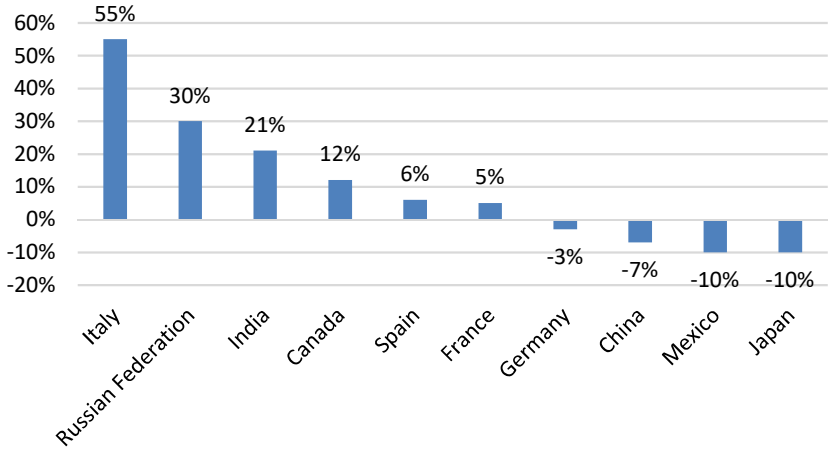

**Growth in exported value between 2014-2018 (%, p.a.)**




**% imported in 2018**

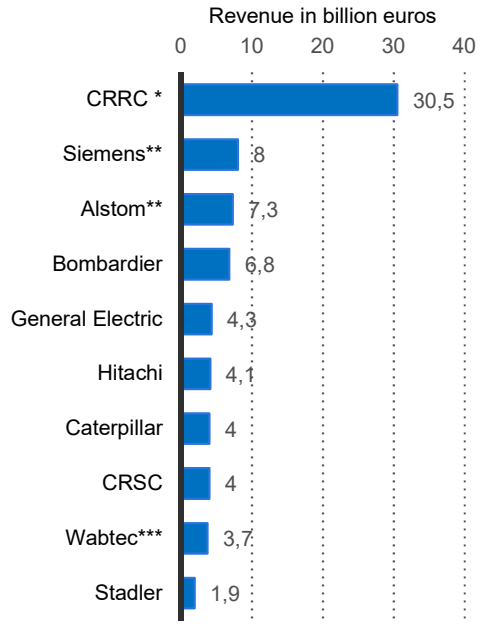



**Growth in imported value between 2014-2018 (%, p.a.)**



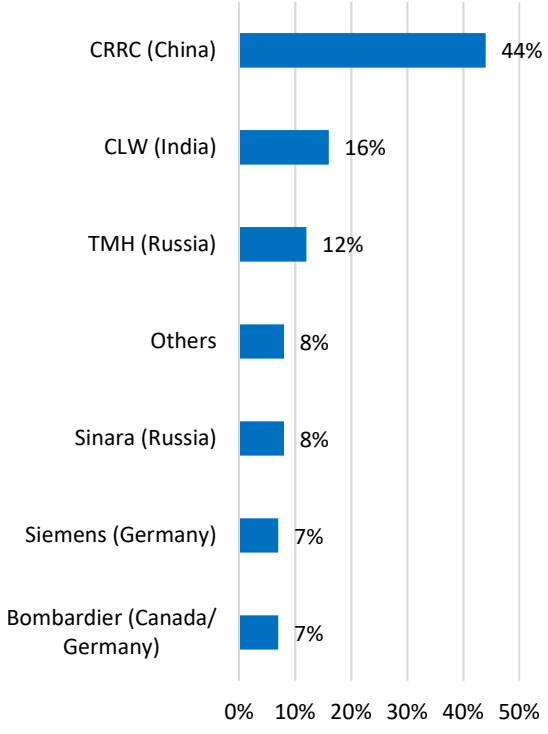

Source: UN COMTRADE.

**Figure 80 Leading rolling stock manufacturers in 2016, by market shares (in billion euros)**



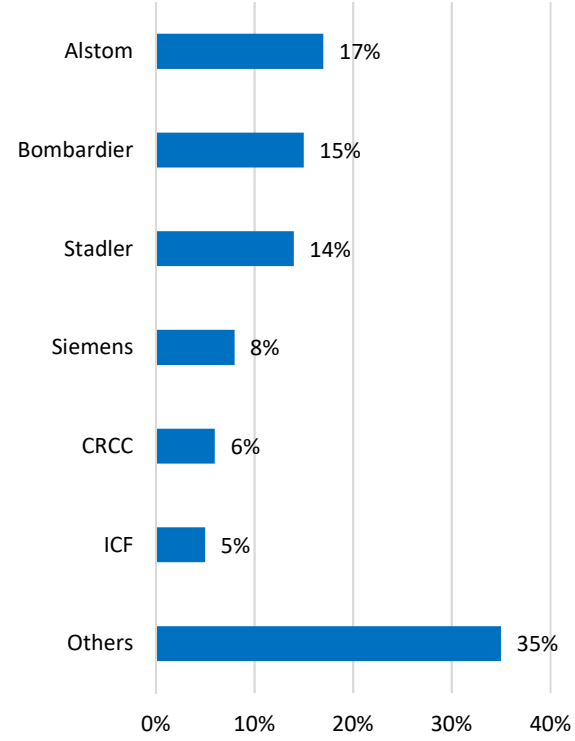

Source: Statista

**Figure 81 Leading electric locomotive manufacturers' global average market share between 2013 and 2017**




Source: Adaptation from Statista based on SCI Verkehr, 2018

**Figure 82 Leading electric multiple unit (EMU) train manufacturers' global market share between 2013 and 2017**




Source: Adaptation from Statista based on SCI Verkehr, 2018

#### 4.2.6.2. Signalling and electrification products

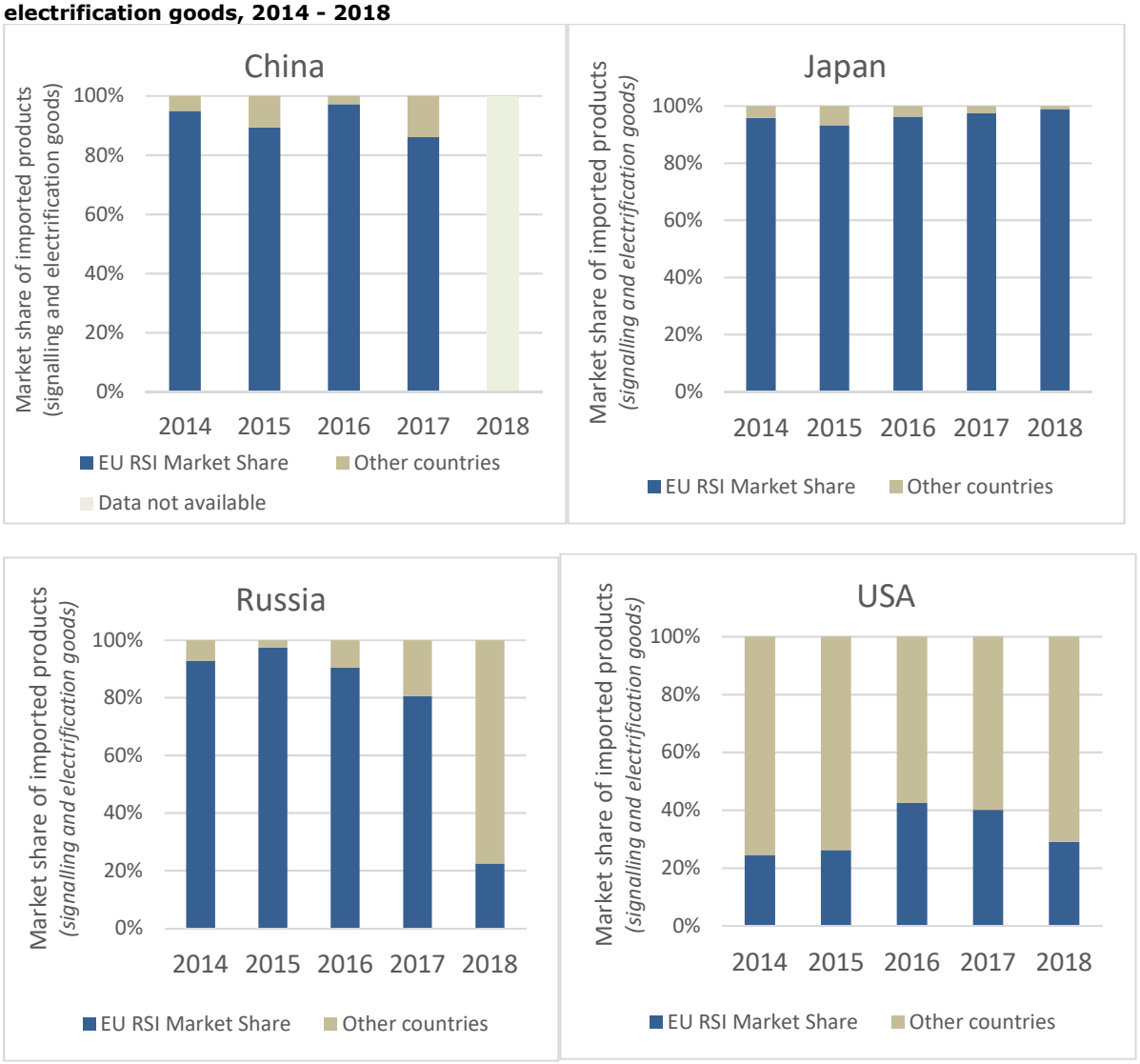
The European industry is also the global leader on railway signalling and electrification goods. Siemens is the global market leader with 40% market share, followed by Thales (20%). Together, they hold approximately 60% of the global market share in this rail supply segment (See Figure 88).

The EU RSI products represent 58% of the China's import and, an impressive, 99% of Japan's imports in this segment. The European industry is also present in Russia and the USA, with 22% and 28% of the imports' market share, respectively.

Japan is also a strong player in this segment, representing 23% market share for imported products in China and 20% in the USA. In China, the value of products imported from Japan increased massively between 2014 and 2018, at a growth rate of 310% per year (see Figure 84).

There was no data available for South Korea.

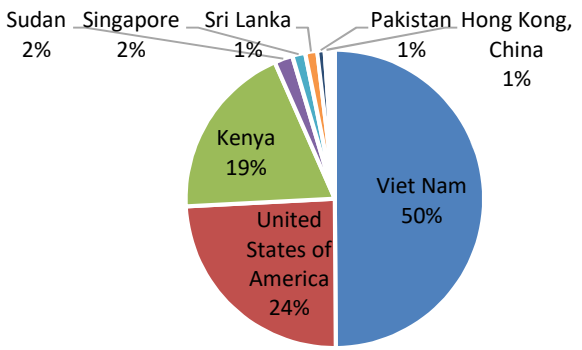
**Figure 83 European RSI market share of imported products in global players, signalling and electrification goods, 2014 - 2018**



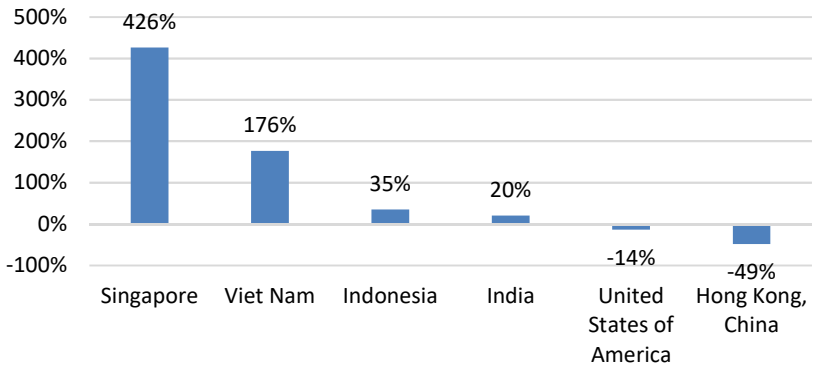

Source: UN COMTRADE.

**Figure 84 China - Product: 853010 Electrical signalling, safety or traffic control equipment for railways or tramways**

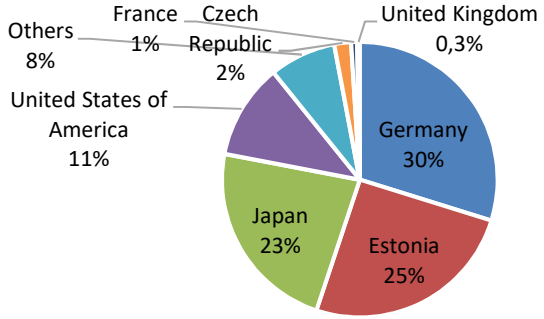
**% exported in 2018**



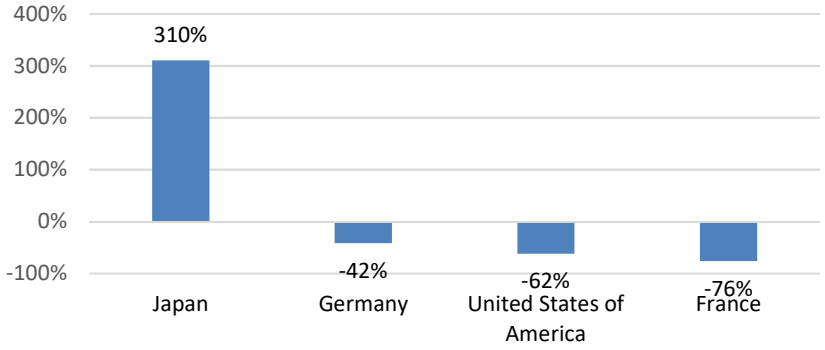

**Growth in exported value between 2014-2018 (%, p.a.)**




**% imported in 2018**



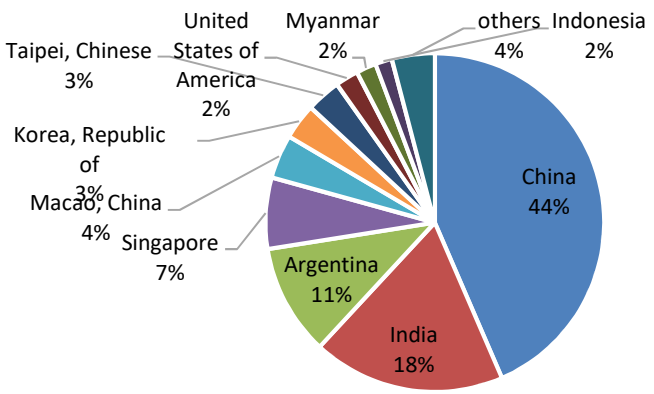

**Growth in imported value between 2014-2018 (%, p.a.)**



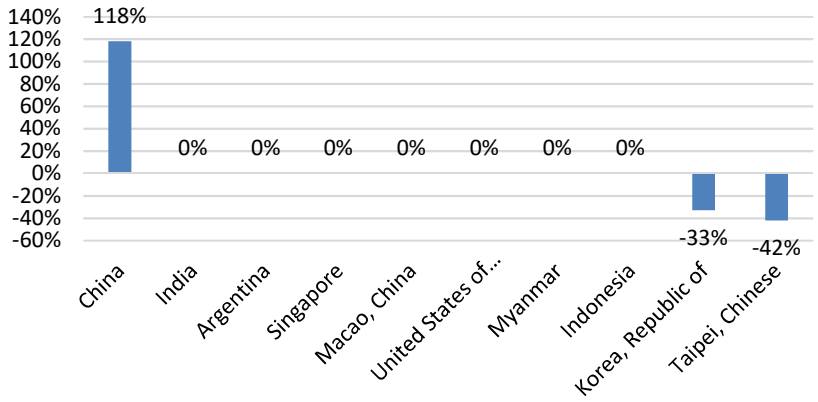

Source: UN COMTRADE

**Figure 85 Japan - Product: 853010 Electrical signalling, safety or traffic control equipment for railways or tramways**

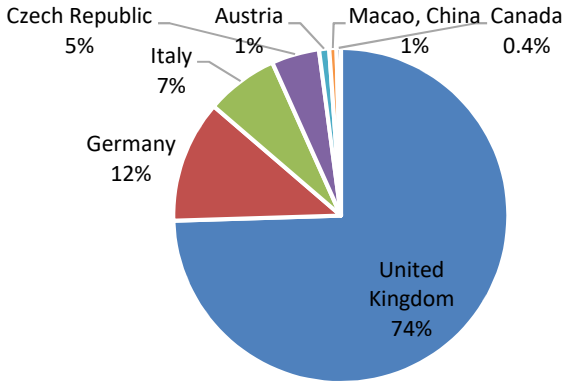
**% exported in 2018**



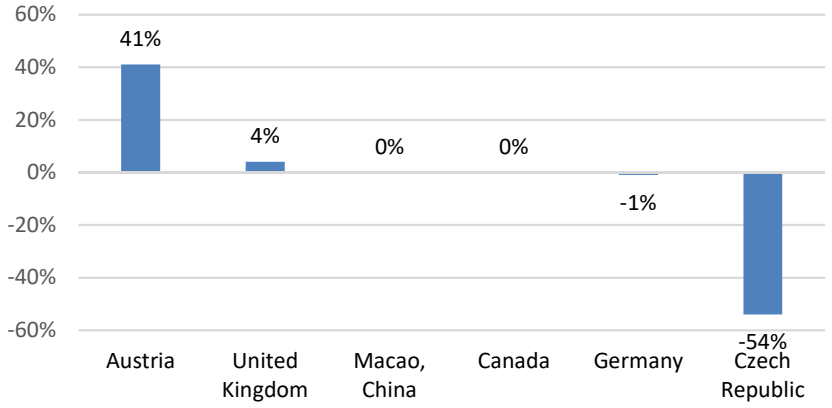

**Growth in exported value between 2014-2018 (%, p.a.)**




**% imported in 2018**



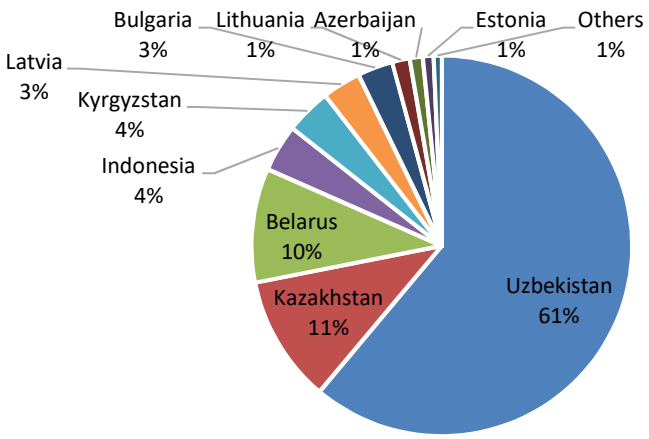

**Growth in imported value between 2014-2018 (%, p.a.)**



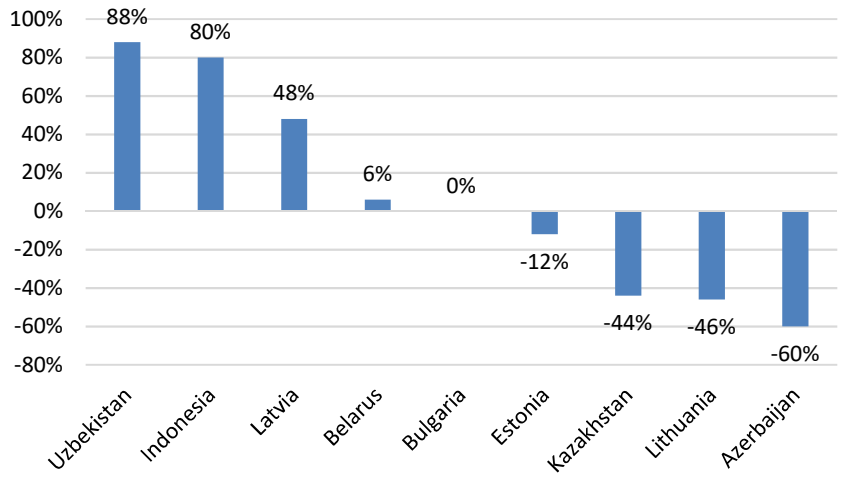

Source: UN COMTRADE.

**Figure 86 Russia - Product: 853010 Electrical signalling, safety or traffic control equipment for railways or tramways**

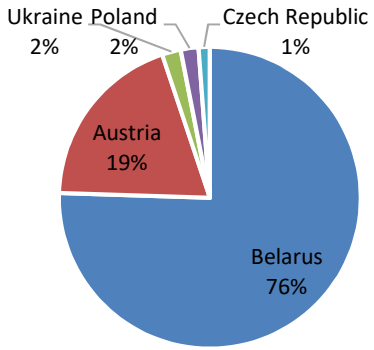
**% exported in 2018**



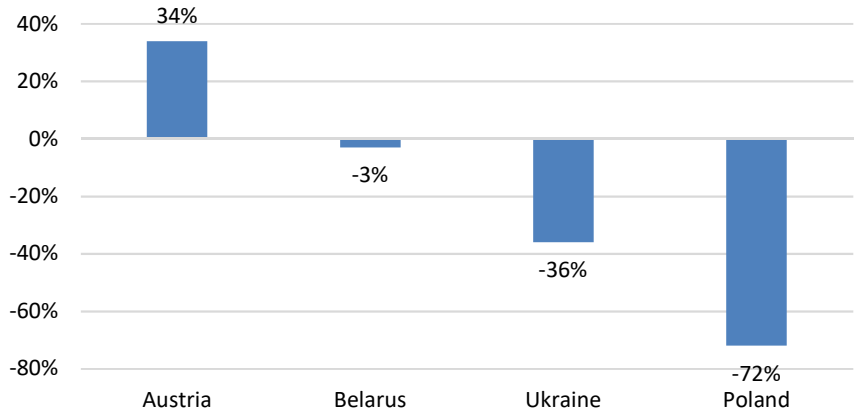

**Growth in exported value between 2014-2018 (%, p.a.)**




**% imported in 2018**



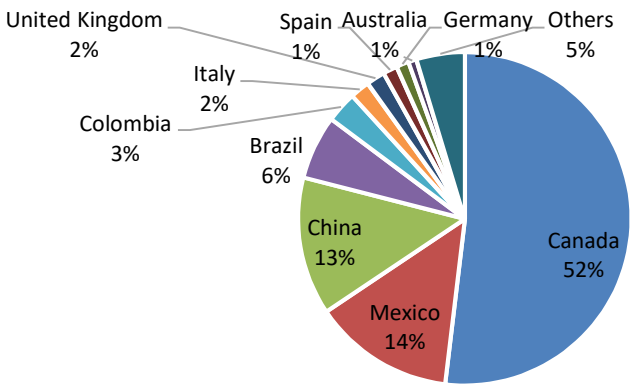

**Growth in imported value between 2014-2018 (%, p.a.)**



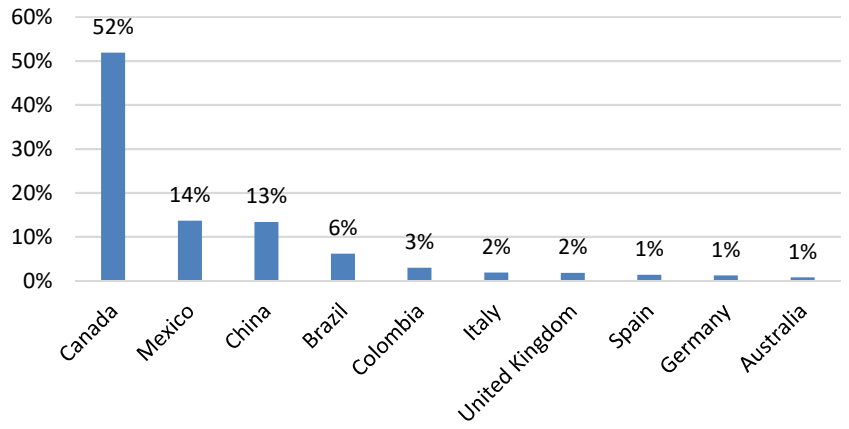

Source: UN COMTRADE.

**Figure 87 USA - Product: 853010 Electrical signalling, safety or traffic control equipment for railways or tramways**

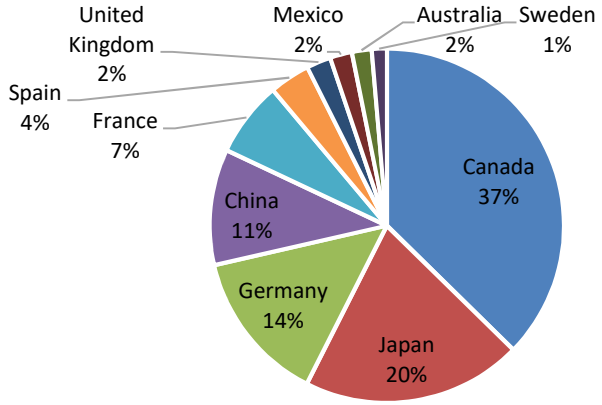
**% exported in 2018**



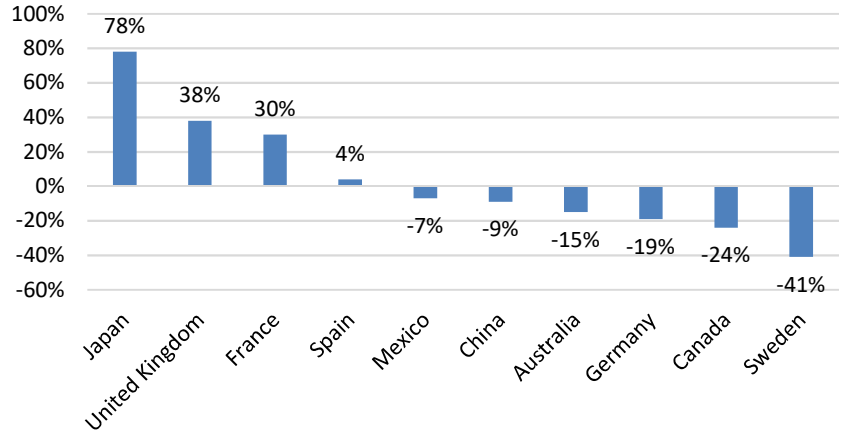

**Growth in exported value between 2014-2018 (%, p.a.)**




**% imported in 2018**

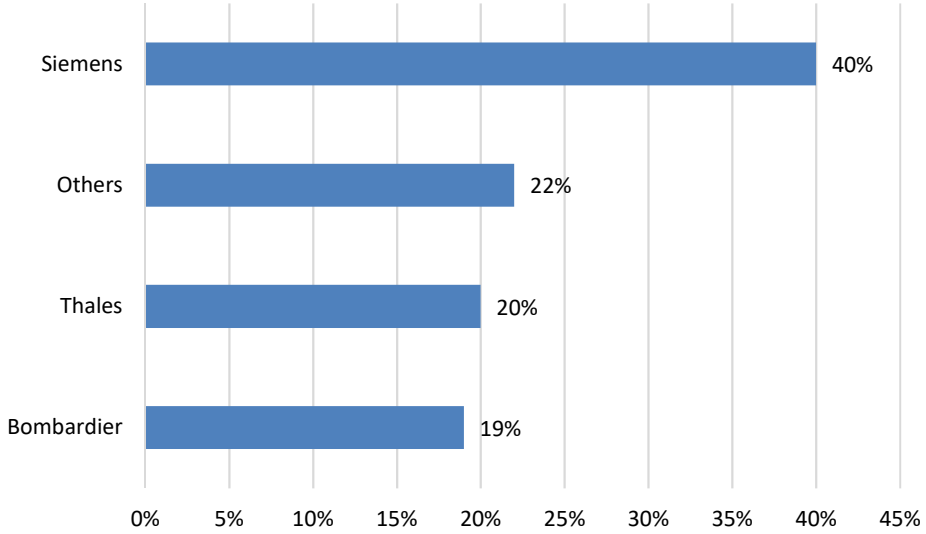



**Growth in imported value between 2014-2018 (%, p.a.)**




Source: UN COMTRADE.

**Figure 88 Market share of the leading railway signalling systems manufacturers in the world in 2017**



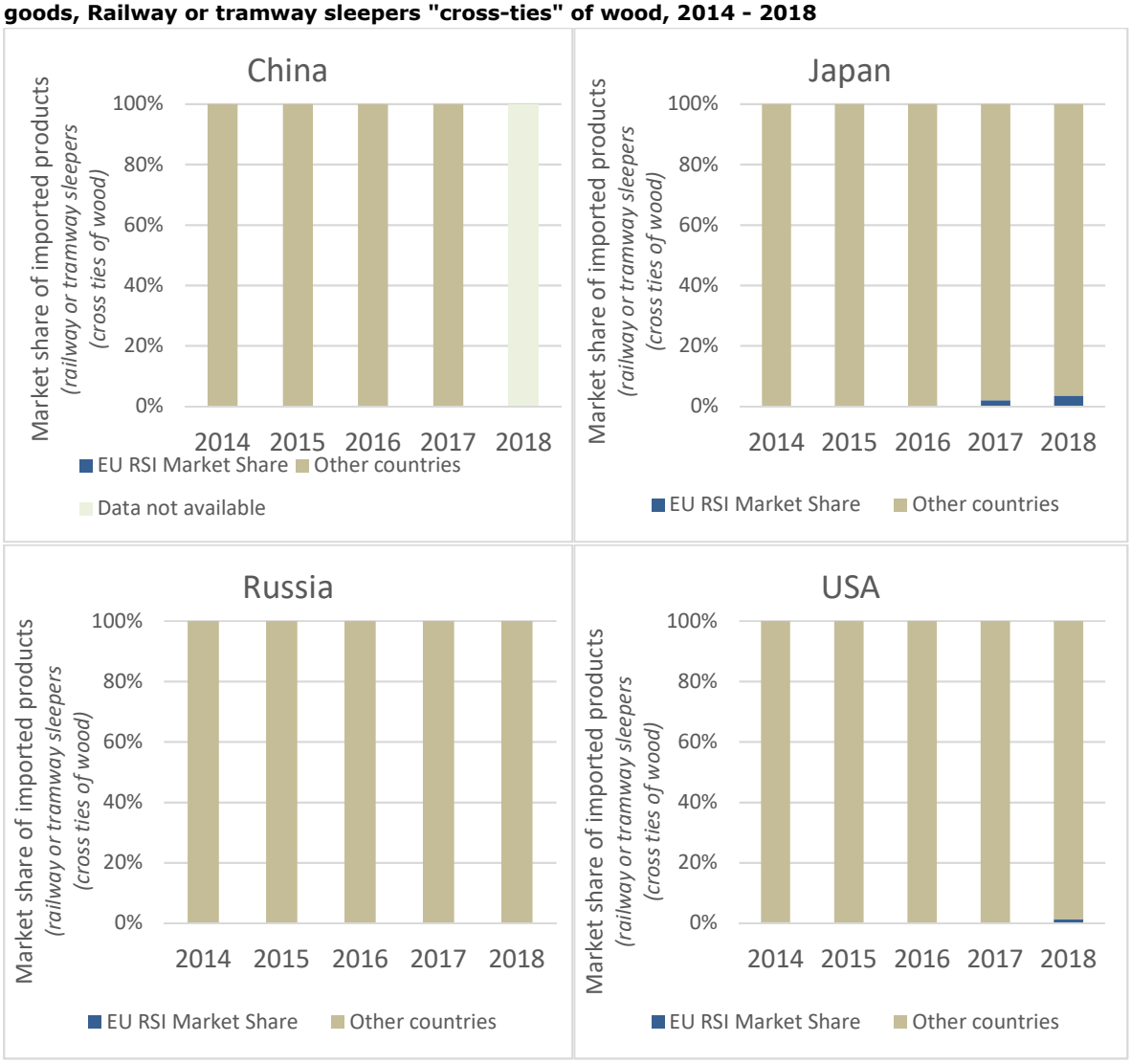

Source: Adaptation from Statista based on Wavestone; Frost & Sullivan, 2017.

#### 4.2.6.3. Rail infrastructure products

When it comes to rail infrastructure goods, two main products were assessed: **Railway or tramway sleepers "cross-ties" of wood and railway or tramway track construction material of iron or steel.**

The European RSI products do not have a large market share of **railway or tramway sleepers "cross-ties" of wood**. The global market is fragmented in this segment. Special attention could be given to Russia, which provides approximately 95% of the wood sleepers and related products to China and Malaysia, who is the main provider for Japan (86% of the total imported products).

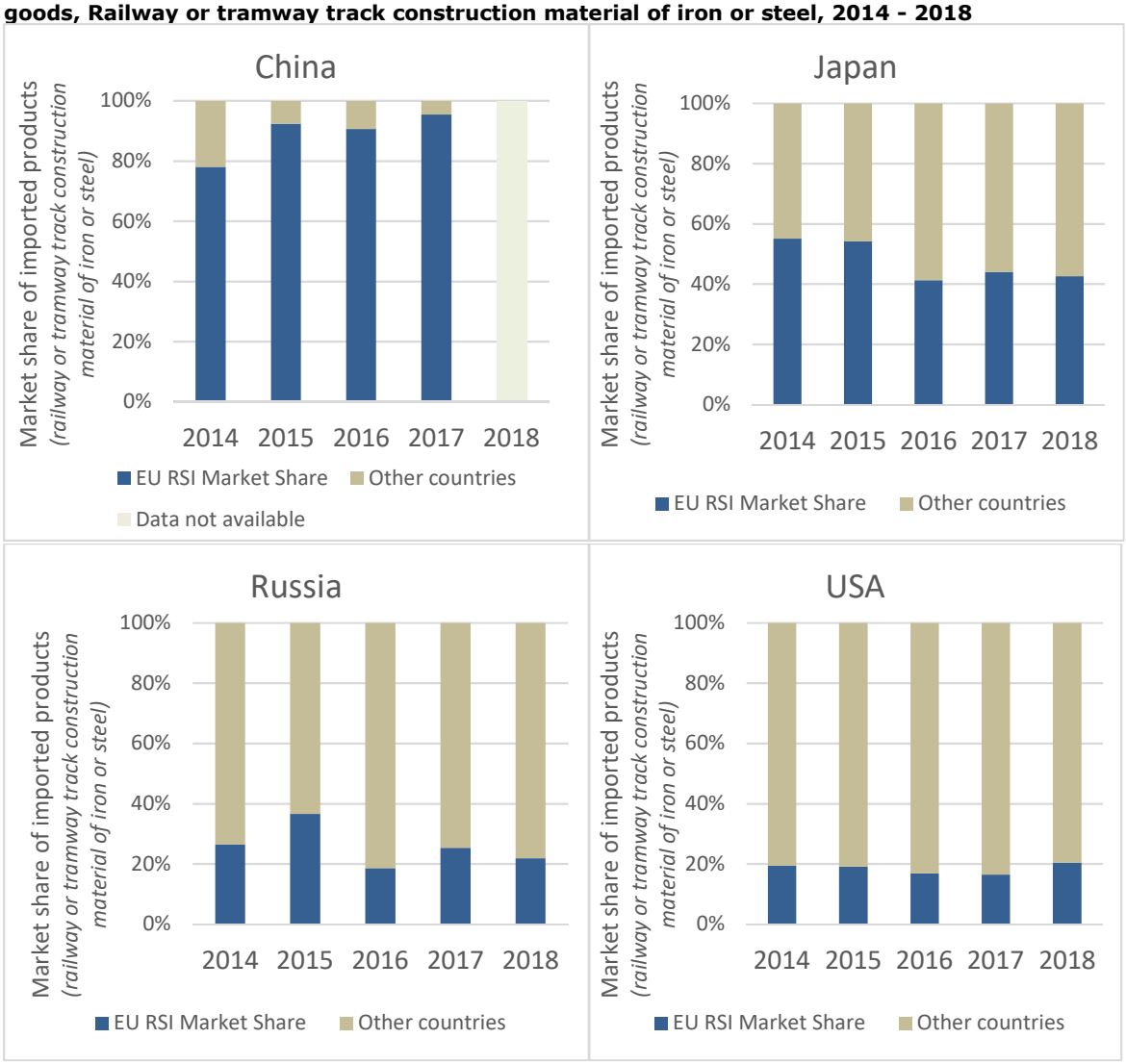
**Figure 89 European RSI market share of imported products in global players, rail infrastructure goods, Railway or tramway sleepers "cross-ties" of wood, 2014 - 2018**




Source: UN COMTRADE

The European RSI is, on the other hand, a market leader on railway or tramway track construction material of iron or steel, such as rails and check-rails. For example, the EU is the origin of 92% of the imported products by China and 42% of those imported by Japan. In addition, it is also among the main providers of track material of iron and steel to Russia, the USA (See Figure 90) and South Korea (See Table 33).

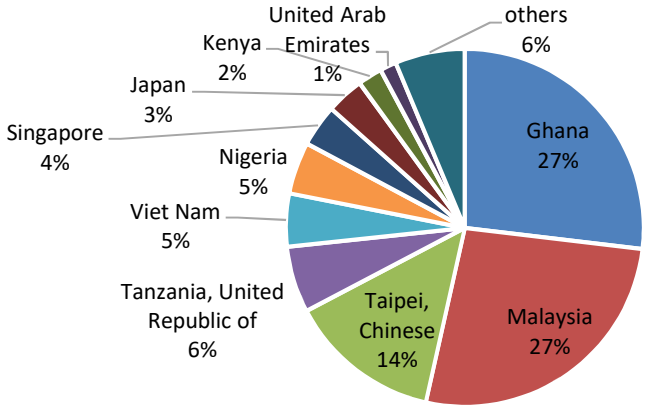
**Figure 90 European RSI market share of imported products in global players, rail infrastructure goods, Railway or tramway track construction material of iron or steel, 2014 - 2018**



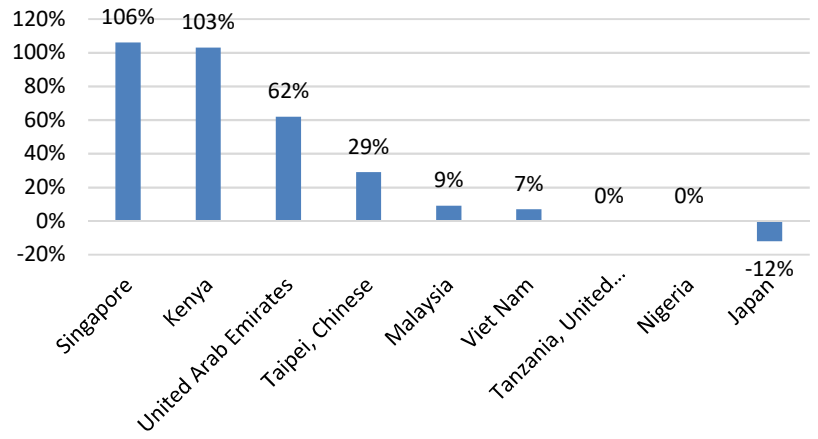

Source: UN COMTRADE.

**Table 29 China - Product: 4406 Railway or tramway sleepers "cross-ties" of wood**

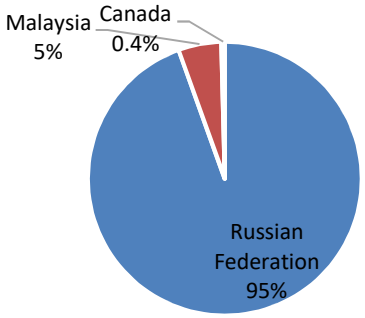
**% exported in 2018**



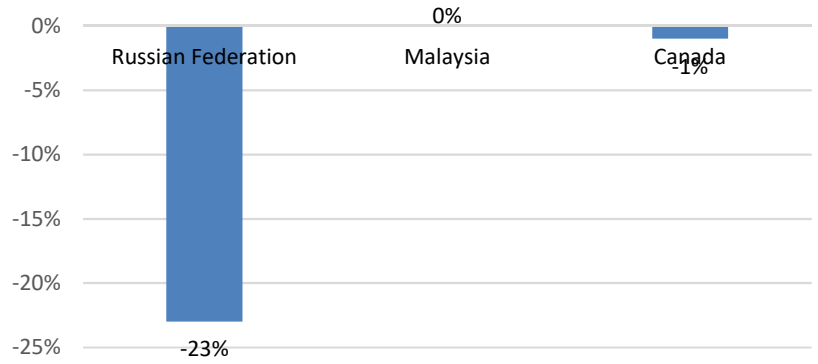

**Growth in exported value between 2014-2018 (%, p.a.)**




**% imported in 2018**



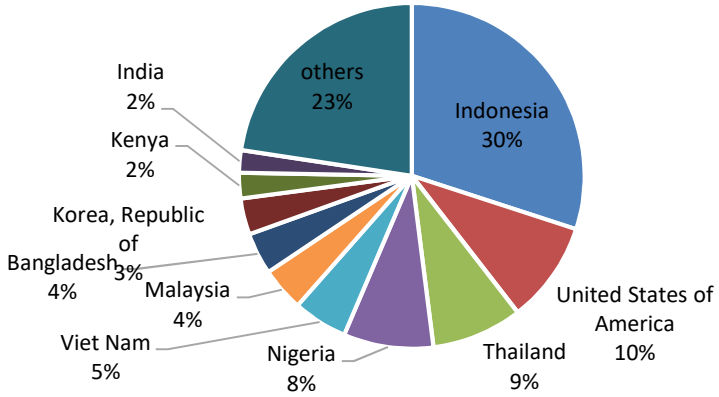

**Growth in imported value between 2014-2018 (%, p.a.)**



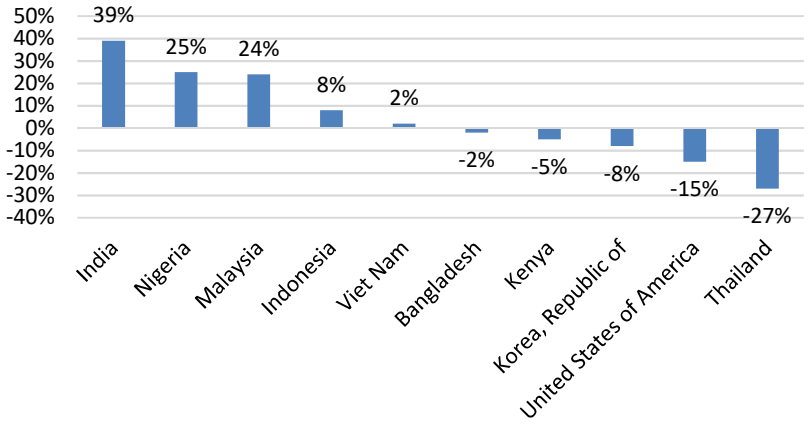

Source: UN COMTRADE.

**Table 30 China - Product: 7302 Railway or tramway track construction material of iron or steel, the following: rails, check-rails**

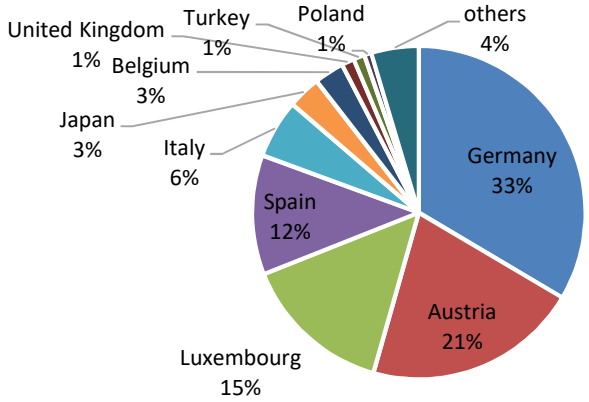
**% exported in 2018**



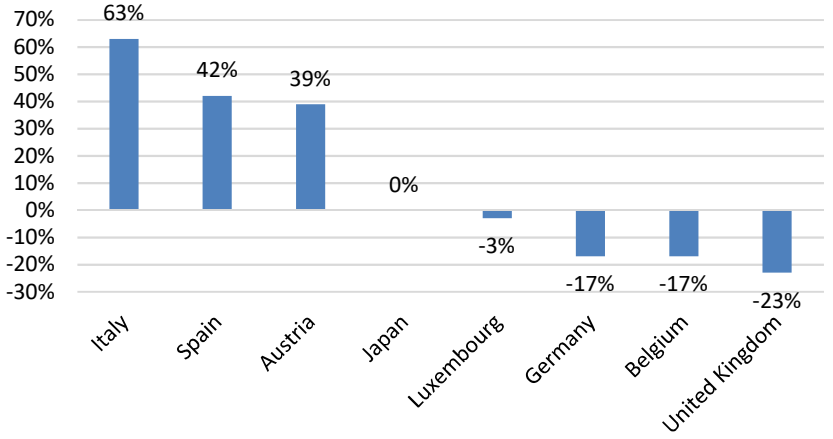

**Growth in exported value between 2014-2018 (%, p.a.)**




**% imported in 2018**




**Growth in imported value between 2014-2018 (%, p.a.)**




Source: UN COMTRADE.

**Table 31 Japan - Product: 4406 Railway or tramway sleepers "cross-ties" of wood**

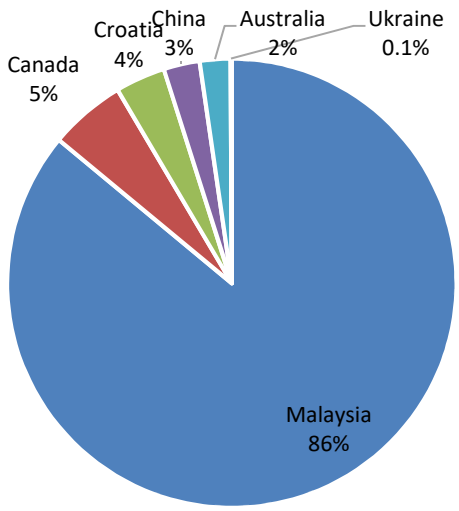
**% exported in 2018**

Singapore 100%

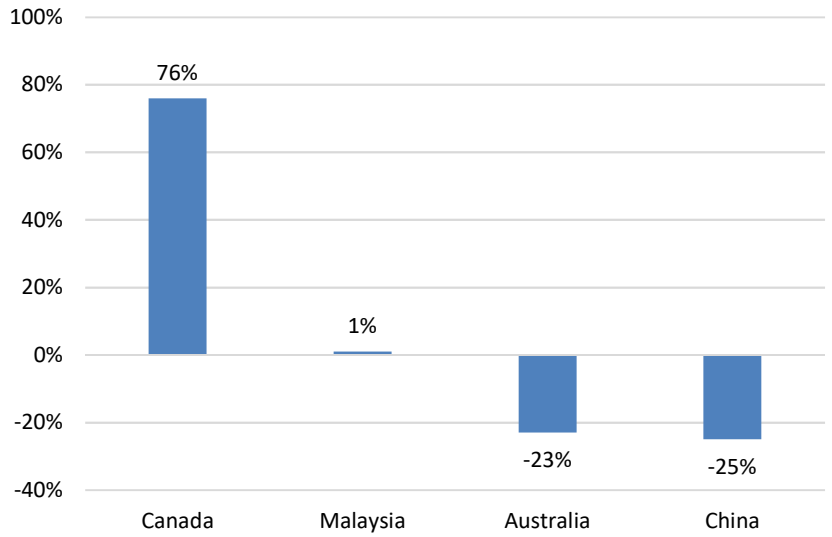
**Growth in exported value between 2014-2018 (%, p.a.)**

N/A

**% imported in 2018**



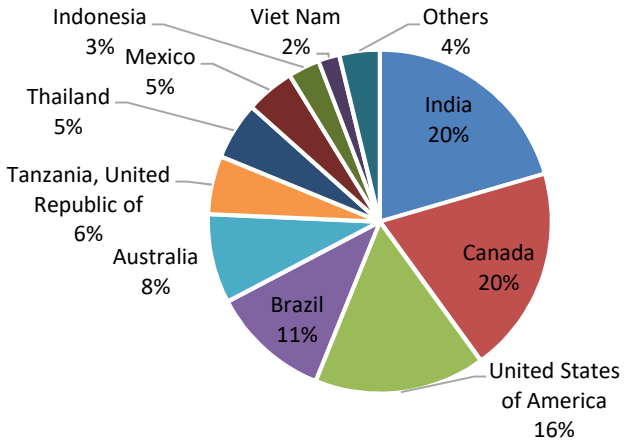

**Growth in imported value between 2014-2018 (%, p.a.)**



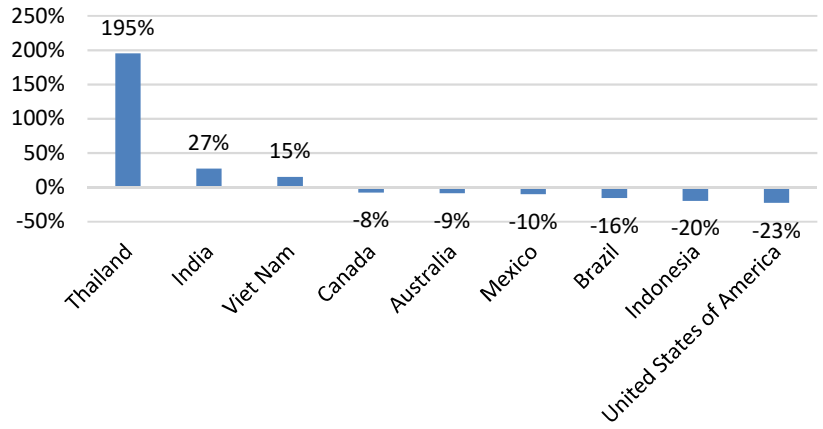

Source: UN COMTRADE.

