Future vision of the rail sector from the point of view of the rail supply industry

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1 INTRODUCTION

Rail is recognised as a major driver in pursuing the strategic European objective of smart, green, and sustainable growth, and is expected to serve as the backbone of the whole European transport system, being responsible for less than 2% of final transport energy use. Rail transport plays a key role for Europe's economy and society but has the potential to contribute much more. The sector is experiencing both a severe skills shortage and a need for re/upskilling. A large share of workforce is expected to retire in next 10 years, while the job attractiveness should increase. In turn, the major transformation process driven by research and innovation requires to bring in suitable skills and competencies. In addition, the European rail sector is affected by a plain fragmentation among its stakeholders (operators, infrastructure managers, suppliers, etc.).

Based on the identification of current and future skills and competence needs for the whole rail sector, suitable training and education paths and curricula will be developed and validated for effectively increasing employability and career opportunities. Cross-European mobility programmes and work-based internships for students, apprentice, and staff will be implemented. STAFFER will deliver human capital solutions for all levels of the rail value chain, gaining the holistic view of the sector as a system of systems, unifying the European rail world.

Deliverable 3.1-"Future vision of the rail sector from the point of view of the rail industry", is the result of WP3-Identification of current and future skills and competence needs from the supplier point of view. It will set the basis for the identification on the skill needs performed in Task 3.2, as well as rail supplier related activities as set out in WP 4, 5, 6 and 7.

Even though WP 3 is specifically addressed at the needs of the rail supply industry, it is also aligned with WP 2 and it will be carried out according to the methodological criteria defined in WP 1. The main activities of this WP will consist of:

1.The definition of a future vision of the rail sector according to the analysis of the needs of the rail supplier and by taking into account the current trends of the rail sector and their specific impact on the rail industries.

2. The application of the methodology developed in Task 1.2 in order to identify the skill needs and occupational profiles from the point of view of rail suppliers. The identified current and future skill needs will be considered as part of the long-term methodology for skills monitoring addressed in Task 6.4.

WP2 and WP3 will cooperate by setting up liaison meetings (i.e., setting up regular videoconferences and a WP final meeting) under the common framework provided by WP1 with the aim of identifying common skill gaps.

The WP3 will provide the definition of one or more possible future scenarios with reference to both RAIL 2030[1] and RAIL 2050 VISION[2] documents by ERRA[3]C. According to this outlook, the rail transport in Europe aims at being the backbone of an intermodal "Mobility as a Service" within cities and beyond, for both passengers and goods, meeting the needs of customers, EU citizens and society. Future scenarios also include a description in terms of internal requirements in the field of education, vocational training, and human resource development, as well as external framework conditions.

Based on this analysis and using the overall methodology developed in WP1 (Task 1.2), the needs of the rail suppliers will be identified. To this end, different stakeholders are to be considered (potential students, workers, who have the need of qualification upgrade, rail suppliers, and regulatory entities and other administration entities related with railway transportation).

Quantitative methodology is implemented for identification of skill gaps and their importance. Therefore, based on the analysed trend, WP3 will:

- **collect and analyse the stakeholders' requirements**
- **identify the needs in terms of training provision**
- **identify the occupational profiles with reference to the classification of the European Skills, Competencies, Qualifications and Occupations (ESCO)**

To this end, three types of questionnaires are developed, and data are gathered from the questionnaires filled out by the stakeholders. A particular focus will be on digital and green skills as they are increasingly important on all job profiles in the rail sector, as well as in the general European Agenda.

Therefore, the objective of the study is aimed at:

- analysing the current situation of the sector from the perspective of rail suppliers as well as of present and future professional profiles, in order to identify skills gaps

- establishing training paths and curricular adaptation to other professional activities.

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[1] https://errac.org/publications/rail-2030-research-and-innovation-priorities-2/
[2] https://errac.org/publications/rail-2050-vision-document/
[3] European Rail Research Advisory Council

The information of this report has been obtained from a complex data collection process. In summary, the approach has been as follows:

a. Hold initial meeting/workshop between consortium members to discuss key issues and concepts as well as define WP scope and deliverables

b. Industry survey to gain insights and data

c. Carry out industry and stakeholder consultations to better understand skills formation and risks to workforce capability in the rail industry

d. Undertake quantitative data collection and skills gap modelling, via a range of sources including an industry survey, access to industry skills data, labour statistics, as well as data on education. Key objectives of the quantitative exercise are to estimate the size of workforce gaps, analysing the difference between existing workforce and labour demand. In addition to estimating labour supply, the model needs to also predict a future demand for occupations across rail construction, operations and maintenance based on technological drivers, being considered among other factors.

e. Present draft findings to STAFFER project consortia and stakeholders/associates.

f. Complete a final report based on feedback to the draft findings.