**Table 32 Japan - Product: 7302 Railway or tramway track construction material of iron or steel, the following: rails, check-rails**

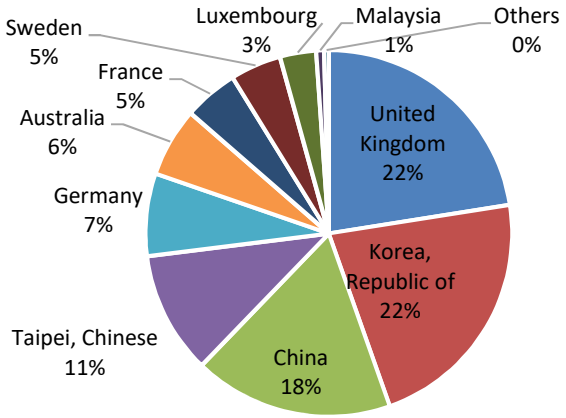
**% exported in 2018**



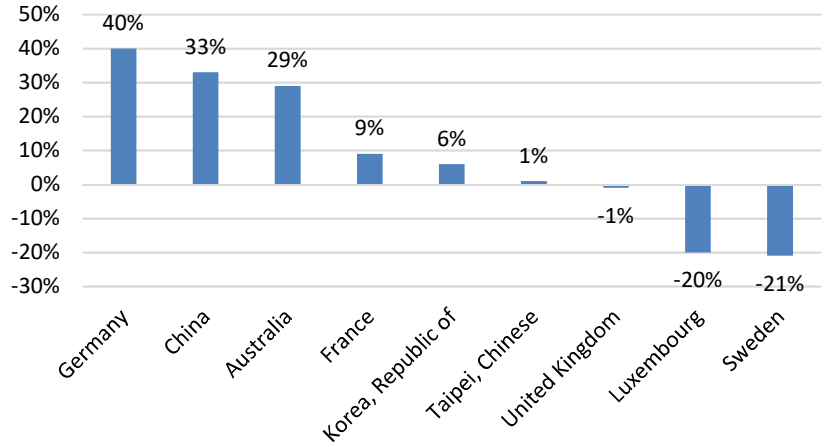

**Growth in exported value between 2014-2018 (%, p.a.)**




**% imported in 2018**



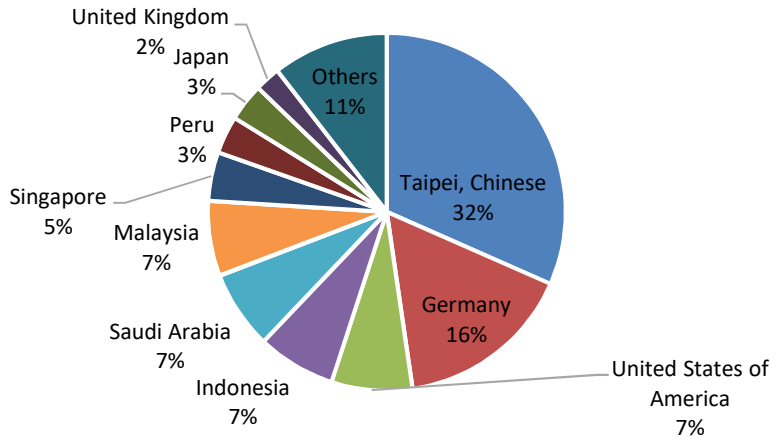

**Growth in imported value between 2014-2018 (%, p.a.)**



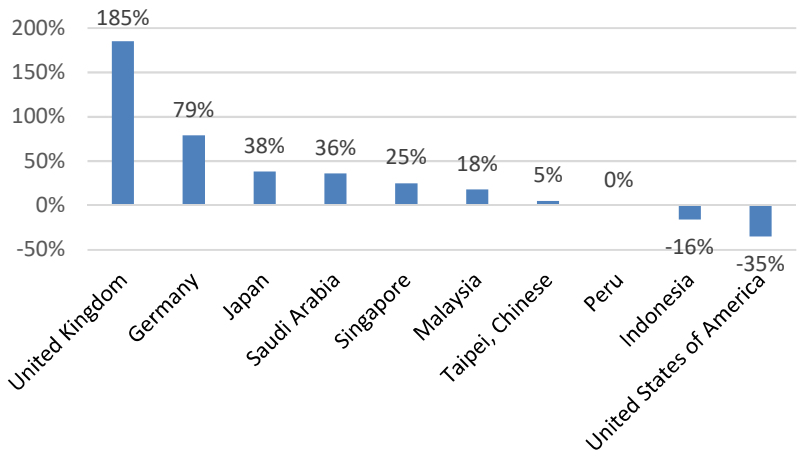

Source: UN COMTRADE.

**Table 33 South Korea - Product: 7302 Railway or tramway track construction material of iron or steel, the following: rails, check-rails**

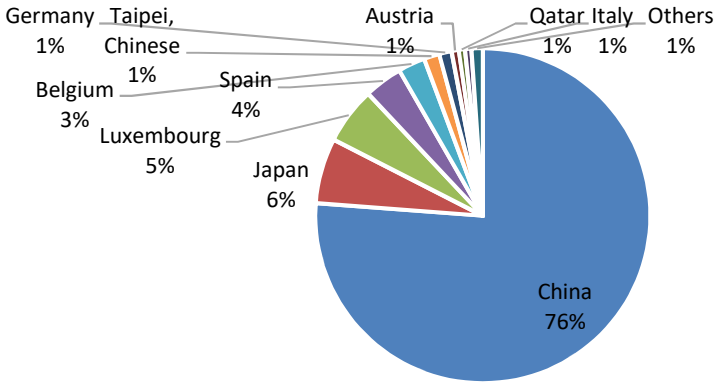
**% exported in 2018**



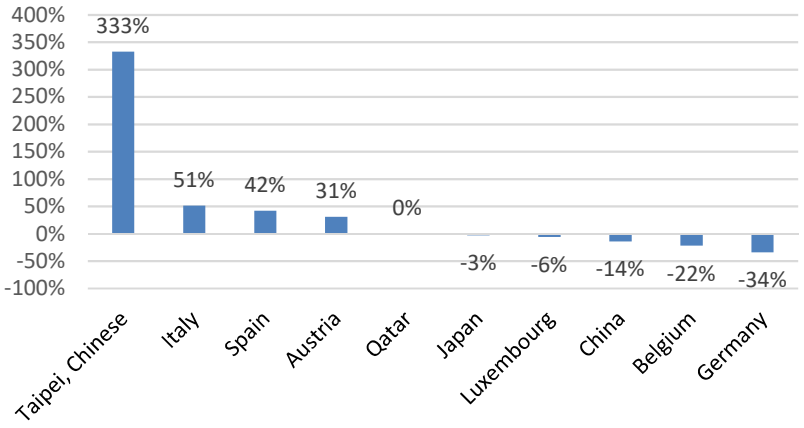

**Growth in exported value between 2014-2018 (%, p.a.)**




**% imported in 2018**



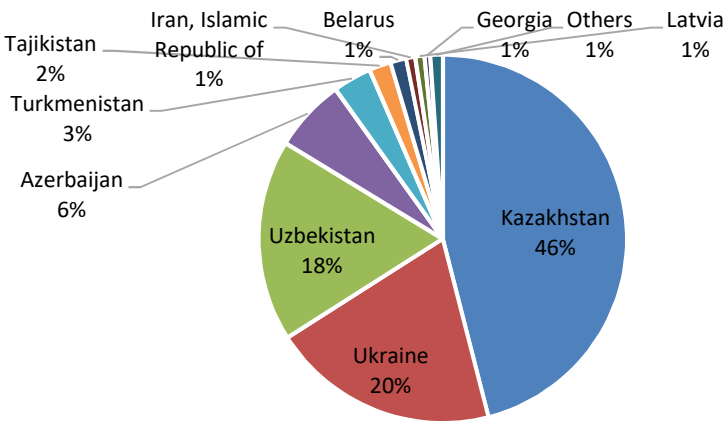

**Growth in imported value between 2014-2018 (%, p.a.)**



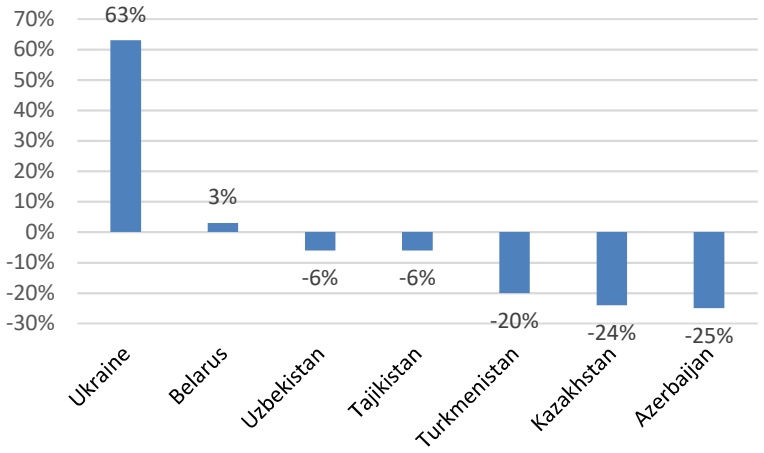

Source: UN COMTRADE.

**Table 34 Russia - Product: 4406 Railway or tramway sleepers "cross-ties" of wood**

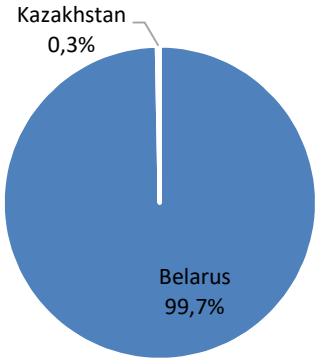
**% exported in 2018**




**Growth in exported value between 2014-2018 (%, p.a.)**




**% imported in 2018**



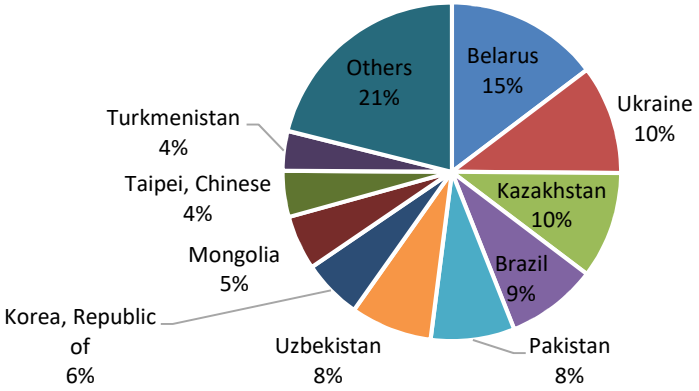

**Growth in imported value between 2014-2018 (%, p.a.)**

Belarus +2%

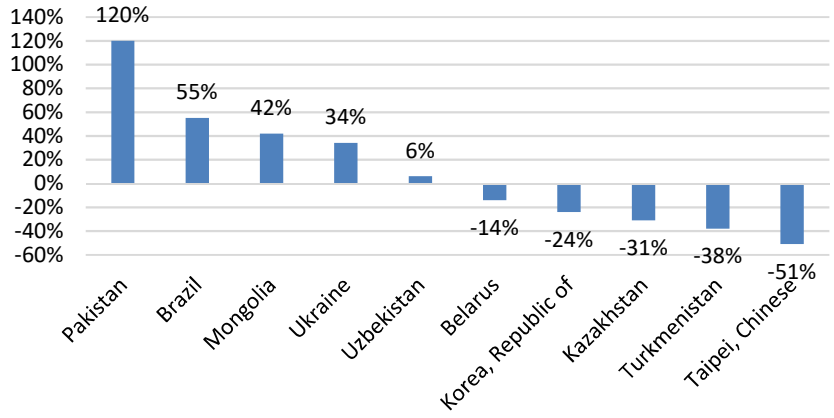
Source: UN COMTRADE.

**Table 35 Russia - Product: 7302 Railway or tramway track construction material of iron or steel, the following: rails, check-rails**

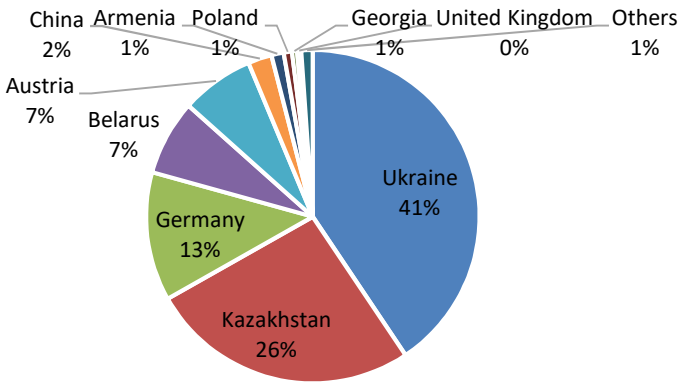
**% exported in 2018**



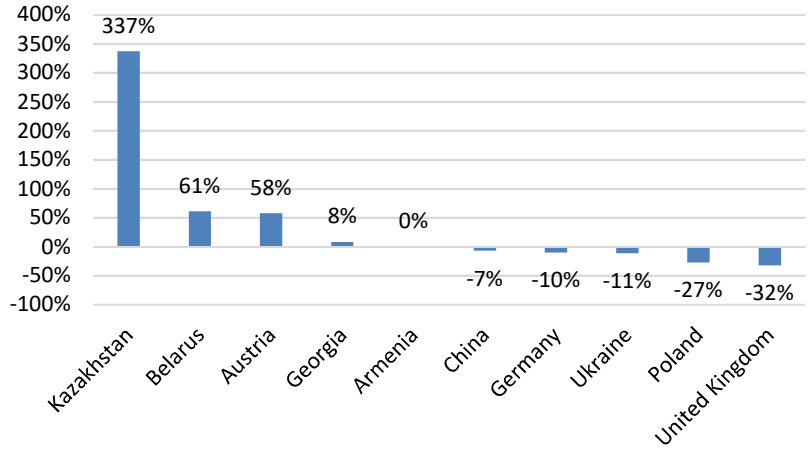

**Growth in exported value between 2014-2018 (%, p.a.)**




**% imported in 2018**



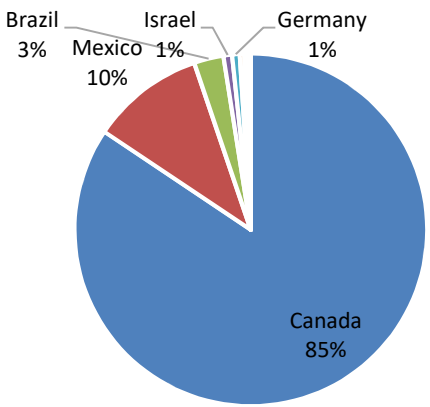

**Growth in imported value between 2014-2018 (%, p.a.)**



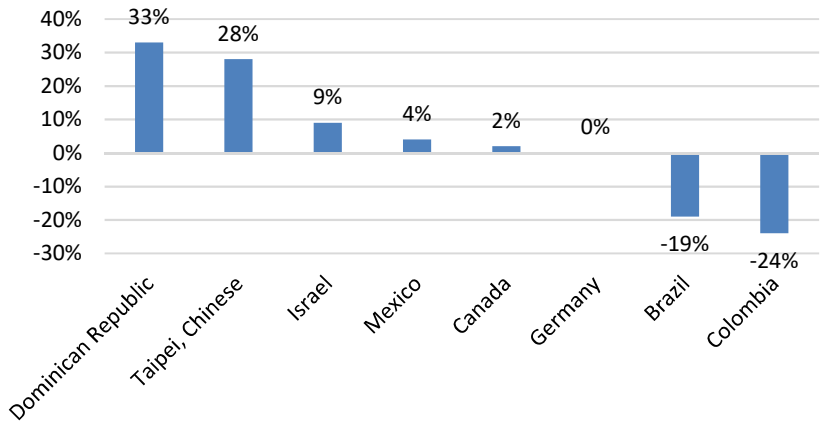

Source: UN COMTRADE.

**Table 36 USA - Product: 4406 Railway or tramway sleepers "cross-ties" of wood**

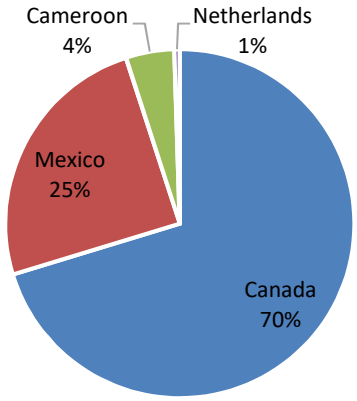
**% exported in 2018**



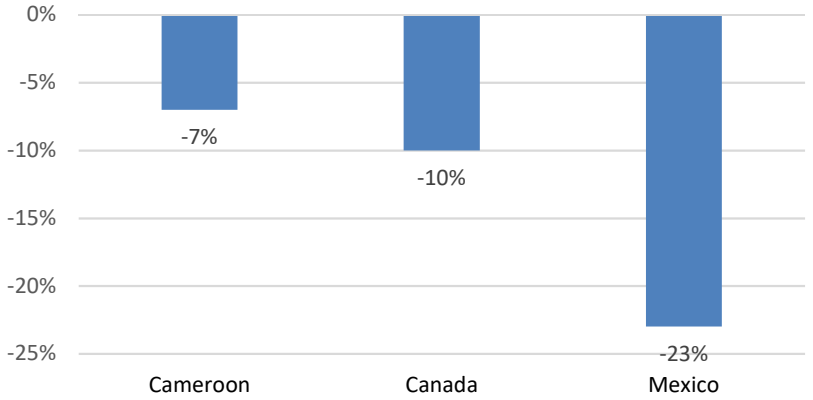

**Growth in exported value between 2014-2018 (%, p.a.)**




**% imported in 2018**



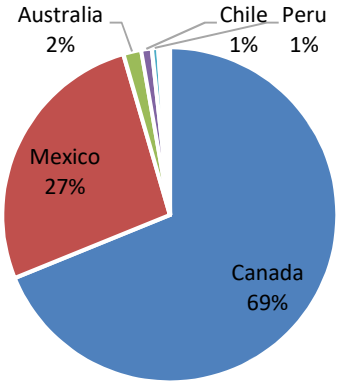

**Growth in imported value between 2014-2018 (%, p.a.)**



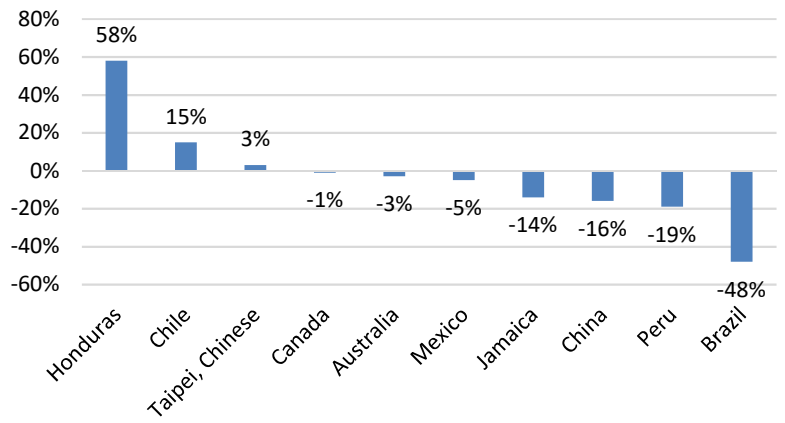

Source: UN COMTRADE.

**Table 37 USA - Product: 7302 Railway or tramway track construction material of iron or steel, the following: rails, check-rails**

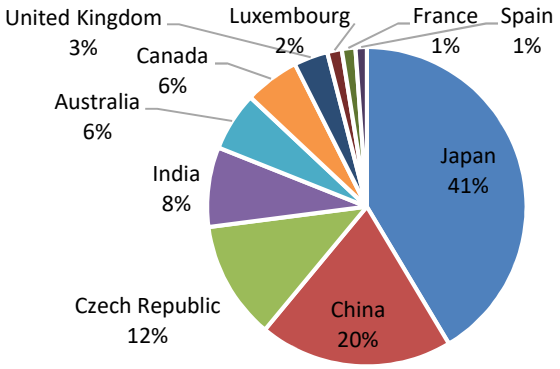
**% exported in 2018**



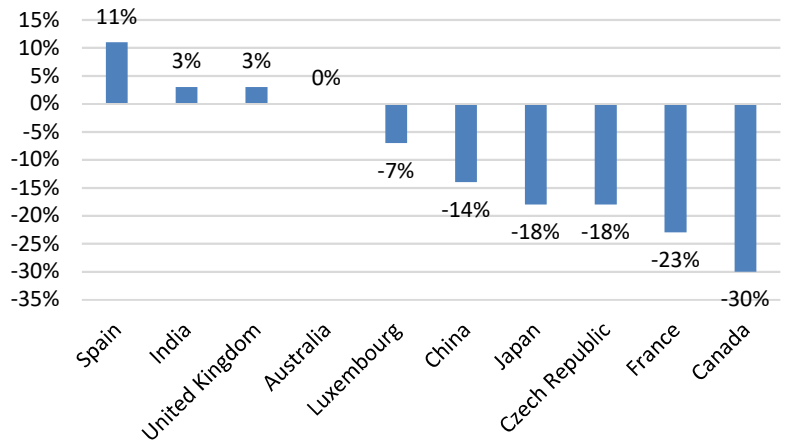

**Growth in exported value between 2014-2018 (%, p.a.)**




**% imported in 2018**




**Growth in imported value between 2014-2018 (%, p.a.)**




Source: UN COMTRADE.

### 4.2.7. *Labour*

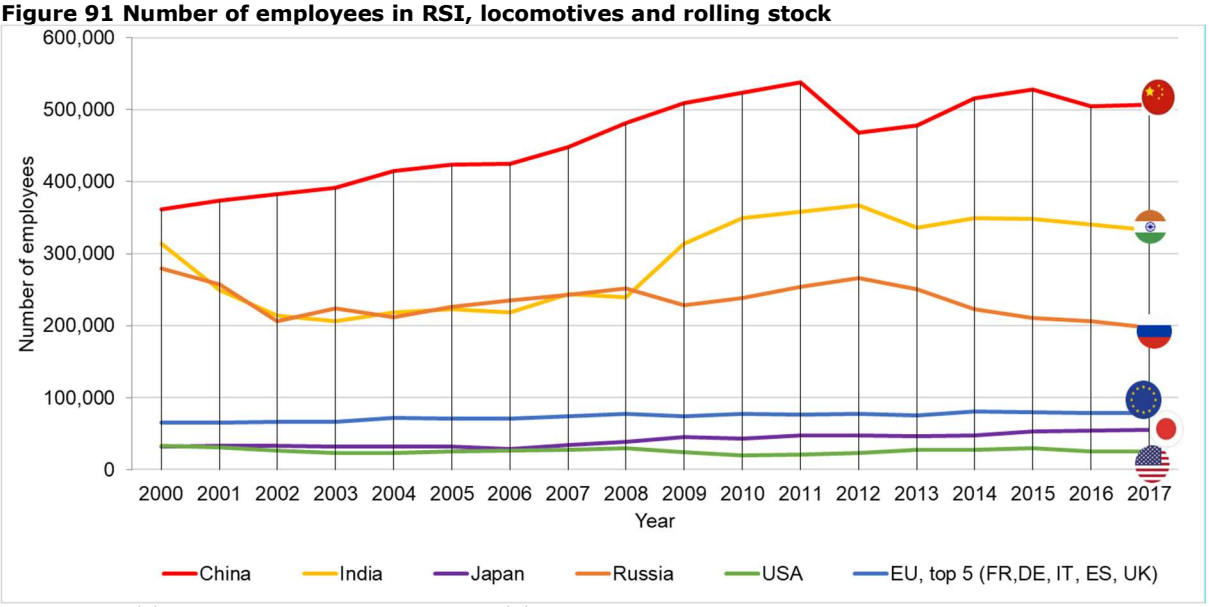
As underlined in chapter 3.6, the **number of employees**[65] in the locomotive and rolling stock segment in the EU has increased by approximately 1% from 2000 to 2017.This section presents how the number of employees in other countries has changed.

In absolute numbers, China, India and Russia are the countries employing the greatest number of people in this particular railway segment, over 1 million people for these countries combined.

In general, the growth rates of the number of employees in the rail sector are modest. Over the period 2000 – 2017, Japan was the country with the highest average growth rate in the number of employees per year with 3.0%, followed by China with 1.9% per year.

On the other end, Russia and the USA experienced a decline in the number of employees in the sector over the period 2000 – 2017 with, respectively, 30% (-82,787 employees) and 23% (-7,724 employees) reduction in the total number of employees.

**Figure 91 Number of employees in RSI, locomotives and rolling stock**




Source: VVA elaboration on Euromonitor International data.

With regards to the percentage of employees in the locomotives and rolling stock segment in comparison to the total working population, all the main international partners considered reflect the same scheme. The analysis indicates that about 0.05% of the working population is employed in RSI sector, apart from USA[66] that shows a lower level (0.01%) and Russia, jumping to a much higher level (0.20%).

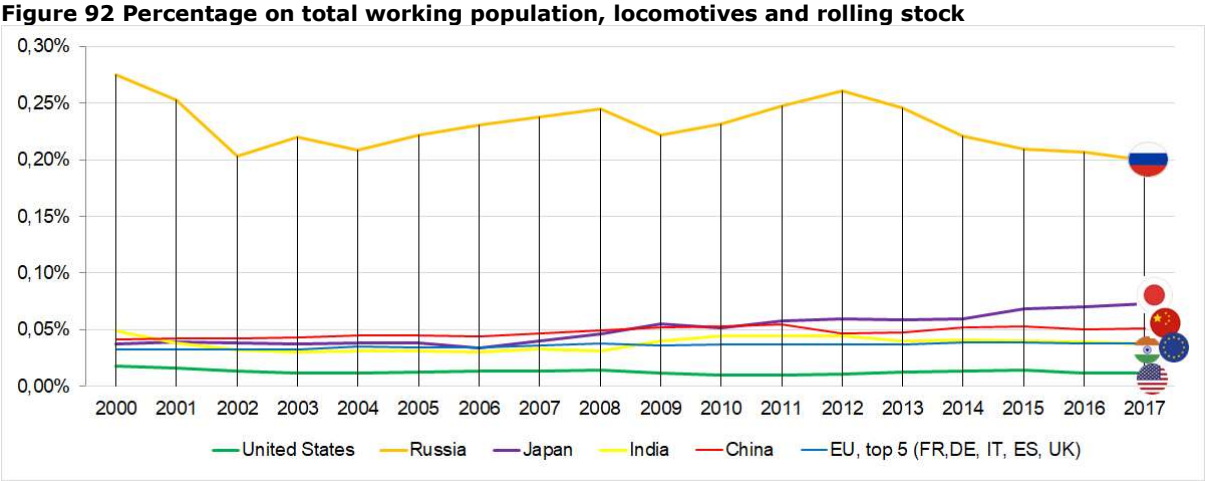
The European rail supply industry is a strategic sector for the EU competitiveness worldwide. European rail suppliers diversify their production, R&D activities, administrative headquarters and sales in several countries across the continent and generate jobs all over the European Union.

According to the data provided and compared to the other countries, RSI also represents an important sector for Russia, with a much higher percentage of working population employed in this sector. While it appears to be on a downsizing trend, RSI role in Russia employment ranged from peaks of 0.27% in 2000 to 0.20% in 2017.

[65] The definition of an employed person is anyone aged 16, or over, who has completed at least one hour of work in the period being measured, or are temporarily away from his or her job, such as being on holiday.

[66] Even though USA as some of the oldest and well-known railways companies such as Union Pacific and BNSF Railway, it shows the lowest level of employment in the railway sector among the selected countries.

**Figure 92 Percentage on total working population, locomotives and rolling stock**




Source: VVA elaboration on Euromonitor International data.

## 4.2.8. *R&D, patents and industrial designs*

The advent of the "knowledge economy" has led to the recognition of intangible assets as essential value creators for companies and enablers of productivity and economic growth (European Commission, 2017).

The only official source of comparable data for R&D investments is the OECD's *statistics on business enterprise R&D expenditure by industry*. [67]

The breakdown between industries follows the "*International Standard Industrial Classification of all Economic Activities*" (i.e. the ISIC classification). Therefore, data can only be provided for the ISIC Rev. 4 30.20 - *Manufacture of railway locomotives and rolling stock*.

In addition, data are provided in millions of national currencies and only eight countries (five European and three Asian) presented a comprehensive time series for the period 2011-2015. For these reasons, Table 38 presents the data focusing on these eight countries and the year-over-year growth rate, to overcome the problem of comparability due to different currencies.

**Table 38 Manufacture of railway locomotives and rolling stock - Business enterprise R&D expenditure – period 2011-2015 – growth rate (baseline 2010)**

| Country | 2011 | 2012 | 2013 | 2014 | 2015 | Average Annual Growth Rate | Compound Annual Growth Rate |
|---|---|---|---|---|---|---|---|
| Czech Republic | 48% | -32% | -1% | -8% | -32% | -5% | -9% |
| Germany | 132% | 2% | -12% | 3% | 1049% | 235% | 90% |
| Italy | -35% | 103% | -13% | -18% | 3649% | 737% | 104% |
| Poland | 50% | 182% | -21% | … | 279% | 123% | 66% |
| Slovenia | … | -67% | -30% | 28% | 309% | 60% | 5% |
| Japan | -38% | -20% | -17% | 554% | 726% | 241% | 86% |
| Korea | 42% | 5% | 5% | 7% | 141% | 40% | 32% |
| Taiwan | -15% | 599% | 10% | 3% | 11%*** | 121% | 40% |

***data not available for the year 2015, 2016 value is used instead.
Source: OECD.

[67] OECD methodology for R&D statistics as laid out in the OECD "Frascati Manual" (see http//oe.cd/Frascati).

Given the substantial limitations of using the OECD data, in order to obtain a rough idea about the output of R&D activities carried out in Europe/worldwide, this section provides an analysis about the number of patents and industrial designs granted between 2011 and 2017 (until September 2018 for industrial designs). In fact, according to a 2013 EUIPO/EPO report[68], the "*manufacture of railway locomotives and rolling stock*" can be categorised as a design- and patent-intensive industry.[69]

Information about patents and industrial designs were retrieved from:

- **Patents**: Patent Statistics Database (PATSTAT), which gathers standardised data from almost all of the world's patent offices;[70]
- **Industrial designs**: Global Design Database industrial designs registered under the WIPO-administered Hague System and/or in participating national collections.[71]

#### 4.2.8.1. Patents

According to the International Patent Classification "B61-Railways" is divided in nine subgroups, which include:

1. systems in which trains or individual passenger vehicles or load carriers run on, or are guided by, ground or elevated tracks defined by rails, ropes, cables, or other guiding elements for wheels, rollers, or sliding anti-friction devices;
2. systems in which carriers or impellers for persons or loads are attached to, e.g. suspended from, a guided traction rope or cable which determines their path of movement;
3. power and free systems of either of the above types in which vehicles, load-carriers, or loads may be selectively coupled to, or uncoupled from, continuous traction members, e.g. cables, chains.

According to PATSTAT, 187,642 patents have been granted worldwide between 2011-2017[72] under the International Patent Classification "*B61-Railways*". Most of them were granted by the Chinese authority (i.e. The National Intellectual Property Administration), followed by the USPTO – US Patent and Trademark Office (17.873), KIPO - Korean Intellectual Property Office (8.587) and JPO – Japan Patent Office (8.088).

[68] EPO & EUIPO (2013): "Intellectual property rights intensive industries: contribution to economic performance and employment in the European Union" Source: http://documents.epo.org/projects/babylon/eponet.nsf/0/8E1E34349D4546C3C1257BF300343D8B/$File/ip_intensive_industries_en.pdf.

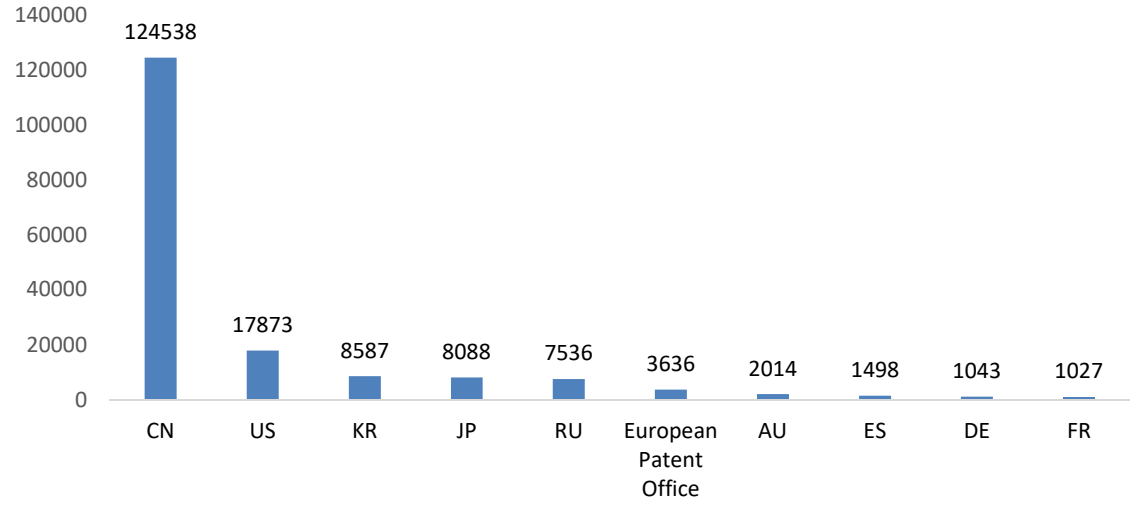
[69] IPR-intensive industries are defined as those having an above-average use of IPR per employee EPO & EUIPO (2013). This analysis is limited to the totally Railway Supply industries due to the specification of the industry thought NACE codes The EPO/EUIPO study does not categorize NACE 33.17 "Repair and maintenance of other transport equipment" as an IPR intensive industry. Therefore, the analysis focuses only on NACE 30.20 "Manufacture of railway locomotives and rolling stock".

[70] Source: https://data.epo.org/access-control/patstatsubscription.jsp.

[71] Source: http://www.wipo.int/designdb/en/.

[72] Disclaimer: this represent a mere count, as we have not grouped patents by patent families (i.e. the same invention disclosed by a common inventor(s) and patented in more than one country).

**Figure 93 Patents granted by national/international authorities, worldwide overview-count, period 2011-2017**




Source: VVA, PATSTAT.

In order to produce descriptive statistics about the patent-holders (i.e. companies, universities and RTOs – patents hold by Individuals were excluded from this analysis), we relied on the name and address of the patent holder as they are published in patent documents as provided in PATSTAT. However, the attribution of a patent to a particular entity is not so simple:

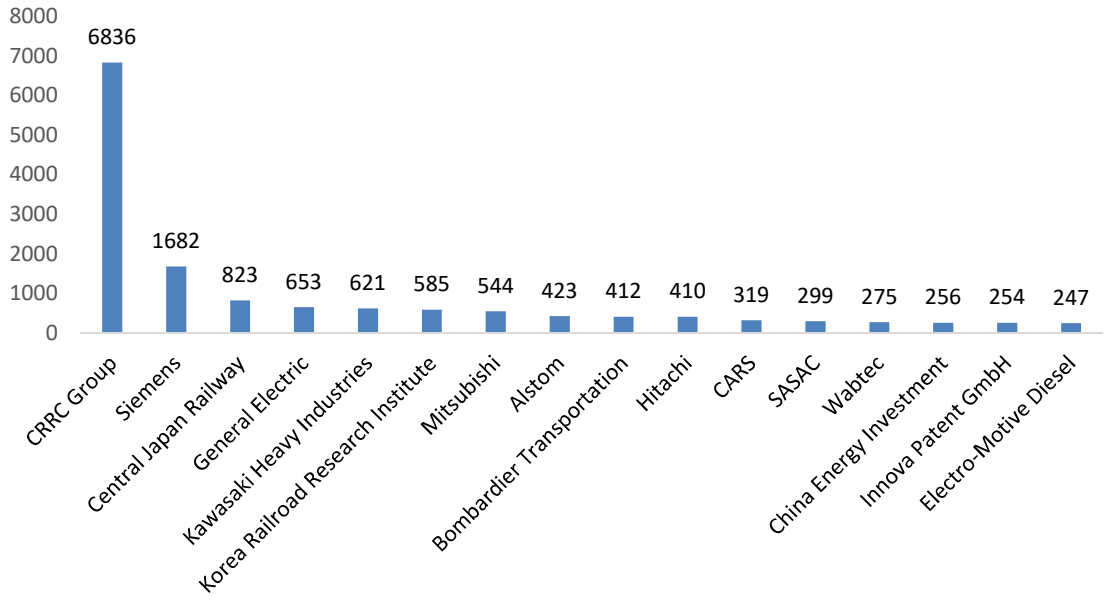
- There may be spelling mistakes;
- Many companies are known under several different names (e.g. acronyms: IBM, International Business Machines);
- Some qualifications can be added to the name (e.g. Siemens, Siemens AG);
- Patents can be taken by affiliates, some of which are easily identified (e.g. Sony US is an affiliate of Sony), whereas others are more difficult (Citroen is part of the PSA group).

The first stage of our approach consists of identifying spelling variations in order to clean the names of patent holders to obtain a standardised name in order to group companies. The second stage is to link the names to match them with their *ultimate owner*:[73] These names were matched with company databases (e.g. Orbis) or retrieved via desk research to find as many potential matches as possible.[74] The results of our approach are presented in Figure 94:

[73] For example according to our approach, if the patent holder is an affiliate company (e.g. Bombardier Transportation GmbH, registered under the German law), the patent is assigned to its mother-company (in this case, Bombardier Transportation, which is a Canadian group).

[74] Disclaimer: reporting errors might have occurred. Therefore, our analysis might not fully represent the reality of the facts.

**Figure 94 Patents granted by companies (top 16), worldwide overview-count, period 2011-2017**




Source: VVA, PATSTAT.

Out of the 187,642 patents that were granted worldwide between 2011-2017, 6,836 patents belong to the CRRC Group (China), 1,682 to Siemens (Germany), 823 to Central Japan Railways (Japan) and 653 to General Electric (US).[75] Among the top patent-holders, the EU is represented by Siemens (Germany), Alstom (France), and Innova Patent (Austria).

However, differences in patent law and practices around the world limit the comparability of patent statistics across countries (Bruegel, 2014). It is therefore preferable to use homogenous patent data - coming from a single patent office or single set of patent offices (Bruegel, 2014). Therefore, to provide a more comprehensive analysis about the investments in intangible assets made by European companies, the second part of this section focuses on the patents granted by European Patent Office between 2011 and 2017.

According to PATSTAT, The *European Patent Organisation* has granted 3,636 patents between 2011-2017 which have validity and coverage in all EU Member States plus Albania, the former Yugoslav Republic of Macedonia, Iceland, Liechtenstein, Monaco, Norway, San Marino, Serbia, Switzerland, and Turkey.[76]

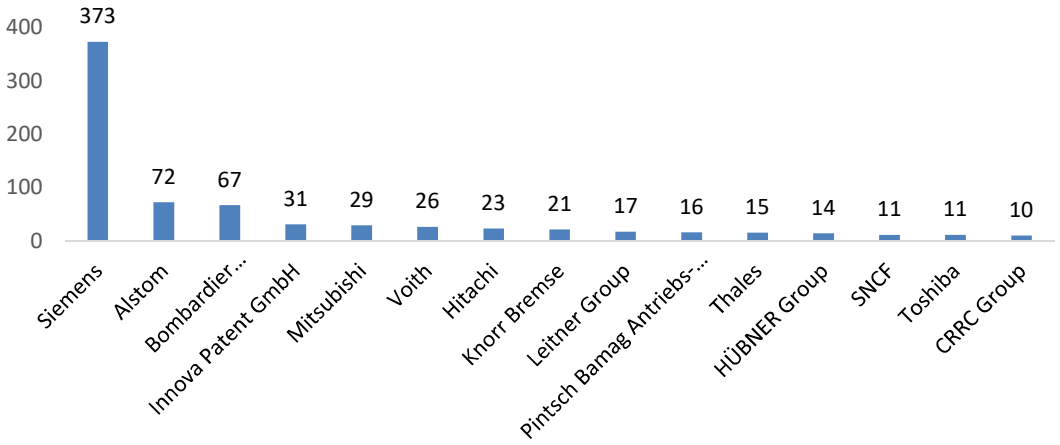
By employing the approach described above, we categorised the EPO patents by company group. The results of this analysis are presented in Figure 95.[77]

[75] Disclaimer: caution should be used in the interpretation of the results, as Figure 52 provides a count of the patents based on PATSTAT IDs. Even though we have aggregated all the PATSTAT IDs that share exactly the same name, double-counting and reporting errors might have occurred.

[76] The European Patent Organisation is not legally bound to the European Union (EU) https://www.epo.org/about-us/foundation.html. Patents can also be granted by Member States' patent authorities individually, which have only validity within the border of their jurisdiction (the Spanish patent authority granted 1.498 patents, the German patent authority granted 1.043 patents and the French patent authority granted 1.027 in the period 2011-2017).

[77] Disclaimer: reporting errors might have occurred. Therefore, our analysis might not fully represent the reality of the facts.

**Figure 95 Number of patents granted by EPO by company (top 16), overview-count, period 2011-2017**

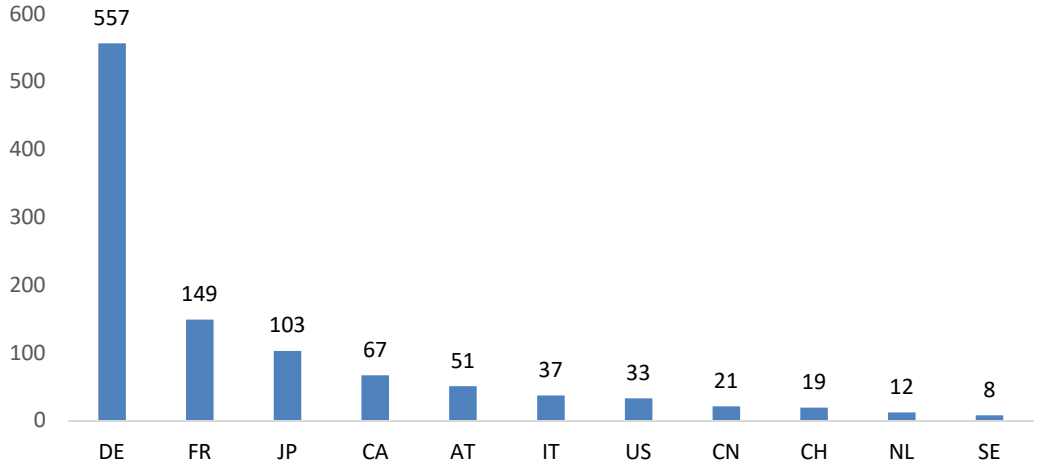



Source: VVA, PATSTAT.

Out of the 3,636 patents granted by the *European Patent Organisation* between 2011-2017, 373 belong to Siemens (Germany), 72 to Alstom (France) and 67 to Bombardier Transportation (Canada) – top three patent holders.

Figure 96 presents the data grouped by country. As explained above, the "country" information of patent-holder is in most cases the "place of business". Therefore, the data is grouped by the country of origin of the *ultimate-owners*.

**Figure 96 Number of patents granted by EPO by country (top 11), overview-count, period 2011-2017**




Source: VVA, PATSTAT.

Out of the 3,636 patents granted by *European Patent Organisation,* 557 belong to German companies/groups, 149 to French companies/groups, 103 to Japanese companies/groups, and 67 to Canadian companies/groups.

#### 4.2.8.2. Industrial designs

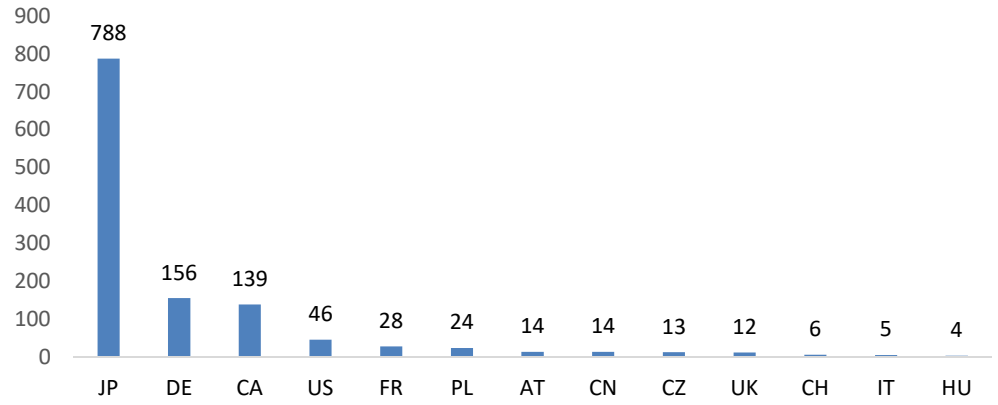
The Locarno Classification is an international classification used for the purposes of the registration of industrial designs. According to this classification, the industrial designs registered under class '12-3' concern '*locomotives and rolling stock for railways and all other vehicle*'.

To produce descriptive statistics about the design-holders (i.e. companies, universities and RTOs – designs held by individuals were excluded from this analysis), the Global Design Database was used as primary source of information. The Global Design Database contains industrial designs registered under the WIPO-administered Hague System and/or in participating national collections.[78]

In a similar fashion to the approach adopted to analyse PATSTAT, the name and address of the holder(s) were analysed to provide descriptive statistics about companies and countries. The first stage of our approach consisted in identifying spelling variations in order to clean the names of design holders to obtain a standardised name in order to group companies. The second stage was to link the names to match them with their *ultimate owner*:[79] These names were matched with company databases (e.g. Orbis) or retrieved via desk research to find as many potential matches as possible.[80]

According to the Global Design Database, 1,533 industrial designs were granted between 2011-2018.[81] 788 industrial designs belong to Japanese companies/groups, 156 to German companies/groups, and 139 to Canadian companies/groups – top three. The total industrial designs granted to all EU Member States amount to 256, which places the EU ranking 2nd behind Japan.

**Figure 97 Industrial designs, period 2011-2018 by countries (top 13)**




Source: VVA, Global Design Database.

In terms of companies, Bombardier Transportation (Canada) ranks first for industrial designs granted between 2011 and 2018, followed by Siemens (Germany) and Mitsubishi (Japan).

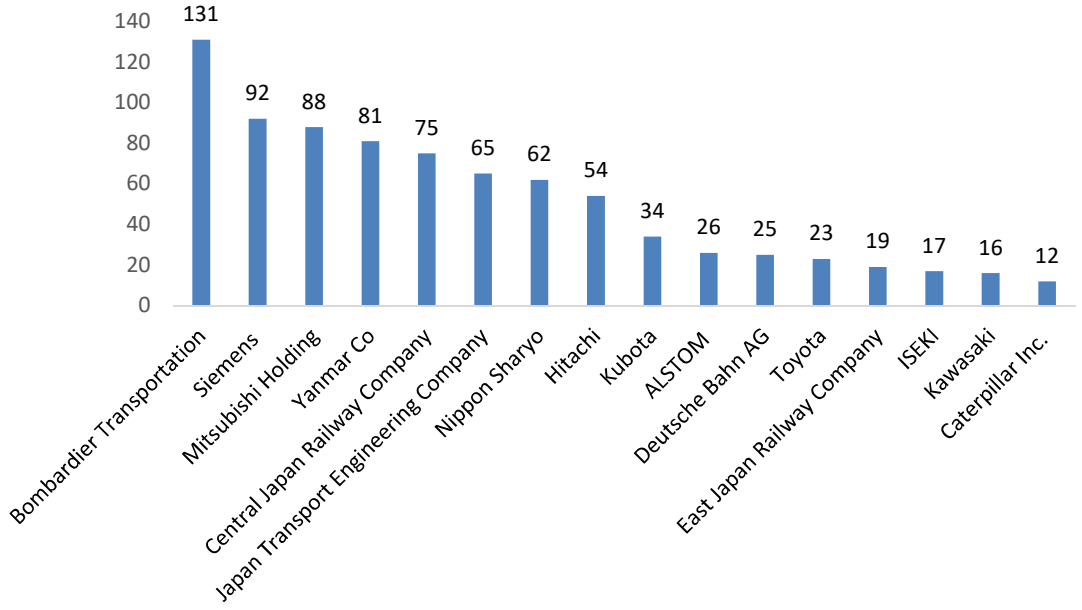
[78] The participating countries are: France, Canada, Jordan, New Zealand, EUIPO, Germany, Georgia, Moldova, USA, Spain, Japan, Mongolia and Indonesia.

[79] For example according to our approach, if the design holder is an affiliated company (e.g. Bombardier Transportation GmbH, registered under the German law), the patent is assigned to its mother-company (in this case, Bombardier Transportation, which is a Canadian group).

[80] Disclaimer: reporting errors might have occurred. Therefore, our analysis might not fully represent the reality of the facts.

[81] As of September 30th 2018.

**Figure 98 Industrial designs, period 2011-2018 by company (top 17)**




Source: VVA, Global Design Database.

Among the top 16 companies by industrial designs granted, the EU is represented by Siemens (DE), Alstom (France) and Deutsch Bahn (DE). Note, in this ranking, 11 out of 16 companies are Japanese.

## 4.3. Boosting European RSI excellence in the global market: case studies on good industry examples and practices

The following section introduces the three case studies that were selected to research, analyse, and present the specific aspects that made, and continue to make, the European RSI innovative and competitive on the international markets. Each case study focuses on one specific aspect of the European RSI and they aim to identify the good technical, financial, and regulatory practices that affected the business of companies active in the sector today.

The **first case study** investigates a highly technologically advanced high-speed train available on the global market, the ***Frecciarossa 1000***, also known as ETR 400. Different elements are of interest in this product, including its technical performances, its interoperability with different signalling systems and its environmental aspects. The environmental aspect is one of the key elements of this product, both at energy level, with new technologies onboard making it extremely energy efficient, as well as from a design point of view, with the use of reusable materials, low noise pollution and limited vibration. The case study also covers the **role public procurement in promoting the technology innovation** by determining the features of the train, in particular regarding the most-economically advantageous tender (MEAT) criteria and key aspects including the environmental and sustainability criteria, is investigated.

The **second case study** focus on the **ERTMS**, the European Rail Traffic Management System. This set of technical standards is nowadays considered as one of the most advanced rail traffic management system and a great example of how companies can find common ground to foster innovation. The system was developed and implemented by major industry players in close cooperation with the UNISIG and ERA. Different reasons were behind the choice of this particular subject as case study: first, ERTMS-based products are today successful in terms of exports and they are implemented in many countries including South Korea, South Africa, and China. Second, it represents an excellent example of partnership between competitors, showing one of the possible ways forward to foster investment in R&D. Third, it is once again a perfect showcase of technological innovation, a distinctive mark of the European RSI.

For the **third case study**, the focus is on the role that Small & Medium Enterprises (**SMEs**) have in promoting innovation and in making the overall European RSI competitive.

The case studies were developed **based on interviews with a selected number of stakeholders** involved in each of the cases presented. Therefore, they might not necessarily reflect the status, opinion, and position of the entire rail supply industry.

### 4.3.1. *Frecciarossa 1000/ETR 400*

#### 4.3.1.1. Introduction

The Frecciarossa 1000, (also known as the ETR 400), is a high-speed train operated by Italian state railway operator Trenitalia, co-developed and produced by a joint venture between Italian rail manufacturer AnsaldoBreda and Bombardier Transportation.

**Figure 99 Frecciarossa 1000/ETR 400**

Source: Trenitalia.

The train was developed and later modified to fulfil the technical, environmental, and regulatory specification of a bid announced by Trenitalia for a new train to service its high speed line Torino – Milano – Roma – Napoli. During August 2010, it was announced that Trenitalia had awarded the contract to the Bombardier/Ansaldo joint venture, and that the first example was set to come into revenue service during 2013. According to the stakeholders interviewed, the lower price offered by the ETR 400 consortium compared to the one offered by other competitors[82], as well as the specially-developed solutions involved in the train's design were the two factors that played the most important role in winning Trenitalia's favour. The train underwent extensive testing in order to be certified to operate on the Italian high-speed rail network at 360 km/h. On 25 April 2015, it was announced that the testing phase of development was successfully completed. During June 2015, commercial services using the type commenced, having officially entered into service for Expo 2015.

The Frecciarossa 1000 is the first high-speed train in the world to have received Environmental Product Declaration (EPD), as it is able to limit $CO_2$ emissions per passenger to 28 grams. This result derives from its extremely low aerodynamic resistance, excellent mass/power ratio, and consequent energy savings. This train also ensures top-level performances in terms of noise and vibration reduction and the materials selected are 85% recyclable and 95% renewable.

#### 4.3.1.2. Drivers of innovation: the role of Public Procurement

Stakeholders involved in the tendering process indicated that the technical specifications that Trenitalia set for the tender were stringent, designed with requirements for a faster, safer and more environmentally friendly train. Those requirements stimulated industry players to propose high standards in terms of innovation and environmental sustainability during the tender process. This element, together with the limited time available, incentivised the companies behind the Ansaldo Breda consortium to develop a new approach to the project, including the use of an *ad-hoc* designed software especially developed to test different variants of the initial design.

The public tender was based on MEAT (most economically advantageous tender) criteria with a technical offer weighing more (70%) than the price (30%). The stakeholders indicated that among the technical elements considered as part of the award criteria, the most relevant ones were: description of the traction system in terms of energy absorption and efficiency, wagon design in terms of drag, and audible noise within and outside of the train, as well as recyclability and recoverability rates of the construction materials. In fact, European policies covering sustainability and environmental impact gave their contribution to the high innovation requirements of the ETR400.

[82] https://www.railwaygazette.com/news/single-view/view/trenitalia-orders-50-high-speed-trains.html.

The interviewees indicated that from a technical point of view, ETR400 project offered interesting solutions related to performances of the train, the rolling stock, the suspension, the noise produced and of the environmental compatibility. From a financial and economic point of view, ETR400 tender was the most competitive one regarding life-cycle costs. In particular, the car body structure with the specific target of optimisation in terms of weight and dynamic behaviour, respecting the static structural and fatigue requirements of the project, reported positive spill-over in terms of know-how following the execution of the project. These and other innovations developed during the project have been later incorporated in the company business products portfolio.

#### 4.3.1.3. Financing issues: access to credit and post-crisis situation

Financing issues did not appear to characterise the companies awarded with the contract in a decisive way. The potential financial issues affecting other potential bidders for this contract were not investigated. On a larger scale, the post-crisis credit restriction affected smaller players, especially in terms of ability to invest in new resources in R&D and new manufacturing technologies.

#### 4.3.1.4. A technology driven industry: drivers of investment in R&D and relations among players in the value chain

Companies interviewed in the context of the case studies and active not only on the rail sector, but also in the heavy motor vehicles sector (e.g. trucks, buses), identified a gap (although reducing) between the amount of investments in R&D currently in the heavy motor sector compared to the amount of investments in R&D in the rail sector.

Stakeholders underlined how the railway domain suffered over the years due to lack of investments in innovation compared to automotive and heavy trucks sector. Stakeholders explained this occurred partially as a direct consequence of political culture of focusing investments on the road transport, which in several countries is considered as the primary means of transportation for both passengers and freight, as well as due to the inherent characteristics of the rail products, designed for a longer lifespan.

Stakeholders also indicated that the rail supply industry has been promoting technological innovation for many years, but the railway sector is slower in the uptake than the highly innovative technological industrial sectors, such as the automotive industry. Many stressed that there is still a lot to do in innovation and much more investments are needed, even though in recent years investments in railways have been growing faster.

Constant investment in R&D are among the key aspects to ensure a high degree of competitiveness of the industry on rail the market, both in terms of investment on human capital and of new equipment and manufacturing tools.

The industry identified the European Commission H2020 grants, national programmes such as tax discounts and low interest rate loans as fundamental tools to ensure constant investment in R&D.

#### 4.3.1.5. Recommendations

Based on the analysis of the case study, the following recommendations are proposed:

- Continue increasing capacity of procuring authorities to ensure that tenders are well-designed and include focus on promoting innovation and environmental aspects;
- Ensure that the MEAT principle with a high technical scoring share is used for the tendering of railway projects to provide incentive for the consortia to invest in developing and proposing innovative solutions for the new product. In the specific case of the Frecciarossa, the new technologies and solutions have been later incorporated in the companies' business products portfolio with positive impact on their competitive position in the long term;
- Continue the development of policies focusing on promoting the shift of investments from road transport to rail;
- Continue the creation of dedicated H2020 call for grants targeting innovation in the rail sector.

### 4.3.2. *The European Rail Traffic Management System: cooperation to foster innovation*

#### 4.3.2.1. Introduction

As of today, there are more than 20 train control systems across the European Union. As a consequence, each train used by a national rail company has to be equipped with at least one system but sometimes more, just to be able to run safely within that one country. Each system is stand-alone and non-interoperable, and therefore requires extensive integration, engineering effort, raising total delivery costs for cross-border traffic. The lack of interoperability reduces internal EU competition and hampers the competitiveness of the European rail sector *vis-à-vis* road transport by creating technical barriers to international journeys. The highly tailored content of the product also reduces the scalability possibilities of the RSI intra and extra EU. Finally, the limited number of units sold per product (i.e. typically less than 100 units) makes the business model of the sector and return on investment considerably different in comparison to the automotive industry.

The ERTMS (European Railway Traffic Management System) was conceived and designed to gradually replace the existing incompatible systems throughout Europe, as a unique European train control system, bringing considerable benefits to the railway sector as it will boost international freight and passenger transport.

In addition, ERTMS is considered as an extremely performant train control system, as it brings significant advantages in terms of maintenance costs savings, safety, reliability, punctuality and traffic capacity. For these reasons, the ERTMS is largely implemented outside Europe, and is becoming the train control system of choice for countries such as India, Taiwan, South Korea, and Saudi Arabia.

#### 4.3.2.2. Background and characteristics

The development history of ERTMS dates back 25 years ago, when the railway sector and European Commission tried to harmonise European railways domain in different segments. The goal of the European Commission was clear: to have a standard that would be interoperable in the different Member States. According to the interviewed stakeholders, there was a strong interest from the industry to participate in the standardisation process and in the specifications drafting, thus industries started to play a role when it came to the definition of the technical specifications and their development process. The main industrial players involved in the process were Alstom Transport, Ansaldo STS, AZD Praha, Bombardier Transportation, CAF, Mermec, Siemens Mobility, and Thales. In order to cope with these challenges in place and to share all the sectorial knowledge that the industry had, the main railway industries at the time decided to create UNISIG, an industrial consortium that helped to develop the ERTMS/ETCS technical specifications.

Circa 2005, European Railway Agency took the lead for ERTMS implementation and deployment. Firstly the European Railway Agency developed a guideline to define in which direction the standards should go, and secondly the Agency acted as arbitrators and neutral body in the European railway sector.

In the global perspective, ERTMS is a successful example both inside and outside of Europe. According to some stakeholders, the success factors are both its interoperability that allows trains to circulate in each European country, and the so-called supplier interoperability: when buying ERTMS products, purchasers are not automatically linked to only one supplier, and this aspect fosters the competition among different providers. Other stakeholders consider ERTMS as a product under continuous development, rather than a cutting-edge innovation.

According to the stakeholders, the main strengths of ERTMS are related to safety, interoperability, capacity, life-cycle cost and competitiveness. Nevertheless, some stakeholders indicated that in the European context, the ERTMS implementation is complex because of the underlying requirements to ensure the interoperability of the new system with the different legacy systems.

When it comes to the financial aspects of ERTMS development, all the stakeholders interviewed agreed on the fact that funding was an important element for the development of the standard and that companies relied on their own funding during the development of ERTMS. It was also highlighted that the limited access to funding and the expected long-term return on investment prevented SMEs to participate in the development process.

Despite the efforts, the implementation of ERTMS in the EU is still limited. One of the reasons is the dependence of the sector on public investments, where the lack of funding prevented some of the network operators to adopt ERTMS. Investments in the railway sector are lower compared to other sectors because of the volume of the market. In markets that sell a huge volume of products (e.g. automotive), investments are proportionate to that volume and greater compared to railways. Lifespan of railway industry products is long, and it reduces the time of the return on investments. Now, with Connecting Europe Facility (CEF) funds, there are incentives for new Member States and east European countries to receive up to 85% of refund for the deployment of ERTMS.

#### 4.3.2.3. Challenges and lessons learnt: standardisation and interoperability

Outside Europe, more and more countries are developing or purchasing European train control systems (e.g. China for instance developed their own ETCS-based system, while Saudi Arabia implemented ERTMS). According to stakeholders, the initial investment on ERTMS is still higher compared to the competing signalling systems because interoperability does not necessarily represent cost reduction in the short term. For example, the Japanese system requires less components and costs less on the short term. However, the efficiency gains from this system and the possibility to rely on different suppliers for maintenance and renovation works throughout the lifespan of the equipment ensures a higher return on investment for ERTMS on the long term.

Within Europe, ERTMS can reach the highest levels of performances in comparison to current national systems, but railway operators often have to deal with legacy infrastructures or system integration issues. The deployment in Europe is still limited, but recent statistics indicate that there are approximately 25,000 km of contracted lines with ERTMS in Europe. The reason for that is that railways, when ERTMS development started, were reluctant in introducing an additional system because most of the players already had existing national systems and they were not interested in investing into ERTMS. However, existing support mechanisms such as TEN-T and CEF have been successful in supporting ERTMS roll out and should be continued. The penetration of the ERTMS in trackside contracts in Europe reached 46% in 2017. On the other hand, the deployment of ERTMS outside Europe has been successful, representing approximately 35% of the new trackside contracts in Asia and 16% in the Middle East and Africa.[83]

According to suppliers' point of view, one of the major gaps during specifications discussions was that specifications were organised at European level, but responsibilities fell on Member States and national authorities. There was a long-lasting process to guarantee the system stability and taking into consideration all national demands and specifications was challenging because every State wanted to provide its contribution and to promote its own signalling system.

The migration from current systems to ERTMS impacts trains, rail infrastructure, and signalling. Stakeholders indicated that the lack of ERTMS deployment in Europe is not only related to cost, but also to the challenges to roll-out a coordinated deployment action plan for ERTMS and to the lack of strategies for the dismissal of functioning system for which the pay-back might not have been achieved. The European Commission has taken action to address challenges related to the coordinated deployment of ERTMS in the EU, for example, in the Commission Implementing Regulation (EU) 2017/6 covering the coordination on track-side implementation of the main ERTMS Corridors and in the CCS TSI that provides for a national implementation plan in order to coordinate the deployment of ERTMS in countries. Particularly, replacing the system on board of the train represents the most difficult and expensive aspect. In Denmark and Sweden, infrastructure managers took control of the replacement process which led to positive results. In other countries, authorities let the rail suppliers negotiate among themselves how to replace the

[83] Statistics on ERTMS deployment available at: http://www.ertms.net/?page_id=58.

signalling systems and the cost of these services, generating an unbalanced playing field and contributing to the slow uptake of ERTMS.

The deployment of an interoperable system requires that common technical solution and operating rules are implemented. A common technical solution is important to ensure that the different devices can communicate to each other accurately while common operating rules provide the correct framework for a safe and cost-effective operation of the railway systems. According to some stakeholders reached out, the ERTMS is the best technical solution for the train control but as operational rules remain national based, interoperability challenges across the EU remain.

#### 4.3.2.4. On the potential of cooperation between companies to foster innovation EU RSI

Cooperation among different rail suppliers was mainly based on pre-competitive collaboration to develop the technical standards. This collaboration was driven by the European Union with the aim of creating a European Train Control System.

Another example of collaboration is the institutional partnership Shift2Rail where private and EU funds are combined and managed in a shared governance. It is an important vehicle for innovation, even though the companies did not develop any commercial product within Shift2Rail, but they stop their activities at the demonstration of interoperable prototypes (TRL7). Manufacturing companies continue to collaborate, in particular to support the work of the European Union Agency for Railway through UNISIG, a working group from UNIFE that contribute to the ERTMS/ETCS technical specifications.

#### 4.3.2.5. Recommendations

Based on the analysis of the case study, the following recommendations are proposed:

- The EU should continue taking the lead in fostering the cooperation between industry players for the development of industry standards when required;
- Continue the investment in mechanisms to support the ERTMS roll-out in Europe, such as TEN-T and CEF;
- Use EU funding schemes as a tool to promote the adoption of common rules of operations across Europe by requiring that beneficiaries of EU funding implement common operating rules across the EU;
- Promote bilateral industrial collaboration agreements with third-countries to promote the use of ERTMS outside Europe.

### 4.3.3. *SMEs and their role in the European Rail Supply Industry*

#### 4.3.3.1. Introduction

According to the interviews undertaken with SMEs and larger companies, small and medium enterprises (SMEs) represent a clear added value for the European rail supply industry. Over the past years, they increasingly gained more importance and visibility in the sector, becoming some of the key players both for competitiveness and innovation. Furthermore, partnerships between large companies and SMES have become more popular as both parties normally benefit from the cooperation. The following chapter analyses the role of SMEs in the RSI and the main challenges faced by these players.

#### 4.3.3.2. SMEs role in the RSI

The respondents to the questionnaire indicated that one of the key facts that represents an added value of SMEs compared to large companies is the flexibility. Nowadays, SMEs are becoming more specialised within the rail sector and this allows them to deliver highly customised products to the client or end-user, leveraging on the specific capabilities of SMEs to deliver innovation in a short time span. The innovation process in larger companies is typically longer due to the higher amount of internal procedures and more complex decision making process on new investments. Therefore, the more agile approach of SMEs also benefit the larger companies as they can incorporate new products into their portfolio quicker through strategic partnerships with SMEs.

The cooperation between large companies and SMEs has increased in recent years because some technical knowledge which in the past was present in major companies, is now better covered by small companies that focus all their expertise on that specific field. The cooperation gives benefits and incentives to both sides: big companies can benefit from SMEs through the innovative solutions they provide and their specific expertise[84], whereas SMEs will potentially gain access to new markets through important projects, contracts or investments as subcontractors. SMEs might also allow major companies to cover the commercialisation aspects of the new solutions developed, as the commercialisation phase is normally a difficult aspect to be faced by SMEs.

However, from the point of view of the SMEs interviewed, these are not the only benefits that they receive. Sometimes large companies can also help SME partners to obtain a better rate within financial institutions for loans or financial support by providing reassurance to the lenders on medium/long-term financial commitments.

#### 4.3.3.3. Access to third markets

In general, the access to third markets is essential for European SMEs, notably because of limited size of the EU market and slower growth in comparison to some third markets currently expanding their rail networks. Nevertheless, one of the main barriers to internationalisation are the requirements often set by local/national tendering authorities which require the engagement of local SMEs for the provision of rail supplies. Although partnerships with large players can support the SMEs to explore new markets, the above-mentioned local requirements within tenders can be restrictive and hinder the possibilities of collaboration with SMEs.

Stakeholders also highlighted that European international hubs, such as IPR helpdesk, were useful to make SMEs feel more "protected" within European facilities, rather than relying on local private consultants, which can be risky.

#### 4.3.3.4. Financing issues: access to credit

According to some of the stakeholders interviewed, having access to funding is a challenging aspect for SMEs. The main reason for this is that the railway sector has a long time span in terms of return of the investments. Often, banks or financial institutions are reluctant in granting loans to SMEs because of the risks of long-term railway projects. These limitations prevent most of the small companies to invest in the promotion of their products and to benefit from new opportunities across Europe and across the world.

Some stakeholders also highlighted challenges related to the promotion of their products within and outside the EU. Some European countries have certain national and regional funding schemes available for SMEs already selling products outside Europe for promotional activities. The practice is also similar in some third countries, such as Turkey. These funding schemes are mainly aimed at covering costs related to the start-up activities and commercialisation process of the products, such as exhibitions, office rental, and promotional activities. Nevertheless, the non-homogenous presence of such schemes across the EU might result in an unfair competitive position of some European SMEs when promoting their products within and outside the EU.

Finally, according to the stakeholders, another important aspect to consider when addressing SMEs environment is that the innovation cycles and return on investments tend to be slower in the railway sector compared to other sectors like automotive. SMEs could be severely affected by this divergence between what they spend in R&D activities and innovation and the concrete return of the investments and increase of the incomes. This divergence can impact, as a result, the sustainability of the business.

When it comes to access to third markets, authorities need to support SMEs with adequate financial schemes that can support the internationalisation process. One of the challenges is that, on one side, some EU national export credit agencies provide companies with credit only if there is a national content in the supply (at least 60%, in some cases), while on the tendering country side

[84] For example, a partnership between a large company and an SME specialised in cybersecurity during the development of the product means that the large company would not need to develop that specific expertise in-house, which could be both time consuming and costly.

(third countries), the procurement rules also require at least 60% of the product to be manufactured in country of tendering. In such circumstances, the SME would be prevented from collaborating with other locally present companies due to limited access to credit for their own products.

#### 4.3.3.5. Human resources turnover

As described above, based on the interviews, SMEs play an important role in promoting innovation through their flexibility and provision of highly specific knowledge. Nevertheless, keeping talents has demonstrated to be challenging because careers inside SMEs have only few role upgrades, whereas in large companies, workers have more opportunities of career advancement.

Thus, according to the SMEs interviewed, they normally need to start from scratch in creating new specializations, in investing in trainings for new tasks and in looking for motivated and high-skilled candidates. In order to do so, SMEs often operate through universities, signing training agreements for students or young workers.

#### 4.3.3.6. Participation in EU research projects

According to the Shift2Rail, the participation of SMEs in the S2R calls increased from 108 (24% of the entities participating in the call) in 2016 to 120 (26% of the entities) in 2017.

Despite the increasing numbers, some of the interviewed stakeholders indicate that it is difficult for an SME to follow the procedures of the H2020 and therefore Shift2Rail calls, as these types of projects have a high level of bureaucracy, many documents to provide and the preparatory phases are resource intensive, in particular for companies that have small teams. Indeed, big companies have enough resources to follow these calls and often SMEs or group of SMEs ask for their support or for the support of consultants, but that still is an expensive solution.

#### 4.3.3.7. Recommendations

Based on the analysis of the case study, the following recommendations are proposed:

- The cooperation between SMEs and the promotion of partnerships between SMEs and large companies should be encouraged, leading to more innovation with more appeal and higher foreign competitiveness. Building up an effective SME network or clusters could increase the sharing of knowledge, exchange information and increase the visibility of SMEs;
- National credit agencies should be flexible in applying the rule of minimum national content (of the crediting agency's country) to avoid limiting the participation of SMEs in tendering opportunities of third countries which would require a specific partnerships between the SMEs and local companies;
- Continue the investment on European international hubs to support SMEs abroad;
- The participation of SMEs in the standardisation committees would be beneficial for both SMEs and the rest of the industry, however costs related to their participation can be troublesome and limit the participation of SMEs in developing standards. In some countries, for example France, SMEs receive funding to participate in such meetings. Increase the available European funds to support the participation of SMEs in the development of standards, especially travel expenses, could enable the participation of more SMEs. Creating schemes, or using existing schemes (e.g. EU funding instruments), to shorten the time for the innovation uptake in European standards and technical specifications for interoperability would also be beneficial.

## 4.4. Findings on the competitive position of the RSI in relation to other industries and globally

Based on data analysed in Chapter 4, this section summarises the findings in relation to the competitive position of the RSI in relation to other similar European industries and to other global market players.

First of all, the **manufacture of railway locomotives and rolling stock** experienced a **growth in enterprises, turnover, value added, and number of persons employed** but to a lower

extent compared to peer EU transport manufacturing industries. In addition, between 2011 and 2017 the level of **gross investment per person employed was below the average investment in EU manufacturing** (per person employed). The longer lifespan of some rail supply products such as locomotives and rail infrastructure contribute to a longer period for return on investment, making investment in R&D in the industry less appealing than in other sectors, such as motor vehicles. However, recent trends indicate an **increase of R&D investment in the rail sector**.

Data on production of locomotives and rolling stock shows a **constant growth of EU production**, although an important slowdown started to characterise the growth in terms of production starting from 2009, with a partial recovery only taking place from the 2013 onwards. The **EU remains the largest net exporter since 2000**, with the only exception of 2005 in which Japan presents a higher value of net exports compared to the European value of the same year.

In the **locomotives and rolling stock segment**, the European RSI can currently be considered as the lead exporter worldwide. The European RSI has the highest market share among imported products of locomotives and rolling stock in China, Japan and South Korea with considerable presence also in the Russian and USA markets. Next to the rolling stock segment, the European industry is also the global leader on railway **signalling and electrification goods**. Siemens is the global market leader with 40% market share, followed by Thales (20%) and Bombardier (19%). Together, they hold close to 80% of the global market share in this product segment. The EU RSI products represent 58% of the China's import and, an impressive, 99% of Japan's imports in this segment. The European industry is also present in Russia and the USA, with 22% and 28% of the imports' market share, respectively. In the **infrastructure segment** the picture is a bit more mixed, but also positive considering Europe's lead in the sub-segment of railway or tramway track construction material of iron or steel. For example, the EU is the origin of 92% of the imported products by China and 42% of those imported by Japan. In addition, it is also among the main providers of track material of iron and steel to Russia, South Korea and the USA.

Nevertheless, the **global industry has radically changed in the last decade**. Starting from the beginning of the 2000's, China started to become a key player in the global RSI industry. Supported by its strong internal demand, often of public investment nature, the **Chinese RSI has seen its production growth exponentially**, more than quadrupling its overall turnover between 2007-2017.

In addition to this, trade performances in terms of exports and imports seem to indicate a new role for **Chinese RSI** not only in terms of ability to satisfy the internal demand, but also as a **role of exporter**, especially in developing countries in south-east Asia and Africa. This aspect should be strictly monitored and analysed by European policy makers, as it reflects not only an increase in China's capabilities to produce low-technology content products, including raw materials, intermediate products and electrical components, but also to bring on the market products capable of satisfying safety and regulatory certification.

These new export capabilities can also be seen as the result of **investment in R&D by Chinese companies in the RSI**, as reflected in the increased number of patents registered in China, as reported in the previous chapters.

The advent of the "knowledge economy" has led to the recognition of intangible assets as essential value creators for companies and enablers of productivity and economic grow. **Intellectual property rights (IPR)** play an important role in the railway supply industry. According to a 2013 EPO & EUIPO study, the manufacture of locomotive and rolling stock can be categorized as intensive in patents and industrial designs. It is in particular German and French companies which play a major role for the EU when it comes to newly granted patents and registered industrial designs. In a worldwide comparison, in the period under analysis, Chinese and Japanese companies result to be the most intensive in IPRs.

To conclude, the analysis shows that:

- **European RSI remains a major player** in the rolling stock related industry and, despite slowing down between 2009 and 2013, it has recently recovered its growth rate to approximately 5% per year;
- **China's internal demand and external policies have driven production of rolling stock and related supplies** to grow more than four times in the last decade to reach

**EUR 60 billion per yea**r. China became a net exporter in 2010 and **started gaining international market share** ever since, with strong focus on South-East Asia and Africa as part of the "One Belt One road" initiative;

- Despite China's large production of locomotives and rolling stock and related supplies (almost double of the EU's), China exports only 5% of its production and the **EU industry remains the main net exporter** of the rail supply products globally, followed by China and the USA;
- China has managed to develop, in the past 10 years, enough know-how and technical knowledge to develop a national RSI capable of satisfying a great part of their internal demand, as well as exporting in some of the commercial partners in East-Asia and Africa. **Japan RSI is also almost self-sufficient** with the share of imports in the consumption representing only 2% of the total;
- The **EU intra-trade of rolling stock and related supply** represents a **significant share** in Member States exports and imports, 61% and 78% respectively;
- **Trade barriers** in the RSI sector continue to hinder the trade of RSI goods, with percentage of exports representing a limited part of the total production for all the major global players. When compared to other industries, the European RSI lags in terms of **export intensity**, or the share of exports in relation to the total production, where the **USA and Japan are global leaders**;
- **Employment** on RSI sector remains overall constant, with the rail supply industry to continue to represent an important source of jobs both for low and high skilled workers. **China, Russia and India** employ the largest number of workers, in total **more than 1 million;**
- **SMEs** continue to represent a fundamental source of **innovation**, know-how and highly specialised workers in the manufacturing segment. Access to finance to promote R&D projects, as well as protection of IP rights when going abroad, represent two of the most critical areas in which extensive European and national action is required;
- The **cooperation between large companies and SMEs** increased and can be beneficial to both parties. Large companies benefit from SMEs through the innovative solutions they provide and their specific expertise. Whereas SMEs benefit from important projects, contracts or investments as subcontractors and they can also allow major companies to cover the commercialisation aspects of the new solutions developed, which represents a difficult aspect for SMEs;
- **Innovation** remains one of the key elements of success of European RSI. R&D, *ad-hoc* cooperation projects to share knowledge and capabilities between companies, as in the case of ERTMS, appears to be an excellent way to maintain the innovation;
- The ambitious design objectives fixed by the procurement tender technical specifications together with **MEAT principles** (e.g. 70% technical, 30% price) incentivized companies interested in participating in the tendering process to develop and propose new technologies and solutions;
- The joint participation of the railway industry in the development of the **ERTMS** technical solution and standards was essential for its success. Despite the technical standardisation, operation rules remain national based and they are still a barrier for seamless cross border rail operations. ERTMS was successful in its implementation outside Europe, but deployment in the EU remains low due to the additional costs required to ensure compatibility with national legacy systems.

# 5. FINDINGS ON THE REGULATORY AND FRAMEWORK CONDITIONS

In addition to insights into the market segmentation and developments of the RSI (presented in chapter 3), a review of literature, interviews with selected stakeholders, and a survey among industry and industry associations provided insights into the regulatory and framework conditions.

The main topics of attention identified are:

- Harmonisation and interoperability;
- Developing the rail transport infrastructure;
- Social and environmental sustainability;
- Labour demand force and labour conditions;
- International market access;
- Foreign Direct Investment;
- Innovation.

## 5.1. Harmonisation and interoperability

Harmonisation and interoperability were, the focus of past EU policies. This focus is part of a broader policy focus aimed at (1) opening the rail transport market to competition, (2) improving interoperability and safety, and (3) developing rail transport infrastructure.[85] The previous 2012 study already signals the gradual creation of an internal market improving harmonisation and interoperability by means of the Directive concerning interoperability (2008/57/EC), the set-up of the European Rail Research Advisory Council (ERRAC) in 2001, and the creation of the European Railway Agency (ERA, currently the European Union Agency for Railways) in 2004 with its twofold objective to enhance interoperability and safety on the European railway system.[86]

More recently, a number of additional actions were developed to further strengthen the objectives of harmonisation and interoperability with the goal to strengthen the internal market. These include the Fourth Railway Package, the Single European Railway Area (SERA), the Shift2Rail (S2R) initiative, and various initiatives related to standardisation.

These EU actions supported harmonisation and interoperability on the European market. In our survey, 88% of respondents agreed with this statement.[87] However, 94% of respondents agreed that many national legacy systems still lack integration into the European system and additional developments are required to achieve an economical, unified, interoperable, and flexible railway.[88] Before looking into how current EU actions such as the Fourth Railway Package, SERA, and S2R address these and other issues, we provide a short overview of the current regulatory framework.

### 5.1.1. *The Regulatory framework*

The current regulatory framework is the result of a process dating back nearly 30 years of various attempts to create an internal railway market. Four different railway packages have been implemented reshaping the market. Starting in 2001 with the first one updating the old regulatory framework. The second one in 2004 brought further updates, but more importantly established the European Railway Agency (Regulation No 881/2004[89]). The third package opened up the passenger market and facilitated the recognition of certifications of operators across Member

[85] Ecorys, Sector Overview and Competitiveness Survey of the Railway Supply Industry, 2012.
[86] ERA, Consolidated Annual Activity Report 2017.
[87] Survey question: EU policies (such as the 4th Railway Package, standardisation initiatives, reduction of national rules) and Shift2Rail have greatly supported improving harmonisation and interoperability. Do you agree or disagree with this assessment?; Response: 22% of respondents strongly agreed with his statement, 66% agreed, 6% did not have an opinion and 6% disagreed and 0% strongly disagreed.
[88] Survey question: Railway design and operation was in the past very national-orientated. However, many national legacy systems still lack integration into the European system and additional developments are required to achieve an economical, unified, interoperable and flexible railway. Do you agree or disagree with this assessment?; Response: 41% of respondents strongly agreed with his statement, 53% agreed, 3% did not have an opinion, 3% disagreed and 0% strongly disagreed.
[89] Later updated by Regulation (EU) 2016/796 reshaping the Agency into the European Union Agency for Railways.

States. The fourth and final one, aims to complete the Single European Railway area with its 'technical' and 'market' pillars.

The EU directives currently in place apply to a number of fields, namely: (i) infrastructure and interoperability, (ii) internal market, freight and passenger rights, (iii) employment and working conditions, and (iv) railway safety. The implications for the railway supply industry mainly exhibit themselves in infrastructure and interoperability and railway safety. However, some of the other Directives, such as on freight markets and passenger rights, have indirect effects on the railway supply industry. For example, the European Rail Network for Competitive Freight (Regulation EU 913/2010) aims at strengthening competitiveness of rail freight while also promoting intermodal transport thereby facilitating a modal shift towards rail in line with the Transport White Paper goals. The table below highlights the currently active regulations and directives and their direct and indirect importance to the railway supply industry.

| Directive/ Regulation | | Focus | Implication for Railway Supply Industry |
|---|---|---|---|
| Directive 2012/34/EU | | Establishing a Single European Railway Area by recasting the first railway package and merging previous directives on the development of railways, licensing of railway undertakings, and on railway infrastructure capacity and infrastructure charges into one. | Indirect: Creating a more efficient market for Railway Supplies. |
| Regulation (EU) 2016/796 | Technical pillar | European Union Agency for Railways (ERA). | ERA is in charge of interoperability and safety on Europe's railways. It became authority for issuing single safety certificates of rail operators and the authorization of railway vehicles. Using a "one-stop-shop" principle it forms as a single entry point for all applications as well as pre-authorising tender specifications for ERTMS trackside projects. This initiative aims to eliminate the need for manufacturers and operators to apply to national authorities in each country. |
| Directive (EU) 2016/797 | | Interoperability Directive. | Created a more homogenous European market by defining an optimal level of technical harmonisation. Outlines Technical Specifications for Interoperability (TSIs) for each subsystem. Ensures cross-acceptance of rolling stock. |
| Directive (EU) 2016/798 | | Railway Safety Directive. | Lays down the safety requirements of the European rail system (which includes operations as well): common safety targets (CSTs) and common safety measures (CSMs). Its impact for the RSI is primarily indirect as the requirements are, in first instance, imposed upon infrastructure manager and railway undertakings. |
| Regulation (EU) 2016/2338 | Market pillar | PSO Regulation: Award of public service contracts for domestic passenger transport services by rail. | Indirect: Creating a more efficient passenger rail market. |
| Directive 2016/2370/EU | | Governance Directive: Opening market of passenger rail transport and the governance of railway infrastructure. | Indirect: Creating a more efficient passenger rail market. |
| Regulation (EU) No 913/2010 | | European rail network for competitive freight. | Indirect: Facilitating a modal shift towards rail freight. |
| Directive 2007/59/EC | | Certification of train operators. | None. |
| Regulation (EC) No 1371/2007 | | Rail passengers' rights and obligations. | None. |

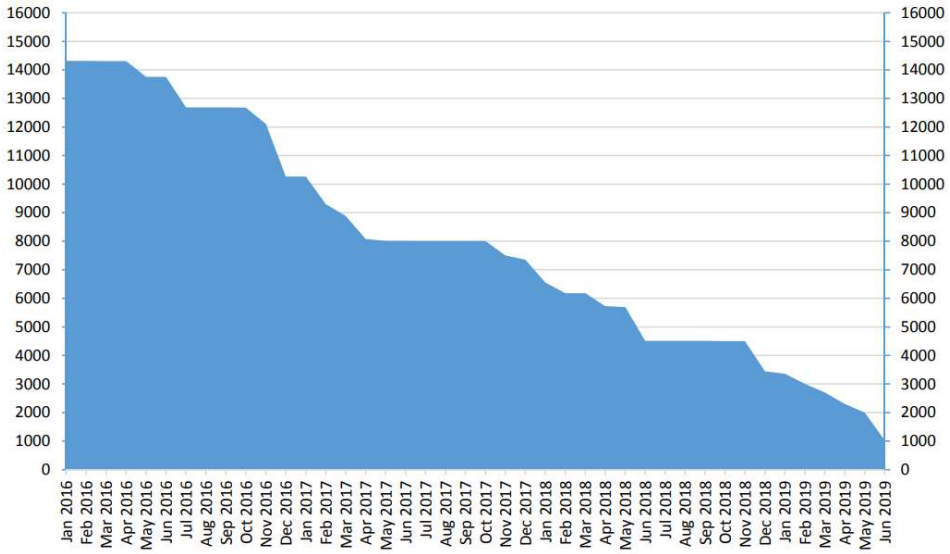
### 5.1.2. *The Fourth Railway Package*

The European Commission proposed the Fourth Railway Package in January 2013 to address remaining national differences and inefficiencies. The Package was officially adopted on April 2016 and contains initiatives in three main areas: (1) domestic passenger market opening, (2) infrastructure governance aimed to optimise capacity and guarantee non-discriminatory access, and (3) removal of remaining administrative and technical barriers for interoperability and safety.

As mentioned, the Fourth Railway Package made the European Union Agency for Railways (ERA) into the authority for issuing single safety certificates for rail operators and for the authorisation of railway vehicles. Using a "one-stop-shop" principle, the European Union Agency for Railways forms a single entry point for all applications as well as pre-authorising tender specifications for European Rail Traffic Management System (ERTMS) trackside projects. This initiative aims to eliminate the need for manufacturers and operators to apply to national authorities in each country as of 2019, diminishing the risk of insufficient transparency and disguised discrimination of new operators. Nonetheless, only nine Member States actually transposed the Package by June 2019, the remaining Member States will transpose it by June 2020. Switzerland implemented only the parts on vehicle authorisation and safety certification by June 2019, while the remaining aspects of the Package will be implemented by June 2020. Consequently, this patchwork of regulatory frameworks could present a challenge in particular for safety certification, vehicle authorisation and ERTMS trackside authorisation according to CER.[90]

At the request of the Commissioner Violeta Bulc, the ERA has, since 2016, conducted a programme to remove redundant and unnecessary national rules. According to a report issued by ERA in 2019, the following figure shows the progress in "cleaning up" of national rules in the vehicle authorisation process:

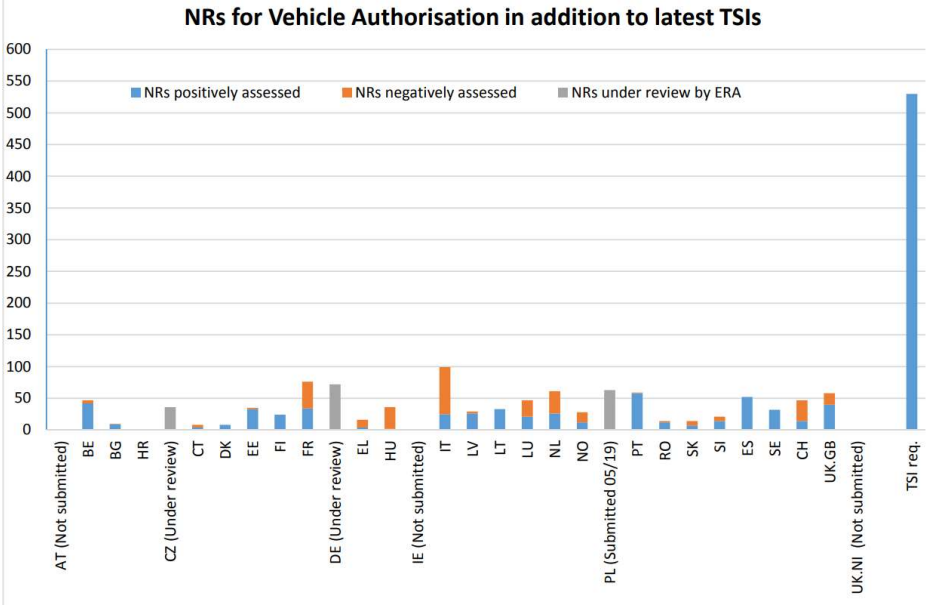
**Figure 100 EU-wide progress in the clean-up of national rules (NRs) for Vehicle Authorisation.**




Source: European Union Agency for Railways (2019) Evaluation Report – National rules RST&CCS ERA-PRG-006-REP-RST.

[90] CER (2019) Annual Report 2018.

**Figure 101 Progress of assessment of national rules (NRs) for Vehicle Authorisation per EU Member State.**




Source: European Union Agency for Railways (2019) Evaluation Report – National rules RST&CCS ERA-PRG-006-REP-RST.

Many of the changes put forward by the technical pillar are starting to be implemented. For example, ERA's role was expanded from an agency supporting the drafting of technical regulation to an operational European railway authority. ERA is now in charge of granting safety certificates and vehicle authorisations. From June 2019, these certifications and authorisations can be requested via a single electronic portal[91] allowing a coordinated approach and reducing the administrative burden of applicants, who do not have to address National Safety Authorities (NSAs) individually. Moreover, ERA will also have a centralised oversight of the ERTMS implementation. The new certification and authorisation regimes apply as of 16 June 2019.[92] ERA's new responsibilities would decrease costs and administrative burden especially for cross-border undertakings. In order to facilitate the implementation of issuing single safety certificates, vehicle and vehicle type authorisation, cooperation agreements are agreed between the NSAs and ERA. The first one with the German authority was signed in April 2019 and since then similar agreements were signed with French, Dutch, Finnish, and Italian authorities.

Further to ERA, the European Commission is implementing the technical pillar via secondary legislative acts in the form of Implementing Acts, such as the Implementing Act for the Single European Safety Certificate (June 2017) and the Implementing Act for Vehicle Authorisation (November 2017).

As our survey showed, stakeholders agree that national legacy systems still lack integration into the European systems showcasing that much needs to be done in transposing these EU rules into national rules. The Commission voiced its disappointment in some Member States delaying implementation until 2020, but also emphasised the European Commission's commitment to make SERA a reality by 2019 and 2020.

The World Rail Market Study: Forecast 2016 to 2021[93] discusses the EU's Fourth Railway Package, signalling that the general view of stakeholders is rather positive, as they expect positive impacts: significant time reduction for rolling stock and ERTMS authorisation; significant reduction for average time to market for new rolling stock; increase of annual capital expenditures; and

91 European Union Agency for Railways. One-Stop Shop (OSS) Available at: https://oss.era.europa.eu/logon.html.

92 European Union Agency for Railways. Applicants. See: https://www.era.europa.eu/applicants/applications-single-safety-certificates_en.

93 Roland Berger, UNIFE, World Rail Market 2016.

increase of market share for new entrants. At the same time, the report indicated it will be essential to further drive harmonisation of rail traffic within Europe (ERTMS). The subsequent version of the market study[94] further supports this notion, arguing that the entering into force of the technical pillar of the Fourth Railway Package in June 2019 will drive increased liberalisation of the EU rail market, which will continue the positive effect of driving down costs.

According to the latest report of the European Union Agency for Railways, the achievement of the agency's goals and therewith the technical pillar of SERA will be implemented through four strategic operational activities: (1) a harmonised approach to safety, (2) the elimination of technical barriers, (3) a single European train control and communication system (the European Railway Traffic Management System or ERTMS), and (4) a simplified access for customers.[95] The evaluations of actions undertaken for each of these goals in the 2017 ERA Annual Activity Report were generally positive.

### 5.1.3. *The EU Public Procurement framework*

An important consideration when analysing investments and their policy framework is to not only zoom in on policies regarding provision of funding for investment, but also to evaluate the policy framework in place for procurement, made possible with this funding. As in the previous competitiveness study, public procurement in the RSI falls under the Government Procurement Agreement (GPA) for signatory countries (Ecorys, 2012). This is the case for the EU, Korea, Japan, the US and others, but not for China. Countries within the GPA were not allowed to discriminate foreign companies coming from one of the Parties of the Agreement and bidding for public contracts above a certain threshold. However, the GPA contains certain exceptions, reducing the effective amount of procurement falling under the agreement. Furthermore, countries that did not sign the GPA were not obliged to follow the guiding principles of openness, transparency and non-discrimination on which the GPA was built.

The EU public procurement framework changed with the adoption of a reformed public procurement framework in 2014, consisting of three directives that entered into force in 2016. At the core of the new framework is the use of the award on the basis of Most Economically Advantageous Tender (MEAT) or best quality-price ratio (BQPR)[96]. According to this principle, EU countries shall eliminate price as the sole award criterion, and offer contracting authorities the flexibility to select the most economically advantageous tender ('value for money').

One of the three underlying directives is dedicated to utilities (water, energy, transport and postal services). These services play a vital role in national economic and social development, and fall therefore under a distinct section of the Procurement framework. Specifically, this is due to the different circumstances under which entities in these sectors operate in EU Member States, and the closed nature of the markets in which they operate. This can be due to natural monopolies or exclusive rights granted by Member States concerning the supply to, provision or operation of networks for specific services.[97]

The procurement rules for these sectors are more flexible and apply not only to traditional public purchasers, but also to public or certain private companies. In particular, the new public procurement rules determine which procedures apply to the award of contracts in utilities markets. Overall, it provides a lighter public procurement regime for companies in the utilities sector, offering commercial or industrial activity. Particularly, this lighter framework originates from certain deviating procurement rules, such as[98]:

- The threshold for application of EU rules, except for works contracts, is higher than the threshold for regular public authorities;
- The possibility to use without restriction the negotiated procedure with publication.

---

94 Roland Berger, UNIFE, World Rail Market 2018.
95 European Union Agency for Railways (2018) Consolidated Annual Activity Report 2017.
96 BQPR can be used interchangeably with MEAT. In this report, the term MEAT is used. The Directive (EU) 24/2014 established the MEAT principle, enabling the contracting authority to take account of criteria that reflect qualitative, technical and sustainability aspects as well as price.
97 http://ec.europa.eu/growth/single-market/public-procurement/rules-implementation_en#factsheets.
98 https://ec.europa.eu/growth/content/public-procurement-utilities-sector-water-energy-transport-and-postal-services-0_en.