The ultimate result of STAFFER will be the establishment of a rail stakeholder partnership, the Sector Skill Alliance, to finally develop a holistic Blueprint strategy to recognise present and new skill needs to suitably, timely and substantially, contribute to achieving a Single European Rail Area. Such a strategy will allow to overcome the fragmentation of the rail sector and help the rail industry and VET institutions to design and realise concrete actions to satisfy skills needs, going beyond the project's lifetime and beyond the organisations involved in the Alliance.

Recommendations and findings resulting from this research allows the rail industry and stakeholders to work collaboratively across the sector and with all levels of educational institutions to ensure that mid- to long-term strategic workforce planning needs are identified and addressed.

2 METHODOLOGY

The methodology of the study followed a sequential, systematic process reported in Figure 1.
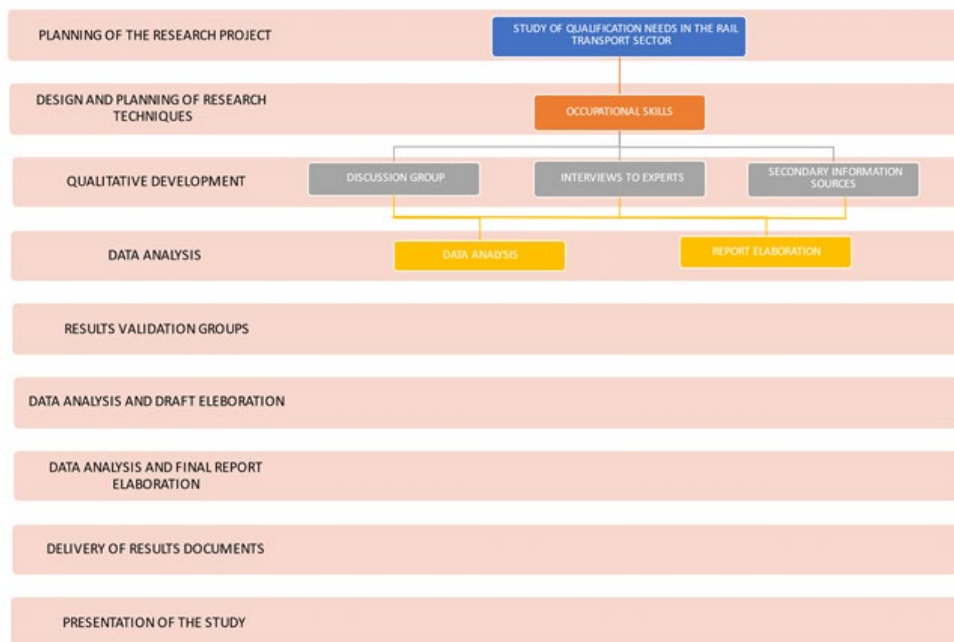
FIGURE 1 - METHODOLOGY

As the first stage, the "state of the art" in the sector has been highlighted. This analysis describes the conceptual framework and allows STAFFER project to obtain the necessary requirements for the correct design of the data collection tools. Based on the collected information, the more important concepts have been defined, industrial activities have been analysed and the industrial and the occupational map has been drawn up. Additionally, relevant reports and documents as well as scientific articles have been analysed in order to collect all the amount of information about the current and expected changes in the European rail sector.

Based on this analysis, an online survey has been defined to obtain quantitative feedback on the different issues concerning the rail industry's workforce capability in the EU.

The survey instrument generates quantitative ratings of industry opinion and complements the state-of-the-art analysis and the qualitative feedback from industry interviews.

The responses to the survey are provided in section 5. This survey was designed to get a broad cross section of views of the sector stakeholders, including manufacturers, suppliers, and training agencies, as well as railway undertakings, infrastructure managers, stakeholders and governmental entities and industry.

All participants were asked to note whether they define as important (on a scale from 1 to 5) the future changes and trends, already identified in the project, under the 4 main categories.