In this way, the new EU public procurement rules also have a reinforcing effect on the development of the rail market. According to the new rules, the SMEs will have cheaper and easier access to bid for public contracts.

In June 2018, UNIFE drafted and widely shared a position paper on the MEAT principle setting out recommendations to rail contracting authorities and the EU institutions. UNIFE used this paper to promote the use of the MEAT principle to public authorities in Europe and beyond (through its bilateral cooperation activities). With this paper, UNIFE also pursued its cooperation within the European rail community (CER, EIM) to elaborate joint sectoral recommendations on best value procurement. Furthermore, in September 2018, UNIFE organised a roundtable at the European Parliament with Romanian MEP Maria Grapini to discuss how the implementation of best value procurement can lead to a more sustainable approach to public procurement for infrastructure.

The Commission has published guidelines for green procurement[99] and innovation procurement[100]. However, one stakeholder noted that application of the MEAT criterion mostly happens in North-West Europe, while price still remains an important award criterion for Eastern Europe. Currently, only about 50% of EU tenders are awarded based on the use of quality criteria (as presented in section 3.7.2 of this report). Still, the use of the MEAT criterion steadily increased in the EU over the last three years (see Figure 3.4.6). A correlation between use of the MEAT criterion and economic position of the country (GDP per capita) can be observed. Similarly, one stakeholder remarked that tenders using the MEAT criteria are mainly prevalent in Western Europe compared to Eastern Europe, where low price criteria are dominant.

More broadly, a systematic approach to MEAT and sustainable procurement practices still seems to be lacking, according to one of the stakeholders interviewed.

### 5.1.4. *International public procurement*

The Commission aims to use FTAs negotiations to ensure better access to foreign procurement markets for EU rail suppliers, for example in the context of the bi-lateral negotiations. In January 2016, the European Commission revised its proposal to promote a level playing field for international public procurement with the International Procurement Instrument (IPI). In the eyes of the Commission, IPI will be a useful tool for leverage in the ongoing negotiations on market access in public procurement with third countries not signatory of the GPA or a bilateral FTA with the EU.[101] The new proposal included substantial changes compared to the previous text (from 2012), and if enacted it would allow the EU to take proportionate and more targeted action in cases of alleged discrimination against European companies in the procurement markets of other countries.[102]

The proposed procedure would consist of three steps. First, if alleged discrimination by a third country of EU companies in foreign procurement markets was observed, the Commission would initiate a public investigation. If discriminatory restrictions against EU goods, services or suppliers are found, the Commission will invite the country concerned to consult on the opening of its procurement market. If this consultation has no result, the Commission can apply a price penalty to bids from the targeted country with a total value of at least € 5 million of which at least 50% consists of goods and services are originating from the targeted country. This provision applies to tenders covering products from third countries with which the EU has not concluded an agreement ensuring comparable and effective access for Union undertakings to the markets of those third countries. The Council, however, never managed to issue an opinion because of deep divisions among Member States. Recently, discussions on IPI have come up again under attention of the institutions.

---

99 http://ec.europa.eu/environment/gpp/index_en.htm.

100 https://ec.europa.eu/digital-single-market/en/innovation-procurement.

101 Resolution tabled pursuant to Rules 128(5) and 123(2) of the European Parliament's Rules of procedure by the Committee on Industry, Research and Energy (ITRE).

102 http://www.europarl.europa.eu/legislative-train/theme-a-balanced-and-progressive-trade-policy-to-harness-globalisation/file-international-procurement-instrument-(ipi).

Beside trade barriers, the Commission also puts a lot of emphasis on the protection of the European rail technology and intellectual property rights, and has a firm position regarding the legal security in third countries. Not only to the legal conditions under which the contracts would be signed and implemented, but also to the legal protection in case of dispute.[103]

### 5.1.5. *Administrative burden*

One of the four core objectives of the new EU Public Procurement framework is the reduction of administrative burden, by offering more flexibility in contract award procedures.[104] For instance, the framework offers shorter minimum time-limits for participation and submission of tenders. Also, the framework introduces a new standard electronic European Single Procurement Document, and it offers the possibility of excluding bidders from the procedure if they have previously shown significant or persistent deficiencies in a public contract. Still, the most important guiding principle in the new EU Public Procurement Framework is the introduction of the MEAT (or BQPR) principle.

The UNIFE study on the RSI (2018) argues that although different rules can act as barrier to entry and protect established suppliers, standardisation – as proposed in the Fourth Railway Package – is largely beneficial for the rail supply industry, as it creates a level-playing field for suppliers.[105] This package ensures interoperability of ECTS equipment across Europe, to save firms from having to file multiple costly applications if they operate in multiple member states – effectively deleting former administrative burdens, where railway undertakings and manufacturers had to be certified separately by different national safety authorities.

Furthermore, a lot of the potential for diminishing administrative burden stems from opportunities to digitalise the railway and railway supply industry. Current policy objectives and frameworks on a digital Europe offer ambitions and opportunities for this development. The European Commission set up an expert group, aimed at improving interoperability in freight transport, called the Digital Transport and Logistic Forum. The group provided input for a legislative proposal, which had the objective of encouraging the use and acceptance of e-freight information by state authorities and business operators in all transport modes, including rail, and to propose interoperable IT solutions to exchange this information. Digital transformation leads to a reduction in the use of paper documents, make the transport of goods more reliable and, according to the Commission, generate savings in administrative costs.

The results of the survey show that stakeholders have opposing views on the administrative burden experienced as a result of RSI regulation. While a considerable group of stakeholders believes the level of the burden is acceptable, others indicate that still much can be gained on it. The lack of consensus can be explained by the fact that stakeholders indicate that the level of administrative burden varies per Member State. In some Member States, rather heavy administrative burden is borne by stakeholders, while in others these burdens are less heavy. Moreover, in some MS there are no specific procedures to help understand the processes to be applied. Stakeholders believe that simplification of administrative procedures, the harmonisation of regulation at the national level, deployment of ERTMS, and enforcement the Fourth Railway Package would alleviate this burden. However, transposition of this package took place in only eight Member States in June 2019. The remaining Member States will transpose the package by June 2020.

### 5.1.6. *Standardisation*

The role of standardisation in the railway domain has changed as a consequence of liberalisation and the on-going creation of SERA, as the principle of an interoperable trans-European rail system was introduced. As discussed in the previous section, standardisation plays, in general, an

---

[103] http://www.europarl.europa.eu/legislative-train/theme-a-balanced-and-progressive-trade-policy-to-harness-globalisation/file-international-procurement-instrument-(ipi).

[104] European Commission (2016), EU Public Procurement reform: Less bureaucracy, higher efficiency – An overview of the new EU procurement and concession rules introduced on 18 April 2016, on: http://ec.europa.eu/DocsRoom/documents/16412/attachments/1/translations.

[105] UNIFE – Annual Report 2018.

important role in improving the rail sector's competitiveness by eliminating technical barriers to trade, decreasing costs, increasing efficiency and interoperability as well as market access for all stakeholders. According to Art. 2 (1) of Regulation (EU) No 1025/2012 standards are technical specifications adopted by a recognised standardisation body, for repeated or continuous application, with which compliance is not compulsory. These standards can be subdivided into the following four categories: (1) international standards, (2) European standards, (3) harmonised standards[106], and (4) national standards.[107] In the following two sub-sections, we discuss the main actors in the standardisation process and go more in depth into the process.

#### 5.1.6.1. The main actors in standardisation

The European Union Agency for Railways (ERA) is the agency responsible for assisting the EU and the Members States in implementing the Directives for safety and interoperability of the EU railway system. In recent times, the rail sector has undergone profound changes resulting in a significant increase in the number of organisations representing the various stakeholders in the sector. These organisations participate in the development of European standards, but also develop other technical documents serving the specific needs of their stakeholders[108]. With regard to the development of Technical Specifications for Interoperability (TSIs), **ERA** plays a central role in promoting interoperability and harmonising technical standards.

The main actors involved in standardisation at European level are the European Standardisation Organisations (ESOs) CEN-CENELEC and ETSI. They prepare, publish, and market European standards (ENs).[109] In regard to rail related ENs, the three bodies cooperate in the **Sector Forum Rail** in form of the Joint Programming Committee Rail[110] with other stakeholders from the railway industry and professional European and international organisations (UNIFE, UITP, UIC, CER, etc.). Finally, the **national standardisation bodies** in Member States (such as DIN or AFNOR) are the national members of CEN and CENELEC. They implement European standards as national standards and they can develop their own standards (not in competition nor in conflict with European standards). At the international level, ISO (International Standards Organisation) and IEC (International Electrotechnical Committee) work on standardisation. For the latter, the technical committees ISO/TC 269 and IEC/TC 9 work on international standards for railways and its industries.

In order to address the multitude of actors working on standardisation, the European Commission initiated the creation of the **Rail Standardisation Coordination Platform for Europe** (RASCOP). RASCOP met for the first time in November 2016. The meeting was attended by the European Commission, ERA, CEN-CENELEC, ETSI, CER, EIM, EPTTOLA, ERFA, JPCR, NB-Rail, S2R, UIC, UIRR, UIP, UITP and UNIFE. As an advisory group its aim is to streamline activities of stakeholders active in the development of European and international standards and other technical documents related to the railway sectors. Its objectives are (1) to contribute to streamlining of the European standardisation landscape; (2) to facilitate coordination regarding related activities at international level in order to foster the promotion of European Standards outside of the EU and to influence the development of international standards; and (3) to ensure that the needs of rail-related standardisation are taken into account in EU policies having an impact on rail and in general standardisation processes.

---

106 A harmonised standard is a European standard adopted on the basis of a request made by the Commission for the application of Union harmonisation legislation.

107 Regulation (EU) No 1025/2012 on European standardisation.

108 For example, UIC publishes International Railway Solution leaflets that combine voluntary solutions to support the design, construction, operation and maintenance of the railway system. See: https://uic.org/irs.

109 The ESOs respective mandates on Interoperability of the Rail System and on Urban Rail are M/483 and M/486.

110 https://www.cencenelec.eu/standards/Sectors/Transport/Rail/Pages/SectorForum.aspx.

#### 5.1.6.2. The standardisation process

Having a look at the legislative framework and its relationship with standards, we find that the top of the pyramid starts with the high level Interoperability directive (Directive (EU) 2016/797 [111]) explaining the "why" this is being done, then it moves to a specific set of EU documents, the **Technical Specifications for Interoperability** (TSIs)[112]. They describe the "what" needs to be done and what supports the directives. Today's principle of "New Approach Directives" limit the TSIs essential requirements to those "whats" that must as a minimum be in place for system interoperability within the EU. As previously explained Directive (EU) 2016/797 defines the subsystems, which are either structural or functional.[113] In order to facilitate application of TSIs, ERA prepared a general application guide as well as specific guidelines for each TSI. The coordination group of the notified bodies (NoBo) for interoperability in the railway sector NB-Rail can issue recommendations for use (RFU). A RFU cannot alter any mandatory content of TSIs, but aims to ensure a uniform application of the technical provisions it relates to. ERA is informed about RFUs and able to comment.[114]

At the pyramid's bottom are the standards (European standards, ENs) which describe "how" to design the railway system in order to enable the implementation of the TSIs. In other words, standards provide detailed requirements and related assessment criteria for how compliance with mandatory requirements of the TSIs can be achieved. The use of standards can be voluntary (in particular the so-called harmonised standards) or mandatory (in the case of standards that are directly referenced in the TSIs). The subsystems forming part of the European Union's railway systems and their essential requirements[115] are defined in Directive (EU) 2016/797.[116]

Basically, two types of railway standards exist: product and process standards. The former follows the later as solutions for technical functions and interfaces which enable harmonisation of operational and maintenance principles. Process related standards are general application principles that can be used by a wide range of stakeholders for the daily operation. They contain functional and system requirements and assessment methods for specific processes, such as the standard for requirements for braking performance. While, product related standards enable basic common harmonisation of technical equipment. They contain functional and system requirements and assessment methods for specific technical components, such as standards that define necessary characteristics for brake blocks or discs.

As mentioned in the previous section, ENs are voluntary standards published by the ESOs with the aim to facilitate business and remove trade barriers. They are implemented as national standards by the National Standardisation Bodies (NSBs) members of the ESOs. ENs developed under a request for standards given by the European Commission, are so-called "harmonised standards".[117] A manufacturer following the relevant harmonised EN benefits from a 'presumption of conformity' to the related essential requirement. However, these standards might also be specified in a TSI and thereby become mandatory European standards. Finally, ENs can be purely voluntary, developed at the initiative of the industry and national standardisation bodies (as long as they are not conflicting with existing harmonised standards or TSIs).

---

111 Directive (EU) 2016/797 of the European Parliament and of the Council of 11 May 2016 on the interoperability of the rail system within the European Union.

112 They define the technical and operational standards which must be met by each subsystem or part of subsystem in order to meet the essential requirements and ensure the interoperability of the railway system of the European Union.

113 Subsystems in structural areas are: infrastructure, energy, trackside control-command and signalling, on-board control-command and signalling and rolling stock. In functional areas, they are: operation and traffic management, maintenance, telematics applications for passenger and freight services.

114 A complete list of RFUs can be found on NB-Rail's website, http://nb-rail.eu/co/co_docs_rfu_en.html.

115 Essential requirements relate to safety, reliability, availability, health, environmental protection, technical compatibility and accessibility.

116 For example, a 2019 amendment of the TSI relating to the 'control-command and signalling' subsystems (CCS TSI) set up the first milestone for a harmonised trackside and vehicle control-command and signalling system architecture.

117 A summary list of these harmonised standards for Rail system interoperability can be found here: https://ec.europa.eu/growth/single-market/european-standards/harmonised-standards/interoperability-rail-system_en.

At **international level**, the ESOs cooperate also closely with international standard setting bodies. For example CEN and CENELEC have cooperation agreements with ISO and IEC respectively. Similarly, ERA is engaged in setting international standards, for example by being a liaison member of ISO/TC 269 on railway applications.[118] The general view among stakeholders is also that the use and promoting of European standards internationally is an opportunity for the rail supply industry. However, China as a competitor has identified technical standard setting as an angle for promoting its interests, notably within its Belt and Road Initiative. Currently, the NSBs still hold more leadership positions within the Technical Committees (TCs) of ISO and IEC than any other major economic power.[119] However, Asia's number of leadership positions in TCs has been increasing. In addition, a recent standardisation reform and the strategy "China Standards 2035" hint at certain ambitions to increase Chinese influence on international standards.[120]

#### 5.1.6.3. The progress of TSI application

The introduction of the new interoperability directive (Directive (EU) 2016/797) as part of the Fourth Railway Package and thereby the establishment of a more advanced underlying subsystem of TSIs had the goal of improving interoperability and creating a more homogenous European rail market. Based on data from ERA we can see the progress made towards a harmonised European railway system.[121]

In terms of infrastructure, the progress of the deployment of trackside infrastructure conforming to the Energy TSI (EU Regulation No 1301/2014) and the Infrastructure TSI (EU Regulation No 1299/2014) is slow with only ten Member States having any track infrastructure that conforms. This slow process is caused by the long life cycle of infrastructure and the fact that TSIs only apply to new installations and upgrades or renewals. Nevertheless, in terms of derogation requests[122] (for TSIs INF, ENE, SRT and PRM) a positive trend towards more interoperability can be observed with the number of requests decreasing in the past years (two in 2018 compared to 20 in 2012). Similarly, the number of applicable national technical rules for vehicles and rolling stock is decreasing constantly. The number of published national rules applicable for vehicles covered by TSIs dropped from about 14,000 in January 2016 to 5,700 in June 2018. In terms of derogation requests for rolling stock related TSIs (LOC&PAS, WAG, NOI, CCS) we see some stability with an average of ten requests between 2007 and 2018; however, with a peak of over 40 requests in 2017.

#### 5.1.6.4. The geopolitical dimension of standardisation

While the primary purpose of standardisation is to reduce transaction costs, improve market efficiency and contribute to economic growth, standardisation can and is also used for political purposes. The country or region that has the strongest influence on the standard setting, sets the norms that are internationally used and thereby advance its interests, allowing it to leverage its power in standardisation into economic power.[123]

In the literature review and the interviews with stakeholders, the increasing role of China in international standardisation was often mentioned. In particular, China is claimed to aim to gain "first mover advantage" in technical standardization, by suggesting new areas of work for new

---

[118] ERA is a type B liaison member of ISO/TC 269. Liaisons B are "Organizations that have indicated a wish to be kept informed of the work of the technical committee or subcommittee." Source: https://www.iso.org/organization/5718402.html.

[119] In regard to rail, Germany (DIN) holds currently the Secretariat for ISO/TC 269 and France (AFNOR-UTE) for IEC/TC 9. The secretariats of subcommittees (SC) of ISO/TC 269 are held by France (SC 1 Infrastructure and SC 2 Rolling Stock) and Japan (SC 3 Operations and services). EU Member States also chair the five Working Groups of IEC/TC 9.

[120] The Swedish Institute of International Affairs (2019) China's standard power and its geopolitical implications for Europe.

[121] European Union Agency for Railways (2018) Report on Railway Safety and Interoperability in the EU.

[122] Derogations represent technical barriers for vehicles, because vehicles have to be compliant with these derogations (additional national technical rules) in addition to the TSI requirements.

[123] The impact of China becoming world leader on the new industrial revolution is described in, inter alia, Rob de Wijk, *De nieuwe Wereldorde*, 2019 (translation in English upcoming) or *Power Politics, How China and Russia Reshape the World*, 2015 by the same author.

technical standards and by commercializing innovative technology as early as possible.[124] China's power to set standards is based on three dimensions: (a) reform of its internal procedures for standard setting; (b) its influence on international standard setting institutions; and (c) its ambition to set standards on the ground through its massive foreign infrastructure investments.[125]

In order to formulate an appropriate response to the geopolitical use of technical standardisation by China (but also by the USA), Fägersten and Rühlig formulate a number of recommendations, including:[126]

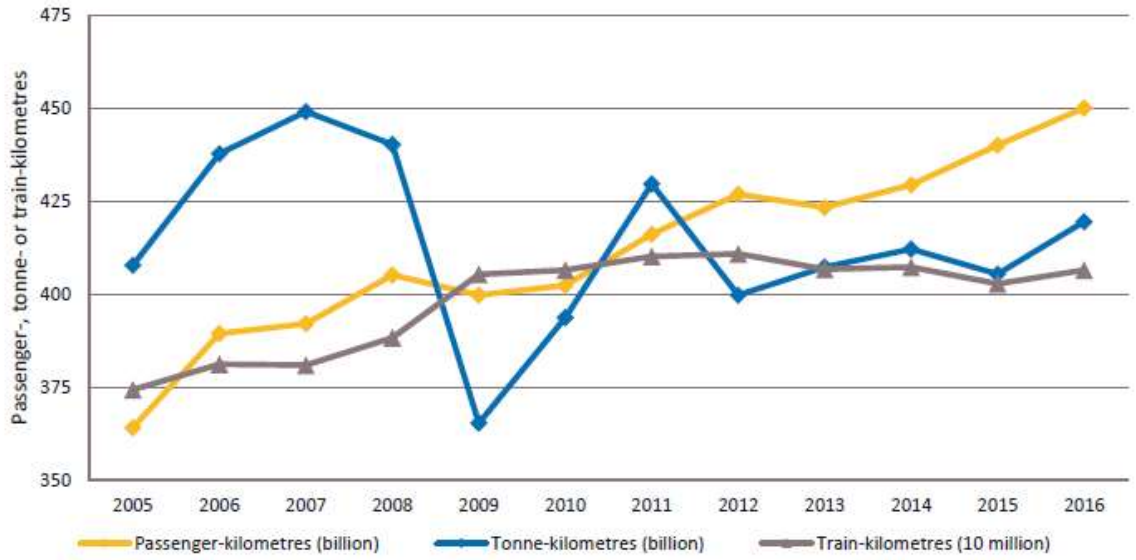
- the European Commission may consider the creation of a new EU Commissioner for geopolitics to help to reframe economic issues, including technical standards, in terms of the geopolitical implications;
- more EU Member States should make technical standardization a priority, not leaving the subject to private sector technical standardization bodies, but work closely with them to develop a strategic European approach to the subject;
- CEN and CENELEC should continue to promote the European model of hierarchical and clear-cut standardisation.

## 5.2. Developing rail transport infrastructure

The European Railway Supply industry's most important market is naturally the European market. In order to assess the market's potential it is important to look into the development of its infrastructure. Numbers from the European Commission's sixth report on monitoring development of the rail market[127] can give us an idea on the status of Europe's rail network and its development. Each year about 1.6 billion tonnes of freight and 9 billion passengers are transported on the EU's rail network with a total length of around 221,000 line kilometres in 2016 (1.6% lower than in 2011). About 54% of this network was electrified in 2016. The EU's high-speed network has doubled its length since 2003 and now has over 9,000 line kilometres.[128] The following graphic highlights the development of passenger and freight volumes.

[124] The Swedish Institute of International Affairs (2019) China's standard power and its geopolitical implications for Europe.
[125] The Swedish Institute of International Affairs (2019) China's standard power and its geopolitical implications for Europe.
[126] The Swedish Institute of International Affairs (2019) China's standard power and its geopolitical implications for Europe.
[127] SWD(2019) 13 final.
[128] In comparison China has about 25 000 km (though much of it not profitable), Japan 2 765 km, South Korea 1 048 km and Turkey 745 km (Source: https://www.worldatlas.com/articles/countries-with-the-most-high-speed-rail.html).

**Figure 102 Passenger and freight volumes, 2005-2016**




Source: RMMS, 2018. Infill data from various other sources and estimates. Taken from: Report From the Commission to the European Parliament and the Council - Sixth report on monitoring development of the rail market {SWD (2019) 13 final}.

In 2011, the European Commission adopted the EU's Transport 2050 strategy, which in turn resulted in the transport White Paper. This is a Roadmap to a Single European Transport Area, aiming to incentivise and develop a competitive and resource efficient transport system removing major barriers in key areas and fuel growth and employment.

The most important Transport White Paper Goals related to the railway industry set in the White Paper are:

**Table 39 Railway related goals of the Transport White Paper and current status**

| Segment | Transport White Paper Goals | Current status |
|---|---|---|
| Passenger rail | (1) Triple the length of the HS rail network by 2030 so that, by 2050, the majority of medium-distance passenger transport should go by rail and HS rail, should outpace the increase in aviation for journeys up to 1000 km. | At the end of 2017, there were 9,100 km of track with another 1,700 km under construction. However, a European Court of Auditors' (ECA) report found that these trains rarely run at maximum speed; that projects have been delayed and MS failed to utilise funding provided to them by the EU. The ECA finds the goal highly unlikely.[129] |
| | (2) By 2050, connect all core network airports to the rail network, preferably HS. | The ECA report notes that only a few HS rail stations currently have a direct HS connection to an airport.[130] Moreover, it is complicated for passengers to combine HS rail and air travel. |
| | (3) By 2020, establish the framework for a European multimodal transport information, management, and payment system. | Commissioner Bulc acknowledged that there are several barriers to overcome, such as insufficient accessibility and availability of multimodal travel and traffic data of good quality, lack of interoperable data formats and services and insufficient cooperation amongst stakeholders. A roadmap 'towards EU-wide multimodal travel information, planning and ticketing services' was published in 2014[131] and Consultations and a study were done in 2015.[132] Based on that a |

[129] European Court of Auditors (2018) A European high-speed rail network: not a reality but an ineffective patchwork.
[130] European Court of Auditors (2018) A European high-speed rail network: not a reality but an ineffective patchwork.
[131] Commissioner Violeta Bulc's written reply to the European Parliament, 7 SEP 2015. Available at: http://www.europarl.europa.eu/doceo/document/E-8-2015-010117-ASW_EN.html#def1.
[132] https://ec.europa.eu/transport/themes/its/consultations/2015-its-mmtips_en.

| Segment | Transport White Paper Goals | Current status |
|---|---|---|
| | | roadmap was published in 2016.[133] Shift2Rail also work on the issue from an R&I perspective, providing the technological enablers. |
| | (4) Deployment of ERTMS on the European Core Network by 2030 (51 000km). | The ERTMS Deployment Plan targets that by 2023 30 to 40% of Core Network Corridors shall be equipped with ERTMS. From June 2019 the ERA will approve ERTMS trackside projects.[134] In the EU there are 21 877 km of ERTMS contracted tracks,[135] but in 2015 only 9.4 % of the Core Network putting the ambitions in question.[136] |
| Freight rail | (5) By 2030, 30% of road freight over 300 km should shift to other modes such as rail or waterborne, and > 50% by 2050. | Between 2000 and 2012 total freight increased by 7.3 %, road freight increased by 11.2 %, but rail only by 0.4%.[137] Rail freight volumes remained volatile, but grew incrementally from 400 to 418 billion Tonne-Kilometres between 2012 and 2016 – an increase of 4.5%[138] |
| | (6) Increase rail freight adding 360 billion tonne km (+87%) compared to 2005. | In 2011, there were 422 billion tonne/km for rail, in 2016 this decreased to 411 billion tonne/km[139]. |
| | (7) By 2050, connect all seaports to the rail freight system. | No information. |
| | (8) Make rail freight corridors the backbone of transport. | The modal share of rail freight decreased since its peak in 2011 (19%), but remained steady at around 17 % in 2016. At the same time, road freight increased from 75% to 76% in modal share.[140] |
| | See (4). | See (4). |
| Urban mobility | (9) Halve the use of 'conventionally-fuelled' cars in urban transport by 2030; phase them out in cities by 2050. | EU passenger car fleet grew by 4.5% over the last five years[141], however more and more cities ban cars from their inner cities. |
| | (10) Achieve essentially CO2-free city logistics in major urban centres by 2030. | Commercial freight transport account for large shares of urban emission. Rail freight is estimated to reduce total heavy goods vehicles (light goods vehicles) in urban freight vehicle kilometres and CO2 emissions by 1.6 % (0.7 %) by 2030[142]. |
| | See (3). | See (3). |

As can be observed from Table 39, none of these goals are on track to be achieved by their deadlines despite some progress. Causes are not fully known. Despite a relatively good pace on the side of the Commission in proposing new measures, it has become evident that the follow-up adoption of the proposals by the legislators as well as the implementation is lagging behind.[143]

[133] http://ec.europa.eu/smart-regulation/roadmaps/docs/2015_move_021_travel_info_services_its_en.pdf.
[134] European Commission (2017) ERTMS Deployment Action Plan.
[135] ERTMS Deployment Statistics. Available at: http://www.ertms.net/?page_id=58.
[136] European Union Agency for Railways (2016) Railway System Report - Pilot Phase Findings.
[137] European Parliament, Policy Department B; Steer Davies Gleave: 2015.
[138] European Commission (2019) Sixth report on monitoring development of the rail market {SWD(2019) 13 final}.
[139] Eurostat. Freight Transport Statistics. Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php/Freight_transport_statistics_-_modal_split#Modal_split_in_the_EU.
[140] European Commission (2019) Sixth report on monitoring development of the rail market {SWD(2019) 13 final}.
[141] European Automobiles Manufacturers Association. Vehicles in use - Europe 2017. Available at: https://www.acea.be/statistics/article/vehicles-in-use-europe-2017.
[142] CITYLAB (2017) Assessing the EC's target of essentially CO2-free city logistics in urban centres by 2030. Available at: http://www.citylab-project.eu/deliverables.php.
[143] Progress Report on the White Paper.

Reasons may be related to lack of support of (some of) the goals[144] or possibly insufficient direct returns on investment.[145]

In line with these objectives, the 2012 Single European Rail Area (SERA)[146] strategy was adopted by the EU which has an objective of the creation of a unique efficient inter-European freight and passenger market, favouring cross-border competition. The aforementioned 4th Railway Package puts forward six legislative texts along a technical pillar and market pillar for the completion of SERA. The European Union Agency for Railway is the main actor pushing forward the implementation of the technical pillar.

Another aspect next to providing the right policy framework is providing investments into infrastructure. In this respect, it should be noted that the European Investment Bank has EUR 12-14 billion in funding available for transport, with 27% of this amount allocated to rail. Nonetheless, the lack of public funding for major projects and other factors drive increasing demand for private finance. It is, therefore, important to find ways to tackle backlog in infrastructure spending. The rail sector has been discovered as a business opportunity by private investors: it offers relatively safe opportunities and steady returns, with the benefit of tacit or overt government backing. RSI companies need to prepare for a future in which there is a greater use of private finance for railway projects.

Next to the EIB's investments there are various funding instruments that companies can make use of for infrastructure projects in Europe and in third countries. Financing instruments include the Connecting Europe Facility (CEF), the European Fund for Strategic Investment (EFSI), the European Structural and Investment Funds (ESIFs), including notably the Cohesion Fund (CF) and the European Regional Development Fund (ERDF). Key for European infrastructure development, is the TEN-T programme.

TEN-T aims at creating nine European Core Network Corridors. In order to create these corridors, 30 priority projects were identified and planned to be completed by 2020. Their focus lies on environmental friendly transport modes and thereby should greatly support shifting freight and passenger transport to rail[147]. Between 2007 and 2013, EUR 6.95 billion was spent under TEN-T, amongst which 56% went towards rail projects and 7% towards ERTMS development (to road 4%). For the 2014-2020 period, CEF provides a budget of EUR 22.4 billion to implement TEN-T projects. The 2019 CEF Transport call for proposals provides EUR 65 million to removing bottlenecks, enhancing rail interoperability, bridging missing links and improving cross-border sections of the TEN-T network and EUR 35 million to sustainable and efficient transport systems. The recently published EU Transport Scoreboard[148] shows that at EU level 60% of conventional rail and 45% of high-speed rail of the TEN-T Core network corridors are completed with especially East European Member States lagging behind. It appears that further investments are necessary. It becomes important to see how the EU can measure up to this in the new multiannual financial framework (2021-2027 period) or how actual synergies can be created. CEF Transport is planned to receive in the next period EUR 12.8 billion, plus an additional contribution of 11.3 billion from the Cohesion Fund and 6.5 billion for military mobility.

The EU-China connectivity platform offers opportunities for cooperation on transport decarbonisation and digital transformation as well as on investment in infrastructure projects

---

144 For example, Dokumentation der Veranstaltung des Europabüros der Metropolregion FrankfurtRheinMain, p.7/8 https://www.region-frankfurt.de/media/custom/2629_287_1.PDF?1468507424, where there was scepticism on two goals: modal-shift from road to rail and the 300km rule (which argues that freight for distances beyond 300km should be done by rail or maritime transport).

145 See, for example, the Court of Auditor Report on the High Speed Network (https://www.eca.europa.eu/Lists/ECADocuments/SR18_19/SR_HIGH_SPEED_RAIL_EN.pdf), which states: " *Given the state of indebtedness of national public finances (Member State governments are the main investors), the limited return on this public investment* (our emphasis)*, and the time it takes in practice to complete a high-speed rail investment, the goal of tripling the high-speed rail network is very unlikely to be achieved."*

146 Consistent with the roadmap to a Single European Transport Area.

147 18 are railway projects, 3 are mixed rail-road projects, 2 are inland waterway transport projects and one refers to Motorways of the Sea.

148 https://ec.europa.eu/transport/facts-fundings/scoreboard_en.

based on sustainability criteria, transparency and a level-playing field to foster investment in transport between EU and China. During the fourth meeting of the EU-China Connectivity Platform held in April 2019 both sides committed to openness, transparency and a level playing field in the area of infrastructure connectivity. They also agreed on a joint study to assess the current situation of railway-based corridors between Europe and China and identify the most sustainable transport corridors.[149] However, in the meantime China is also making bilateral agreements with Member States such as Italy and Hungary.

Finally, an important source of investment funding comes from national investment, allowed under the State aid framework. In 2008, the Commission has set out guidelines on State aid for railway undertakings. [150] Given the nature of the Railways sector, which constituted traditionally of monopolistic and national markets within the EU, the incentive to innovate and reduce costs was minimal. As a result, essential investments were not always made or railway undertakings had to rely on investments by the Member State, while they were actually not in the position to finance them from their own resources. Furthermore, due to a lack of standardisation and interoperability at the EU level, national railway networks consisted of various differences in technical characteristics. Due to the lack of investment, the quality of railways declined and transport of citizens and freight through alternative modes of transport rose.

However, as the railway potentially is safer and cleaner than most other medium to long distance transport modes, the Commission recognized the need to revitalise the rail industry. Consequently, it proposed a three-pronged policy: (i) gradually fostering competition, (ii) encouraging standardisation and technical harmonisation on the European rail networks, and (iii) granting financial support at Community level (in the TEN-T programme and the Structural Funds framework). Aid for railway undertakings has risen significantly in recent years in Member States.[151] The guidelines presented in 2008 are still in force, although a fitness check was announced in January 2019.[152]

| EU (in millions of euros) | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|
| State aid to the railways undertakings | 30674 | 41119 | 42315 | 43233 | 46254 | 47155 |

*Source: EU State Aid Scoreboard 2017, on:* http://ec.europa.eu/competition/state_aid/scoreboard/state_aid_scoreboard_%202017.pdf p. 70.

On a national level, especially France (over EUR13billion), Italy (EUR 7billion) and Germany (EUR 6 billion) provided significant subsidies in 2017, trailed by Austria and Belgium (both EUR 3 billion).[153]

## 5.3. Social and environmental sustainability

One of the major societal challenge, that also impacts the RSI, is social and environmental sustainability. Social sustainability encompasses such topics as social equity, liveability, and social capital, while environmental sustainability is focused on maintaining the quality of environment on a long-term basis. The United Nations captured the main challenges in their Sustainable Development Goals.

On an EU level, initiatives are undertaken for the development and application of Environmental Product Declarations (EPDs). EPDs contain voluntarily developed information that provide quality-assured and comparable information regarding the environmental performance of products in

[149] European Commission – Press release. 2019. EU-China Summit: Rebalancing the strategic partnership. Available at: http://europa.eu/rapid/press-release_IP-19-2055_en.htm.
[150] Community guidelines on State aid for railway undertakings, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52008XC0722(04).
[151] Arrigo, U., & Di Foggia, G. (2013). State Aid to Railways in Europe. https://www.academia.edu/6361611/State_Aid_to_Railways_in_Europe.
[152] http://europa.eu/rapid/press-release_IP-19-182_en.htm.
[153] http://ec.europa.eu/competition/state_aid/scoreboard/index_en.html.

accordance with the ISO 14025 standard.[154] For instance, UNIFE established a topical group that developed Product Category Rules (PCR) for rail rolling stock – a standardised method to apply environmental life-cycle assessments in a transparent and reliable way. By using the PCR, UNIFE members can apply common and harmonised calculation rules for a specific product category to ensure that similar procedures are used when preparing an EPD. PCR was first introduced for rail rolling stock by UNIFE in 2009. It is regularly updated to take into account new approaches like the Recyclability and Recoverability Calculation Method – Railway Rolling Stock, and the Railway Industry Substance List.[155]

Railsponsible is another RSI initiative focused on sustainability. Railsponsible focuses on sustainable procurement, with the aim to continuously improve sustainability practices throughout the railway industry supply chain.[156] The initiative aims at improving environmental and social practices of companies of the railway sector and railway sector supply chain through best practice sharing and capability building. As such, Railsponsible falls within the corporate social responsibility (CSR) narrative. One of the main aspects of CSR is evaluating and choosing your business partners, suppliers, manufacturers and other service providers based on their positive impact on the world.

It also aims at improving efficiency in the analysis of supply chain CSR practices, and to promote greater transparency to meet increasing stakeholder requirements. Actions undertaken under the Railsponsible initiative include, inter alia:

- Initiation of dialogue with railway industry suppliers on environmental, social and ethical performance;
- harmonisation to sustainable performance assessment.

Finally, one major route to achieve the goal of social and environmental sustainability is by means of public procurement with various initiatives developed, such as the use of the award on the basis of the MEAT principle. Application of this principle offers the possibility of making procurement decisions based on other factors than price alone. For instance, on its sustainability, substantiated by life-cycle assessments or assessments of environmental and societal impact. More in general, the increased use of Green and Sustainable Procurement practices in public procurement offers great potential to prioritize social and environmental factors in railway supply tenders.

## 5.4. Labour demand and labour conditions

Three factors shaping the demand for railway labour force can be distinguished: the growing need to replace retiring engineers; the trend to implement more sophisticated railway technologies (such as the ERTMS and new digital solutions);[157] and digitisation and robotisation reducing demand for labour in the sector.

According to Rail 2050 Vision - Rail the Backbone of Europe's Mobility (2017; ERRAC), the European rail mobility is sustained by a skilled workforce, but around 30% is expected to retire in the next 10 years and there is a need for skills and competencies to address the major transformation process driven by research and innovation. With an increasing number of employees ageing and a large number of workers retiring the coming years, the EU is facing a loss of substantial knowledge and experience.

In addition, the trend to implement more sophisticated railway technologies has become increasingly important. R&I initiatives are being taken as part of the S2R programme to bridge the gap between changes in the railway sector imposed by rapid technological advances and future job profiles. Recently S2R has commissioned a project in the framework of the service contract S2R.2016.OP.02: CCA – Human Capital, on the potential impacts of the S2R work programme on the future labour force of the rail sector and the required skills. Although the scope of this study is

[154] http://ec.europa.eu/environment/ipp/pdf/epdstudy.pdf.
[155] http://unife.org/component/attachments/?task=download&id=105.
[156] http://railsponsible.org/about-us/.
[157] There seems to be also low public awareness about the high-tech jobs opportunities that are offered by the sector in connection with deployment of increasingly sophisticated railway technologies.

on the railway companies, it should be noted that the changes for operators also reflect in some cases changing demands towards the RSI. The following skill impacts were identified in this study:

- At the level of tasks, there is a shift towards more use of ICT, systems, materials and production processes, but also a tendency towards simplification of tasks and even a phasing out of certain tasks, with redundancy of jobs;
- At the level of competences and skills, most of the changes relate to science, technology, engineering and mathematics (STEM). The different IP-programmes demand different technical knowledge to be developed. Next to STEM, there are rising social demands, communicative demands and on organisational demands in all jobs in the rail sector, except for train drivers.

The following six measures to deal with the skill gap, have been assessed in the Shift2Rail Human Capital study[158,159]:

- Next Generation Learning (transfer of knowledge);
- Access to virtual learning (transfer of knowledge);
- Access to education (transfer of knowledge);
- Attractiveness of sector to new entrants (transfer of workforce);
- Transfer from reintegration (transfer of workforce);
- Transfer from less represented groups (transfer of workforce).

The *transfer of knowledge mechanisms* help Vocational Education and Training (VET), on-the-job training and academic education to prepare themselves for the future skill gaps that will arise. The 'transfer of workforce' mechanism needed to deal with alternative learning systems, the needs of various skill levels, and lifelong learning aspects of skills segments of the workforce are needed to help the rail sector with new personnel in the future.

The EU Blueprint for Sectoral Cooperation for Skills (launched as part of the New Skills Agenda) encourages the establishment of frameworks of cooperation between key stakeholders. In August 2019, the Commission adopted the 2020 Erasmus+ Annual Work Programme, which includes rail supply and transport industry as a sector eligible for the 4th wave of the Blueprint project. This framework can provide a forum to better address the skill gaps caused by the ageing workforce and the shift in the required skills.

## 5.5. International market access

The Sector Overview and Competitiveness Survey of the Railway Supply Industry (2012; Ecorys) reports on international non-tariff barriers, in particular in China (barriers due to standardisation, technical regulations, insufficient IPR enforcement and heavy certification procedures) and Japan (barriers due to industry structure and lack of transparency, like restriction to access contracts awarded by the railway and urban transport operators). At the same time, the EU market is reported as being accessible (76%). For non-EU countries, a tendency to replace more and more the contractor's components by equipment locally produced is identified. As a result, EU manufacturers focus more on the production of key components and system integration. Labour intensive, less know-how driven components, and the assemblage are carried out locally in third markets.

The World Rail Market Study: Forecast 2018 to 2023 (2018; Roland Berger, UNIFE) also discusses market volume accessible for foreign operators. The accessible market volume per region, as measured in the World Rail Market Study is presented below, with the figures presented in Ecorys

[158] Source: Steven Dhondt, Frans van der Zee, Peter Oeij, Ming Chen, Dewan Islam (2018), Shift2Rail Human Capital D3a. Bridging the skills gap for the Rail Sector. Analysis and recommendations.

[159] Note: Product development and instructions by the RSI, should enable and support virtual learning to make this feasible; ICT expertise should be linked to product expertise (see also box). This may also be relevant for other types of education/learning mentioned. As such these gaps listed here are relevant for both operators as RSI.

2012 figures for the period 2007-2009 (based on previous World Rail Market Studies) between brackets added for comparison.

- NAFTA 88%; (83%);
- Latin America 80%; (75%);
- Africa/Middle East 84%; (60%);
- Western Europe 82%; (76%);
- Eastern Europe 61%; (63%);
- CIS[160] 48%; (40%);
- Asia Pacific 33% (65%).

Although the numbers may show a general improvements in accessibility (with the exception of the Asia Pacific), these may also be the result of methodological changes in the calculation of market accessibility. Sector feedback rather hints at stable levels of market accessibility outside the EU, again with the exception of Asia Pacific. [161] The strong fall in accessibility in the Asia Pacific region comes mainly from China (51 to 18%), but again, can partly also be explained by a change in methodology in assessing accessibility. A selection of countries is discussed in more detail.

**China**

The Chinese market is considered as minimally accessible. In order to boost exports, China not only supports its companies but locks the home market with trade barriers, subsidies and financing from development banks. As a stakeholder noted, China identified the rail industry as a one of its top priority sector in its strategy (Made in China 2025 strategy), which is mirrored by Chinese political support coming from the Belt and Road Initative (BRI) and the current 5 year plan (EUR 519 billion of investments for rail). Other stakeholders confirmed the worsening of accessibility of the Chinese market.

Main barriers in China are:

- Indirectly, the large amount of subsidies to the Chinese state owned enterprises make competition on the Chinese market more difficult (according to one source, CRRC receives EUR 450 million per year in subsidies)[162];
- Large market, but accessible only via joint ventures and technological transfer agreements[163];
- Non-transparent procurement procedures as well as Buy Chinese policy and localisation rates.[164]

Negotiations on an EU-China Investment Agreement were launched in 2013. This led to an understanding on the scope of the future agreement in 2016 in which both parties confirmed that it would focus on improving market access opportunities, by guaranteeing no discrimination against foreign companies.[165] Given the barriers, stakeholders see limited opportunities in the Chinese market beyond maintaining certain niche market segments. The EU and China exchanged some initial offers on market access in 2018, but a final agreement is not yet expected.

According to the stakeholders, the domestic Chinese market became less attractive, since many Chinese cities already built transport systems, but the outlook will probably increase in 2020-21.

---

160 Commonwealth of Independent States (Armenia, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan).

161 Individual stakeholders also voiced concerns over Russia (due to increased localisation requirements) and Africa (mainly due to export credits from competing countries).

162 IndustriAll (2017) Keeping track of globalization in the rail industry. Available at: https://news.industriall-europe.eu/Article/147.

163 Public procurement is only accessible for Chinese companies or joint venture with a controlling interest from the Chinese party. Additionally, tenders have as evaluation criteria the localisation rate and whether the tender has full ownership of IPR to perform the contract.

164 European Commission. Trade. Market Access Database, available at: http://madb.europa.eu/madb/barriers_details.htm?barrier_id=11020.

165 UNIFE – Annual Report 2018.

In this regard, the Belt and Road initiative (BRI) is financed by the Chinese government to make use of overcapacity in its domestic market.

Here, engagement through the EU-China Connectivity Platform constitutes a major chance by coordinating between TEN-T and BRI, as well as promoting the application of market principles and open and recognised standards, such as EU standards. Another opportunity could come from the political support from Chinese government for the rail industry. The 13th five year plan (2016-2020) allocated about EUR 519 billion of investments for rail and reflects the transition of the Chinese economy towards a more sustainable economic model. The slow-down of economic growth (now exacerbated by US tariffs), has had an effect on Chinese policymakers, which can be seen in shifting excess capacity towards exports (via BRI), but also in reducing it, which is one of the goals of the current five year plan. In its transition towards a new growth model, the five year plan also advocates for a consumption-led and environment friendly approach that favours innovation.[166, 167] A cooperative approach could allow European companies to access these investments by offering sustainable technologies and working together with Chinese competitors in China's transition. However, at the same time this would likely entail joint ventures and potential technology transfer agreements. Moreover, the overall slow-down of the Chinese economy could decrease demand for European rail products.

Other observations with respect to China are:

- Chinese companies could benefit from technology transfer agreements and huge investments, especially in the high speed segment[168];
- The 2015 merger of two key railway supply manufacturers, CNR and CSR, into the CRRC. CRRC has since become a leading producer of railways supply, especially to the developing world, with superior economies of scale due to their protected domestic market and strong pricing power;[169]
- Pressure from the United States in form of tariffs, might move China to increase market access to foreign companies and increase domestic investment to combat decreasing demand[170];
- The EU also seems to increase its pressure on China and other countries by pushing stronger for reciprocity[171].

One solution suggested by a stakeholder is to use the EU-China investment treaty or the Connectivity platform to re-open the Chinese public procurement market for European RSI companies. This is also voiced by UNIFE, which advocates in many of its policy positions for reciprocity and that the EU should seize all instruments (Connectivity platform, Investment Agreement and WTO GPA accession of China) at its disposal to achieve a level playing field with China.

**Japan**

The Trade Sustainability Impact Assessment (TSIA) for the Economic Partnership Agreement (EPA) between Japan and the EU pointed at a trade deficit for the EU on RSI. This was calculated to be in 2014 at about EUR 229 million. This deficit has been fluctuating quite a bit in the past years due to demand side effects (from large infrastructure projects), but overall decreasing from a peak of

---

166 In fact, the 13th Five year plan mentions for the first time Low Carbon Transport. It also advocates as part of its transport sector goals to construct a total length of 30 000 km, connecting more than 80% of all large cities, adding 3 000 km of new urban rail transit lines and improve intercity rail networks (e.g. Beijing-Tianjin Hebei, Yangtze Delta, etc.).

167 GIZ (2017) Overview of China`s Five-Year Plans in the Transport Sector; AND European Commission (2016) Can Economic Transitions Be Planned? China and the 13th Five-Year Plan.

168 For example: *The Chinese firms hot on the heels of Europe's rail infrastructure giants*, Railway Technology Magazine, available at: https://www.railway-technology.com/features/featurethe-chinese-firms-hot-on-the-heels-of-europes-rail-infrastructure-giants-5888409/ AND *The importance of China's high-speed tech transfer policy*, Railway Technology Magazine, available at: https://www.railway-technology.com/features/featurethe-importance-of-chinas-high-speed-tech-transfer-policy-5748075/.

169 VDB (2017) Die Bahnindustrie in Deutschland - Zahlen und Fakten zum Bahnmarkt und –verkehr.

170 Financial Times (2019) China steps up fiscal spending as it approves $125bn of rail projects. Available at: https://www.ft.com/content/c272c1fc-0fee-11e9-a3aa-118c761d2745.

171 Politico (2019) EU accelerates moves to block China's market access. Available at: https://www.politico.eu/article/eu-accelerates-moves-to-block-chinas-market-access/.

EUR 642 million in 2007. Looking instead at EU share in Japan imports from the world and Japan share in EU imports from the World, the TSIA shows a different picture. Here the EU only imports 10-15%of its total imports from Japan while Japan imports 30-40% from the EU (between 2002 and 2014). This shows a certain strength of EU suppliers on the Japanese RSI market; however, this is also a result of the overall low RSI imports in Japan. In fact, according to DG TRADE data only 10% of public procurement is open to foreign companies and 5% is actually won by non-Japanese companies. Offering more details, one stakeholder mentioned Japanese customers are looking only for non-Japanese suppliers when there is no Japanese alternative.

There are several barriers to access to the Japanese market that might explain low Japanese imports:

- Many of Japan's main rolling stock manufacturers have close ties with the major rail operators in Japan;
- This is further complicated by a mature and saturated market. This makes it difficult for European suppliers to access the market against well-established incumbents considering the slow investment cycles in rail;
- Public authorities seem reluctant to engage foreign manufactures;
- In addition, a different business culture in Japan makes access especially difficult for SMEs; The Operational Safety Clause to the Japanese GPA limits access, which allows to keep procurement closed if the operational safety of railways could be affected. In addition to these, insufficient willingness to get familiar with the local Japanese market and an inadequate understanding of prevailing business culture in Japan (and securing Japanese language capability) might give another barrier to EU entry to the Japanese market. Japanese are often active in additional services such as after sales services, for which a clear presence and understanding of local culture and markets is necessary;[172]
- The need to have a physical presence in Japan to, inter alia, ensure after-sale services, has been mentioned, but no firm proof on these requirement was found.

In December 2017, the European Commission and Japan reached a final agreement on their bilateral Economic Partnership Agreement (EPA). EPA facilitates guarantees to EU RSI on public procurement. Especially, the Japanese commitment to remove the Operational Safety Clause (OSC) – which is a major non-tariff barrier discriminating against non-Japanese RSI firms – within a year following the entry into force of EPA, is potentially of great impact on RSI trade in Japan. As the agreement was ratified by the European Parliament on 12 December 2018, one stakeholder pointed out that EPA is not yet implemented and no changes in market accessibility have been witnessed so far. Monitoring implementation of the agreement is therefore key.[173] Another core objective of the EPA is to promote a high level of regulatory cooperation and recognition of standards, which could reduce administrative burden for bilateral trade.[174]

While it is yet too early to measure its effect, the implementation of the EPA could constitute a major chance for European companies. Already the negotiations led Japanese private railway operators to voluntary agree on purchasing railway stock and expanding their supplier base. This voluntary agreement surpassed GPA provisions. For example, Japanese Railways Groups (JRs) like JR East[175] (63 foreign suppliers in 2016) are actively trying to expand their supplier base and offering more opportunities to access the market[176]. Further achievements from the EPA, such as removing the OSC, increased cooperation via the "Railway Industrial Dialogue" and the "Technical Expert Group on Railways" should remove major barriers and increase transparency through cooperation on railway standards. In addition, Japan granted non-discriminatory access for EU suppliers to public procurement at sub-central level with opening up procurement markets of 48 cities of around 300,000 inhabitants and promised to make information about public tenders more easily accessible.

---

172 EUbusinessinJapan.eu (2016), The Railway Market in Japan.
173 UNIFE – 2018 Annual Report.
174 Trade Sustainability Impact Assessment of the Free Trade Agreement between the European Union and Japan Final Report.
175 Japan Railways Group, more commonly known as JR Group, consists of seven for-profit companies that took over most of the assets and operations of the government-owned Japanese National Railways.
176 EU-Japan Centre for Industrial Cooperation (2016) The Railway Market in Japan.

At this stage the EPA still needs to be implemented; however, the EU should closely monitor the follow-up to ensure a proper implementation. Moreover, some barriers such as a different business culture, close ties between Japanese operators and manufacturers and reluctance of public authorities to engage with foreign suppliers cannot be solved by a free trade agreement alone.

**South Korea**

South Korea is considered an interesting market for rail telecommunication and 5G application by one of the stakeholders interviewed, while another stakeholder flags South Korea as an important market for rolling stock. In 2011, the EU and South Korea agreed upon a FTA to lower non-tariff barriers (NTBs). However, a Commission evaluation on the implementation of the FTA in 2017 showed that according to stakeholders the market is not considered accessible to EU RSI.[177] Rail tenders in Korea tend to have a strong preference for domestic industry, as most tenders require localisation or undefined technical compatibility with existing equipment. This view is also shared by one of the stakeholders consulted, who had rather negative experiences with the EU-Korea FTA. The stakeholder reported a slow transposition of Korea's commitments into national law and complained that even after transposition, localisation requirements were sometimes included in tenders. Moreover, procurement rules are considered not to be transparent at all despite South Korea's membership in the WTO's GPA agreement.

**USA**

The domestic market for railroad and rolling stock is estimated to total USD 19 billion in 2016. Large foreign OEMs from Europe (Alstom, Bombardier, CAF USA, Siemens, Skoda, and Talgo) and Japan lead the USA market and have established production facilities in the USA due to Buy American rules. Especially firms at the lower tiers of the supply chain are American.

Main barriers observed in the USA are:

- Buy American rules can constitute a non-tariff barrier[178] but are often a lifeline for the US industry[179];
- Foreign OEMs are encouraged to establish domestic production facilities in the USA[180];
- the USA have very specific technical standards, especially for main line due to freight being the dominant service;
- Negotiations on the Transatlantic Trade and Investment Partnership (TTIP) halted, with the last negotiation round taking place in October 2016. However, in a joint USA-EU statement, following President Juncker's visit to the White House in July 2018, both countries agreed to launch a close dialogue on standards in order to ease trade, reduce bureaucratic obstacles, and slash costs.[181]

Buy America rules apply to public procurement and procurement using public funds. In terms of the RSI this comes among others from the Federal Transit Administration (FTA), the Federal Railroad Administration (FRA), Amtrak, and state or local governments using federal funds (some states might also have similar laws for state-funded purchases). Buy America entails the following requirements:

- For both the FRA and FTA: steel, iron, and manufactured goods used in the project must be produced in the United States. Price thresholds: for the FRA above USD 100,000 and for the FTA above USD 150,000;

---

177 Commission (2017) - Evaluation of the Implementation of the Free Trade Agreement between the EU and its Member States and the Republic of Korea, Interim Technical Report Part 2: Stakeholder Consultation Report.

178 UNIFE (2017) UNIFE – Annual Report 2017.

179 Erik R. Pages, Brian Lombardozzi and Lindsey Woolsey (2012) The Emerging U.S. Rail Industry: Opportunities to support American manufacturing and spur regional development.

180 With this, the USA artificially reinforces its "weak" industry to create (temporary) employment with local content requirements. Currently this is at 60%, but it will rise to 70% in 2020. For big companies this is manageable, but SMEs struggle since they cannot open branch offices.

181 http://europa.eu/rapid/press-release_STATEMENT-18-4687_en.htm.

- For Amtrak: (1) unmanufactured articles, material, and supplies must be mined or produced in the United States; and (2) and manufactured articles, material, and supplies must be manufactured in the United States substantially from articles, material, and supplies mined, produced, or manufactured in the United States.[182]

Procuring entities can apply for a waiver under various circumstances such as that US goods are not produced in sufficient quantity or quality to meet project needs, US rolling stock or power train equipment cannot be delivered within a reasonable time or domestic material will increase the cost of the overall project by more than 25%. These waivers are subject to a case-by-case review and can take up 6 to 12 months.[183] However, as signatory to the GPA, the USA has to treat goods, services, and suppliers of other signatory countries over a certain dollar threshold no less favourably than USA ones ("national treatment"). Nevertheless, Amtrak is not an entity covered by the GPA[184] and procurement at state and local level are also not covered by it, which has caused considerable tension with trading partners such as Canada and the European Union. Under the Trump administration, Buy American rules were extended. The US administration asked federal agencies to promote the purchase of American-made materials by contractors working on infrastructure projects that receive federal grants or loans and to minimize the use of waivers.[185]

**Russia**

The Russian market is considered to be more open than some of the relatively closed markets, like Japan, Korea or China. Especially when being active on the market via joint ventures with local partners, little restrictions seem to be present.

Main barriers to enter the Russian market are:

- Existing localisation requirement and an entirely normative environment;
- 'Buy Russian' act which since July 2014 restricts public procurements in various sectors including Imported vehicles and Radio-electronic products (includes since July 2017 also electronic signalling devices for traffic safety);
- Russia is not a member of the GPA agreement.

One stakeholder remarked that issues related to cybersecurity and IP protection play an important role.

Other notable observations include:

- UNIFE is cooperating with their Russian counterparts (NP UIRE) on technical standards and compiled a Glossary of Railway terms;[186]
- In discussion of joining the GPA, but Russia appears to be turning away from WTO principles.[187]

**India**

India is considered one of the future growth markets and drivers of demand for the rail supply industry[188] (see also section 6.2.1, opportunities in emerging markets). According to UN COMTRADE data, the EU was the second biggest exporter to India in 2018.[189] Companies like

---

182 United States Department of Transportation - Buy America Provisions. Available at: https://www.transportation.gov/buy-america-provisions-side-side-comparison.

183 Federal Railroad Administration – FRA Buy America and Related Requirements. Available at: https://www.fra.dot.gov/Elib/Document/3372.

184 See Annex 1 of the USA's coverage schedule under the revised GPA. Available at: https://www.wto.org/english/tratop_e/gproc_e/gp_app_agree_e.htm.

185 Congressional Research Service (2017) Effects of Buy America on Transportation Infrastructure and U.S. Manufacturing: Policy Options.

186 Ibid.

187 Office of the United States Trade Representative. Annual Reports on China's and Russia's WTO Compliance. Available at: https://ustr.gov/about-us/policy-offices/press-office/press-releases/2018/january/ustr-releases-annual-reports-china.

188 Andreas Schwilling (Roland Berger) at the 3rd meeting of the Commission Expert Group on Competitiveness of the rail supply industry, 24 October 2018.

189 https://comtrade.un.org/db/dqBasicQueryResults.aspx?cc=86&px=HS&r=699&y=2018&rg=1&so=9999.

Alstom, Siemens and Bombardier Transportation established sites in India specifically in the metro segment. British companies won 22, French 22, German 8 and Spanish 4 contracts out of a total of 104 between 2003 and 2013.[190]

Still, some barriers to enter the Indian market remain present:

- Price preference for local suppliers in government contracts and government procurement practices and procedures vary among the states[191];
- India's new public procurement law (2017) promotes Indian suppliers with local content requirements of 50%;
- India is not a member of the GPA agreement;
- India uses broad track gauges (1676 mm), different from the standard gauge (1435 mm), which is more common in Europe.[192]

According to one stakeholder, the complex standards also make the market difficult to access. On the other hand, one stakeholder that is active on the Indian market does not consider any major barriers to be present in India.

Notable observation on India:

- FTA negotiations between India and the EU were launched in 2007. Currently it is unclear if these will continue;
- 2017 "Make in India" initiative to promote local manufacturing[193].

**Sub-Saharan Africa**

The Sub-Saharan African (SSA) region shows a strong growth over the last years. In a 2016 study, UNIFE presents promising economic statistics for seven countries – Angola, Ethiopia, Ghana, Kenya, Mozambique, Nigeria and Tanzania – with expected economic growth rates between 4% and 18% for 2015 to 2020.

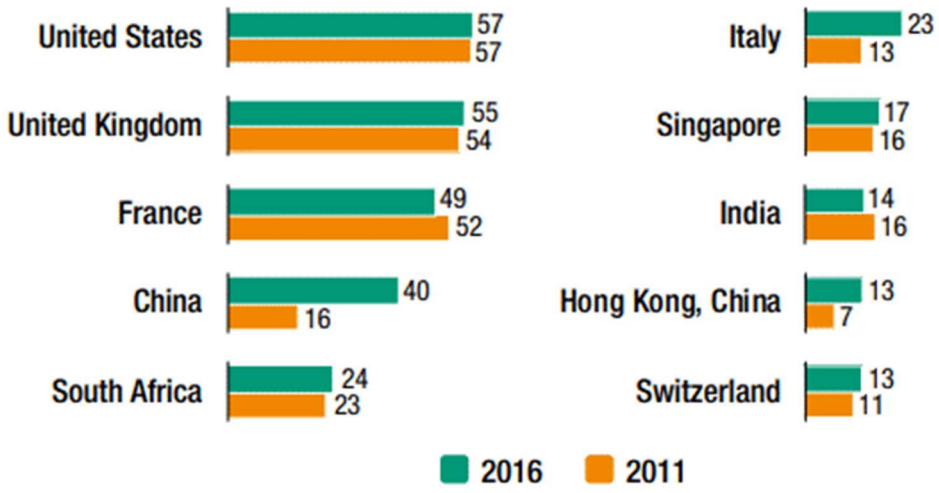
Railway networks are mainly small and disconnected, and due to the growing population and the economic prospects, several railway projects were announced recently. For instance, Nigeria and Ethiopia are developing plans for internal and cross-border railway projects. The total rail supply market is expected to witness a growth of 14% *per annum* until 2021. In particular, Nigeria, Tanzania and Angola account for 74% of the total SSA railway supply market. The primary demand for railways is for optimising freight transport. However, recently demand for passenger transportation rose as well, and SSA countries are considering the adoption of rail technologies from EU RSI.

Specific attention is needed for the role of China in the region. Since 2009, China was the main economic trade partner of the SSA, with transportation equipment as China's most important export product. Furthermore, infrastructure is one of the key investment sectors in SSA for Chinese firms. However, a decline is visible since 2014.[194] Chinese investment in African infrastructure projects fell by 77% to USD 3.1 billion (2.5% of China's total FDI). Next to the economic downturn, much of China's investment seems also to be directed to other regions. For example, Latin America received in 2017 USD 18 billion (compared to the 3.1 billion towards Africa).[195] Although China has a significant presence in SSA, there is still considerable scope for investment of European RSI. Overall, the total Chinese FDI stock in Africa increased substantially and is the fourth largest according to 2016 data (see Figure 103).

---

190 UK Trade & Investment (2013) India Metros: A High Value Opportunity for the UK Rail Sector.
191 https://www.export.gov/article?id=India-Trade-Barriers.
192 FICCI (2018) Railway sector – A key driver for 'Make in India' program.
193 http://www.makeinindia.com/about.
194 https://www.brookings.edu/blog/africa-in-focus/2018/09/05/chinas-2018-financial-commitments-to-africa-adjustment-and-recalibration/.
195 Brookings Institute (2018) China's 2018 financial commitments to Africa: Adjustment and recalibration. Available at: https://www.brookings.edu/blog/africa-in-focus/2018/09/05/chinas-2018-financial-commitments-to-africa-adjustment-and-recalibration/.

**Figure 103 Top 10 investor economies by FDI stock, 2011 and 2016 (Billions of dollars)**




Source: UNCTAD (2018) World Investment Report 2018.

Over the period 2018 to 2023, a steady growth of the African rail supply market is expected.[196]

**South Africa**

South Africa is a small market compared to the other markets presented above (both for stock and for infrastructure). In combination with the existing barriers to access, this makes the South African market a less attractive market. However, some European RSI companies have a strong foothold in South Africa. Most notably, Alstom which has been operating in the country for the past 100 years. Alstom's local joint venture company Gibela built a new construction site in 2016 and is tasked to deliver 600 metro trains over the next ten years.[197] Meanwhile, Siemens Mobility works together with the Passenger Rail Agency of South Africa since 2011 in installing intelligent signalling systems in South Africa.[198]

Main barriers in South Africa are:

- Industrial Action Plan is pushing for Rail to become the backbone of South African transport and mobility by 2050. The plan takes it lesson from Chinese industrialisation strategy and supports local manufacturing;[199]
- Minimum local content thresholds for public procurement are set as part of the Industrial Action plan, Rail recapitalisation programme:[200]
  - Rail signalling 65% minimum local content;
  - Diesel locomotives 55%;
  - Electric locomotives 60%;
  - Wagons 80%;
  - Electric Multiple units 65%.
- South Africa is not a member of the GPA agreement.

196 UNIFE (2018), World Rail Market Study: forecast 2018 to 2023.
197 RFI (2019) Investing in South Africa's railway network. The French connection and 2030 goals. Available at: http://en.rfi.fr/africa/20190513-france-south-africa-railway.
198 Railway Technology (2019) Siemens deploys signalling system in three South African stations. Available at: https://www.railway-technology.com/news/siemens-intelligent-signalling-system-south-african-stations/.
199 http://www.engineeringnews.co.za/article/rail-to-form-backbone-of-south-african-transport-mobility-by-2050-2018-10-11/rep_id:4136.
200 Industrial Action Plan 2018/19 – 2020/21. Economic sectors, employment and infrastructure development clusters, p.44. Available at: https://www.gov.za/st/node/779706.

One stakeholder did not consider the barriers problematic. Localisation requirements and the Black Economic Empowerment framework apply to all actors and no "national champions" exist that would be favoured by this. For example, Alstom owns Gibela together with its African partner Ubumbano Rail and recently Russian rolling stock group Transmash holding opened its first factory in South Africa together with its 'black economic empowerment partner' Mjisa Investments.[201] Moreover, the Industrial Action Plan pushes also for more infrastructure investment, creating opportunities for European suppliers active in South Africa.

**Overall**

Various countries have plans in place to support local production, mostly in the form of 'Buy from home-country' programmes, moving to more local content requirements and less imports. Some countries have even tighter regulations to limit market access for foreign suppliers. As a consequence, export markets have significantly shifted with the very low accessibility of the Chinese market to the Middle East, Central Asia and Latin America.

Overall, a negative trend can be observed with many countries establishing market access barriers with localisation requirements and industrial policies that heavily support and favour their industries on the domestic and on third markets. Some suggestions to address the lack of market access and absence of a level playing field are:

- Investigating whether third countries' subsidies are compliant with WTO or EU rules;
- Ensure that more countries join the GPA;
- Secure bilateral FTAs and follow-up on their implementation;
- Ensure that export finance does not distort competition;
- Promote EU standards globally.

In terms of future international policies, the best way forward may be the proposed International Procurement Instrument, which would be effective in incentivising other countries to offer reciprocal market access. As a plus this instrument is fully up to the EU and does not rely on third parties approval. Bilateral or multilateral negotiations can achieve the same, but require more time. At the same time negotiations can cover more than just procurement. An in-depth investigation on national subsidies should also be undertaken. Further EU actions should be to continue working on the accession of third countries to the WTO GPA Agreement and to improve the monitoring of the implementation of existing FTAs as well as the identification of market access barriers.

Especially SMEs have difficulties in accessing international markets. As a result, continuation of support instruments for SMEs, such as the EU-Gateway programme[202] and the European Commission's Foreign Partnership Instrument, should be ensured.

## 5.6. Foreign Direct Investment

Foreign Direct Investment (FDI) can be seen as an opportunity, but also as a threat to Europe's rail supply industry. It is an opportunity, because it can bring much needed investments into the development of new plants, production lines and infrastructure. For instance, Hitachi's acquisition of Ansaldo Breda and Ansaldo STS and the subsequent formation of Hitachi Italy is an example of successful FDI. Another one, albeit more mixed due to several restructurings and closure of plants, are the investments of Bombardier Transportation in Europe. That FDI can also be perceived as a threat is depicted by the recent debates about foreign investment screening. A new European Foreign Investment Screening framework entered into force April 2019. The goal of this new framework is to monitor investments and safeguard Europe's security, public order and strategic interests. This framework was conceived against the backdrop of increasing Chinese investments

[201] Railway Gazette (2019) TMH Africa inaugurates South African plant. Available at: https://www.railwaygazette.com/news/business/single-view/view/tmh-africa-inaugurates-south-african-plant.html?sword_list[]=south&sword_list[]=africa&no_cache=1.

[202] In 2017, SMEs from the rail supply industry participated as the key sector in the Gateway business mission to Japan.

in Europe. Fearing that investments might endanger the EU's critical infrastructure and technology it was decided to monitor these developments more closely.

FDI stocks held by third countries in the EU amounted to EUR 6,295 billion in 2017.[203] However, exact numbers on FDI into the rail supply industry are not easy to come by. A recent Commission Staff Working Document on FDI in the EU[204] provides some insights into foreign ownership based on a new database consisting of firm-level data. Overall, the document shows that the traditional main investors (advanced economies) in the EU remain well ahead, but also the emergence of new investors among them China. No railway related NACE category falls under the top 20 in terms of share of non-EU controlled firms and assets in the EU. However, both Land Transport and Manufacture of other transport equipment have seen strong increases in share of foreign owned assets in 2015-16 compared to 2007-08. The former increased by 278% and the latter by 100%. In the segment of Civil Engineering foreign ownership increased by 38%.

An in-depth look into Manufacture of other transport equipment reveals for Manufacture of railway locomotives the following distribution of foreign owned assets per region[205]:

- Australia and New Zealand: 0%;
- Central and South America: 0%;
- China, Hong Kong and Macao: 0.1%;
- Developed Asia (Japan, Singapore, Taiwan, Korea (ROK)): 1.6%;
- EFTA: 0.9%;
- Gulf Countries: 0%;
- India: 0.3%;
- Offshore Financial Centres: 0.6%;
- Other Middle Eastern Countries and Turkey: 0%;
- Rest of the World: less than 0.05%;
- Russia: less than 0.05%;
- USA and Canada: 40.7%.

In total, the European railway locomotives segment had eight mergers or acquisitions deals between 2015-2017 from foreign based companies, four of which came from the USA and Canada category. A notable one was the acquisition of the French railway system provider Faiveley Transport for EUR 1.7 billion by the US company Wabtec in 2016. The acquisition created a rail equipment company with revenues of about USD 4.2 billion. This trend of consolidation in the industry seems to continue as the recent news announcing that CRRC is to acquire Vossloh Locomotives. This would be CRRC ZELC's first acquisition of a European company. [206]

[203] European Commission - Press release. Foreign Investment Screening: new European framework to enter into force in April 2019. Available at: http://europa.eu/rapid/press-release_IP-19-1532_en.htm.
[204] SWD(2019) 108 final.
[205] Note: Unfortunately, the report provides no detailed data on civil engineering.
[206] International Railway Journal (2019) CRRC to acquire Vossloh Locomotives. Available at: https://www.railjournal.com/financial/crrc-to-acquire-vossloh-locomotives/.

**Box 2 Trends in mergers and acquisitions**

**Trends in mergers & acquisitions**

In the Ecorys' 2012 RSI competitiveness study, a steadily increasing process of consolidation was observed in the sector. Three Western market players – Bombardier, Alstom and Siemens – had a leading role in the industry, while Chinese manufacturers CSR and CNR completed the top five.

A 2016 report by McKinsey indicated that key industry players were increasingly engaged in M&A transactions and growing in size, with OEMs increasing their overall market shares. Most important was the merger between two Chinese key railway supply manufacturers, CNR and CSR, in 2015 into the CRRC. This created a system integrator with a turnover in 2015 of about EUR 30 billion larger than the turnover of Alstom Transport, Bombardier Transportation and Siemens Mobility combined (circa EUR 21 billion).

Also, Hitachi's acquisition of Ansaldo Breda could have impact on the hierarchy of competitors on the European market, while a merger of Siemens and Alstom could have further upset the hierarchy.

Consequently, shifts are expected in the industry and competitive landscape. The global rolling stock industry is under consolidation pressure given the large overcapacity issues that it has long been plagued by. Moreover, consolidation is taking place both horizontally and vertically. Both types of integration put increased pressure on SMEs in the industry, who are increasingly forced to opt for either leaving the market or being acquired by a larger competitor (McKinsey, 2016).

Given the high levels of underutilisation of capacity in production facilities in Europe (40%), North America (40%) and Asia (60%) reported by McKinsey further consolidation is seen as the most likely scenario for the coming years.

*Sources:*
McKinsey (2016), Huge value pool shifts ahead - how rolling stock manufacturers can lay track for profitable growth;
VDB (2017) Die Bahnindustrie in Deutschland - Zahlen und Fakten zum Bahnmarkt und –verkehr;
European Commission (2019)
Press release: Mergers: Commission prohibits Siemens' proposed acquisition of Alstom, Brussels, 6 February 2019, on: https://europa.eu/rapid/press-release_IP-19-881_en.htm.

## 5.7. Innovation

### 5.7.1. *Investment in R&D&I*

The Sector Overview and Competitiveness Survey of the Railway Supply Industry (2012; Ecorys) signalled that the EU RSI sector is challenged to stay on the leading edge of technology. This message has remained valid over the years. Rail 2050 Vision - Rail the Backbone of Europe's Mobility (2017; ERRAC) echoes this message of the rail sector needing to continue to invest in RDI and requiring strategic support through policies at national and EU level. An estimated investment over the next 30 years of about EUR 250 billion in total is expected to be needed, according to the Rail 2050 vision. This is accompanied with a call for public funding, both at EU and national level, since investments from financial markets are discouraged due to significant risks, but firms' cooperation and commitment is needed. The EU rail supply industry invests in R&D&I up to 3.6% of its annual turnover.[207]

As of 2021, Horizon 2020 will be succeeded by Horizon Europe, a similar research and innovation programme with a total proposed budget of EUR 100 billion. Continued joint R&D&I activities under this upcoming Horizon Europe in form of a Shift2Rail 2 are supported by stakeholders.[208] The continuation of this collaborative research-model should be continued under Horizon Europe. Moreover, instruments facilitating the deployment of the innovative technologies developed within the Shift2Rail should be explored. For instance, connected autonomous vehicles (CAVs) or the increasing success of new business models could be considered.

Supplementary requirements to ensure the targets of the 2050 vision are achieved, are:

[207] https://www.railwaypro.com/wp/shift2rail-2-to-decisively-contribute-to-eu-wide-objectives-fulfilment/.
[208] https://www.railwaypro.com/wp/shift2rail-2-to-decisively-contribute-to-eu-wide-objectives-fulfilment/.

- European research and innovation system assuring continuity though fundamental and blue-sky research, applied research, etc. over many years;
- Strong cooperation between stakeholders;
- Integration from experts from other scientific disciplines and sectors;
- Effective cooperation with other modes of transport.

The R&D requirements have been specified in a range of measures. These include:

- Substantially increase the European funding instruments for RDI (e.g. PPP projects like S2R);
- Put in place simple and accepted mechanisms to coordinate shared objectives for RDI projects at private, EU, national and regional level in FP9;
- Enable and incentivise a much shorter time to market (integrated research and innovation ecosystem, phasing out of obsolete technologies, promote virtual, risk-based and rapid prototyping and testing);
- Attract, develop and retain highly-skilled staff, managers, engineers and researchers;
- Maintain strong links with academic institutions and foster collaboration with specific RDI programs;
- Promote centres of excellence fostering a high participation in knowledge networks allowing for cooperation between stakeholders and technology transfer;
- Maintain leading edge design, manufacturing, and system integration capabilities;
- Maximise component-driven development and modularised products for the rapid deployment of innovation (focus on disruptive technologies), agile development approaches (hackathons, open-labs).

While international data on RD&I investment is limited, information on patents (see section4.2.8, R&D, patents and industrial designs) clearly shows China's investment efforts. This picture is confirmed by the interviewees, who all note that Chinese RSI companies perform a lot of R&D. For instance, CRRC invested more than USD 9 billion in science and technology development over the last five years, representing 5.34 percent of company's total investment.[209] The apparently huge yearly Chinese investments are focused on reducing costs (and indirectly price). Currently, European companies still have the technological advantage, according to stakeholders, but China is improving their skills and technology.

One stakeholder observed national industrial policy initiatives, like Italy's industrial policy "Industria 4.0", led to a general improvement in productivity within the sector due to greater automation in routine tasks and investments in training and upgrading of personnel.

### 5.7.2. *Shift2Rail*

EU Regulation No. 642/2014 established the Shift2Rail Joint Undertaking. The Regulation tasks S2R to manage all rail-focused research and innovation actions co-funded by the EU. Its task is to find market-driven solutions by accelerating the integration of new and advanced technologies into innovative rail product solutions. S2R promotes the competitiveness of the European rail industry and meets changing EU transport needs (Shift2Rail: 2014, pg. 4).

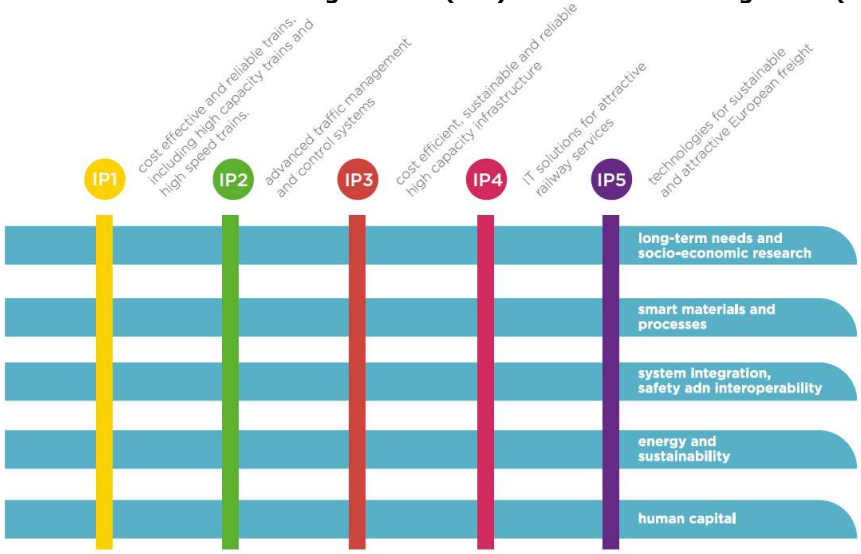
S2R seeks to develop, integrate, demonstrate, and validate innovative technologies that uphold the strictest safety standards and the value of which can be measured by the following KPIs:

- 100% increase in rail capacity, leading to increased user demand;
- 50% increase in reliability, leading to improved quality of services;
- 50% reduction in life-cycle costs, leading to enhanced competitiveness;
- Removal of technical obstacles holding back the sector in terms of interoperability and efficiency;
- Reduction of negative externalities linked to railway transport, in particular noise, vibrations, emissions and other environmental impacts.

[209] Railway Pro (2018) CRRC invested USD 9 billion in R&D projects. Available at: https://www.railwaypro.com/wp/crrc-invested-usd-9-billion-rd-projects/.

The work conducted within the S2R framework is structured around five asset-specific Innovation Programmes (IPs), covering the different structural (technical) and functional (process) sub-systems of the rail system:

**Figure 104 S2R Innovation Programmes (IPs) in five cross-cutting areas (CCA)**




Source: Shift2Rail (2014) Multi-Annual Action Plan.

These five IPs are supported by work in five cross-cutting areas (CCA) covering themes that are of relevance to each of the projects and which address the interactions between the IPs and the different subsystems. By the end of 2017, EUR 333.2 million had already been invested in R&I activities by the partnership. Tangible results of these investments were shown at the InnoTrans trade fair in 2018 with the presentation of 20 different solutions, among these were:

- An Interoperability Framework that provides real-time information enabling the planning, booking and purchasing of multimodal trip allowing for seamless door-to-door travel;
- Smart Metering for Railway Distributed Energy Resource Management System, which assesses energy efficiency and flows in rail systems and thereby make networks more energy efficient;
- The digital test brake, which avoids manual check of brakes and thereby makes mandatory checks faster and more efficient;
- A wireless system that gets rid of many of today's needed cables on trains while ensuring the functioning of safety-critical train functions;
- Computer simulations that are able to assess differences in noise and vibration levels, thereby allowing manufactures to find solutions that avoid unnecessary noise and vibration.

The expected economic benefits of reaching the S2R targets through focused and coordinated R&I include[210]:

- An indirect leverage on industry R&I related to the development of industrial products exploiting H2020 innovations, worth up to EUR 9 billion between 2017 and 2023;
- Creation of additional GDP at EU level worth up to EUR 49 billion between 2015 and 2030;
- Creation of up to 140,000 additional jobs between 2015 and 2030;
- Additional exports worth up to EUR 20 billion between 2015 and 2030 due to the worldwide commercialisation of new rail technologies;
- Life-cycle cost savings worth around EUR 1 billion in the first ten years and then, through continued implementation, worth around EUR 150 million per year.

The innovation principle entails taking into account the impact on research and innovation in the process of developing and reviewing regulation in all policy domains. Bearing this in mind, standards and standardisation are highlighted under the Europe 2020 strategy as pivotal in

[210] These benefits where identified when performing an impact assessment of the S2R JU proposal.

supporting the EU's research and innovation activities, pointing them out as necessary to eliminate technical barriers to trade and increase market access, ensure interoperability and reduce the risk of "lock in" to proprietary solutions and to create certainty and confidence for users to adopt new technologies. As within the intricate European railway system no change can be made to a subsystem without carefully checking the potential consequences for other stakeholders, the foreseen research results of S2R are ambitious as they will need the wide agreement of the whole sector. Currently, S2R is closely working with the standardisation bodies in Europe and with the European Union Agency for Railways and actively contributing to the Rail Standardisation Coordination Platform for Europe[211].

The Shift2Rail Joint Undertaking (S2R JU) has a positive impact on the competitiveness of the European rail industry and meets changing EU transportation needs. Research carried out under this Horizon 2020 initiative develops the necessary technology to complete the Single European Rail Area (SERA). Through railway research and innovation, S2R JU provides the capabilities to bring about the most sustainable, cost-efficient, high-performing, time driven, digital and competitive customer driven transport mode for Europe.

### 5.7.3. *Potential of digitalisation*

Four digitalisation trends are deemed most relevant within RSI in the coming years: improved multimodal transport, business opportunities due to new products, efficiency improvements due to digitisation and the threat of driverless cars and trucks. [212]

The recognition of digital transformation as an important driver in the RSI is shared in European Institutions as well as among industry stakeholders. Currently, digital technologies already govern rail customers' expectations, ticket reservation and purchasing habits, operators' information, and payments systems; but experts believe these technologies have much more to offer the sector.[213] For example, according to UNIFE, the deployment of digital and enabling technologies in rail are lacking behind other transport modes.[214] Indeed, although innovations are implemented in the rail supply industries, the score for the transport equipment sector on the index of digital intensity was relatively low in 2017.[215] Results from a survey among rail supply industry executives indicate that this might be due to the following reasons: high implementation costs of new technologies, remaining questions of ownership and use of data (need for a standardised approach), issues of data and cyber security, and a lack of digital skills.[216]

Nevertheless, overall digital transformation is seen as a necessary step towards a mature rail supply industry and rail transport network. As it can improve manufacturing, operations and maintenance. Rail companies and infrastructure managers view digital transformation as a lever to improve their efficiency and management, lower their operating costs, and enhance their competitiveness with other transport modes. Rail companies and their suppliers launched investments, start-up incubators and research to develop new digital solutions to run their businesses. It is likely that digital transformation will further offer new opportunities to rail transport actors, for instance in asset management, operations or the role of users, and contribute to the emergence of new players in the rail market.

Main goals of digital transformation of trains are the improved efficiency of operations and serving the customer more effectively. For example, customers are served better through internet connection on the train and interactive applications for services, such as reservations, ticketing, timetables, and real-life information. Opportunities also arise for train manufacturers, such as remote monitoring, real-time diagnostics of rolling stocks, and predictive maintenance. This can be done, for instance, through the use of smart sensors. This, for instance, allows train operators to reduce the fleet reserves they always have to keep in case of defaults, and increases their effectiveness and reliability. Infrastructure managers too will be able to optimise the exploitation

---

211 DG MOVE launched the Rail Standardisation Coordination Platform for Europe (RASCOP) in 2016. The platform gathers all relevant stakeholders from industry and the EU.
212 UNIFE 2018 RSI Study.
213 European Parliament (2019), Digitalisation in railway transport, http://www.europarl.europa.eu/RegData/etudes/BRIE/2019/635528/EPRS_BRI(2019)635528_EN.pdf.
214 UNIFE (2019) UNIFE Vision Paper on Digitalisation. Digital Trends in the Rail Sector.
215 https://ec.europa.eu/digital-single-market/en/integration-digital-technology.
216 Roland Berger (2017) Rail supply digitization.

of big data obtained for the nowcasting and forecasting of infrastructure conditions and reduce their maintenance costs.

Rather than putting forward legislation or programmes dealing exclusively with rail digital transformation, the EU has adopted broader cross-sector initiatives and projects that can contribute to this process in the rail supply industry. In 2010, the European Commission presented the digital agenda as one of the seven pillars of the '**Europe 2020 strategy**'. Aiming at exploiting ICT more effectively to create growth, it underlined their potential to contribute to more efficient and sustainable intelligent transport systems. In 2010, the EU provided one of the first measures of digital transformation applied to transport. The co-legislators adopted a framework to deploy innovative technologies, known as intelligent transport systems (ITS), in road transport as well as in its interfaces with other transport modes, and identified priorities such as EU-wide multimodal travel information.

In 2016, the European Commission put forward in its '**Digitising European Industry**' communication a common strategy to take digital transformation forward and unlock the potential of the 4th industrial revolution. With the creation of a European platform of national initiatives, the strategy spurred 15 national initiatives in countries such as Germany (Industrie 4.0), Sweden (Smart Industry), France (Alliance pour l'industrie du Futur) and Italy (Industria 4.0). However, the original 'Digitising European Industry' communication mentions the transport sector very briefly, limiting itself to the subject of automated driving. It also highlights the importance of deploying and taking up high performance internet networks in all economic sectors and in particular in transport. In relation to this topic, the European Commission introduced a new strategy on connectivity in a September 2016 communication '**Connectivity for a competitive digital single market – Towards a European gigabit society**'. Referring to transport, the strategy sets a Gigabit connectivity objective for 2025 for all main transport hubs, to facilitate the use of intermodal transport, based on innovative applications. Additionally, it proposes to support the coordinated development of the fifth generation of mobile telecommunication technology (5G) networks and sets the objective of covering all major terrestrial transport paths (railways, motorways and roads) and urban areas with 5G. The 2017 '**Council conclusions on the digitalisation of transport**' takes a more direct focus on transport and rail by encouraging Member States and stakeholders to further deploy European rail traffic management system (ERTMS)and encouraging data sharing between railway and logistics sector to improve the competitiveness of rail freight.

An important example of beneficial digital transformation specifically aimed at the railway industry is the **ERTMS**. In the EU, there are currently more than 20 signalling systems, a situation that can cause technical or operational issues at borders. Trains must be equipped with at least one system but sometimes more. To overcome this shortcoming, the EU decided to develop, adopt and deploy a single control, command, signalling and communication standard, the ERTMS, establishing an interoperable rail framework across EU territory. Digitalising CCS and traffic management systems often goes hand-in-hand with ERTMS deployment. A recent study commission by ERA[217] showed that out of nine analysed European countries[218], all have digital transformation programs. These programs aim at the deployment of digital based CCS-systems, which often includes the implementation of ERTMS.

Despite its advantages, ERTMS rollout across Member States is slow compared to its target of full deployment on the Core Network Corridors by 2030 (See Figure 105). The ERA study argues that this is due to a lack of knowledge on digital based CCS-systems as well as a natural reaction by government and infrastructure managers to lean to the safe, low-cost and known options. Consequently, the outcome is a patchwork of quick, low-cost and short-term solutions and the translation of national and analogue train safety philosophy into ETCS with each country developing its own ETCS adaption. The following recommendations were provided:

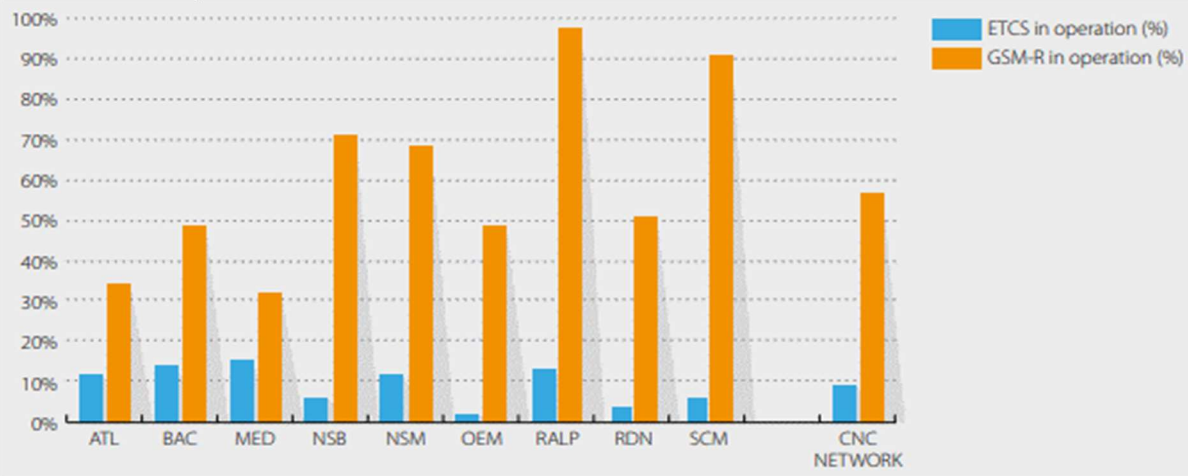
- Work towards a standardised CCS-system to initiate a new signalling and control philosophy, taking into account all new technological possibilities:

[217] ARCADIS (2018) Feasibility Study Reference System ERTMS. Digitalisation of CCS (Control Command and Signalling) and Migration to ERTMS.

[218] These countries were the UK, France, Belgium, the Netherlands, Germany, Switzerland, Italy, Norway and Denmark. Australia was included in the study as well and also has a digitalisation program.

  - With a simplified system architecture, a common (European) set of operational rules and a lingua franca for person-to-person communication.
- Consider onboard ETCS as part of trackside:
  - Currently, infrastructure managers and operating companies/railway undertakings have different business cases with the latter not being eligible for subsidies for deployment, which leads to onboard deployment of ETCS lagging behind trackside deployment.
- Support training of workforce:
  - The fundamental change towards digital requires an update of knowledge and skills and a common understanding of the potential of digital based CCS-systems.
- Stronger mandates and more resources for ERA:
  - In order to achieve a standardised CCS-system a coordinator with authority is needed.

**Figure 105 Percentage of core network corridors equipped with ETCS and GSM-R in operation in SERA as of 1 May 2018**




Source: European Union Agency for Railways (2018) Report on Railway Safety and Interoperability in the EU; TENtec database. Notations: ATL=Atlantic Corridor, BAC= Baltic-Adriatic Corridor, MED=Mediterranean Corridor, NSB=North Sea-Baltic Corridor, NSM=North Sea-Mediterranean, OEM=Orient/East-Med Corridor, RALP=Rhine-Alpine Corridor, RDN=Rhine-Danube Corridor, SCM=ScandinavianMediterranean Corridor.

Related to the second recommendation, CER remarks in its annual report that financing is still a big issue regarding ERTMS deployment especially for railway undertakings.[219] Similarly, in our stakeholder survey 91% of respondents support the notion that the EU and/or Member States need to increase their investments into the expansion of ERTMS, while 88% believe that further harmonisation and interoperability by for example supporting ERTMS rollout in Europe would support the growth of production in the sector and sector competitiveness.

Overall, multiple EU **funding instruments** (partially) focus on rail digital transformation (see the examples of Horizon 2020, the Digital Europe programme and the CEF above). The European Commission and the European Investment Bank recently launched the new CEF Transport Blending Facility, which provides EUR 200 million for the deployment of ERTMS (and development of alternative fuels). This blending facility serves also as a pilot for the next financing period.

For the rail sector, the digital transformation poses a **threat** and an **opportunity** at the same time. It can be seen as a threat because it transforms the roles and the business models. From a rigid value chain linking suppliers, integrators and end-users, the sector is evolving towards dynamic networks with added-value, joining suppliers, integrators, technological platforms, mobility service provider, and clients in permanent interaction. The potential benefits are as huge as its challenges. For instance, a study by Roland Berger estimates that the rolling stock

[219] CER (2019) CER Annual Report 2018.

maintenance costs as a major portion of operation costs or rail companies could be potentially lowered by 20% if digitization is properly understood and implemented.[220]

Aware of the opportunities and threats, UNIFE identified in 2016 the key role for the EU RSI in digital transformation as[221]:

| **Contribution to the Railway performance** |
|---|
| 1.Signaling solutions, with ERTMS/ETCS, and CBTC for urban rail; |
| 2.Traffic management systems to increase the capacity and make a better use of the network; |
| 3.Energy management solutions which is a high political priority; |
| 4.Digital based maintenance, with monitoring and diagnosing tools (incl. Development of sensors, asset management); |
| 5.Cyber-security, a needed complement of digitalisation; |
| 6.Physical security, and specifically Video system, including software image recognition, situational awareness; |
| 7.Communication solutions, including onboard safety related (TCMS); |
| 8.Use of Internet of Things; |
| 9. Big data applications, including business analytics. |
| **Improvement of end customer's satisfaction** |
| 1.Infotainment (internet on board); |
| 2.(Real time) passenger information solutions, new apps, new HMI; |
| 3.Seamless access to all travel services; |
| 4.e-ticketing and/or various rights to travel; |
| 5. Digital tracking/tracing applications (for freight and passengers). |
| **Internal digital transformation of the Railway manufacturing industry** |
| 1.Industry 4.0 with automation of production, of the supply chain and collaborative workplaces; |
| 2. Digital based design and/or production (Simulation, Collaborative design), virtualization. |

In 2019, UNIFE updated this position paper with its Vision Paper on Digitalisation, where the association calls for the continuation of the Shift2Rail Joint Undertaking under Horizon Europe and the establishment of a European platform on digitalisation in the rail sector. UNIFE also calls for the recognition of transport (and specifically rail) as being a key area for the digital transformation and it becoming a priority within the Digital Europe programme. In addition, the association identified five focus areas for the sector:

| **Five focus areas for the RSI according to UNIFE** | |
|---|---|
| **1. Big data** | - To clarify and increase the transparency regarding the way rail data is categorised, in order to promote a common understanding about which data should be shared between stakeholders;<br>- To set adequate rules to provide a framework for data and information-sharing across the whole rail sector;<br>- To streamline the exchange of data and develop a standardised communication system utilising several radio technologies. |
| **2. Cyber-security** | - The European Commission should continue to develop European legal framework and management system for detecting and addressing cybersecurity risks, including the implementation of the Directive on security of network and information systems (NIS Directive);<br>- To develop a cybersecurity culture, raising the awareness of risks and the acquisition of cybersecurity skills (incl. in the rail sector);<br>- To strengthen cross-sectoral cooperation and exchanges of best practice across all transport modes;<br>- Any European certification scheme to be developed by ENISA in the framework of the EU Cybersecurity Act must remain voluntary;<br>- To ensure the independence of safety application modules and network/operating systems, to maximise protection against cyber threats and also to minimise the maintenance costs of rail systems. |

[220] http://www.rolandberger.com/media/pdf/Roland_Berger_TAB_RailMaintenance_20160624.pdf.
[221] UNIFE (2016) Position Paper on Digitalisation of Railways, on: http://www.unife.org/component/attachments/attachments.html?id=737&task=download.

| Five focus areas for the RSI according to UNIFE | |
|---|---|
| **3. Artificial Intelligence** | - To scale up ambitions and resources for AI among the EU and its Member States, in order to develop the technologies that are necessary for Europe to compete with other leading players in the global economy;<br>- Recognition of rail transport as a strategic area for ambitious and ring-fenced investments in AI-based technologies;<br>- To support the development of AI-based technologies for autonomous driving of railway vehicles, as well as the establishment of test fields/tracks for assisted, automated and autonomous driving;<br>- To establish standardised certification processes for AI technologies in order to facilitate the deployment of AI-based solutions;<br>- To review relevant standards and regulations, taking the emerging role of AI-based technologies into account whilst also ensuring the highest possible levels of safety;<br>- To establish a common legal and ethical EU framework in order to foster the deployment of AI technologies in the transport sector in a fully transparent and responsible manner, which will also contribute to building confidence and trust. |
| **4. New Mobility Services** | - To put individual customer at the centre of the integrated and digital transport solution fostered by new mobility services. Rail, as the backbone of sustainable and multimodal transport, shall drive the development of a new mobility paradigm;<br>- To develop a new governance framework for the coordination of multimodal traffic management systems, giving priority to rail and other 'green' mobility modes. |
| **5. Digital transformation of freight logistic services** | - To support technological development of rail freight in order to integrate rail better within the multimodal and digitalised freight logistics chain;<br>- To develop a common legal EU framework to support the sharing of data and information among relevant parties in the logistics chain. |

**Manufacturing and design**

Digitalization can also benefit manufacturing and design, although still to a smaller extent if compared to the previous fields. Production volumes are still not comparable to those of the automotive industry, so robotisation has a limited impact on the production process efficiency. As shown in section 4.1, manufacturing of railway locomotives and rolling stock lacks behind the manufacture of motor vehicles in terms of indicators such as value-added, productivity and turnover. Moreover, in terms of investment per employee, rail lacks far behind automotive.Nevertheless, some benefits can still be obtained and investments seem to be increasing (See Figure 64). For example, Caggiano et al. (2014) developed a "3D Digital Reconfiguration of an Automated Welding System" to be applied to the production of boogie frames[222] and Alstom recently installed the highest-capacity welding robot of the rail industry. [223] On the one hand, these developments improve the precision and customization of the production process, but on the other hand, they may be too expensive when economies of scale or economies of experience are not reached.