3 EU KEY FACTS

At European level, the rail supply industry is a strategic industrial ecosystem due to its technological level, its workforce (around 400.000 employees across the EU), its constant innovation and economic growth.

As the European Commission states on the Report of the expert group on competitiveness of the European rail supply industry[4], the turnover or the European rail industry amounts to over 50 million euro, having become a world leader despite growing unfair competition, technical and non-technical barriers when accessing third countries.

The European Institutions have always been fully aware of this context and, in order to allow the industry and other stakeholders to continue playing a central role in securing safe, reliable, and clean transport in Europe, as well as ensuring connectivity within and among its Member States, they designed ambitious policies and instruments around two major areas:

1. **improving interoperability and safety**

2. **developing rail transport infrastructure**

3.1 European Initiatives

As a direct consequence, the European Commission aims at creating a Single European Railway Area in order to revitalise the rail sector and make European railways more innovative and competitive in relation to other modes of transport. Having a Single European Railway Area is far to be achieved but significant steps were taken in this respect, i.e.:

- **implementation of the Fourth Railway Package**,

- **creation of the European Union Agency for Railways (ERA)**

- **deployment of ERTMS and promotion of interoperability.**

3.1.1 EU Industrial Strategy

On 10 March 2020, the European Commission presented A New Industrial Strategy for Europe with a plan to help EU industry lead the twin green and digital transitions and make EU industry more competitive globally. On the following day, the World Health Organization announced the COVID-19 as a pandemic. On 5 May 2021, the Commission therefore presented an update of its Industrial Strategy taking into account the effects of COVID-19 on the European industry.

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[4] https://ec.europa.eu/docsroom/documents/37829

The Commission confirms its approach based on giving priority to a limited number of industrial ecosystems bringing together all players within a value chain. The Commission has identified 14 priorities ecosystem including one on Mobility gathering the automotive, the rail and shipbuilding industries.

Through the Annual Single Market Report, the Commission will analyse every year the state of play of the European economy based on an assessment of these 14 industrial ecosystems. In its 2021 Annual Single Market Report, the Commission confirms that "all the three components of the ecosystem [automotive, rail & shipbuilding] face the same challenges in terms of decarbonisation, digitalisation and global competition".

3.1.2   Sustainable and Smart Mobility Strategy

In the framework of the EU Green Deal, the European Commission (EC) presented in December 2020 its Sustainable and Smart Mobility Strategy together with an action plan consisting of 82 initiatives that will guide the EC work over the next four years. This document lays the foundation for the green and digital transformation of the EU transport system.

The European Commission sets a series of key targets and milestones to achieve. By 2030, at least 30 million zero-emission cars will circulate on European roads, 100 cities in the EU will be climate neutral, high-speed rail traffic will have doubled throughout Europe, rail freight traffic will increase by 50%, scheduled collective travels under 500 kilometres will be carbon neutral, automated mobility will be deployed on a large scale, and zero-emission ships will be ready for commercialization.

Furthermore, by 2050, all new cars, vans, buses, and heavy vehicles will be zero-emission; high-speed rail traffic will have tripled, rail freight traffic will have doubled, and a fully operational multimodal trans-European transport network (TEN-T) will provide high-speed connectivity for sustainable and smart transport.

3.1.3   Green Deal

At the end of 2019, Ursula von der Leyen, President of the European Commission, presented the European, Green Deal, a plan that includes fifty concrete actions to fight climate change, and which aims to make Europe the first climate-neutral continent by 2050.

The objective of this 'European Green Deal' is for Europe to have a clean economy, with zero emissions, and to protect our natural habitat to improve the well-being of people and companies, and to take the lead in climate action across the planet.

This green pact aims to transform the EU economy into a fully sustainable one, leading to a change in the social and economic model of the European Union, while providing the economic resources that allow a just transition.

The European Green Deal also includes actions to promote the efficient use of resources with a special emphasis on those that produce the most emissions, such as transport.

Transport represents 25% of EU emissions, which is why the European Commission is promoting the use of cleaner, more efficient, and healthier public and private transport. The objective is to reduce the emissions emitted by cars, maritime and air transport, investing in the development of alternatives.

To make the Green Deal a reality, the European Commission has already taken a series of key initiatives such as the 'European Climate Law', the new Industrial Strategy, and the Circular Economy Action Plan.