To support the realisation of these economies of scale and economies of experience, a case for more standardization and modularization can be made. Modular production and more standardized designs[224] are two important steps that can allow train manufacturers to increase the use of robotisation in the production process, since they facilitate highly specialised robots to work on specific modules instead of requiring robots that perform a wide range of task in manufacturing for example a train.

Even if not yet widely established, the modularization has been under study for years and is already being implemented. One example is the MODBOGIE sub-project, led by AnsaldoBreda and supported by Politecnico di Milano. The project includes the definition, development and testing of interchangeable bogie components (dampers, wheel sets), focusing on full standardisation of

[222] Caggiano, A., Nele, L., Sarno, E., Teti, R. (2014). 3D Digital Reconfiguration of an Automated Welding System for a Railway Manufacturing Application. Procedia CIRP, 25, pp. 39 – 45.

[223] RailTech (2019) New welding robot will make parts of TGV trains, available at: https://www.railtech.com/digitalisation/2019/04/05/new-welding-robot-will-make-parts-of-tgv-trains.

[224] Shift2Rail, „Innovation Programme 5," 2019. [Online]. Available: https://shift2rail.org/research-development/ip5/; Shift2Rail, „Innovation Programme 1," 2019. [Online]. Available: https://shift2rail.org/research-development/ip1/.

overall dimensions and mountings.225 Modularisation has to some degree already been adopted by Hitachi Rail, which uses a standardized approach encompassing interior modules (such as ceiling, floor, and seats), outfitting modules (wires, pipes) and functional modules (the driver's cab module, the toilets modules) which are easy to assemble and substitute.226 Overall, modularisation makes it cheaper and facilitates replacing parts of rolling stock; thereby reducing maintenance and retrofitting costs, and thus making it easier for asset owners to upgrade and maintain their rail assets.

Standardization does not necessarily mean adjusting currently existing vectors, but it can also be driven by innovation and the development of new components, wagons, locomotives. In fact, even apparently small efficiency gains can yield substantial changes. For example, Rail Cargo Wagon has presented a new prototype of cargo modular prototype. By developing a new baseframe, the thickness of the steel structure was halved from 2cm to 1cm, resulting in a 20% lighter vector that can load four more tonnes of cargo.[227]

## 5.8. Overall conclusion

Several of the internally-focused policies had a positive impact on the global competitiveness of the EU RSI. Public investments in infrastructure, from EU funding instruments, such as EIB's investment, CEF and the TEN-T programme, as well as national investment allowed under the State aid framework have helped to stimulate demand for RSI products and the industry to remain dynamic. Nonetheless, there is still significant room for additional investment to meet the ambitions set out in plans, such as Rail 2050 vision, the Transport White Paper, TEN-T and SERA. As such, sector competitiveness has not received optimal support in the form of public infrastructure investments from all national governments.

Nonetheless, the sector managed to maintain a leading position globally thanks to various initiatives related to stimulation of R&D&I, e.g. by means of the S2R programme. This investment in R&D&I may be quite necessary in light of the significant investments taking place in other regions, most notably China. Initiatives in the field of digitalisation will support the RSI in maintaining the leading position in the near future.

Also contributing to the overall positive competitive position of the RSI over the past years has been the stimulation of the internal market, by means of domestic competition and public procurement on the basis of best-quality-price-ratio / most economically advantageous tenders. Both elements forces companies active in the RSI to keep improving their products. The competitiveness figures presented in the previous chapter underline the leading position of the EU RSI.

A lack of international level playing field and the limited market access to some regions limits the EU RSI to fully monetise its competitive position. Furthermore, despite EU common market and technical standards (like the implementation of ERTMS), which were promoted on a global level, having supported the EU RSI, geopolitical aspects related to standardisation, most notably the upcoming position of China in international standardisation, poses a challenge for the RSI.

---

225 European Commission, „Final Report Summary - MODTRAIN (Innovative modular vehicle concepts for an integrated European railway system)," 2011. [Online]. Available: https://cordis.europa.eu/project/rcn/74302/reporting/pl.

226 H. Rail, „Module Interior," [Online]. Available: http://www.hitachi-rail.com/products/rolling_stock/a_train/feature03.html.

227 I. R. journal, „Rail Cargo Wagon shows new modular wagon prototype," 2018. [Online]. Available: https://www.railjournal.com/freight/rail-cargo-wagon-shows-new-modular-wagon-prototype/.

# 6. STRATEGIC OUTLOOK

## 6.1. Future trends and positioning rail in the mobility and logistics system

### 6.1.1. *General Future trends*

There are many societal developments that will impact the future of the RSI. In Figure 106 the mobility related trends and their inter-relationships, as identified by the H2020 Mobility4EU, are summarised. The topics are described in the Mobility4EU report D2.1 which is publicly accessible through the project web-page[228]. In this section we will therefore not repeat all the descriptions of all these topics.

It should be noted that Figure 106 is focussing on the (context of the) mobility system as a whole, from which the position/share of rail will evolve. Some of the trends are favourable for rail where others are either neutral or may introduce new challenges.

Developments favourable for rail are:

- European integration;
- Harmonisation (legislation);
- Stricter regulation for environmental protection;
- Moving away from fossil fuels towards energy efficiency and renewable energy.

Developments introducing new challenges (requirements) for rail are:

- Personalisation of liquid modernity society[229];
- Acceleration and flexibility of liquid modernity society;
- Expectations of customers and digitalisation of mobility;
- New players and new business models;
- Diversifying approaches of governance (more coordination, involvement of business and civil society).

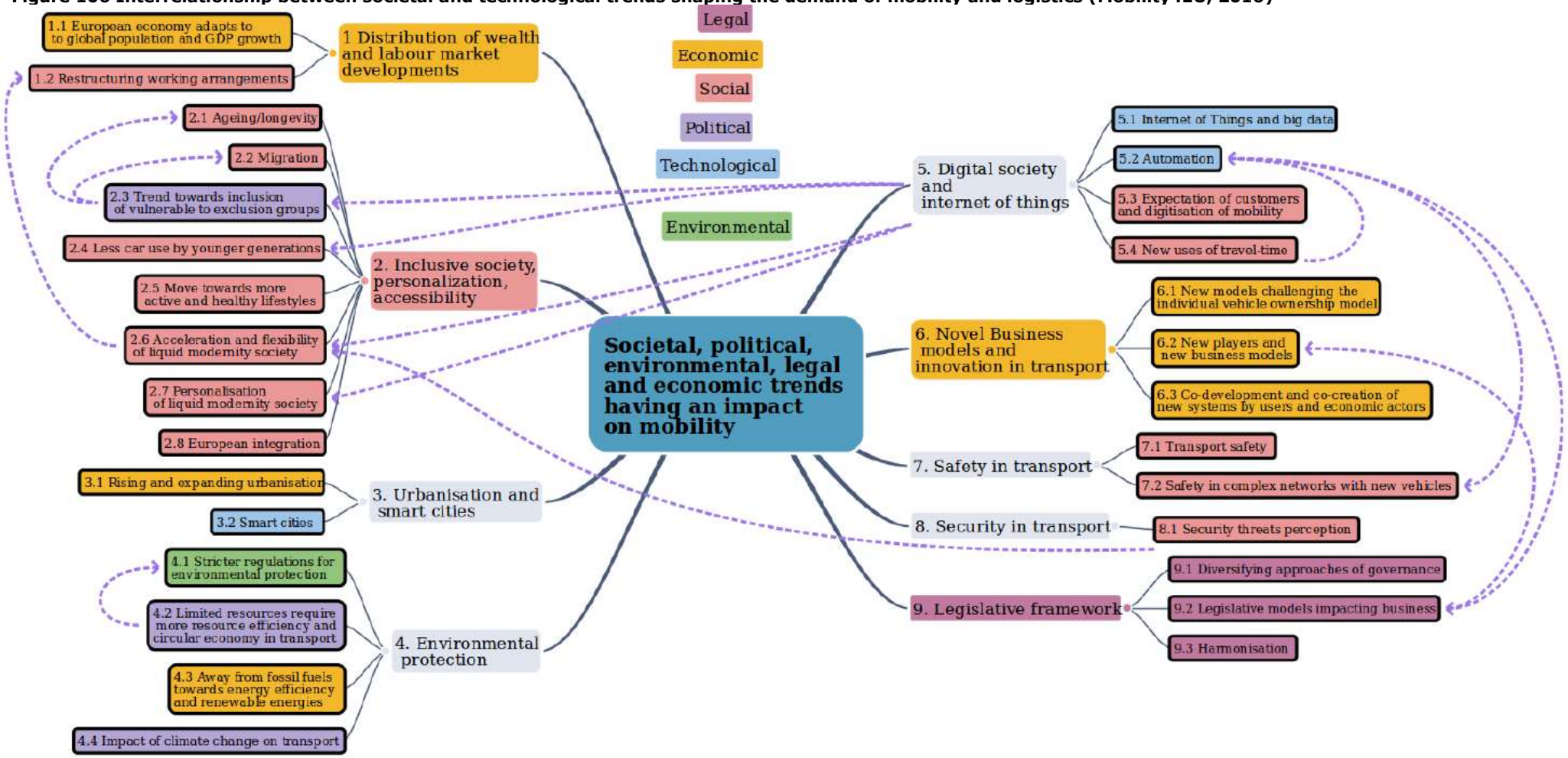
The other developments in the figure are of less interest in this context since they are:

- Generic requirements for new mobility services that already have to be taken into account for innovations;
- Influencing the relative share of market segments or the market size for rail and not the innovation requirements or potential.

[228] Mobilty4EU D2.1 web-link: https://www.mobility4eu.eu/?wpdmdl=1245.

[229] Liquid modernity (or late modernity) is the characterization of today's highly developed global societies as the continuation (or development) of modernity. It is marked by the global capitalist economies with their increasing privatisation of services and by the information revolution.

**Figure 106 Interrelationship between societal and technological trends shaping the demand of mobility and logistics (Mobility4EU, 2016)**



The favourable developments for rail are well known and taken into account in rail roadmaps already for some time. In particular most of the developments introducing new challenges and requirements for rail require some more explanation. In the following sections, we will discuss the related issues along the following topics:

- Digital transformation & Business models of the New economy;
- User orientation redefined;
- Relative speed of innovation of modes.

### 6.1.2. *Digital transformation & Business models of the New economy* [230]

New business models and business strategies which were shaped in the past years are being applied in a growing number of working areas. These business approaches take optimal benefit from the new technological possibilities and the acceleration of innovation. In the case of **'digitalisation'** the focus is on achieving efficiency gains within the current organisational structures. In the New Business model, however, the new technologies are applied in an innovative way replacing existing structures and removing traditional barriers and cost elements by automation, which is called a '**digital transformation'**.

Known examples of services using new business strategies are for instance Airbnb and Uber. Tim O'Reilly (2017) has generalised this 'Business model of the new economy' and differentiates the following key components:

- Information instead of material (for instance a smaller stock);
- Deliver a magical user experience (user needs plus something "unimaginable");
- On-demand service provision (when the user needs it);
- Design around network platforms (ICT platform with defined rules);
- Coordination is done by algorithms (no human intervention needed);
- Employees are supported by technology (technology instead of training/education);
- On-demand asset and labour management (no unused capacity possible).

Some practical implications of this approach are the following:

- Due to the significant cost reduction and service improvement that can be achieved simultaneously these services will disrupt traditional markets;
- Since use is made of a platform and decisions are made by algorithms, the rules for all involved are clear but still quite rigid. The platforms on which these services are offered, set the rules to be followed by the suppliers and users of services. Also quality monitoring of services delivered and fair pricing mechanisms based on real-time demand and supply information can be embedded;
- Ownership of assets is where possible avoided and is organised such that the risks for unused capacity is minimised and the organisation is resilient for fluctuations in demand;
- Availability of real time and integrated information is a key requirement for the business model. This is easier to establish when the whole process is in hands of one organisation rather than when cooperation of different entities is required;
- The likelihood of matching demand and supply is larger and therefore the service level higher, when more people make use of the same service; this creates a tendency towards a few large players dominating the market.

### 6.1.3. *Risk assessment for future rail: Exploration of possible implications of new business models in the transport sector*

In the following a high level exploration is described, using the characteristics of the upcoming new business models, which are applied to the transport services for different future automation levels. Since we are discussing disruptive innovations, a quantitative assessment with models based on historical patterns (data) is by definition not possible, but in these cases generally a combination of alternative methods is needed (National Research Council, 2010). For this

[230] This section is a shortened and slightly adapted version of an earlier published paper (Chen, M., 2018).

exploration we have chosen for a qualitative and deductive method and we only highlight the main tendencies resulting from this digital transformation. Policy interventions or alternative implementations and (rail) service innovations coming to market may radically change the perspective. **This exploration therefore should be merely seen as a risk assessment for the rail sector which can be used to target future R&I to mitigate the risks.**

First passenger mobility is described followed by logistics.

**Passenger Mobility**

For passenger mobility the availability of fully automated road vehicles (SAE level 5) opens up the door for radical changes in mobility. The earlier phase where automated road vehicles are only available on designated roads (SAE level 4) may create new options for inter-urban trips, but will for most still involve a first and last mile connection. Therefore, this is not expected to lead to radical changes for inter-urban trips as compared to the current mobility system (depending on price levels). It may imply additional alternatives though. The further assessment is thus done for the situation with fully automated road vehicles as competition for the available alternatives (including rail, metro, and tram).

Impact of the changing service levels will not be the same everywhere. In Table 40, a differentiation is made of the relevance of some key drivers for success for urban, inter-urban, and rural services.

**Table 40 Key drivers for success of mobility services**

| Drivers for PT options choice in the transition towards level 5 automation (future); 5=high relevance, 1=low relevance | | | |
|---|---|---|---|
| | urban | inter-urban | rural |
| low density will lose from new business models (not competitive) | 3 | 4 | 5 |
| low frequency schedules will lose share to on demand (even at some higer costs) | 3 | 4 | 5 |
| door to door is prefered over connecting rides (even at some higher costs) | 5 | 4 | 3 |
| limited supply of on demand (increased waiting time and higher costs) | 1 | 3 | 5 |

From this we can derive the market potential of the Public Transport (PT) options in these sub-markets, which is summarised in Table 41. Especially for rural areas dependency on the new PT concepts will be high since they are expected to replace the traditional low frequency/density services in these areas. This can lead to a better availability of PT than before; however, when prices are determined real-time based on demand/supply there is a risk that this goes together with higher prices. These higher prices may reduce the inclusiveness for lower-income groups with high PT dependence; which may lead to further urbanisation of this group. At the same time Connected Automated Vehicle (CAV) owners can increase their driving distances and may move to rural areas (CPB 2017).

For urban and inter-urban mobility shared CAV and on demand PT may take over part of the traditional PT especially where the densities are low and traffic volumes small. Also here driving distances are likely to get longer and the share of the motorised (or non-active modes) modes will increase. As such, the pressure on the road capacity will increase; especially for urban areas this may lead to complications due to limited availability of space (TNO 2018).

**Table 41 Indicative market potential of PT mobility services with fully automated road vehicles, without mitigating policy measures and rail R&I**

| Market potential of PT mobility options with level 5 automation (future); 5=high potential, 1=low potential | | | |
|---|---|---|---|
| services | urban | inter-urban | rural |
| On demand car | 5 | 3 | 2 |
| on demand bus (different sizes) | 3 | 2 | 4 |
| scheduled bus | 1 | 3 | |
| tram | 3 | | |
| metro | 3 | | |
| train | | 4 | 1 |

## Logistics

For Logistics (freight services) change can be expected already when level 4 automation is available since labour costs can drop significantly for especially medium to long distance services. Currently labour costs account in some countries for up to 50% of the total costs for road transportation (Panteia 2018). This will make it attractive to have logistical nodes and business activities in general, situated at roads where level 4 automated driving is allowed. Where this is not the case it can be an option to bring the truck to the nearest entrance point for the automated driving network and pick it up near its destination. This will be a competitive solution especially in cases where the driver also delivers other services.

Hubs/DCs may evolve at the edge of cities from where the city distribution is organised. Business activities in general (including shops) will favour locations situated at the 'level 4 automation network' to obtain a competitive cost advantage. Especially when completion of level 5 automation takes long, this may lead to shifts of logistic & business locations and creation of required facilitating physical infrastructure. Level 5 automation will make all locations equally attractive again. However, the expected increase of road use for passenger mobility leads to capacity issues, especially within cities. The (hub-oriented) network/facilities created in the period of level 4 automation might remain unchanged.

Within this transition new logistical business models/services will evolve, which will offer the services for which data is available in the system. Automation of the trucks and terminals will make the organisation lighter since less labour management is needed. Matching demand and supply can be done real time by algorithms and administrative processes (contracting, payment) can be automated as well. The more capacity is available in the system the more attractive offerings of the platform/service will be for the users. A large system could be established by combining the capacity of many different suppliers. However currently most companies are hesitant to cooperate and share the required data/information. In this situation, the larger global players such as Amazon and Alibaba, will be able to make a better offering and could push smaller players from the market.

Services can arise concentrating purely on making the required assets (trucks, terminals, etc.) available. The large logistical service platforms can cooperate with these asset providers which makes it possible to apply on-demand asset management and as such reduce their financial risks in periods of low demand. New specialised companies could arise for level 4 automated freight transportation for which mainly capital is needed and no labour force. Traditional trucking companies could be held back in a fast shift to automated trucks by the obligations towards their contracted drivers, but are better positioned to deliver the services where drivers are still needed (first and last mile, value added). Combined passenger mobility/city logistics vehicles/services could evolve in case of level 5 automation as concluded in the passenger mobility assessment.

The significant cost reductions by level 4/5 automation could have big implications for the modal split. Although the rail sector is also working on automation and improvement of quality of service, the timing of market readiness of the innovations will decide the direction of the modal shift (Smart-Rail 2018). Given the complexity of the rail system at this moment it seems likely that rail innovations are slower than for road. In the table below an estimate is given for each of the possible situations.

A cost reduction of road transport of 50% enables, in some cases, even a shift of bulk flows from rail to road. This could lead to increased road congestion where one of the intended targets of road automation is to reduce congestion. Development of the rail sector can be accelerated when use is made of technological developments made in other sectors such as the automotive sector (Smart-Rail 2018).

**Table 42 Balance between road and rail for different automation levels and rail service improvements (rail automation expressed in equivalent levels as for road)**

| Balance between road and rail for different automation levels and rail service improvements | | | |
|---|---|---|---|
| **rail vs road services** | **additional improvements rail** | **truck (level 3)** | **truck (level 4/5)** |
| **trains** | **none** | status quo | price for long distance road transport significantly reduced (20%-40%) and for rail slightly reduced. Small demand for combined services. More freight transport on highways. |
| **train (level 3)** | **shared logistical information system** | reduced risk for shippers and increase demand for combined services | |
| **train (level 4/5)** | **shared logistical information system, self organising rail system, automated terminals** | | Change price difference road/rail much smaller than above. Rail service information exchange, reliability and flexibility closer to road service quality. Integrated information system with rail terminals functioning like the future highway hubs. Potentially some more demand for combined services. |

### *Transport market and governance implications*

Many implications can be derived from this exploration of which a selection is listed below:

- The platforms and their algorithms determine many important aspects within the mobility and logistics sector. Especially in case of full automation a simple change of settings could make a large difference in mode choice, routes chosen, revenues of a specific asset provider, salaries earned by workers, and tax incomes of the government. These platforms and algorithms provide powerful steering mechanisms with predictable/certain and collective outcomes. Transparency of the algorithms applied is essential to be able to ensure fair market conditions and ethical decisions. Being able to influence these algorithms is also very interesting and even essential for policy makers; legislation can be designed to ensure the algorithms make socially desirable choices/decisions;
- The new business models/services tend to result in market domination by a few large players. As is currently the case with e.g. Uber and Lyft, these players could be global/non-EU service providers even though the service provided and assets used are clearly local within the EU. Financial revenues might flow outside the EU with no taxes paid to finance amongst others the required infrastructure construction/maintenance and other societal costs caused by the services. New legislation is required to maintain the balance and ensure economical sustainability of the changing societal organisation which comes along with the disruptive innovations;
- Harmonisation of systems, standardisation, and interoperability initiatives are complex and require involvement of many stakeholder groups. For instance, communication between smart vehicles and infrastructure require harmonisation of infrastructure investments of national, regional, and local governments as well as the private sector. Timely anticipation and early start of these processes and investments is essential;
- For passenger mobility the major paradigm shifts due to use of new business models and platforms are expected to occur at the moment level 5 automation comes to market, leading to changes in the PT system. With level 3 and 4 automation, changes are expected in cost structures and modal split, but the overall mobility organisation will remain similar to the current one with potentially some growth for the sharing options;
- Inclusiveness of all income groups should be guarded since the (currently unknown) pricing of the upcoming on-demand services could lead to unwanted effects, especially in rural areas;
- For logistics at level 4 automation disruptions will take place due to large cost savings that can be achieved by new business models and changed logistical organisation; about 50% of the costs can be saved for driverless stretches. Shippers will be driven by competition to make use of these cost reductions as fast as possible, which will lead to a fast transition to the automated services wherever it is possible;
- Connectivity to the 'level 4 network' provides shippers/companies a competitive advantage which could influence the location choice of companies. The design of the 'level 4 network' should be done pro-actively by policy makers and infrastructure managers taking these possible implications into account;
- The attractiveness of the new passenger mobility services tends to lead to more vehicles on the road and less use of other modes. Also, the radical cost reduction that can be achieved for road freight transport could lead to a shift from rail to road if the innovation of rail does not keep pace. Balancing the innovation speed of the different modes is essential, in order to rule out counterproductive impacts. For instance, transfer of road innovations, such as the vehicle communication technology to the rail sector (including

tram and metro), could accelerate the rail automation process and also ensure harmonised vehicle communication especially in cities (tram/metro);
- Although the new services have the potential to establish a highly interconnected transport system, they can only incorporate those modes/options for which information is available to the system. Since they can also deliver high quality services with only road options included, they could lead to divergence of market potential of the modes as well. Active high-level governance of information sharing and collective and multi-modal information platform development could ensure a more balanced availability of transport services.

One interesting development for the RSI is the Hyperloop, a system of vacuum sealed tubes through which a pod travels. It is not yet fully settled if this competes with the rail sector (most notably High Speed Train (HST)) or, due to the potential speed to be achieved, with aviation. With respect to sustainability, Hyperloop may provide a better option than HST since it consumes much less energy than HST. For the sector and policy, a key question will be whether to support HST or Hyperloop. Considering that the main initiatives related to Hyperloop are conducted by firms outside the current RSI, the development of Hyperloop may be considered a threat to the RSI, unless a form of multi-modal transportation is developed.

### 6.1.4. *User orientation redefined*

**Passengers**

From the analysis of the new business models it becomes clear that society will be offered a wide range of on-demand services. We will get used to being able to order anything we like at any time of day and wherever we are. Also services will get more integrated and connected to each other all with the aim to make life of the client easier. Services can also become more dedicated to the specific user needs due the detailed preference information that the user can make available for all connected services.

For passenger rail services this implies that the current users may have completely different needs in the future situation. The user will expect integration of rail services into the mobility service he/she needs to get from one place to the other. Ordering a service may imply that it will be expected that all is arranged throughout the trip (including payment).

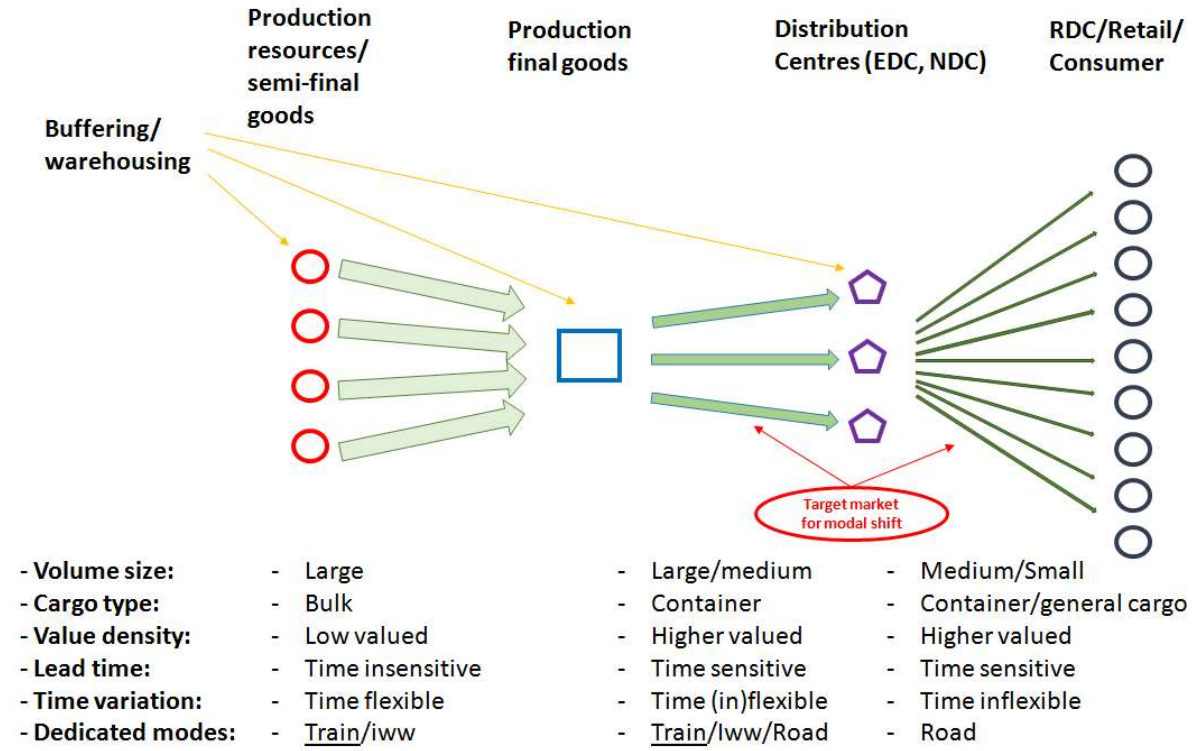
**Logistics[231]**

For freight services more or less the same should be expected. In particular the markets that are shifting from road to rail and are currently still offered the same service level as the traditional rail freight markets.

In Figure 107, a generalised overview is provided of the currently typical market segmentation of transport modes based on supply chain characteristics. It is important to note that the new rail markets to be attracted, largely consists of medium to small sized shipments that individually will not fill a complete train and therefore will have to be grouped with other shipments. For this cooperation to happen it is necessary, for example, to compose trainloads from individual wagonloads. Another important lesson is that this market segment requires shorter lead times (time-sensitive) and less variation in arrival time (time-inflexible). For this we need a more reliable rail system, information systems/ETA, etc. From the Smart-Rail findings it is concluded that, next to ensuring sufficient capacity and access point to the rail system, significant cost effective gains can be made from technological investments in providing visible, reliable and flexible transport services which lead to much lower overall supply chain costs. Substantial gains were also identified from implementing various forms of cooperation between railway and non-railway related actors in supply chain.

[231] This section is largely taken from Smart-Rail recommendation report (Smart-Rail, 2018).

**Figure 107 Simplified example of targeted market for rail services with buffering function included**[232]



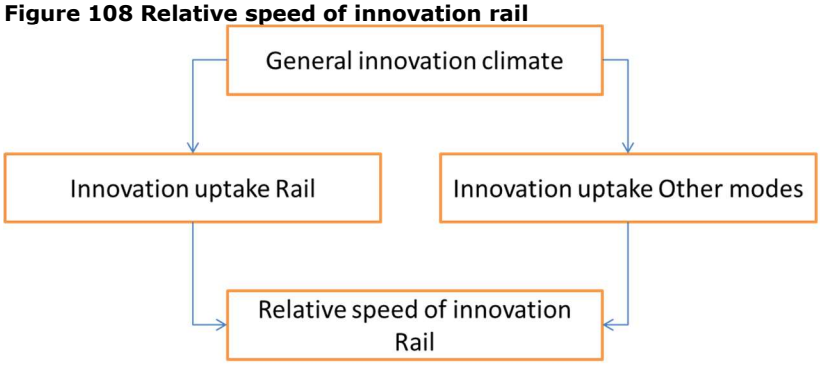

### 6.1.5. *Relative speed of innovation of road and rail*[233]

In order to encourage modal shift from road to rail, the improvements made by the rail sector should lead to convergence of quality of relevant road and rail service aspects. Since this is a development over time we cannot compare the 'future' rail service levels with the 'current' road service levels since improvements in the road sector are also expected (see Figure 108). The uptake of innovations in the road sector is fast due to the large size of the market and consequently large investment potential. The first semi-automatic passenger cars are already on the road and there are successful tests for truck platooning on European Roads. The first pilot tests with automated locomotives on the rail network are currently happening; and therefore, rail is keeping up with the pace of these technological developments. Additional actions are organised by Shift2Rail aiming for cross fertilisation of innovation from other sectors.

[232] It should be noted that this representation is not valid for all situations; there are also non-market-driven reasons, such as specific local circumstances or regulation, leading to the choice of rail. This is for instance for liquid bulk/dangerous goods, the trans-Alpine flows, etc. Also there are more advanced logistical connections possible and also maritime ports can be part of the chain, but this does not affect the main principles addressed in this example. In the overview we also find the market segment dedicated to rail which logically evolves from the nature of goods as well as the function in the supply chain of the destination location.

[233] This section is largely taken from Smart-Rail recommendation report (Smart-Rail, 2018).

**Figure 108 Relative speed of innovation rail**




The relative speed of innovation can be characterised by the following issues:

- **Transition speed.** The potential penetration speed of innovations in the market is fast for road due to the significantly shorter lifetime of the road vehicles than the lifetime of railway rolling stock. The Tesla solution involves transition by software updates of existing cars such that the next steps in development of automation will be less dependent on the replacement of the vehicle stock, leading to an overall acceleration in innovation. Rail has the advantage that implementation can be done in a controlled environment, unlike automated road vehicles for which safety has to be guaranteed within a very organic environment;
- **Time and effort to adjust operation.** Most innovative processes involve a gradual process in which improvements to the system in place are made step-by-step. A disruptive innovation is typically not the result of a gradual process and is often introduced by stakeholders new to a sector (as seen, for instance in the digital camera market). The innovation is large enough to allow the innovator to gain a decisive advantage and overtake the traditional market in a short period of time (see Figure 108). Radical system changes in the current rail system will not happen overnight and will involve a high degree of preparation. The rail system is complex and entangled, and therefore a large scale uptake of innovation requires cooperation and organisation across a wide range of stakeholders;
- **Competition driving innovation.** Due to the high interdependency and complexity in the rail system an individual operator can only distinguish himself from the competition with innovations that stay within the boundaries of the overall system. This largely levels out the relative performance of operators on the quality of service aspects. Major system improvements require a collective effort from the rail sector as a whole, resulting in a collective improvement; but not in a competitive advantage for one of the stakeholders (within the rail sector). In the road sector, an innovation for truck technology or in organisation can be implemented independently by one company and therefore an innovation can create a competitive advantage;
- **Access (and response time) to international transport demand.** For the road sector there are hardly any differences in operation between countries and crossing a border can be done unannounced and at any moment in time. For rail there is a large fragmentation of systems and scheduling, implying that there are major (organisational and financial) barriers for initiating new cross-border activities. This limits the reaction speed to new market opportunities (new trade flows that may arise);
- **Level playing field.** This high investment costs and lead time for opening up a rail service for a specific origin–destination (and especially cross-border) limits the possibilities for smaller rail operators to expand and therewith decreases the competitiveness in the rail market. For instance, most truck operators own only one or two trucks and are not limited to one origin-destination combination;
- **Access for new entrants.** The road freight sector is easily accessible for any new entrant and start-up costs are relatively low. Sunk costs can be a major issue for a company or an industry in case of game changing events. Having to accept non-recovery of investments in traditional technology as sunk costs is one of the barriers which incumbents in a market experience in case of sudden transition towards a new technology. There is a clear difference to observe in this respect between the incumbent and the newcomers. Newcomers (such as Tesla in the automotive sector) are not held back by investments in old technology and have an even stronger drive to move the innovation towards the market as fast as possible in order to generate the first revenues. The market power of the

incumbents is much bigger than the influence of the newcomers and therefore this is an important factor that could delay the uptake of innovations in the early stage. Also the high start-up costs and complexity of the system in the rail sector make it difficult to enter the market for new entrants.

### 6.1.6. *Current trends within the rail supply industry*

The Rail 2050 Vision identifies a number of technological developments related to the RSI. Development of intelligent trains is foreseen. These intelligent trains use shared data that allows them to adjust automatically according demand and to feed information about infrastructure to support predictive maintenance. Intelligent trains are part of a broader trends towards autonomous train operations, requiring supporting rail vehicles, infrastructure, and command and control systems. Additionally, intelligent assets lifecycle management will be enabled.

Some technological challenges still remain for intelligent rolling stock. These mainly relate to interaction of rolling stock with other, non-connected, vehicles. For example, the presentation Autonomous LRT Operation (2018; Ramboll) points to the lack of driverless trams as a result of trams being surrounded by mixed traffic, meaning lots of unpredictable situations can occur. Trains and metros, with their tracks separated from the traffic environment, does not face such challenges. Solutions to the technological challenges are developed, for example in Germany, where a driver assistance system warns against collision (and possibly brakes automatically).

Next to the introduction of intelligent and interconnected trains, the rail supply industry and its sub-segments are changed by various innovations and new products. The table below shows a collection of areas and innovative technologies that we have identified in our research.

**Table 43 Overview of technologies, innovations and new products affecting the rail supply industry**

| | Technology/Product/Area | Description |
|---|---|---|
| Infrastructure | High capacity infrastructure. | Infrastructure that allows operation of longer/ heavier trains or reducing headways (the latter is more related to train control equipment). |
| | Track resistance and durability. | Increase in speed or load requires increased track resistance (e.g. via MHH-grade steels resistant to very heavy traffic loads, or switch diamonds for trains worked at 300 km/h). |
| | Better power supply infrastructure. | Provides harmonised management of the operational status of the electric railway from a core power-supply control network. |
| | Energy storage and smart grid. | Better energy distribution and usage. |
| | Modular "plug-and-play" infrastructure. | Slab track systems, longer rails, fastclip resilient fasteners, direct in-track electric welding, switches and crossings for rapid track installation. |
| | Optimised noise and vibration control. | New materials that reduce noise and vibration (e.g. built-in vibration dampers). |
| | Maintenance (More reliable infrastructure). | Real-time monitoring, condition-based and/or predictive maintenance through sensors and big data[234], robotics and modularity guaranteeing asset health and availability. |
| Rolling stock | Maintenance (More reliable fleets). | See above, to increase efficiency and reduce total cost of ownership and reduce the required level of reserve asset capacity. The latter might be beneficial for operators but less for the manufacturers. |
| | High-capacity rolling stock. | e.g. increase of capacity by creating more space; components that can be easily interchanged on a 'plug and play' basis. |
| | Longer (freight) trains. | Technology of coupling, power distribution and braking will facilitate longer trains (1500 meter). |
| | Modular design. | Will allow easy upgrades during a vehicle's service life. |
| | New braking systems. | e.g. regenerative braking to recover energy from the trains reducing both costs and environmental harm. |
| | New bogie designs. | |
| | Flexible coupling. | e.g. central couplers for easier assembling and reduction of pull and stress forces between wagons. |

[234] Efficiency gains from condition-based maintenance between 10-15% and for predictive maintenance between 5-10%; Source: McKinsey (2017) The rail sector's changing maintenance game: How rail operators and rail OEMs can benefit from digital maintenance opportunities.

| | Technology/Product/Area | Description |
|---|---|---|
| | Use of lightweight materials. | Increasing efficiency. |
| | Alternative propulsion systems. | Hybrid powertrains, electrification, self-powered trains. |
| | Noise and vibration reduction. | Better weight distribution that reduce noise and vibration. |
| | Better interiors. | Providing a working and/or leisure environment. |
| CCC | ERTMS. | Optimisation of the management of rail traffic (putting the "M" into ERT MS) to minimise the cost of the railway system and to improving capacity. |
| | Smart sensors. | Big data and smart data analytics to improve sensors. |
| | Automated train operation. | Train driving-aid and control-command systems or full automation through communication between CCTV systems and Traffic Control Centres. |
| | Intelligent trains. | Self-monitoring and regulation of trains, communication between trains. |
| | Real time (intelligent) traffic management. | To increase capacity, flexibility and energy efficiency. |
| | Reducing headways. | Moving block and through the concept of convoying. |
| | Satellite-based services. | e.g. train positioning. |
| | Improved interfaces. | Standardised modular structure for on-board systems that is clear and comprehensive. |
| | Wireless data transfer. | |
| Other | Low cost railway. | Simplified control-command system, lightweight materials, LLC approach, simplified train certification. |
| | New information systems. | Better passenger information to improve customer services. Smart traffic management, automated dynamic timetables. |
| | Mobility as a service. | Personalised service. |
| | Intermodal travel. | Seamless travel. |
| | Logistics on demand. | Real-time synchronisation to demand, flexibility and utilisation; IT systems that enable buying and selling of capacity in wagons and a reliable door to door track and trace. |
| | Integration of databases. | To offers door-to-door freight transport across transport modes. |

Source: Ecorys literature review.

Modular design (and manufacturing of modules) offers various advantages, including:[235]

- Minimising cost, by reducing the diversity of parts in a product range;
- Modular products enable faster, easier, and more efficient customisation of standard products to unique user needs;
- Modular design enables quick and easy upgrades (driven by either technology or user improvement), thus enabling products to evolve;
- Modular design gives businesses the possibility to outsource the assembly of some modules, therefore freeing-up manufacturing capacity and increasing the number of products delivered on time.

Regarding maintenance, the most recent developments in the RSI are conditions-based and predictive maintenance. Traditionally, rail operators applied two rationales for maintenance: a planned preventative maintenance approach and an unplanned reactive repair approach. The former approach is based on time or usage of components, and is applied to critical security components that are highly regulated, such as brakes, and highly visible quality components, like air-conditioning. The latter approach is used for all other components and goes by a 'fix when broken' principle.[236]

Under preventative maintenance, prior estimates are made based on the lifetime of products and used for planning maintenance services. Conditions-based and predictive maintenance offer more sophisticated and educated estimates of lifetime. Both methods help to improve lifetime of products and avoid any unplanned maintenance activity with the use of build-in AI and other data generating tools, such as sensor technology and advanced analytics solutions. In the conditions-based method, a specific parameter of a component's real-time condition is measured to identify a critical threshold for scheduling maintenance to avoid failure. Predictive maintenance uses a more advanced method, based on multivariate data inputs and analyses to enable replacement of

[235] http://www.advice-manufacturing.com/Modular-Design-Benefits.html.

[236] McKinsey (2017) The rail sector's changing maintenance game: How rail operators and rail OEMs can benefit from digital maintenance opportunities.

components after alarms from machine learning systems are raised, but before those components actually fail. This approach may increase maintenance efficiency, reduce downtime of equipment and prevent more expensive, large-scale repairs. On the other hand, the implementation of predictive tools for such a maintenance program can be time consuming and costly. Consequently, the expected benefits of predictive maintenance need to be weighed against the costs of the program.[237]

## 6.2. Future challenges and opportunities

### 6.2.1. *Market opportunities*

The total market for rail supply industry is forecasted to continue its growth at a yearly rate of 2.7% until 2023.[238] While all regional markets are projected to grow in the future, the highest growth rates are expected in the relatively small markets of Latin America and Africa/Middle East. For these regions, the expected yearly growth rates are 4.8% and 5.2%. More mature markets like Western and Eastern Europe, Asia Pacific, and NAFTA will also grow and account for the biggest share of absolute growth. Yearly growth rates from these regions are expected to range from 2.2% to 3.1%.

***Emerging markets***

Part of the growth in demand for rail technology comes from new or under-developed markets with networks being developed in regions with little or no previous experience in rail (Middle East, parts of Africa and Latin America). The driver of high growth rates in these regions outside Europe are significant investment programs launched in those regions.

One emerging market with ample potential opportunities is that of countries in Sub-Saharan Africa (SSA). Countries in SSA are primarily commodity producers and thus, a key need of the region is to obtain improved freight transport solutions. However, in recent years passenger transportation in the region has increased, pointing out the need for investing in urban rail solutions for carrying large number of passengers while maintaining affordable prices. In addition, an increase in the middle income class is observed in the region. The local situation and the potential increase in demand together with the know-how and the excellent reputation of European companies could be an opportunity for the rail supply industry.

Brazil also offers plenty of opportunity and is expected to be the biggest growth export market for European RSI for the period 2020 to 2023, according to stakeholders. With many European manufacturers already establishing their factories there, the local content requirement (25% local production) is easily met. Brazil's neighbour Argentina offers a similar strong outlook, but here Chinese companies have obtained sound investment opportunity due to one of the flagship cooperation projects between China and Argentina aimed at revamping the Argentinian rail network, including cargo and passenger trains[239], make it more challenging for EU manufacturers to enter the market.

India is considered one of the future growth markets and drivers of demand for the rail supply industry. Despite India's new public procurement law promoting use of Indian suppliers, the future growth potential may still make India an interesting market for the future. Some of the major EU RSI companies have established sites in India and some success has been achieved in winning contracts. Strong competition is faced and may be expected for the future. Key expected challenge for the EU RSI is how to offer financially competitive products in light of the price preference of (local) governments.

Finally, the Gulf countries such as Saudi Arabia have a lot of infrastructure projects going on. No details on the competitive position of the EU RSI for these market was obtained.

---

[237] Source: McKinsey (2017) The rail sector's changing maintenance game: How rail operators and rail OEMs can benefit from digital maintenance opportunities.

[238] UNIFE (2018).

[239] Xinhuanet, *Feature: Cooperation with China revamping Argentina's rail network*, 3 December 2018. http://www.xinhuanet.com/english/2018-12/03/c_137647800.htm.

When analysing which product characteristics are most important in these emerging markets, price is pointed out as the most important factor to consider, especially in countries with low GDP levels. The general understanding is that products are successful if they are less complex, allowing them to be sold cheaply. Less complex products may have the added benefit that they can (partially) be produced locally and are sufficiently robust to withstand difficult environmental surroundings in some cases. In addition, export finance is often needed to access these markets in order to support governments in emerging economies in procuring large-scale railway projects. As described before, this is an area where the EU RSI may be at a disadvantage compared to some of the main competitors, to whom financing is more easily available (see section 5.5).

***Mature markets***

In the **locomotives and rolling stock segment**, the European RSI can currently be considered the lead exporter worldwide. The European RSI has the highest market share among imported products of locomotives and rolling stock in China, Japan and South Korea with considerable presence also in the Russian and USA markets. Next to the rolling stock segment, the European industry is also the global leader on railway **signalling and electrification goods**. Siemens is the global market leader with 40% market share, followed by Thales (20%) and Bombardier (19%). Together, they hold close to 80% of the global market share in this product segment. The EU RSI products represent 58% of the China's import and, an impressive, 99% of Japan's imports in this segment. The European industry is also present in Russia and the USA, with 22% and 28% of the imports' market share, respectively. In the **infrastructure segment** the picture is a bit more mixed, but also positive considering Europe's lead in the sub-segment of railway or tramway track construction material of iron or steel. For example, the EU is the origin of 92% of the imported products by China and 42% of those imported by Japan. In addition, it is also among the main providers of track material of iron and steel to Russia, South Korea and the USA (see section 4.2.6).

Growth in the mature markets will be driven by large-scale projects like the California High Speed Rail (USA) and various projects in Western Europe and Asia Pacific (Sydney Metro). For the rolling stock market, automated systems, and very-high-speed and high-speed trains are the segments expected to grow the fastest with annual growth rates of 8.5% and 5.3%.[240] In the infrastructure market, the highest growth rates are expected for urban super structures and electrification with annual growth rates of 4.0% and 3.1%.

### 6.2.2. *International competition*

As observed from the analysis of the competitive position of the EU RSI and mentioned in the previous section, the EU is the worldwide leader in exporting locomotives and rolling stock, signalling and electrification goods and has also considerable importance in the infrastructure segment. However, since 2006, China's imports are decreasing while simultaneously its exports are increasing. Other economies such as Japan and India also increased their exports. Looking at the various markets, we see that the EU has still a strong position, but that competition has increased. [241]

In the **USA**, the rolling stock segment is mainly served by China (42%), but due to their proximity Canada (24%) and Mexico (10%) have also considerable market shares, while the EU (11%) and Japan (8%) are less prevalent on this market. In signalling and electrification equipment, the European RSI's main competitors are Canada (37%), Japan (20%) and China (11%). The EU's share was in 2018 at 28%.

In **Japan**, the EU holds the relatively small share in imports with 49% for the rolling stock segment and 99% among the signalling and electrification products. For the former, China is the main competitor. It had in 2018 a share of 33% of rolling stock imports, but its increases are lower than the ones of the EU's RSI in the past years, which are increasing since 2014. The latter seems to be firmly in hold of the European RSI.

[240] UNIFE (2018).

[241] For more detailed information, see section 4.2.6 on Market share of the European RSI in other markets worldwide.

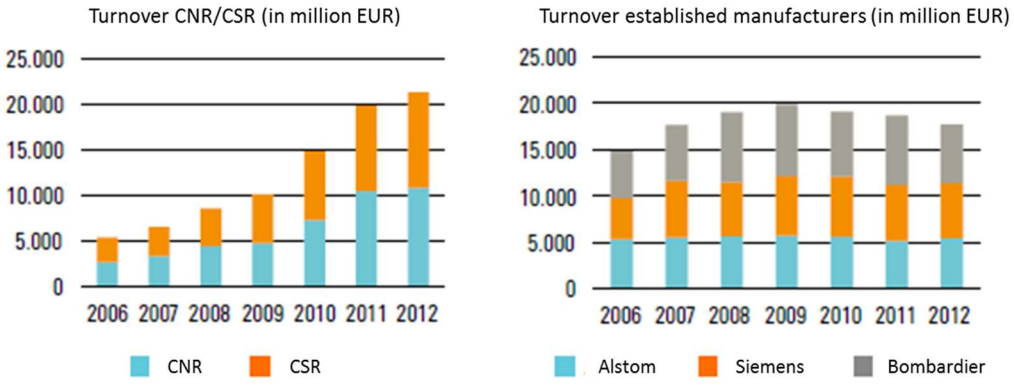
In **Russia**, the European RSI is an important player with 30% and 22% share of Russia's imports in rolling stock and signalling and electrification respectively. Main competitors for rolling stock are Ukraine (35%), China (14%) and Belarus (10%). For signalling and electrification, it is Belarus with 76%.

For **China**, we see China's dependency on imports in rail supplies decreasing while simultaneously its exports to other markets are increasing. Nevertheless, in 2018, the European RSI still had a strong presence on the Chinese import market with 69% in rolling stock and locomotives and 58% in signalling and electrification. For rolling stock, the main competitors in the Chinese import market are Japan (12%), the USA (5%) and South Korea (4%). For signalling it is mainly Japan (23%) and the USA (11%). Interestingly, the value of signalling and electrification products imported from Japan increased massively between 2014 and 2018, at a growth rate of 310% per year, while the EU and the USA lost their market shares.

The EU is also a market leader in **South Korea**, with 30% of the imports in rolling stock having origin in the European RSI; however, Chinese exports to South Korea increased to 29% and it is expected that China might become the main exporter. Another important competitor in this market are the USA (22%).

Overall, pressure in terms of international competition stems mainly from China. There is a widely-carried opinion among stakeholders interviewed that China's industry caught up in high-tech components, which mostly were only produced by European companies. This explains the decreasing imports of China, which still invests massive amounts of money into its railways, but relies less on European high-tech components. Simultaneously, Chinese companies are becoming leaders in world market. Until 2010, European players such as Siemens, Alstom and Bombardier were leading the world market in terms of turnover, but CNR and CSR replaced them (See figure below) and later on merged to the massively huge CRRC Corporation. However, over 90% of their revenue in 2018 was realised in mainland China and of the revenue realised abroad less than 40% was generated in Europe. This includes also products such as auto parts and deep-sea robots. [242]

**Figure 109 Development of turnover for established and Chinese manufacturers in comparison**




Source: Hans Böckler Stiftung (2016) Branchenanalyse Bahnindustrie: Industrielle Und Betriebliche Herausforderungen Und Entwicklungskorridore; Translation by Ecorys.

Chinese competition in the European market is currently still low. Currently, one of the major projects financed by Chinese credit is the Budapest-Belgrade Railway Line.[243] However, the 16+1 Forum and bilateral agreements such as with Italy show certain ambitions in Europe. In addition to the European market, CRRC has also a growing presence on the world market. The company is the

[242] CRRC Corporation (2019) Annual Report 2018.

[243] An interactive map of Chinese operations in large scale transport investment in Europe can be found here: http://www.scribblemaps.com/maps/view/Chinese_Operations_in_Large-Scale_Transport_Infrastructures_in_Europe/1666908.

number one producer of high-speed trains, electric locomotives, and metro cars, and number two for diesel locomotives.[244] Its exports have grown between 2010 to 2015 from EUR 761 million to EUR 3,850 million. The company has grown its reputation in many export markets, specifically in emerging markets in Asia-Pacific, South America, and Africa; but also in developed markets (e.g. fleet renewal programs for the Boston and Chicago metros). This is actively supported by the Chinese government, for example: alone in 2018, China pledged USD 60 billion in aid and loans, which "will be focused on infrastructure to help speed African countries' development".[245] Details on the division of the funding was limited. Infrastructure connectivity is one of eight initiatives being stimulated with the funding. In comparison, Japan pledged USD 30 billion (including USD 10 billion for infrastructure loans). [246]

After CRRC, Alstom, Siemens and Bombardier (the next biggest manufacturers) are the US owned Wabtec (which recently merged with GE Transportation) as well as Caterpillar and the Japanese Hitachi Rail. Wabtec, which acquired Faiveley Transport in 2016 shows certain ambitions into expanding into the European market. Similarly, Hitachi has shown strong growth in the European market after acquiring Ansaldo Breda. However, overall European manufacturers of rolling stock, rail equipment and signalling systems seem to hold sway in terms of competitiveness as shown in the market shares Europe holds in the relevant segments. This is also underpinned by the SCORE project (Score board of competitiveness of European transport manufacturing industries), which concluded that European companies "enjoy unrivalled competitive hegemony over their contenders from Asia and North America". European companies' technological leadership and strong export performance outperforms Japanese and Chinese competitors whose reliance on domestic market exceeded 90%. However, overcapacity especially among Chinese suppliers will encourage them to target more aggressively European and other export markets.[247]

In this international competition, it should be noted that the harmonisation and interoperability of the Internal Market does not only favour internal EU competitiveness, but also makes the European market more attractive for foreign competitors, since a large market becomes more easily accessible when certification and authorisation procedures become more unified and compliance does not depend on national rules.

Various stakeholders pointed out that there is an imbalance in the rules applied. Some export credit agencies do not obey to OECD rules[248] and financing as well as insurance is offered comparatively less advantageously to European RSI companies. The producers interviewed are convinced that EU loans and grants cannot compete with what China is offering. One stakeholder noted that most of the time export markets require local contents above 50%, which makes it very difficult to get access to financing from domestic entities or export credit agencies.

Many countries — most notably, but not exclusively China and Japan — are believed to use development aid financing to gain market shares in third countries. In particular, official export credits are less used and instead domestic exports are tied to development aid funds, thereby supporting its companies to gain market shares.

**Box 3 China in the world – One Belt One Road Initiative and how China position itself on new markets**

Overcapacity in its own market and the ambition to become a global leader in development aid has created a political ambition in China to position itself in emerging markets with large-scale infrastructure projects. The Belt and Road Initiative (BRI) is at the core of this ambition. However, no official definition of what the BRI actually entails exists. Its geographical scope includes 65 countries, there is no clear development plan nor a budget. Furthermore, responsibility is shared between several branches of the Chinese government and

244 McKinsey (2016) Huge value pool shifts ahead – how rolling stock manufacturers can lay track for profitable growth.

245 The Washington Post (2018) China pledges $60 billion in aid and loans to Africa, no 'political conditions attached'. Available at: https://www.washingtonpost.com/world/china-pledges-60-billion-in-aid-and-loans-to-africa-no-strings-attached/2018/09/03/a446af2a-af88-11e8-a810-4d6b627c3d5d_story.html?noredirect=on&utm_term=.730faccd9b41.

246 African Law & Business (2018) China to invest USD 60 billion in Africa. Available at: https://www.africanlawbusiness.com/news/8609-china-to-invest-usd-60-billion-in-africa.

247 SCORE (2018) D2.3 Analysis of competitiveness of European transport manufacturers from an economic perspective.

248 For example, the payback period in the EU is 14 to 15 year, while in China this period is 20 to 25 years.

funding comes from several Chinese and Asian Banks. The general perception in Europe is that this funding comes with conditions that force borrowers to make use of Chinese suppliers, but the official policy according to the Chinese government is that BRI is open and inclusive. However, a lack of transparency regarding procurement makes it in reality difficult for non-Chinese companies to participate. Moreover, the official BRI website lists only Chinese State-owned-enterprises[249]. Having said this, international companies have taken part in BRI. For example, the EU SME Centre notes Siveco China, a French maintenance and facility-management consulting SME, as a success story of a company benefiting from belt and road projects.[250] In addition, a study, commissioned by the European Parliament[251], found that especially rail might benefit from improved services due to BRI projects, by shifting 2.5 million twenty-foot equivalent unit (TEUs) from maritime to rail transport and 0.5 million from air to rail by 2040. Nevertheless, examples from BRI projects also often point out the abovementioned conditionality of BRI funding as well as other issues such as lack of environmental and sustainability standards. To mention some:

- Malaysia - East Coast Rail Link: The project was recently renegotiated revealing that in the original agreement the Chinese SoE CCCC would have built the line, while operation and costs thereof, which included repayment of a RM 56.7 billion loan from the Export–Import Bank of China, would have been shouldered by a Malaysian company;[252]
- Easter Africa: East African countries owe China USD 29 billion in loans for infrastructure, energy and construction projects. Concerns were raised that these countries might lose its sovereign assets similar to ports in Sri Lanka and Pakistan;[253]
- Environmental concerns: Concerns of environmental sustainability were raised in various countries on BRI projects, for example a high-speed line in Indonesia was halted. A lack of transparency in China coupled with the predominance of weak environmental regulations and controls in developing countries increases the problem.[254]

Nevertheless, it seems that due to increased criticism China has become more lenient (e.g. renegotiations with Malaysia, debt restructuring in some African countries) and started the International Coalition for Green Development on the Belt and Road after enacting two directives that focus on environmental sustainability[255]. Here, engagement through the EU-China Connectivity Platform constitutes a major chance by coordinating between TEN-T and BRI as well as promoting the application of fair market principles and EU standards.

### 6.2.3. *Consultation results; experienced barriers from the past and views on the future of the rail supply industry*

Most stakeholders consulted indicate that the 4th railway package and Shift2Rail contribute to harmonisation and interoperability. However in the comments provided it was noted that the process is not fast enough and still much has to be done to complete the process.

For cross border operations it is indicated that one perceives the outdated and inconsistent national regulations as an important barrier. The lack of consensus amongst stakeholders to change the national technical standards is also mentioned in this context. Practically this implies that the RSI market is still fragmented which leads to high investment costs and a slow-down of the transition. Another reason mentioned for the slow transition speed is the long life time of assets already in place. Acceleration of the replacement of assets would mean creation of sunk

[249] China Briefing: China's Silk Road Development Criteria: It's Only OBOR If We're Involved, available at; https://www.china-briefing.com/news/chinas-silk-road-development-criteria-its-only-obor-if-were-involved/.

[250] Belt & Road Initiative: Business Opportunities and Challenges for European SMEs, Available at: http://www.eusmecentre.org.cn/press-article/belt-road-initiative-business-opportunities-and-challenges-european-smes.

[251] Research for TRAN Committee: The new Silk Route - opportunities and challenges for EU transport; http://www.europarl.europa.eu/RegData/etudes/STUD/2018/585907/IPOL_STU(2018)585907_EN.pdf

[252] Financial Time (2019) Malaysia renegotiated China-backed rail project to avoid $5bn fee. Available at: https://www.ft.com/content/660ce336-5f38-11e9-b285-3acd5d43599e.

[253] Africa Centre for Strategic Studies (2019) Implications for Africa from China's One Belt One Road Strategy. Available at: https://africacenter.org/spotlight/implications-for-africa-china-one-belt-one-road-strategy/.

[254] Pacific Standard (2018) Environmentalists Are Raising Concerns Over China's Belt And Road Initiative. Available at: https://psmag.com/environment/environmental-concerns-over-chinese-infrastructure-projects.

[255] The Belt and Road Ecological and Environmental Cooperation Plan and the Guidance on Promoting Green Belt and Road.

costs for which financial support is required. And the complexity was mentioned with respect to changing the mentality and vision of all required people in the large rail organisations.

Concerning the positioning of rail compared to other modes, a main problem that arises is that the taxation compared to air and road creates an unfair market disadvantage for rail since all external costs should be internalised. In particular for aviation where no tax on kerosene is charged at all.

Automation of road vehicles is by a small majority seen as threat for rail. In particular urban areas are mentioned as a segment at risk, as the physical environment is most suited for the development of car automated driving (for example due to the, in comparison to other physical environments, limited infrastructural investment required). Nonetheless, the efficiency of rail to offer electric mass public transport may still allow rail to maintain a strong position.

Convergence of safety systems for road and rail is by most seen as a benefit for the RSI. For urban areas it is mentioned to be a must due to the interaction of trams and road vehicles. There will be many similarities in the safety systems of the two modes where both can benefit from alignment of systems. However it is also mentioned that convergence may not be always possible and therefore should not become an objective in itself.

Flexibility and reliability is seen as an important barrier for rail to become the backbone of the EU freight transport system. It is mentioned that flexibility and reliability should be specified more precisely since this may not be the same for all market segments and situations. Tracking, tracing, ordering and scheduling are mentioned as examples of service aspects for rail freight to be improved.

Creation of smooth multi-modal and intermodal connections with rail is seen as an important condition for success for the rail sector.

The key topics of influence for the future development of the rail sector mentioned are:

- Requirements for rail:
  - The rail sector should become more attractive for its users (passengers and freight);
  - Increase reliability and flexibility of rail;
  - Reduce the lead time for rail services (user perspective);
  - Improve convenience for users;
  - Inter-modality to be improved, smooth transition between rail transportation and other modes;
  - Efficiency (execution) of railway services should be improved;
  - Noise reduction at source of its origin;
  - Reduce emissions in rail transport, complete electrification.
- Actions and improvements:
  - Keep our (EU) innovation and R&D to support our RSI companies and jobs;
  - Recruitment of skilled people;
  - Faster Time to Market of new Innovations;
  - Successful building of Single European Railway Area;
  - Practically prioritising Railways instead of road transport;
  - Create level playing field between regions & transport modes;
  - Replacement of existing fleets with new vehicles more recyclable and less energy consuming;
  - Higher volume of transported units;
  - Integrate in ERTMS all Railway Signalling functionalities and make ERTMS the only technology that really needs to be installed on lines;
  - Stimulate the increased use of ERTMS features and functionalities to push Industry R&D and revenue in short-term period;
  - make better use of the European Voluntary Standardisation System (CEN-CENELEC);
  - Meet the goals of a joint development of a Reference CCS Architecture to update ERTMS including its game-changers with significant improvements with respect to cost, pace of roll-out and interoperability[256];

[256] EULYNX (2018) White Paper Reference CCS Architecture Based On ERTMS, available at: https://eulynx.eu/index.php/news/37-reference-ccs-architecture-white-paper.

- Digitalization of the rail sector;
- Cyber security;
- Integrating the railway sector into the digital economy;
- Master Mobility-as-a-Service in multimodal scenarios especially with urbanisation.

### 6.2.4. *Challenges and opportunities*

We have identified five main challenges and opportunities the European Rail Supply Industry will have to address. The table below present these.

**Table 44 Overview of identified challenges and opportunities in the Rail Supply Industry**

| Challenges | Opportunities |
|---|---|
| Interoperability | |
| One of the main challenges Europe still needs to overcome is its fragmentation into various networks with different sets of rules and standards and different ways of operating. | Moving towards a Single European Rail Area (SERA) has the potential for vitalising the railway market. The 4th Railway Package (4RP) emboldening the role of the European Railway Agency (ERA), the deployment of ERTMS and the development of TEN-T Core Network Corridors are pushing the EU to a common railway market. |
| Sustainability and climate change | |
| The sustainability challenge is currently reshaping many sectors forcing them to become more resource efficient and environmental friendly. In case of rail this relates to introducing lightweight materials and regenerative breaking making trains more energy efficient and resilient, but also reducing noise and vibration caused by tracks and trains. | Unlike other sectors, transport has not experienced a gradual decline in its greenhouse gas emissions, 70% of these emission come however from road transport, while <1% come from rail. Therefore a modal shift towards rail is seen by many as a solutions to the sustainability challenge and part of the European Commission's official strategy.[257] |
| Urbanisation | |
| Rapid urbanisation puts immense pressure on urban infrastructures, full metros and trams make for an unpleasant journey and discourage taking public transport, while updating and expanding infrastructure in rapidly growing cities is often difficult and involves complex construction projects. | Rapid urbanisation is a trend across the globe requiring cities to update their mass transit systems or face traffic backlogs. Reports, like UNIFE's World Rail Market study already highlight the Metro segment as performing well and see future positive trends. |
| Ageing societies and skills | |
| The rail supply industry already faces a skills shortage, combined with a decreasing workforce, perception as an unattractive sector (especially for women) and changing skill requirements[258], the sector will require investments into skill development and/or automation and robotisation. | Similar to urbanisation, an ageing society will require more and better public transport infrastructure. Next to buses, rail is well placed to provide this infrastructure. |
| Sharing Economy / Modal shift and intermodal transport | |
| Railway already faces fierce competition from traditional competitors on road and in air, however the rise of the sharing or platform economy and with it new players such as Uber or widespread bicycle and car sharing systems challenges directly rail operators and indirectly the rail supply industry. | While mainly being a challenge, rail has also the opportunity to benefit from this new trends, the buzz word here is intermodal transport. Especially railway and metro stations can become central nodes where people can easily switch between transport modes and take for example the bike to finish the last mile of their journey. This relates also to freight transport, since rail can deliver goods to central freight centres from which then trucks (or drones) could pick up these goods and bring them to their final destination. |

Rail 2050 Vision - Rail the Backbone of Europe's Mobility (2017; ERRAC) reports urbanisation driving an increasing demand for efficient and sustainable transport and increased freight transport demand in Europe, with rail as the answer. However, the need for more resilience is raised due to climate change, variations in temperature and rare weather events, which all

[257] A European Strategy for low-emission mobility, available at: https://ec.europa.eu/clima/policies/transport_en.

[258] Rail Supply Group (2016) Fast Track to the Future - A strategy for productivity and growth in the UK rail supply chain.

increase the risk of disruption and failure of critical infrastructure. As for international demand, the study identifies huge rail and metro investment programmes outside Europe and a stable growth of metro networks in the Rest of the World.

The Vision and Roadmap for Sustainable Mobility – Rail towards 2050 report (2015; Fraunhofer Institute) forecasts passenger and freight transport by rail to respectively nearly triple and quadruple until 2050. In order to accommodate for the increase in demand, the report refers to the LivingRAIL research project; which was designed to explore the strategic measures through which transport policy, spatial planning, and the rail sector can maximise the market share of electrified rail.

In Freight on Road: Why EU Shippers prefer Truck to Train (2015; European Parliament), it is reported that deindustrialisation in many Member States with contributing other factors, like the rise of e-commerce and on-time delivery, has generated new demand that is met by light goods vehicles travelling by road, particularly in and around urban areas. This has made road more competitive compared to rail.

The S2R Multi-Annual Action Plan (2017; Shift2Rail) considers it important for the sector to strengthening the role of rail in the European transport system and the global competitiveness of European industry. In order to address the challenges, three opportunities for the railway are identified:

1. To become the backbone of current and future mobility concepts and on-demand future logistics - capitalise on strengths of railway to provide seamless door-to-door travel by integrating it with other services (e.g. Bike/ Car sharing);
2. To identify and establish new market segments for exploitation;
3. To enhance the overall competitiveness of the industry, both in Europe and globally, in various key areas, like products and system solutions, skills, cost optimisation, improved manufacturing, new markets, boosted productivity, and performance.

In the literature, there seems to be a general concern of Europe losing its technological advantage. Similarly, some interviewees argued that technology transfers from European to Chinese companies, has helped the latter to catch up. Moreover, a huge number of patents are granted to Chinese entities, while European companies face a lack of IP protection in China.

## 6.3. Recommendations

Based on the assessment of the current situation and the strategic outlook, a number of recommendation are suggested.

**The Internal Market**

For the strengthening of the Internal Market for rail supply products, a range of actions may be taken. First of all, market demand may be increased by stimulation of domestic infrastructure investments to promote the use of rail (and thus indirectly, the need for rails supply products), encouraging the shift from road transport (or other modes of transport) to rail. As market growth within the European Union will strongly rely on large-scale projects, stimulating Member States to invest in these projects will be essential. A more in-depth assessment of the reasons underlying the lack of infrastructure investments at Member State level should be conducted to properly address any barriers.

Secondly, promotion of the application of the MEAT principle in the domain of railway procurement will allow the industry to move (further) away from purely cost-based competition in favour of competition on a broader value-added. The Commission has published guidelines for green procurement and innovation procurement. Another prominent initiative in this field is the development by Unife and the European rail community (CER, EIM) of joint sectoral recommendations on best value procurement in the rail sector. Application of the MEAT principle with a high technical scoring share should be used for the tendering of railway projects to provide incentive for the consortia to invest in developing and proposing innovative solutions for the new products. The Commission may offer a supporting role in the promotion of the recommendations to rail contracting authorities. Furthermore, the capacity of procuring authorities to ensure that

tenders are well-designed and include focus on promoting innovation and environmental aspects should be enhanced by Member States.

Thirdly, the shift from road and air to rail transport should be further encouraged by promoting rail as a sustainable alternative and introducing measures that aim to internalise the external costs of transport modes. However, infrastructure investments in Member States and intermodal transport possibilities are needed to allow rail to compete with more flexible private transport modes (e.g cars and trucks).

Finally, to stimulate the more rapid roll-out of ERTMS, the European Commission may initiate or stimulate efforts towards a standardised CCS-system to initiate a new signalling and control philosophy, taking into account all new technological possibilities. This would also include support of training of the workforce and stronger mandates, and possibly more resources, for ERA.

**The global market**

With respect to access to foreign procurement markets for EU rail suppliers, the current initiatives of the European Commission, which include FTAs negotiations, accession of additional third countries to the Government Procurement Agreement and the proposal of the International Procurement Instrument (IPI) are considered to be the most effective actions available. Continuation of this policy is advised.

Monitoring and acting on barriers to market access, non-tariff barriers, procurement strategies and forced technology aspects should be continued. Other policy initiatives such as the China Investment Treaty, the EU-China Connectivity Platform, and regulatory diqlogues with third countries on the Government Procurement are also considered beneficial.

One important factor causing a misbalance in the international level playing field concerns state support and export credits. Calls from various stakeholders to reform the OECD Rail Sector Understanding (RSU) on export credits or at least introduce a guarantee mechanism to bridge the gap with non-OECD countries were made during the interviews. One stakeholder suggested that the OECD RSU needs an increased loan tenure duration, since it currently does not match the life cycle of the EU products and cannot compete with Chinese credits. Additionally, national credit agencies should be flexible in applying the rule of minimum national content (of the crediting agency's country) to avoid limiting the participation of SMEs in tendering opportunities of third countries which require a minimum local content to be manufactured in country of tendering.

Continued investment in European international hubs to support SMEs abroad will also benefit the international position of the EU RSI.

**Innovation and standardisation**

In addition to the arrangement in place to support the sector to conduct R&D&I initiatives, a continuation of the dedicated collaborative R&D partnership Shift2Rail should be ensured under Horizon Europe. Moreover, instruments facilitating the deployment of the innovative technologies within Shift2Rail should be explored. To further support cooperation within the sector in the field of innovation, cooperation between SMEs, and the promotion of partnerships between SMEs and large companies should be encouraged; leading to more innovation with more appeal and higher foreign competitiveness. The aim should be to build up an effective SME network or clusters; which could increase the sharing of knowledge, exchange information, and increase the visibility of SMEs.

To make the innovations most effective, a leading role of the EU in the standardisation process should be maintained. To this aim, the EU should continue taking the lead in fostering the cooperation between industry players for the development of industry standards when required. Bilateral industrial collaboration agreements with third-countries can be used to promote the use of ERTMS outside Europe. Internally, EU funding schemes can be used as a tool to promote the adoption of common rules of operations across Europe by requiring that beneficiaries of EU funding implement common operating rules across the EU.

The participation of more SMEs in the standardisation committees would be beneficial for both SMEs and the rest of the industry; however, costs related to their participation can be troublesome and limit the participation of SMEs in developing standards. Increasing the available European

funds to support the participation of SMEs in the development of standards, especially travel expenses, could enable the participation of more SMEs.

**Labour**

As for many other industries, the inflow of skilled labour is a point of attention. For the skill development, the recent inclusion of the RSI and rail transport into the next wave of the Blueprint for Sectoral Cooperation for Skills should be promoted and made use of. Furthermore, the recommendations of the S2R initiative can be taken over. The recommendations with relevance for the RSI include, inter alia:

- Enhance cooperation between VET, academia and companies;
- More support from companies for higher (academic) apprenticeships;
- Transfer workforce by developing alternative learning systems and lifelong learning approaches from the perspective of new groups (such as persons with a technical education that have previously not been employed in similar functions that are requested by the RSI, but could fit the required profile with the help of some training).

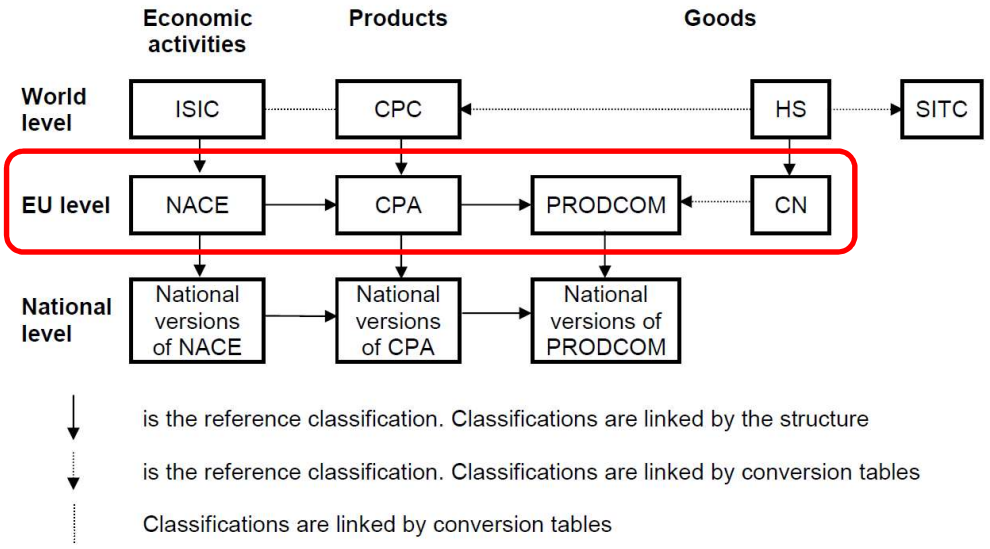
# ANNEX A - INTRODUCTORY NOTES PRODCOM-CPA-NACE-CN

One task of the study was to identify the railway industry in different industry classifications as well as goods classifications, i.e. NACE, CPA, PRODCOM and CN. Although being different classifications for different purposes, they are interrelated with each other (see Figure 110): In general, they rely on a very similar structure and are therefore comparable to a high degree.

**NACE** (NACE Rev. 2) is the European standard classification of economic activities[259]. Data according to NACE are used by among others, the Structural Business Statistics (e.g. number of enterprises, number of persons employed, turnover, value added) and the Business Demography.

**CPA** (CPA 2.1) is a product classification whose elements are related to activities as defined by NACE Rev. 2. Each product - whether it is a transportable or a non-transportable good or a service - is assigned to one single NACE Rev. 2 activity.[260] The linkage to activities as defined by NACE Rev. 2 gives the CPA 2.1 a structure parallel to that of NACE Rev. 2 at all levels distinguished by NACE Rev. 2. The most detailed level of NACE Rev. 2 is the 4-digit level, while the most detailed level of CPA 2.1 is the 6-digit level, i.e. CPA is more detailed than NACE. Therefore, the detailed linkage between products and activities can only be established to a certain degree. There are, nevertheless, cases where products can be assigned to activities only at a higher level than the class level or even where a class in CPA 2.1 has no activity counterpart in NACE Rev. 2. Data based on CPA provide the basis for preparing statistics of output, the various inputs to the production process (labour, materials, energy etc.), capital formation and the financial transactions of such units.

**Figure 110 Relation between NACE, CPA, PRODCOM and CN**




Source: Eurostat, CPA 2008 Introductory Guidelines, p. 2.

**PRODCOM** provides statistics on the production of manufactured goods (production value / production volume). The List of Products used for the Community Survey of Industrial Production (PRODCOM list) uses the structure of CPA 2008 for structuring the items in the field of the survey. The headings of the PRODCOM list are derived from the CN (as regards both their content and their terminology), but their code is a further breakdown of the CPA 2008 code. PRODCOM headings are coded using an 8-digit numerical code, the first four digits are the classification of the producing enterprise given by the Statistical Classification of Economic Activities in the European

[259] All enterprises are assigned to a NACE code according to their main business activity. As companies usually have several activities, the assignment is done by identifying the main focus of business activities (main share of the value added) and translating it to the respective NACE code. The NACE classification is used for statistical purposes. Data that are based on NACE, e.g. number of enterprises, number of persons employed, turnover, value added, always refer to the main business activity of the enterprise.

[260] http://ec.europa.eu/eurostat/documents/1995700/1995914/CPA2008introductoryguidelinesEN.pdf, 19 January 2018.

Community (NACE), the first six digits of which are identical to those of the CPA code. The remaining digits specify the product in more detail - products are identified by an 8-digit code. The PRODCOM list is therefore linked to, and thus consistent with, NACE and CPA. It is updated annually.

The **Combined Nomenclature** (**CN**) is a tool for classifying goods, set up to meet the requirements both of the Common Customs Tariff and of the EU's external trade statistics. The CN is also used in intra-EU trade statistics. It is a further development (with special EU-specific subdivisions) of the World Customs Organization's Harmonised System (HS) nomenclature, which is a systematic list of commodities applied by most trading nations (and also used for international trade negotiations). The structure of CN differs from NACE, CPA and PRODCOM. Some distinctions of CPA are not possible in CN, and the level of detail between the ranges of the products covered may also be quite different. Despite different classification criteria, in some areas, the structures of CPA and CN come closer to each other on the lower level of classifications. However, comparisons between these classifications are possible only by using conversion tables due to some differences of principle in the treatment of particular products. Just like the PRODCOM list, also the CN list is updated annually. The following table shows a summary of the classifications and their related data / indicators:

**Table 45 Classifications and their related data / indicators**

| Classification | Description | Data / indicators |
|---|---|---|
| NACE | Industry classification, based on main activity of the enterprise. | i.e. Structural Business Statistics, Business Demography:<br>• Number of enterprises;<br>• Employment;<br>• Turnover;<br>• Value added;<br>• etc. |
| CPA | Product classification (goods and services). | Basis for collecting and calculating statistics on the production, distributive trade, consumption, international trade and transport of such products. |
| PRODCOM | Production of manufactured goods (covering sections B-C of NACE). | e.g. production value, production volume. |
| CN | Goods classification. | International trade data: exports, imports. |

In order to arrive at a sound and reasonable definition of railway supply industry, three issues were taken into account:

- first, the definition of the railway supply industry has to **include all branches and products**;
- second, the railway supply industry has to be **reflected in the codes** of the relevant economic activity / product codes and vice versa;
- third, **data availability** for the selected branches / products - i.e. codes containing relevant data - is crucial for making statements on the situation and development of railway supply industry.

## Railway Supply Industry in PRODCOM-codes

The starting point was a list of **PRODCOM-codes** that are potentially included in the railway supply. We used a "*best-fit*" approach to establish the link between the identified products and the corresponding 2017 - PRODCOM codes.

In order to thoroughly assess whether a specific code is part of the railway supply industry or not, the purpose/use of the underlying good(s) was investigated. When this was not sufficiently clear from the PRODCOM description, the shares were assessed by taking into account existing data/information on production value/ volume and turnover at EU level for this specific code.

The main inclusion criterion of a code to be part of the railway supply industry statistic definition is a threshold of 20% of "purpose/use" within this specific code.

The following table is a detailed list of PRODCOM-codes their railway supply industry share:

**Table 46 PRODCOM-codes for the railway supply industry**

| PRODCOM 2017 code | PRODCOM 2017 description | Railway share in PRODCOM-code in % |
|---|---|---|
| 16101300 | Railway or tramway sleepers (cross-ties) of wood, not impregnated. | 100 |
| 16103200 | Railway or tramway sleepers (cross-ties) of impregnated wood. | 100 |
| 22299150 | Plastic parts for locomotives or rolling stock, railway or tramway track fixtures and fittings, mechanical signalling, safety or traffic control equipment. | 100 |
| 24107500 | Railway material (of steel). | 100 |
| 2410T252 | Railway material. | 100 |
| 24511290 | Ductile iron castings for locomotives/rolling stock/parts, used other than in land vehicles, bearing housings, plain shaft bearings, piston engines, gearing, pulleys, clutches, machinery. | 100 |
| 24511390 | Grey iron castings for locomotives/rolling stock/parts, used other than in land vehicles, bearing housings, plain shaft bearings, piston engines, gearing, pulleys, clutches, machinery. | 100 |
| 24521090 | Steel castings for locomotives/rolling stock/parts, use other than in land vehicles, bearing housings, plain shaft bearings, piston engines, gearing, pulleys, clutches, machinery. | 100 |
| 25501280 | Drop forged steel parts for locomotives or rolling stock, aircraft, spacecraft, electrical machinery and equipment, optical, photographic, cinematographic, measuring, checking or precision apparatus[261]. | 2 |
| 25621013 | Turned metal parts for articles of HS 7326, 7419, 7616; turned metal parts for vehicles and apparatus for fixing railway track of HS 86. | 100 |
| 25941115 | Screws and bolts for fixing railway truck construction material, iron or steel. | 100 |
| 25992910 | Railway or tramway track fixtures and fittings and parts thereof. | 100 |
| 27903330 | Parts of electrical signalling, safety or traffic control equipment for railways, tramways, roads, inland waterways, parking facilities, port installations and airfields[262]. | 11 |
| 27907010 | Electrical signalling, safety or traffic control equipment for railways or tramways. | 100 |
| 30201100 | Rail locomotives powered from an external source of electricity. | 100 |
| 30201200 | Diesel-electric locomotives. | 100 |
| 30201300 | Other rail locomotives; locomotive tenders. | 100 |
| 30202000 | Self-propelled railway or tramway coaches, vans and trucks, except maintenance or service vehicles. | 100 |
| 30203100 | Railway or tramway maintenance or service vehicles (including workshops, cranes, ballast tampers, track-liners, testing coaches and track inspection vehicles). | 100 |
| 30203200 | Rail/tramway passenger coaches; luggage vans, post office coaches and other special purpose rail/tramway coaches excluding rail/tramway maintenance/service vehicles, self-propelled. | 100 |
| 30203300 | Railway or tramway goods vans and wagons, not self-propelled. | 100 |

261 http://ar2013.citicpacific.com/citic_pacific/annual/2013/gb/English/pdf/CITIC_Pacific_AR13_businesses_E.pdf.

262 Statista based on the UK National Office of Statistics – survey of traffic control equipment manufacturers.

| PRODCOM 2017 code | PRODCOM 2017 description | Railway share in PRODCOM-code in % |
|---|---|---|
| 30204030 | Parts of locomotives or rolling-stock. | 100 |
| 30204050 | Mechanical or electromechanical signalling, safety or traffic control equipment for roads, inland waterways, parking facilities, port installations or airfields. | 100 |
| 30204060 | Mechanical signalling, safety or traffic control equipment for railways or tramways; parts of mechanical (including electromechanical), signalling, safety or traffic control equipment for railways, tramways, roads, inland waterways, parking facilities, port installations or airfields. | 100 |
| 30209100 | Reconditioning of railway and tramway locomotives and rolling-stock. | 100 |
| 33171100 | Repair and maintenance of railway and tramway locomotives and rolling-stock and of mechanical (and electro-mechanical) signalling, safety or traffic control equipment. | 100 |
| 399900Z5 | Railway or tramway track fixtures and fittings (excluding sleepers of wood, concrete or steel, sections of track and other track fixtures not yet assembled and railway or tramway track construction material); mechanical, including electromechanical, signalling, safety or traffic control equipment for railways, tramways, roads, inland waterways, parking facilities, port installations or airfields; parts of the foregoing. | 100 |

Source: VVA.

## Railway Supply Industry in CPA-codes

Due to the fact that PRODCOM and CPA classifications both refer to production data, it was easy to calculate the "railway share" in CPA based on PRODCOM shares, because the six-digit level in both classifications is identical. The "railway share" in CPA-codes was calculated by taking into account the following elements:

- For codes in manufacturing: "railway shares" for each PRODCOM-code;
- For codes in trade and services:
  - Corresponding production data according to PRODCOM;
  - Share of railway-related PRODCOM-codes (8-digit level) within a 6-digit level CPA-code. In addition, to thoroughly assess whether a specific code is part of the railway supply industry or not, its share was assessed by taking into account existing data / information on production value / volume and turnover at EU or national level from external data providers (such as: Statista).

The following table shows CPA-codes that were identified:

**Table 47 CPA-codes including railway supply**

| CPA 2.1 code | CPA 2.1 description | Railway share in CPA-code in % | Rounded railway share in CPA-code for further calculations in % |
|---|---|---|---|
| 16.10.13 | Railway or tramway sleepers (cross-ties) of wood, not impregnated. | 100% | 100% |
| 16.10.32 | Railway or tramway sleepers (cross-ties) of wood, impregnated. | 100% | 100% |
| 22.29.91 | Manufacturing services of other plastic products. | 0.71% | 0% |
| 24.10.75 | Railway or tramway track construction material of steel. | 100% | 100% |

| CPA 2.1 code | CPA 2.1 description | Railway share in CPA-code in % | Rounded railway share in CPA-code for further calculations in % |
|---|---|---|---|
| 24.51.12 | Casting services of spheroidal cast iron. | 20.65% | 20% |
| 24.51.13 | Casting services of grey cast iron. | 17.74% | 20% |
| 24.52.10 | Casting services of steel. | 40.53% | 40% |
| 25.50.12 | Stamping services of metal. | 11.87% | 10% |
| 25.62.10 | Turning services of metal parts. | 11.91% | 10% |
| 25.94.11 | Threaded fasteners, of iron or steel, n.e.c. | 3.38% | 0% |
| 25.99.29 | Other articles of base metal n.e.c. | 1.53% | 0% |
| 27.90.33 | Parts of other electrical equipment; electrical parts of machinery or apparatus n.e.c. | 5.85% | 10% |
| 27.90.70 | Electrical signalling, safety or traffic control equipment for railways, tramways, roads, inland waterways, parking facilities, port installations or airfields. | 52.89% | 50% |
| 30.20.20 | Self-propelled railway or tramway coaches, vans and trucks, except maintenance or service vehicles. | 100% | 100% |
| 30.20.31 | Railway or tramway maintenance or service vehicles. | 100% | 100% |
| 30.20.32 | Railway or tramway passenger coaches, not self-propelled; luggage vans and other specialised vans. | 100% | 100% |
| 30.20.33 | Railway or tramway goods vans and wagons, not self-propelled. | 100% | 100% |
| 30.20.40 | Parts of railway or tramway locomotives or rolling-stock; mechanical traffic control equipment. | 100% | 100% |
| 30.20.91 | Reconditioning and fitting out services ("completing") of railway and tramway locomotives and rolling-stock. | 100% | 100% |
| 30.20.99 | Sub-contracted operations as part of manufacturing of railway locomotives and rolling stock. | 100% | 100% |
| 33.17.11 | Repair and maintenance services of railway locomotives and rolling-stock. | 100% | 100% |
| 42.12.10 | Railways and underground railways. | 100% | 100% |
| 42.12.20 | Construction works for railways and underground railways. | 100% | 100% |
| 71.12.14 | Engineering services for transportation projects[263]. | 34% | 30% |

Source: VVA.

## Railway Supply Industry in NACE-codes

In general, the determination of railway supply industry shares in NACE-4-digit-level-codes is a challenging issue – in particular, the following two facts are responsible for this:

- In structural data according to NACE (e.g. Structural Business Statistics), a company, and thus their persons employed, turnover, value added, etc., is allocated to the industry in

[263] Based on Statista: Share of civil engineering output in France, Germany, Italy, Spain and UK by sector in 2015.

which is the main activity of the company. This means that indicators / data include also activities of the company that may have been accomplished in other sectors;
- The "railway" share in a specific NACE-code may vary depending on the observed indicator, i.e. number of enterprises, persons employed, turnover or value added. While it is possible in terms of structural similarities to apply the (aggregated) railway supply industry shares from PRODCOM to NACE for the indicators "turnover" and "value added", it is very problematic to apply a specific share for calculating the indicator "number of enterprises" or "persons employed"[264].

In order to provide a reasonable definition of railway supply industry in NACE, a similar approach to *ESSnet Culture* (2012)[265] regarding the definition of the cultural and creative sector (CCS) and a recent study conducted for EASME about the Sport Related Industries (2018)[266] were followed. Here, NACE-codes in the field of CCS are assigned a "cultural rank", i.e. to be either "totally cultural", "mainly cultural" or "partly cultural", depending on the cultural content in terms of description and products. In analogy to this procedure, the same was also applied for the railway supply industry, i.e. the NACE-codes were assigned "totally railway supply" (100% "railway" share), "mainly railway supply" (50-99% "railway" share) or "partly railway supply" (20-49% "railway" share), by taking into account the content of a NACE code in terms of description, products and trade data. Codes with a "railway" share smaller than 20% were not taken into account.

To identify the "railway" share in NACE-codes:

- For the **manufacturing sector**, the railway-related share was calculated from production at 4-digit level by aggregation of 8-digit-PRODCOM data (using an average for the period 2013-2017), which is identical with the NACE 4-digit;
- For the **construction and service sector**, where detailed data (more detailed than 4-digit level) at EU level is not available in any other classification, the "railway" shares were calculated / assessed by:
  - Share of railway supply industry-related CPA codes (6-digit level) within a 4-digit level code, calculated from the amount of railway supply industry-related production codes (PRODCOM) within a 4-digit-level code. The calculations in PRODCOM product groups were then rounded in 10%-steps;
  - The estimation of the share in these codes was based on information taken from company annual reports (e.g. ArcelorMittal, Lucchini RS, Siemens, Alstom), statistical information (e.g. Statista).

Based on this information, it was possible to arrive at a categorisation of railway supply-related NACE 4-digit-codes. For the indicators "number of enterprises" and "persons employed, the "totally railway", "mainly railway" and "partly railway" codes were taken into account as a whole, i.e. no share was applied. The shares were used for the indicators "turnover" and "value added", applying the respective railway shares.

---

[264] This can be highlighted by following example: Be it that one enterprise out of three of a specific NACE code is a railway supply enterprise (the railway share in the NACE code would be 33%), but as this enterprise happens to be a very large enterprise and the other two enterprises are not, this enterprise employs 750 employees of all 1,000 employees in this NACE code (which would make a railway share of 75%). Furthermore, it might generate 60% of the whole turnover and 50% of the whole value added in this NACE-code. The fact that the railway share in each indicator can be very different also makes it very problematic to calculate a specific number of enterprises / persons employed, because one single enterprise can be very small (e.g. with low share in employment, turnover and valued added) or very large (e.g. with high share in employment, turnover and value added).

[265] ESSnet Culture (2012): European Statistical System Network on Culture. Final Report. http://ec.europa.eu/culture/library/reports/ess-net-report_en.pdf, 6 April 2017.

[266] https://publications.europa.eu/en/publication-detail/-/publication/42a5c3f6-5ca1-11e8-ab41-01aa75ed71a1/language-en.

The following table shows all NACE-codes with a "railway" share of 20% and more:

**Table 48 NACE-codes including railway supply industry**

| NACE Rev. 2 code | NACE Rev. 2 description | Railway share in NACE-code in % | Rounded percentage of railway share | Railway content in code |
|---|---|---|---|---|
| 30.20 | Manufacture of railway locomotives and rolling stock | 100% | 100% | t |
| 33.17 | Repair and maintenance of other transport equipment | 100% | 100% | t |
| 42.12 | Construction of railways and underground railways | 100% | 100% | t |
| 24.52 | Casting of steel | 38% | 40% | p |
| 24.51 | Casting of iron | 17% | 20% | p |
| 71.12 | Engineering activities and related technical consultancy | 17% | 20% | p |

Note: t…"totally railway" (100% railway share), m…"mainly railway" (50-99% railway share), p…"partly railway" (20-49% railway share).
Source: VVA.

The following NACE-codes were taken into account in the data analysis, although their railway share is smaller than 20%:

**Table 49 NACE-codes with shares less than 20%, EU 28 data as of 2015**

| NACE Rev. 2 code | NACE Rev. 2 description | Railway share in NACE-code in % | Turnover in € million | Value added in € million |
|---|---|---|---|---|
| 16.1 | Sawmilling and planning of wood | 1% | 393.29 € | 80.88 € |
| 22.29 | Manufacture of other plastic products | 0.2% | 172.16 € | 57.49 € |
| 24.1 | Manufacture of basic iron and steel and of ferro-alloys | 1% | 1,393.92 € | 241.57 € |
| 25.5 | Forging, pressing, stamping and roll-forming of metal; powder metallurgy | 3% | 1,877.42 € | 563.26 € |
| 25.62 | Machining | 5% | 4,410.58 € | 1,886.85 € |
| 25.94 | Manufacture of fasteners and screw machine products | 3% | 364.72 € | 127.62 € |
| 25.99 | Manufacture of other fabricated metal products n.e.c. | 1% | 455.96 € | 162.64 € |
| 27.9 | Manufacture of other electrical equipment | 6% | 1,988.42 € | 682.64 € |
| Total | / | / | 11,056.47 € | 3,802.95 € |

Source: VVA.

## Railway Supply Industry in CN-codes

The PRODCOM and the CN classification are linked with a conversion table at the 8-digit-level. The railway supply industry shares that have been identified for each PRODCOM-code are applied in all data analysis done with CN-codes. Likewise, to simplify calculations with CN-data, the shares have been rounded in 10%-steps.

The following table is a detailed list of CN-codes including their share:

**Table 50 CN-codes for the railway supply industry**

| CN 2017 code | CN 2017 description | Railway share in CN-code in % | Railway share in CN-code for further calculations in % |
|---|---|---|---|
| 4406 11 00 | Railway or tramway sleepers (cross-ties) of wood, Not impregnated, Coniferous. | 100 | 100 |

| CN 2017 code | CN 2017 description | Railway share in CN-code in % | Railway share in CN-code for further calculations in % |
|---|---|---|---|
| 4406 12 00 | Railway or tramway sleepers (cross-ties) of wood, Not impregnated, Non-Coniferous. | 100 | 100 |
| 4406 91 00 | Railway or tramway sleepers (cross-ties) of wood, Other, Coniferous. | 100 | 100 |
| 4406 92 00 | Railway or tramway sleepers (cross-ties) of wood, Other, Non-Coniferous. | 100 | 100 |
| 7302 10 10 | Current-conducting, with parts of non-ferrous metal, for railway or tramway track construction material of iron or steel. | 100 | 100 |
| 7302 10 22 | Vignole rails, Of a weight per metre of 36 kg or more. | 100 | 100 |
| 7302 10 28 | Vignole rails: Of a weight per metre of less than 36 kg. | 100 | 100 |
| 7302 10 40 | Grooved rails of Iron or Steel, for Railway or Tramway, New. | 100 | 100 |
| 7302 10 50 | Grooved rails of Iron or Steel, for Railway or Tramway, New (Excl. Vignole rails, Grooved rails, Current-conducting with parts of non-ferrous metal). | 100 | 100 |
| 7302 10 90 | Grooved rails of Iron or Steel, for Railway or Tramway, Used (Excl. Current-conducting with parts of non-ferrous metal). | 100 | 100 |
| 7302 30 00 | Switch blades, crossing frogs, point rods and other crossing pieces, for Railway or Tramway, of Iron or Steel. | 100 | 100 |
| 7302 40 00 | Fish-plates and sole plates, for Railway or Tramway. | 100 | 100 |
| 7302 90 00 | Sleepers "Cross-Ties", Check Rails, Rack Rails, Chairs, Chair Wedges, Rail Clips, Bedplates and Ties and Other Specialised Material for the Jointing or Fixing of Railway or Tramway Track, of Iron or Steel (Excl. Rails, Switch Blades, Crossing Frogs, Point Rods and Other Crossing Pieces, and Fish-Plates and Sole Plates). | 100 | 100 |
| 7318 15 20 | Screws and bolts, of iron or steel "whether or not with their nuts and washers", for fixing railway track construction material (excl. coach screws). | 100 | 100 |
| 8530 10 00 | Electrical signalling, safety or traffic control equipment for railways or tramways (excl. mechanical or electromechanical equipment of heading 8608). | 100 | 100 |
| 8530 90 00 | Parts of electrical signalling, safety or traffic control equipment, n.e.s. | 100 | 100 |
| 8601 10 00 | Rail locomotives powered from an external source of electricity. | 100 | 100 |
| 8601 20 00 | Rail locomotives powered by electric accumulators. | 100 | 100 |
| 8602 10 00 | Diesel-electric locomotives. | 100 | 100 |
| 8602 90 00 | Rail locomotives (excl. those powered from an external source of electricity or by accumulators and diesel-electric locomotives). | 100 | 100 |

| CN 2017 code | CN 2017 description | Railway share in CN-code in % | Railway share in CN-code for further calculations in % |
|---|---|---|---|
| 8603 10 00 | Self-propelled railway or tramway coaches, vans and trucks, powered from an external source of electricity (excl. those of heading 8604). | 100 | 100 |
| 8603 90 00 | Self-propelled railway or tramway coaches, vans and trucks (excl. those powered from an external source of electricity and those of heading 8604). | 100 | 100 |
| 8604 00 00 | Railway or tramway maintenance or service vehicles, whether or not self-propelled, e.g., workshops, cranes, ballast tampers, trackliners, testing coaches and track inspection vehicles. | 100 | 100 |
| 8605 00 00 | Railway or tramway passenger coaches, luggage vans, post office coaches and other special purpose railway or tramway coaches (excl. self-propelled railway or tramway coaches, vans and trucks, railway or tramway maintenance or service vehicles and goods vans and wagons). | 100 | 100 |
| 8606 10 00 | Railway or tramway tank wagons and the like (excl. self-propelled). | 100 | 100 |
| 8606 30 00 | Railway or tramway self-discharging goods vans and wagons (excl. tank wagons and the like and insulated or refrigerated goods vans and wagons). | 100 | 100 |
| 8606 91 10 | Railway or tramway goods vans and wagons, covered and closed, specially designed for the transport of highly radioactive materials [Euratom] (excl. tank wagons and the like and insulated, refrigerated or self-discharging goods vans and wagons). | 100 | 100 |
| 8606 91 80 | Railway or tramway goods vans and wagons, covered and closed (excl. those specially designed for the transport of highly radioactive materials, tank wagons and the like and self-discharging goods vans and wagons). | 100 | 100 |
| 8606 92 00 | Railway or tramway goods vans and wagons, open, with non-removable sides of a height > 60 cm (excl. self-discharging wagons). | 100 | 100 |
| 8606 99 00 | Railway or tramway goods vans and wagons (excl. those specially designed for the transport of highly radioactive materials, tank wagons and the like, insulated, refrigerated or self-discharging goods vans and wagons and open goods vans and wagons with non-removable sides of a height > 60 cm). | 100 | 100 |

| CN 2017 code | CN 2017 description | Railway share in CN-code in % | Railway share in CN-code for further calculations in % |
|---|---|---|---|
| 8607 11 00 | Driving bogies and bissel-bogies for railway or tramway locomotives or rolling stock. | 100 | 100 |
| 8607 12 00 | Bogies and driving bissel-bogies for railway or tramway locomotives or rolling stock (excl. driving bogies). | 100 | 100 |
| 8607 19 10 | Axles, wheels and wheel parts, of railway or tramway locomotives or rolling stock, n.e.s. | 100 | 100 |
| 8607 19 90 | Parts of bogies, bissel-bogies and the like, of railway or tramway locomotives or rolling stock, n.e.s. | 100 | 100 |
| 8607 21 10 | Air brakes and parts thereof, of railway or tramway locomotives or rolling stock, of cast iron or cast steel. | 100 | 100 |
| 8607 21 90 | Air brakes and parts thereof, of railway or tramway locomotives or rolling stock (excl. of cast iron or cast steel). | 100 | 100 |
| 8607 29 00 | Brakes (other than air brakes), and parts thereof, for railway or tramway locomotives or rolling stock, n.e.s. | 100 | 100 |
| 8607 30 00 | Hooks and other coupling devices, buffers, and parts thereof, for railway or tramway locomotives or rolling stock, n.e.s. | 100 | 100 |
| 8607 91 10 | Axle-boxes and parts thereof, for locomotives, n.e.s. | 100 | 100 |
| 8607 91 90 | Parts of railway or tramway locomotives, n.e.s. | 100 | 100 |
| 8607 99 10 | Axle-boxes and parts thereof, of railway or tramway locomotives or rolling stock of heading 8603, 8604, 8605 or 8606, n.e.s. | 100 | 100 |
| 8607 99 80 | Parts of rolling stock of heading 8603, 8604, 8605 or 8606, n.e.s. | 100 | 100 |
| 8608 00 00 | Railway or tramway track fixtures and fittings (excl. sleepers of wood, concrete or steel, sections of track and other track fixtures not yet assembled and railway or tramway track construction material); mechanical, incl. electromechanical, signalling, safety or traffic control equipment for railways, tramways, roads, inland waterways, parking facilities, port installations or airfields; parts of the foregoing. | 100 | 100 |

Source: VVA.