3.1.4 The Trans-European Transport Network (TEN-T)

The Trans-European Transport Network (TEN–T) is the main project supporting the development of railway infrastructure projects in the European Union through the construction of new lines, implementation of innovative solutions, ERTMS deployment, etc.

The TEN-T policy comprises two networks:

- The Core Network: nine corridors expected to be completed by 2030.

- The Comprehensive Network, which covers all European regions and whose completion is expected by 2050

So far, the implementation of the TEN-T has received financial support from the following funding streams:

Connecting Europe Facility (CEF),

- Invest EU programme

- Cohesion Fund (CF) and

- European Regional Development Fund (ERDF).

At the time of writing, the European Commission is reviewing the TEN-T policy and guidelines to foster the necessary changes that will allow facing challenges such as the growing transport demand and the need to meet liberalization, digitalization, and standardization requirements.

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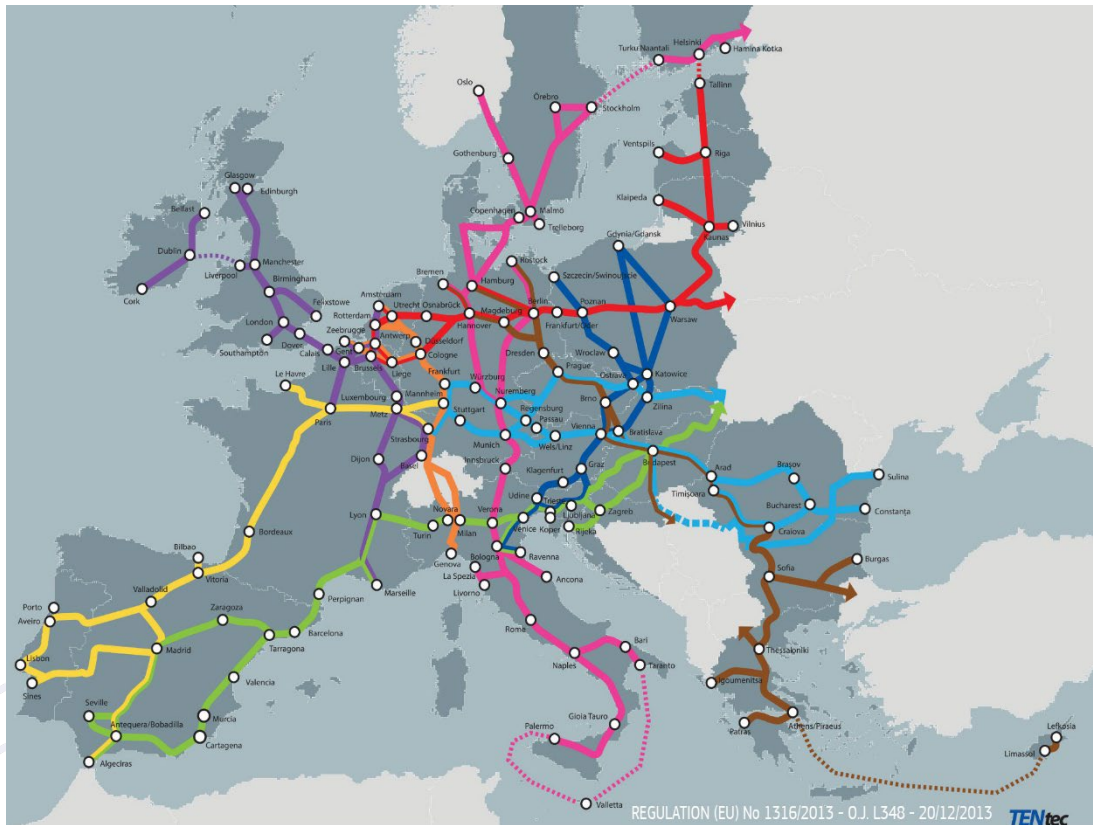
FIGURE 2 - TEN-T NETWORK. *SOURCE: EUROPEAN COMMISSION*

3.1.5   Third level heading

The year 2021 was designated to be the "European Year of Rail" thanks to the impulse led by the European Commission and fully supported by the rail supply industry and other stakeholders (operators, infrastructure managers, etc.). It can also be considered as an action meant to achieve the goals set by the Green Deal in order to promote a sustainable way to connect people and regions. This initiative moves also in the direction of complementing the new Strategy on Sustainable and Smart Mobility and an opportunity to highlight other Community projects such as Shift2Rail, the Fourth Railway Package or the TEN-T revision. But why this focus on rail?