# ANNEX B – LITERATURE / SOURCES CONSULTED IN THE CONTEXT OF THE DEFINITION OF RAILWAY SUPPLY INDUSTRY

## Literature / reports


- Bruegel 'Regression Based Record Linkage with an Application to PATSTAT', available at: http://bruegel.org/wp-content/uploads/imported/publications/WP_2014_10iii.pdf;
- CBI 'Product Factsheet: Railway Equipment Parts in Europe', available at: https://www.cbi.eu/sites/default/files/market_information/researches/product-factsheet-europe-railway-equipment-parts-2015.pdf;
- Ecorys 'Sector Overview and Competitiveness Survey of the Railway Supply Industry' (2012);
- ESSnet-Culture Project coordinator, 'European Statistical System Network on Culture', available at: http://ec.europa.eu/assets/eac/culture/library/reports/ess-net-report_en.pdf;
- Eurostat 'Statistical classification of economic activities in the European Community', available at: https://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF;
- Eurostat 'Information and communication service statistics - NACE Rev. 2', available at: https://ec.europa.eu/eurostat/statistics-explained/pdfscache/10093.pdf;
- European Commission 'Unlocking Investment in Intangible Assets', (2017);
- European Parliament (2019) 'Digitalisation in railway transport – A lever to improve rail competitiveness', available at: http://www.europarl.europa.eu/RegData/etudes/BRIE/2019/635528/EPRS_BRI(2019)635528_EN.pdf
- European Commission (2019) Sixth report on monitoring development of the rail market {SWD(2019) 13 final}.
- EPO & EUIPO 'Intellectual property rights intensive industries and economic performance in the European Union' (2013);
- Interfleet (2007) 'Survey of Competitiveness of the EU Rail Supply Industry';
- Krugman, Paul, and Robert Lawrence, 'Trade, Jobs, and Wages' Scientific American, CCLXX (1994), 22-27;
- Roland Berger (2017) 'Rail Supply Digitalization', available at: https://www.rolandberger.com/en/Publications/Rail-supply-digitization.html
- Shift2Rail (2018) 'Digital Transformation of Rail', available at: https://shift2rail.org/wp-content/uploads/2018/04/DIGITAL_TRANSFORMATION_RAILWAYS_2018_web.pdf
- Statistics Estonia, Unit Labour Costs as an Indicator of the Competitiveness of the Economy, Eesti Statistika Kvartalikiri 4/12, Quarterly Bulleting of Statistics Estonia;
- UNIFE World Rail Market Study (2018);
- Sheilah Frey (2012) 'Railway electrification systems & engineering', Delhi: White Word Publications, 2012;
- VVA & Austrian Institute for SME Research 'Improve Economic and Policy Knowledge in the Field of Sport Related Industries with particular focus on Sporting Goods Sector' (2017);
- VVA & London Economics 'Measurement of impact of cross-border penetration in public procurement' (2016);
- European Commission (2019) Sixth report on monitoring development of the rail market {SWD(2019) 13 final}.


## Statistical information / databases


- EUROSTAT – Structural Business Statistics;
- Comext - https://ec.europa.eu/eurostat/web/international-trade-in-goods/data/focus-on-comext;
- OECD (2018), Labour productivity and utilisation (indicator). doi: 10.1787/02c02f63-en (Accessed on 13 September 2018);
- OECD (2018), Labour compensation per hour worked (indicator). doi: 10.1787/251ec2da-en (Accessed on 13 September 2018);
- PATSTAT - http://documents.epo.org/projects/babylon/eponet.nsf/0/2EB470D75C469647C1257F0700343F6F/$FILE/how_to_load_patstat_data_v1.09_en.pdf;
- PRODCOM - https://ec.europa.eu/eurostat/web/prodcom/data/database/;
- RAMON - Reference And Management Of Nomenclatures;

- Statista;
- WIPO Global Design Database - http://www.wipo.int/designdb/en/.

**Online resources**

- The Railway Technical Website: http://www.railway-technical.com/infrastructure/electric-traction-power.html;
- Railway Directory: http://www.railwaydirectory.net/.

**Interest groups**

- CER - La Communauté européenne du rail;
- UNIFE;
- DICTEFER;
- EIM Rail (interview scheduled but not conducted yet – as of 05/12/2018);
- Siemens AG (interview scheduled but not conducted yet – as of 05/12/2018).

## ANNEX C - LIST OF CPV CODES USED FOR THE ANALYSIS OF PUBLIC PROCUREMENT

| CPV | Description | Sub-sector |
|---|---|---|
| 34900000-6 | Miscellaneous transport equipment and spare parts. | Infrastructure. |
| 34940000-8 | Railway equipment. | Infrastructure. |
| 34941200-7 | Track rails. | Infrastructure. |
| 34941600-1 | Crossovers. | Infrastructure. |
| 34941800-3 | Railway points. | Infrastructure. |
| 34944000-6 | Points heating system. | Infrastructure. |
| 34945000-3 | Track-alignment machinery. | Infrastructure. |
| 34946000-0 | Railway-track construction materials and supplies. | Infrastructure. |
| 34946100-1 | Railway-track construction materials. | Infrastructure. |
| 34946110-4 | Rails. | Infrastructure. |
| 34946120-7 | Railway materials. | Infrastructure. |
| 34946121-4 | Fishplates and sole plates. | Infrastructure. |
| 34946122-1 | Check rails. | Infrastructure. |
| 34946200-2 | Railway-track construction supplies. | Infrastructure. |
| 34946210-5 | Current-conducting rails. | Infrastructure |
| 34946220-8 | Switch blades, crossing frogs, point rods and crossing pieces. | Infrastructure. |
| 34946221-5 | Switch blades. | Infrastructure. |
| 34946222-2 | Crossing frogs. | Infrastructure. |
| 34946223-9 | Point rods. | Infrastructure. |
| 34946224-6 | Crossing pieces. | Infrastructure. |
| 34946230-1 | Rail clips, bedplates and ties. | Infrastructure. |
| 34946231-8 | Rail clips. | Infrastructure. |
| 34946232-5 | Bedplates and ties. | Infrastructure. |
| 34946240-4 | Chairs and chair wedges. | Infrastructure. |
| 34947000-7 | Sleepers and parts of sleepers. | Infrastructure. |
| 34947100-8 | Sleepers. | Infrastructure. |
| 34947200-9 | Parts of sleepers. | Infrastructure. |
| 43500000-8 | Track-laying vehicles. | Infrastructure. |
| 45234116-2 | Track construction works. | Infrastructure. |
| 50200000-7 | Repair, maintenance and associated services related to aircraft, railways, roads and marine equipment. | Infrastructure. |
| 50220000-3 | Repair, maintenance and associated services related to railways and other equipment. | Infrastructure. |
| 50225000-8 | Railway-track maintenance services. | Infrastructure. |
| 71631470-5 | Railway-track inspection services. | Infrastructure. |
| 34600000-3 | Railway and tramway locomotives and rolling stock and associated parts. | Locomotives and rolling stock. |

| CPV | Description | Sub-sector |
|---|---|---|
| 34610000-6 | Rail locomotives and tenders. | Locomotives and rolling stock. |
| 34611000-3 | Locomotives. | Locomotives and rolling stock. |
| 34620000-9 | Rolling stock. | Locomotives and rolling stock. |
| 34621000-6 | Railway maintenance or service vehicles, and railway freight wagons. | Locomotives and rolling stock. |
| 34621100-7 | Railway freight wagons. | Locomotives and rolling stock. |
| 34621200-8 | Railway maintenance or service vehicles. | Locomotives and rolling stock. |
| 34622000-3 | Railway and tramway passenger coaches, and trolleybuses. | Locomotives and rolling stock. |
| 34622200-5 | Railway passenger coaches. | Locomotives and rolling stock. |
| 34622400-7 | Railway carriages. | Locomotives and rolling stock. |
| 34622500-8 | Luggage vans and special-purpose vans. | Locomotives and rolling stock. |
| 34630000-2 | Parts of railway or tramway locomotives or rolling stock; railways traffic-control equipment. | Locomotives and rolling stock. |
| 34631000-9 | Parts of locomotives or rolling stock. | Locomotives and rolling stock. |
| 34631100-0 | Monobloc wheels. | Locomotives and rolling stock. |
| 34631200-1 | Buffers and drawgear. | Locomotives and rolling stock. |
| 34631300-2 | Rolling-stock seats. | Locomotives and rolling stock. |
| 34631400-3 | Wheel axles and tyres and other parts of locomotives or rolling stock. | Locomotives and rolling stock. |
| 42415000-8 | Forklift trucks, works trucks, railway-station platforms tractors. | Locomotives and rolling stock. |
| 42415300-1 | Railway-station platforms tractors. | Locomotives and rolling stock. |
| 42418100-0 | Mine-wagon pushers and locomotive or wagon traversers. | Locomotives and rolling stock. |
| 50221000-0 | Repair and maintenance services of locomotives. | Locomotives and rolling stock. |
| 50221100-1 | Repair and maintenance services of locomotive gearboxes. | Locomotives and rolling stock. |
| 50221200-2 | Repair and maintenance services of locomotive transmissions. | Locomotives and rolling stock. |
| 50221300-3 | Repair and maintenance services of locomotive wheelsets. | Locomotives and rolling stock. |
| 50221400-4 | Repair and maintenance services of locomotive brakes and brake parts. | Locomotives and rolling stock. |
| 50222000-7 | Repair and maintenance services of rolling stock. | Locomotives and rolling stock. |
| 50222100-8 | Repair and maintenance services of dampers. | Locomotives and rolling stock. |
| 50223000-4 | Reconditioning services of locomotives. | Locomotives and rolling stock. |
| 50224000-1 | Reconditioning services of rolling stock. | Locomotives and rolling stock. |
| 50224100-2 | Reconditioning services of rolling stock seats. | Locomotives and rolling stock. |

| CPV | Description | Sub-sector |
|---|---|---|
| 50224200-3 | Reconditioning services of passenger coaches. | Locomotives and rolling stock. |
| 51143000-6 | Installation services of railway engines. | Locomotives and rolling stock. |
| 34632000-6 | Railways traffic-control equipment. | Signalling, control and electrification. |
| 34632100-7 | Mechanical signalling. | Signalling, control and electrification. |
| 34632200-8 | Electrical signalling equipment for railways. | Signalling, control and electrification. |
| 34632300-9 | Electrical installations for railways. | Signalling, control and electrification. |
| 34941100-6 | Rods. | Signalling, control and electrification. |
| 34941500-0 | Crossheads. | Signalling, control and electrification. |
| 34942000-2 | Signalling equipment. | Signalling, control and electrification. |
| 34942100-3 | Signal posts. | Signalling, control and electrification. |
| 34942200-4 | Signalling boxes. | Signalling, control and electrification. |
| 34943000-9 | Train-monitoring system. | Signalling, control and electrification. |
| 45234115-5 | Railway signalling works. | Signalling, control and electrification. |
| 48140000-1 | Railway traffic control software package. | Signalling, control and electrification. |
| 63711100-7 | Train monitoring services. | Signalling, control and electrification. |
| 72212140-2 | Railway traffic control software development services. | Signalling, control and electrification. |

**Table 51 Total value of awards in locomotive and rolling stocks over km of railway by country by year, EU-28 (Value in EUR)**

| Country | 2014 | 2015 | 2016 |
|---|---|---|---|
| AT | 2,593.00 € | 9,507.00 € | 3,668.00 € |
| BE | | 249.00 € | 937,814.00 € |
| BG | 2,274.00 € | 54,771.00 € | 5,073.00 € |
| CY | | | |
| CZ | | 26,997.00 € | 19,153.00 € |
| DE | | 114.00 € | 480.00 € |
| DK | | 33,050.00 € | |
| EE | | 725.00 € | 527.00 € |
| ES | 2,302.00 € | 35,630.00 € | 19,815.00 € |
| FI | 126.00 € | 304.00 € | |
| FR | 39.00 € | 69,668.00 € | 9,425.00 € |
| GR | | 272.00 € | 796.00 € |
| HR | 1,354.00 € | 10,863.00 € | 4,202.00 € |
| HU | 127.00 € | 25,253.00 € | 23,265.00 € |
| IE | | | 160.00 € |
| IT | 2,666.00 € | 97,984.00 € | 294,284.00 € |
| LT | 939.00 € | 8,655.00 € | 11,497.00 € |
| LU | | | |
| LV | | 1,664.00 € | 1,475.00 € |
| MT | | | |

| Country | 2014 | 2015 | 2016 |
|---|---|---|---|
| NL | 138.00 € | 685.00 € | 530,977.00 € |
| PL | 569.00 € | 19,156.00 € | 17,945.00 € |
| PT | 3,182.00 € | | 628.00 € |
| RO | 2,385.00 € | 626.00 € | 1,328.00 € |
| SE | | 11,529.00 € | 36,844.00 € |
| SI | 1,322.00 € | 1,963.00 € | 10,929.00 € |
| SK | 2,116.00 € | 28,698.00 € | 13,551.00 € |
| UK | | 55,557.00 € | 1,805.00 € |

Source: VVA, TED database.

# ANNEX XX – OVERVIEW OF TENDERS IN THE RSI

**Table 52 Number of tenders in signalling and electrification technology per year 2014-2016, EU-28**

| Country | 2014 | 2015 | 2016 |
|---|---|---|---|
| AT | 1 | 6 | 9 |
| BE | 4 | 7 | 13 |
| BG | 1 | 1 | 2 |
| CY | | | |
| CZ | 8 | 9 | 3 |
| DE | 25 | 25 | 95 |
| DK | | | 1 |
| EE | | 1 | |
| ES | 5 | 11 | 13 |
| FI | 1 | 3 | 1 |
| FR | 32 | 42 | 30 |
| GR | | | |
| HR | 2 | | |
| HU | 6 | 2 | 3 |
| IE | | 2 | |
| IT | 10 | 26 | 14 |
| LT | 3 | 1 | 4 |
| LU | 5 | 3 | 8 |
| LV | 2 | | |
| MT | | | |
| NL | 1 | 1 | 1 |
| PL | 5 | 8 | 8 |
| PT | | 1 | |
| RO | 2 | 2 | 3 |
| SE | 1 | 3 | 1 |
| SI | | | |
| SK | 1 | | |
| UK | 1 | 3 | 4 |

Source: VVA, TED database.

**Table 53 Total value of awards in signalling and electrification technology over km of railway by country by year, EU-28 (Value in EUR)**

| Country | 2014 | 2015 | 2016 |
|---|---|---|---|
| AT | | 1,126.00 € | 1,876.00 € |
| BE | | 9,228.00 € | 9,331.00 € |
| BG | | 243.00 € | 220.00 € |
| CY | | | |
| CZ | 446.00 € | 5,661.00 € | 35.00 € |
| DE | | 265.00 € | 426.00 € |
| DK | | | |
| EE | | 380.00 € | |
| ES | | 9,399.00 € | 13,518.00 € |
| FI | | 533.00 € | |
| FR | 34.00 € | 227.00 € | 644.00 € |
| GR | | | |
| HR | 640.00 € | | |
| HU | 67.00 € | 145.00 € | 237.00 € |
| IE | | | |
| IT | 591.00 € | 17,962.00 € | 10,057.00 € |
| LT | 400.00 € | 81.00 € | 883.00 € |
| LU | | | 9,081.00 € |
| LV | | | |
| MT | | | |
| NL | | | |
| PL | 113.00 € | 663.00 € | 1,283.00 € |
| PT | | 309.00 € | |
| RO | | 1,210.00 € | 2,557.00 € |
| SE | | 3,109.00 € | 134.00 € |
| SI | | | |
| SK | | | |
| UK | | | 2,367.00 € |

Source: VVA, TED database.

**Table 54 Number of tenders in railway infrastructure per year 2014-2016, EU-28**

| Country | 2014 | 2015 | 2016 |
|---|---|---|---|
| AT | 13 | 9 | 14 |
| BE | 6 | 18 | 20 |
| BG | 16 | 21 | 20 |
| CY | | | |
| CZ | 14 | 11 | 6 |
| DE | 61 | 75 | 91 |
| DK | 2 | 2 | 4 |
| EE | 4 | 7 | 2 |
| ES | 53 | 45 | 58 |
| FI | 4 | 4 | 8 |
| FR | 64 | 49 | 44 |
| GR | | | |
| HR | 7 | 3 | 2 |
| HU | 11 | 15 | 11 |
| IE | | 7 | 7 |
| IT | 59 | 105 | 79 |
| LT | 8 | 6 | 7 |
| LU | 2 | | 3 |
| LV | 8 | 11 | 6 |
| MT | | | |
| NL | 7 | 10 | 29 |
| PL | 25 | 34 | 26 |
| PT | 3 | 12 | 1 |
| RO | 10 | 9 | 13 |
| SE | 16 | 10 | 13 |
| SI | 1 | 4 | |
| SK | 1 | 4 | 3 |
| UK | 7 | 9 | 8 |

Source: VVA, TED database.

**Table 55 Total value of awards in railway infrastructure over km of railway by country by year 2014-2016, EU-28 (Value in EUR)**

| Country | 2014 | 2015 | 2016 |
|---|---|---|---|
| AT | | 584.00 € | 2,033.00 € |
| BE | 343.00 € | 8,853.00 € | 3,598.00 € |
| BG | 1,993.00 € | 408.00 € | 3,808.00 € |
| CY | | | |
| CZ | 940.00 € | 2,890.00 € | 2,837.00 € |
| DE | 350.00 € | 4,583.00 € | 14,548.00 € |
| DK | | | 14,702.00 € |
| EE | | 7,148.00 € | 3,051.00 € |
| ES | 972.00 € | 9,122.00 € | 12,902.00 € |
| FI | | 10,901.00 € | 10,971.00 € |
| FR | 1,625.00 € | 1,907.00 € | 1,124.00 € |
| GR | | | |
| HR | | 3,209.00 € | 8,715.00 € |
| HU | 29.00 € | 7,153.00 € | 2,997.00 € |
| IE | | 171.00 € | 377.00 € |
| IT | 619.00 € | 31,596.00 € | 37,137.00 € |
| LT | 223.00 € | 800.00 € | 2,758.00 € |
| LU | | | |
| LV | | 3,500.00 € | 4,937.00 € |
| MT | | | |
| NL | | 7,726.00 € | 1,635.00 € |
| PL | 73.00 € | 16,896.00 € | 3,488.00 € |
| PT | 159.00 € | 19,462.00 € | 471.00 € |
| RO | 85.00 € | 182.00 € | 1,459.00 € |
| SE | 57.00 € | 9,056.00 € | 2,228.00 € |
| SI | | 2,214.00 € | - |
| SK | | 4,491.00 € | 874.00 € |
| UK | - | 381.00 € | 2,380.00 € |

Source: VVA, TED database.

# ANNEX D - LABOUR COMPETITIVENESS – DATA OVERVIEW

**Table 56 NACE 30.20 - Unit Labour Cost Growth, Labour Utilization Growth & Labour Productivity Growth (avg.) – details**

| | Labour Utilization Growth | Labour Productivity Growth | Unit Labour Cost growth | Time series |
|---|---|---|---|---|
| Belgium | -13.1% | -19.1% | -23.2% | 2-years |
| Bulgaria | -3.3% | 5.2% | -3.0% | 5-years |
| Czech Republic | -1.5% | 27.0% | -5.0% | 2-years |
| Germany | -1.0% | 4.3% | -2.7% | 5-years |
| Spain | -2.5% | -3.6% | -3.1% | 5-years |
| Croatia | -16.4% | 14.2% | 0.7% | 4-years |
| Hungary | -1.2% | 9.5% | 11.0% | 4-years |
| Netherlands | 0.9% | 29.1% | -12.9% | 4-years |
| Poland | 0.2% | 6.7% | -8.2% | 4-years |
| Portugal | -6.0% | -29.6% | 7.1% | 3-years |
| Romania | -5.2% | 1.0% | -9.3% | 5-years |
| Slovakia | 0.4% | 11.3% | 4.7% | 5-years |
| United Kingdom | 13.3% | 3.6% | -7.4% | 5-years |
| Turkey | 17.7% | 5.2% | -5.9% | 2-years |

Source: VVA, Eurostat, Structural Business Statistics (sbs).

**Table 57 NACE 33.17 - Unit Labour Cost Growth, Labour Utilization Growth & Labour Productivity Growth (avg.) – details**

| | Labour utilization growth | Labour productivity growth | Unit labour cost growth | Time series |
|---|---|---|---|---|
| Belgium | 10% | -4% | -7% | 6-years |
| Bulgaria | -1% | 5% | 1% | 6-years |
| Czech Republic | 18% | -7% | -7% | 2-years |
| Germany | -2% | -1% | -4% | 6-years |
| Greece | 45% | 27% | -19% | 5-years |
| Spain | 14% | -2% | -4% | 6-years |
| Croatia | -8% | -11% | -8% | 6-years |
| Italy | 5% | 4% | 3% | 5-years |
| Lithuania | -3% | 5% | 1% | 6-years |
| Hungary | -20% | 1% | -2% | 6-years |
| Austria | 1% | 2% | 0% | 6-years |
| Poland | -6% | 0% | -2% | 6-years |
| Portugal | -5% | -1% | 0% | 6-years |
| Romania | -5% | 0% | -3% | 5-years |
| Slovakia | -8% | -18% | -20% | 6-years |
| Finland | -9% | 11% | 4% | 6-years |
| Sweden | 1% | 6% | -1% | 5-years |
| United Kingdom | -7% | 7% | 2% | 4-years |
| Norway | 1% | 2% | -4% | 4-years |
| Turkey | 27% | 52% | 33% | 2-years |

Source: VVA, Eurostat, Structural Business Statistics (sbs).

## ANNEX E - LIST OF LITERATURE REVIEWED FOR THE REGULATORY AND FRAMEWORK CONDITIONS

In total 50 different documents of varying size were reviewed. These 50 reviewed literatures distribute as follows from the list of sources.

**Figure 111 Sources of literature reviewed**


Note: These sources do not include reviewed EU Directives or Regulations.

The list of documents is presented in the Table below.

| # | Source | Title | Year | Author | Topic(s) | Main input | Secondary | Other |
|---|---|---|---|---|---|---|---|---|
| 1 | Commercial market surveys | World Rail Market Study: Forecast 2016 to 2021 | 2016 | Roland Berger, UNIFE | World RSI market, current volumes, forecasts | Sector structure | Other framework conditions | Technological trends, Market access, Regulatory environment, Business models |
| 2 | Research programmes | S2R Multi-Annual Action Plan - Executive View | 2014 | Shift2Rail | Challenges and opportunities for European rail sector, future visions | Technological trends | Challenges and opportunities | Regulatory environment, Other framework conditions |
| 3 | Commercial market surveys | The Economic Footprint of railway transport in Europe | 2014 | Ecorys | Focus on railway transport (passenger and freight operators) | Other framework conditions | | |
| 4 | Commercial market surveys | Rail supply digitization (Presentation) | 2017 | Roland Berger | Digitalisation of RSI, interviews with rail supply executives | Technological trends | | |
| 5 | Commercial market surveys | Sector Overview and Competitiveness Survey of the Railway Supply Industry | 2012 | Ecorys | Previous competitiveness study | Sector structure | Competitiveness | All |
| 6 | Research programmes | Rail 2050 Vision - Rail the Backbone of Europe's Mobility | 2017 | ERRAC | Rail sector's economic, societal and environmental contribution, the challenges and opportunities it faces arising and a 2050 vision | Technological trends | Challenges and opportunities | Other framework conditions, Competitiveness, Regulatory environment |

| # | Source | Title | Year | Author | Topic(s) | Main input | Secondary | Other |
|---|---|---|---|---|---|---|---|---|
| 7 | European organisations | Freight on Road: Why EU Shippers prefer Truck to Train | 2015 | European Parliament, Policy Department B; Steer Davies Gleave | Transport mode choice of shippers in the EU; road vs rail; long-term trends of freight transport; main factors driving modal change | Other framework conditions | Regulatory environment | Challenges and opportunities |
| 8 | Commercial market surveys | Autonomous LRT Operation – An Overview (Presentation) | 2018 | Ramboll | Possibility of Autonomous LRT Operation in mixed traffic | Technological trends | | |
| 9 | Research programmes | Vision and Roadmap for Sustainable Mobility – Rail towards 2050 | 2015 | Fraunhofer Institute; SPIDER PLUS and LivingRAIL projects | Joint report on the conclusions of the two FP7 projects SPIDER PLUS and LivingRAIL | Technological trends | Challenges and opportunities | Regulatory environment |
| 10 | Research programmes | Strategic Rail Research and Innovation Agenda - A step change in rail research and innovation | 2014 | ERRAC | Required R&I efforts to achieve Commission's goals stated in the Transport White Paper | Technological trends | Challenges and opportunities | Regulatory environment, Products and Segmentation |
| 11 | International Railway organisations | Railway Standardisation Strategy Europe | 2016 | International Union of Railways (UIC) | Standardisation in Europe and its problems (Business viewpoint) | Regulatory environment | | |

| # | Source | Title | Year | Author | Topic(s) | Main input | Secondary | Other |
|---|---|---|---|---|---|---|---|---|
| 12 | National Railway organisations | Die Bahnindustrie in Deutschland - Zahlen und Fakten zum Bahnmarkt und -verkehr | 2017 | VDB (Association of German Railway Industry) | Facts on RSI sector in Germany, its development, its outlook, trends and some comparisons to world, China and other transport modes | Sector structure | Market Access | Other framework conditions |
| 13 | European organisations | Consolidated Annual Activity Report 2017 | 2018 | ERA | Work of the ERA in regard to the Single European Railway Area with focus on its strategic objectives. | Regulatory environment | Market Access | |
| 14 | Railway magazines | Various articles | | Railway Gazette | Various articles on HS lines | Challenges and opportunities | Products and Segmentation | Other framework conditions |
| 15 | Railway magazines | Various articles | | Railway Technology | Various articles on HS lines and other interesting projects | Challenges and opportunities | Other framework conditions | Market Access, Competitiveness |
| 16 | Commercial market surveys | RSI Watch - Various surveys | 2014 - 2018 | Roland Berger, UNIFE, Railway Gazette | Various surveys with RSI managers on various topics | Business models | | All |
| 17 | Railway magazines | The Hidden Economic Rationale Of China-Europe Rail // New rail routes between China and Europe will change trade patterns | 22.03.2018 // 16.09.2017 | Wade Shepard, Forbes // The Economist | Articles on new silk road and Trans-Eurasian rail | Challenges and opportunities | | |

| # | Source | Title | Year | Author | Topic(s) | Main input | Secondary | Other |
|---|---|---|---|---|---|---|---|---|
| 18 | Academic article | The Emerging U.S. Rail Industry: Opportunities to support American manufacturing and spur regional development | 2012 | Erik R. Pages, Brian Lombardozzi and Lindsey Woolsey | Insights into US RSI, current opportunities through rising passenger demand, rising federal investments and Buy American provision, but also challenges due to severe gaps in the supply chain and over reliance on foreign OEMs (esp. regarding HS rail) | Market access | Other framework conditions | Challenges and opportunities |
| 19 | Government Publication | The UK Rail Sector. A showcase of world-class expertise | 2017 | UK Trade & Investment | Insights into UK RSI, examples of RSI and rail related (e.g. consulting) companies based in UK as well as innovation capabilities | Sector structure | Competitiveness | Other framework conditions |
| 20 | Government Publication | Panorama Of The Manufacturing Industry Of The Czech Republic 2016 | 2016 | Czech Ministry Of Industry And Trade | Overview over several Czech manufacturing sectors including RSI. Gives insights into companies and market | Other framework conditions | Business models | Sector structure, Market access, regulatory environment |
| 21 | International Railway organisations | Rail Technical Strategy Europe | 2014 | International Union of Railways (UIC) | Strategy to shape the future railway in Europe. Mostly vision, objectives and enablers for each RSI segment, gives some insight into interesting | Technological trends | Challenges and opportunities | |

| # | Source | Title | Year | Author | Topic(s) | Main input | Secondary | Other |
|---|---|---|---|---|---|---|---|---|
| | | | | | future technologies | | | |
| 22 | Commercial market surveys | Branchenanalyse Bahnindustrie: Industrielle Und Betriebliche Herausforderungen Und Entwicklungskorridore | 2016 | Lars Neumann und Walter Krippendorf; Hans Böckler Stiftung | Extensive market report on German RSI with 3 examination fields, (1) Inventory of the railway industry in DE (2) portfolio review of the global railway industry and (3) Corporate strategies in the transformation of RSI | Sector structure | Business models | Market Access, Competitiveness, Technological trends, Challenges and opportunities, Products and segmentation |
| 23 | Government Publication | Empresas Españolas: Líderes Mundiales en Ferrocarriles de Última Generación | 2017 | Ministerio de Asuntos Exteriores y de Cooperación | Government Report (to highlight Spanish company projects all over the world) | Competitiveness | | |
| 24 | Research programmes | Regional And Suburban Railways Market Analysis Update | 2016 | UITP under Foster Rail project for ERRAC | Study with focus on local, regional and urban rail. Mainly operators. Presents results collected in 2014 and 2015 and compares to previous study (2006) | Other framework conditions | Sector structure | Products and segmentation, Technological trends |
| 25 | National Railway organisations | MAFEX y el Sector Ferroviario Español | | MAFEX | Business association report on Spanish RSI | Sector structure | Competitiveness | Market access |

| # | Source | Title | Year | Author | Topic(s) | Main input | Secondary | Other |
|---|---|---|---|---|---|---|---|---|
| 26 | International Railway organisations | Statistics Brief - World Report On Metro Automation - July 2016 | | UITP | Fully automated Metros – Current numbers and outlook | Technological trends | | |
| 27 | Government publication | Fast Track to the Future - A strategy for productivity and growth in the UK rail supply chain | 2016 | UK - Department for Transport, Rail Supply Group | UK Strategy to develop UK RSI's capability as a global leader in the next decade | Challenges and opportunities | Other framework conditions | Technological trends, Competitiveness, Market access, Regulatory environment |
| 28 | Government publication | The Railway Market in Japan | 2016 | Lyckle Griek, EU-Japan Centre for Industrial Cooperation | Overview on the current situation in the Japanese railway market. Target audience: Smaller suppliers of innovative rail-related technologies and services | Market access | Sector structure | Future challenges, Business models |
| 29 | Commercial market surveys | On the digital track – Leveraging digitalisation in rolling stock maintenance | 2016 | Roland Berger | Report/survey on future of maintenance for railways. Focus heavily on operators | Technological trends | Sector structure | Regulatory environment |
| 30 | Academic article | Rail freight development in Europe: how to deal with a doubly-imperfect competition? | 2016 | Yves Crozet | Imperfect competition between rail and road freight and between rail and rail. Focus on operators | Regulatory environment | | |

| # | Source | Title | Year | Author | Topic(s) | Main input | Secondary | Other |
|---|---|---|---|---|---|---|---|---|
| 31 | Railway magazines | Rail and Metro Innovation Guide 2018 | 2017 | Smartrail World | Report showcasing technological trends and various innovative solutions | Technological trends | | |
| 32 | International Railway organisations | UNIFE Annual Report 2017 | 2017 | UNIFE | Technological trends (ERTMS, S2R, Research funding); Market access (Japan, China, USA, etc.); regulatory environment (standards, EU policy); other framework conditions (investment, finance) | Technological trends | Other framework conditions | Market access |
| 33 | International Railway organisations | Views Of The Rail Sector Post-2020 Multiannual Financial Framework | 2016 | UNIFE, UITP, UIP, ERFA, EIM, CER | Position paper on post 2020 budget for rail | Challenges and opportunities | | |
| 34 | International Railway organisations | UNIFE briefing for the Estonian Presidency of the Council of the EU | 2017 | UNIFE | Briefing to Estonian presidency, gives overview over main current concerns of RSI (reflects on many issues also covered in UNIFE Annual Report and UNIFE position papers) | Regulatory environment | Other framework conditions | Market access, Technological trends |

| # | Source | Title | Year | Author | Topic(s) | Main input | Secondary | Other |
|---|---|---|---|---|---|---|---|---|
| 35 | European organisations | ERTMS – Deployment Action Plan | 2017 | DG MOVE | Targets for ERTMS deployment, planning and challenges | Challenges and opportunities | Regulatory environment | Technological trends |
| 36 | National Railway organisations | French Rail Excellence | 2015 (?) | Fer de France | Brochure on French Rail sector with limited insights | Competitiveness | Other framework conditions | Sector structure |
| 37 | National Railway organisations | Online overviews and publications by French RSI association | ? | Federation des industries ferroviaires | Overviews over French rail infrastructure, equipment manufacturing, rolling stock and signalling | Sector structure | Technological trends | Business models |
| 38 | Railway magazines | The Fourth Railway Package - Magic bullet or missed opportunity? | 2018 | Keith Barrow, International Railway Journal | Assesses the contents of Fourth Railway Package (4RP) and looks at the challenges facing its implementation | Regulatory environment | Challenges and opportunities | |
| 39 | International Railway organisations | Presentation: The growing importance of project financing in international competition | 2017 | Arturs Alksnis, UNIFE | Export credits and project financing. Unfair competition from 3rd countries | Challenges and opportunities | Other framework conditions | |

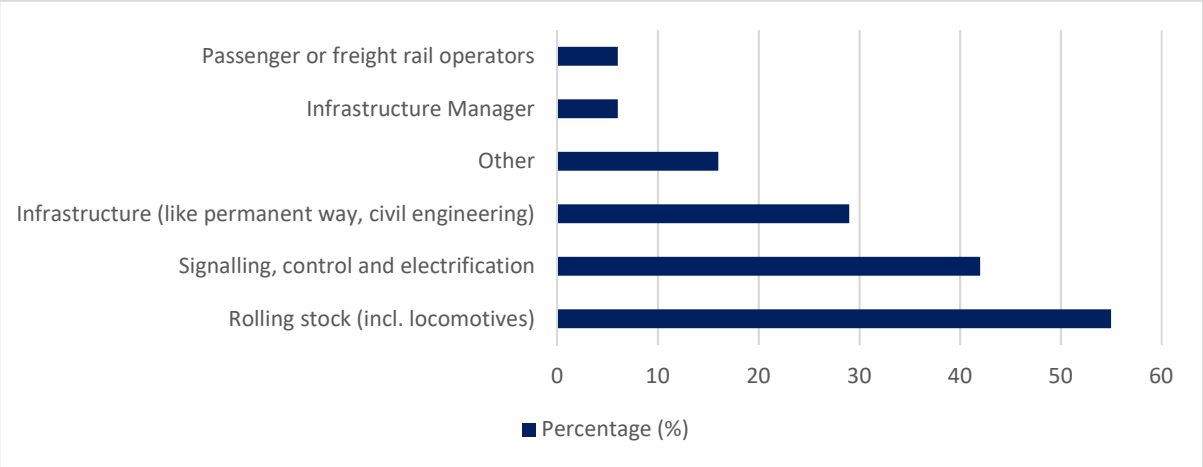
| # | Source | Title | Year | Author | Topic(s) | Main input | Secondary | Other |
|---|---|---|---|---|---|---|---|---|
| 40 | European organisations | Railway System Report | 2016 | European Union Agency for Railways (ERA) | Report on Removing technical barriers (vehicle authorisation); Single EU train control and communication system (ETCS); Moreover on the EU's technical specifications of interoperability (TSI) | Regulatory environment | | |
| 41 | Commercial market surveys | Study on the Cost and Contribution of the Rail Sector | 2015 | Steer Davies Gleave | Study on costs and contribution of rail industry (focus on operators and infrastructure managers) | Other framework conditions | | |
| 42 | Research programmes | Amended Annual Work Plan and Budget for 2018 | 2018 | Shift2Rail JU | Scope of the R&I activities for 2018. Also details the governance structure of S2R JU and the underpinning 2018 Budget | Technological trends | Other framework conditions | |
| 43 | Government publication | Rolling Stock Perspective - Third edition | 2017 | UK Department for Transport | Sets out challenges for the rolling stock industry and franchise companies in UK rail and the work being done to address them | Technological trends | Competitiveness | Other framework conditions |

| # | Source | Title | Year | Author | Topic(s) | Main input | Secondary | Other |
|---|---|---|---|---|---|---|---|---|
| 44 | Research programmes | Smart Rail publication | 2018 | Ming Chen, Milos Milenkovic, Matic Prosen et al. | Challenges to overcome for modal shift towards rail freight | Challenges and opportunities | Technological trends | |
| 45 | Commercial market surveys | The rail sector's changing maintenance game: How rail operators and rail OEMs can benefit from digital maintenance opportunities | 2017 | McKinsey | Overview over the rail maintenance market and the possible disruptive effect of condition-based maintenance on market shares, business models and the opportunities for rolling stock OEMs | Sector structure | Technological trends | Other framework conditions |
| 46 | European organisations | Research for a smart and competitive railway system | 2015 | Transport Research & Innovation Portal | Presents 3 key challenges to overcome for modal shift to rail transport and presents several research projects tackling these challenges | Technological trends | Other framework conditions | Challenges and opportunities |
| 47 | National Railway organisations | Rail Technical Strategy - Capability Delivery Plan | 2017 | Rail Delivery Group, Rail Supply Group | Identifies 12 Key Capabilities that rail needs in order to meet the industry's objectives of increasing capacity and improving customer service in a sustainable and affordable manner | Technological trends | Products and Segmentation | |

| # | Source | Title | Year | Author | Topic(s) | Main input | Secondary | Other |
|---|---|---|---|---|---|---|---|---|
| 48 | Commercial market surveys | The 2017 European Railway Performance Index | 2017 | The Boston Consulting Group | Measures three components of railway performance: intensity of use, quality of service and safety. Operator focus, but infrastructure investment | Other framework conditions | | |
| 49 | National Railway organisations | The Rolling Stock Manufacturing Industry in Japan | 2016 (?) | Japan Association of Rolling Stock Industries (JARI) | Overview over JP rolling stock industry, broad overview including history, but some interesting insights into technological trends and future challenges. BUT, some numbers seem not to add up! | Other framework conditions | Competitiveness | Challenges and opportunities, Technological trends |
| 50 | International Railway organisations | High Speed Rail Competition in Italy - Major Railway Reform with a "Win-Win Game"? | 2016 | OECD, International Transport Forum, Christian Desmaris | Introduction of a new competitor in the HSR market in Italy, unique in Europe and produced significant improvements in favour of passengers and also a 'win-win' game between all railway actors | Other framework conditions | | |

## ANNEX F - CONSULTATION OF THE SECTOR STAKEHOLDERS

Beside the literature review, additional insights have been retrieved from a survey launched and distributed within the Commission Expert Group on the Competitiveness of the Rail Supply Industry, in which representatives of RSI companies, business associations, NGOs and research institutes have a seat. In total, 32 organisations participated in the survey. Over 70% of the respondents were companies, nearly 20% were business associations and one respondent represented a public authority. Furthermore, respondents represented a diverse selection of rail sectors:




The questionnaire of the survey among industry and industry representatives consisted of a number of statements for which the respondent could indicate if they agreed (I strongly agree; I agree; I do not know / I do not have an opinion; I disagree; I strongly disagree). On various occasions, respondents were invited to elaborate on their answer by means of a question with an answer option consisting of an open text field. The statement presented to the respondents were the following (not necessarily reflecting the views of the researchers):

- EU policies (such as the 4th Railway Package, standardisation initiatives, reduction of national rules) and Shift2Rail have greatly supported improving harmonisation and interoperability;
- Railway design and operation was in the past very national-orientated. However, many national legacy systems still lack integration into the European system and additional developments are required to achieve an economical, unified, interoperable and flexible railway;
- ERTMS (European Rail Traffic Management System) has been successful in its implementation outside Europe but deployment in the EU remains low due to the additional costs required to ensure compatibility with national legacy systems;
- Further harmonisation and interoperability by for example supporting ERTMS rollout in Europe would support the growth of production in the sector and sector competitiveness;
- The EU and/or Member States need to increase their investments into the expansion of ERTMS;
- Administrative burden from regulation of the RSI is overall acceptable;
- Currently an unlevel playing field between the different transport modes (rail, road, aviation and maritime) distorts competition to the disadvantage of rail, because some modes do not fully internalise external costs (e.g. environmental or social costs);
- The cooperation between large companies and SMEs has increased and it can be beneficial to both parties. Large companies benefit from SMEs through the innovative solutions they provide and their specific expertise, whereas SMEs benefit from important projects, contracts or investments;
- Commercialisation of new innovations and solution represents a difficulty for SMEs, subcontracting with major companies can facilitate this for SMEs;
- The Rail Supply Industry has sufficient access to finance for investment, even SMEs;
- Access to foreign procurement markets (outside the EU) varies from country to country but overall the level of accessibility of the various markets has remained stable over the last years;

- Overall, Free Trade Agreements (FTAs) are a good instrument to open foreign (outside the EU) markets and to level the playing field;
- In order to maintain competitiveness vis-à-vis other regions, more direct support of innovation via public investments is needed;
- Sustainable procurement rules, using the MEAT principle with scoring based on best quality and price ratio, supports EU policy objectives and improves sector competitiveness;
- The ambitious design objectives fixed by the procurement tender together with MEAT principles (i.e. 70% quality, 30% price) incentivises companies to develop and propose new technologies and solutions;
- To support innovation, procurement schemes targeted at innovation are desirable;
- The RSI will be able to handle the upcoming outflow of engineers and technicians due to retirement in the next 10 year without significant additional recruitment efforts;
- Effective measures to attract engineers include:
  - Increasing the sector's attractiveness (promotion of the sector);
  - Enable skill flexibility;
  - Incentivising access to education (e.g.: apprenticeship-training schemes, life-long learning).
- Most of future innovation will be directly related to digital transformation, such as:
  - Intelligent driver assistance systems;
  - New communication systems (GNSS/telematics);
  - Data and information systems.
- Competition from automated road vehicles will be a significant risk to the RSI sector;
- Aligning technology and safety standards for rail and road automated vehicles could benefit the RSI sector;
- To make rail freight corridors the backbone of transport (as set goal in the EU Transport White Paper), rail needs to be more flexible and reliable;
- One main advantage of rail over other transport modes has always been its sustainability and energy efficiency, however increased electrification of road vehicles will diminish this advantage;
- Supporting multimodal or intermodal transport solutions (combining different modes of transport such as road and rail) for passenger and freight transport would ultimatively benefit rail transport and thereby the rail supply industry.

# ANNEX G - ECONOMIC IMPORTANCE AND COMPETITIVE POSITION OF THE RSI – METHODOLOGY APPROACH

The analysis of Chapter 4 of **production and balance of trade** was done using Euromonitor International Passport Industrial, 2018 edition database, that provide data for the following global economies, in addition to the EU: China, Russia, India, the USA, Japan and South Korea (only production data).

The following categories of products are provided in the Euromonitor International Passport Industrial, 2018 edition database, and they have been included in the present analysis, as well as in the one provided under section 3.2 and section 3.3 of the present report.

- **Rail Locomotives:** this category includes rail locomotives powered from an external source of electricity, diesel-electric locomotives, rail locomotives powered by electric accumulators, other rail locomotives and locomotive tenders;
- **Coaches, Vans and Trucks:** this category includes self-propelled railway or tramway coaches, vans and trucks powered from an external source of electricity, other self-propelled railway or tramway coaches, vans and trucks, railway or tramway maintenance or service vehicles;
- **Other Rolling Stock:** this category includes manufacture of specialized parts of railway or tramway locomotives or of rolling stock as well as mechanical and electromechanical signalling, safety and traffic control equipment for railways and tramways.

For the analysis of exports, imports and consumption, a combination of Euromonitor International and COMEXT databases were used. The first was used as the main source to compare the performance of the EU RSI with global players. The COMEXT data was used to estimate the share of intra and extra EU exports and imports in the total values. The share of extra-EU exports and imports were then applied to the Euromonitor International values and compared with the other global players.

### Disclaimer on the case studies presented in Chapter 4.3

The three case studies were developed based on 16 interviews undertaken with key stakeholders involved, directly or indirectly, in each of the cases presented. Due to the limited number of interviews, it is important to highlight that the findings might not necessarily reflect the status, opinion and position of the entire rail supply industry.

## HOW TO OBTAIN EU PUBLICATIONS

**Free publications:**

- one copy:
  via EU Bookshop (http://bookshop.europa.eu);

- more than one copy or posters/maps:
  from the European Union's representations (http://ec.europa.eu/represent_en.htm);
  from the delegations in non-EU countries
  (http://eeas.europa.eu/delegations/index_en.htm);
  by contacting the Europe Direct service (http://europa.eu/europedirect/index_en.htm)
  or calling 00 800 6 7 8 9 10 11 (freephone number from anywhere in the EU) (*).

  (*) The information given is free, as are most calls (though some operators, phone boxes or hotels may charge you).

**Priced publications:**

- via EU Bookshop (http://bookshop.europa.eu).

**Priced subscriptions:**

- via one of the sales agents of the Publications Office of the European Union
  (http://publications.europa.eu/others/agents/index_en.htm).

[ET-01-18-594-EN-N

Publications Office

doi:[number]