o   Rail is sustainable – 0.5% of transport GHG emissions are generated by rail

o   Rail connects people

o   Rail is safe - the European Union Agency for Railways (ERA) has stated that "dating from 2013, the risk of death for a train passenger within the EU is around 0.16 fatalities per

billion train kilometres, nearly one third that for bus and coach passengers and around 27 times less than for car occupants"[5]

As a result, during 2021, various events and campaigns (with the involvement and participation of all the stakeholders – supply industry, operators, administrations, etc.) will be held in order to promote the rail transport as a whole.

3.2 Market trends

According to the European Commission[6], the European Rail Industry refers to:

1. Manufacture rolling stock and locomotives

2. Signalling

3. Telecommunication

4. Tracks

5. Electrification

6. Parts

7. Services

Therefore, according to the above categories the rail industry is structured on four main areas: railway infrastructure, rolling stock, signalling and control and services.

According to UNIFE WORLD RAIL MARKET STUDY 2020, the services and Rolling stock represent 72% of the market, and it is expected that they both will increase by 2025, although services growth is expected to be more moderated than rolling stock. The infrastructure increase is expected in 13% annual growth driven by high speed and growth rates higher than the rest (in signalling and control 1.5% per year). Figure 3 represents Rail market breakdown by area in kM€.

[5] https://international-railway-safety-council.com/safety-statistics/
[6] https://ec.europa.eu/growth/sectors/mechanical-engineering/rail-supply-industry_en#:~:text=European%20RSI%20invests%202.7%25%20of,indirect%20jobs%20in%20the%20EU
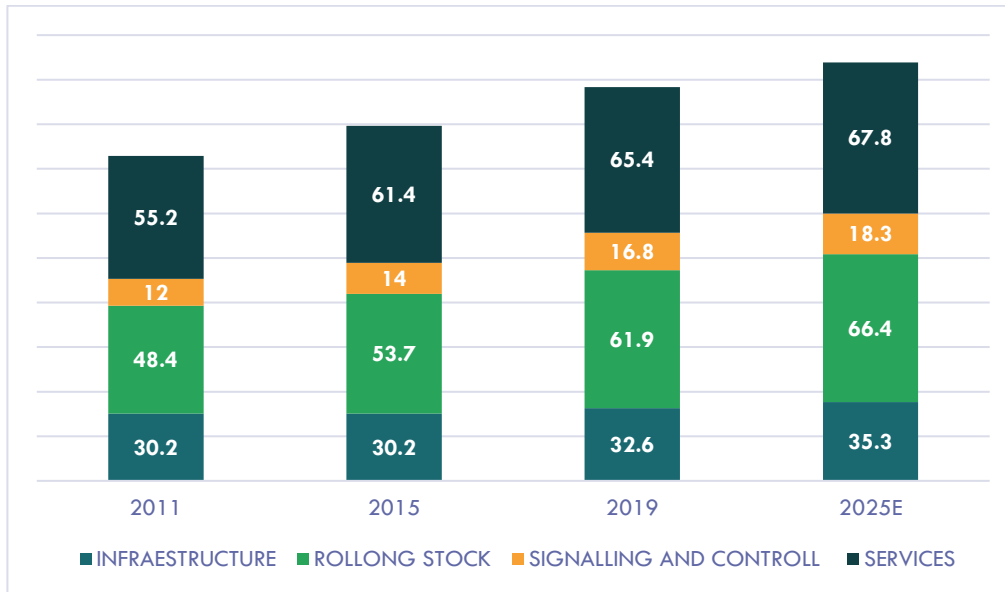
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FIGURE 3 - WORLD MARKET TRENDS (KM€). *SOURCE: UNIFE WORLD RAIL MARKET STUDY 2020*

3.2.1 Services

According to UNIFE WORLD RAIL MARKET STUDY 2020, the railway services market is expected to grow at a rate of 0.7% to € 67.8k in 2025. The main driver for its growth will be seen in the spare parts market and, to a lesser extent, in the services associated with the railway infrastructure. In addition to being the sub-segment with the largest volume within the rail services market, the spare parts sector will continue to be the most accessible services market, accounting for more than 50% of the accessible railway service market.

A decrease in the demand for rehabilitation services is expected due to the increase in the demand for new vehicles, which will replace older units. The increase in the demand for new vehicles and infrastructures, therefore, will make the service market present a less growth. Figure 4 represents Rail services market in € kM.

3.2.2 Rolling stock

According to UNIFE WORLD RAIL MARKET STUDY 2020, the rolling stock is expected to increase at an annual rate of 1.3% from € 61.5kM in 2019 to € 66.4kM in 2025. This growth will be mainly driven by the demand for high-speed railways and subways. High and very high-speed trains are already the third largest volume segment in the market and will continue to grow thanks to the expected increase in demand in Germany, a stable high volume of demand in China and investment from countries that traditionally demanded high speed trains, such as USA, India, or Mexico.

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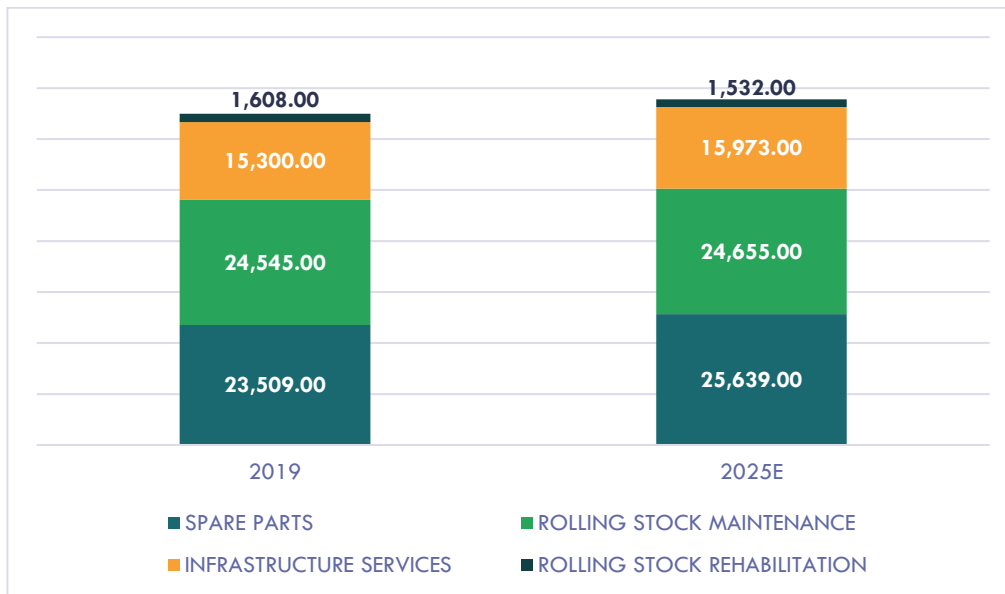
FIGURE 4 - WORLD MARKET TRENDS (KM€). *SOURCE: UNIFE WORLD RAIL MARKET STUDY 2020*

3.2.3 Infrastructure

According to UNIFE WORLD RAIL MARKET STUDY 2020, the infrastructure market is expected to increase from € 32.6kM in 2019 to € 35.3kM in 2025[7], with the superstructure of the passenger and freight transport. Despite its significant growth at a rate between 10% and 17% per year, this subsegment is still far from reaching the market volume of other more established ones. Figure 5 represents infrastructure market in € kM.

3.2.4 Signaling and control

According to UNIFE WORLD RAIL MARKET STUDY 2020, the market will grow at an annual rate of 1.5% from € 16,772M in 2019, to € 18,300M in 2025[8]. Despite the significant growth rate, nominal growth will be limited: it is estimated that it will reach € 18.3 billion in 2025, which will be € 1.5 billion more than in 2019. Asia / Pacific (43%) and Western Europe (32%) lead the market with a combined share of 75%.

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[7] Analysis based on data from UNIFE; Market&Market and SCI Verkehr
[8] Analysis based on data from UNIFE; Market&Market and SCI Verkehr

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FIGURE 5 - RAIL INFRASTRUCTURE MARKET. *SOURCE: UNIFE WORLD RAIL MARKET STUDY 2020*

4 FUTURE TRENDS IN TRANSPORT AND THEIR IMPACTS ON SKILLS AND JOBS

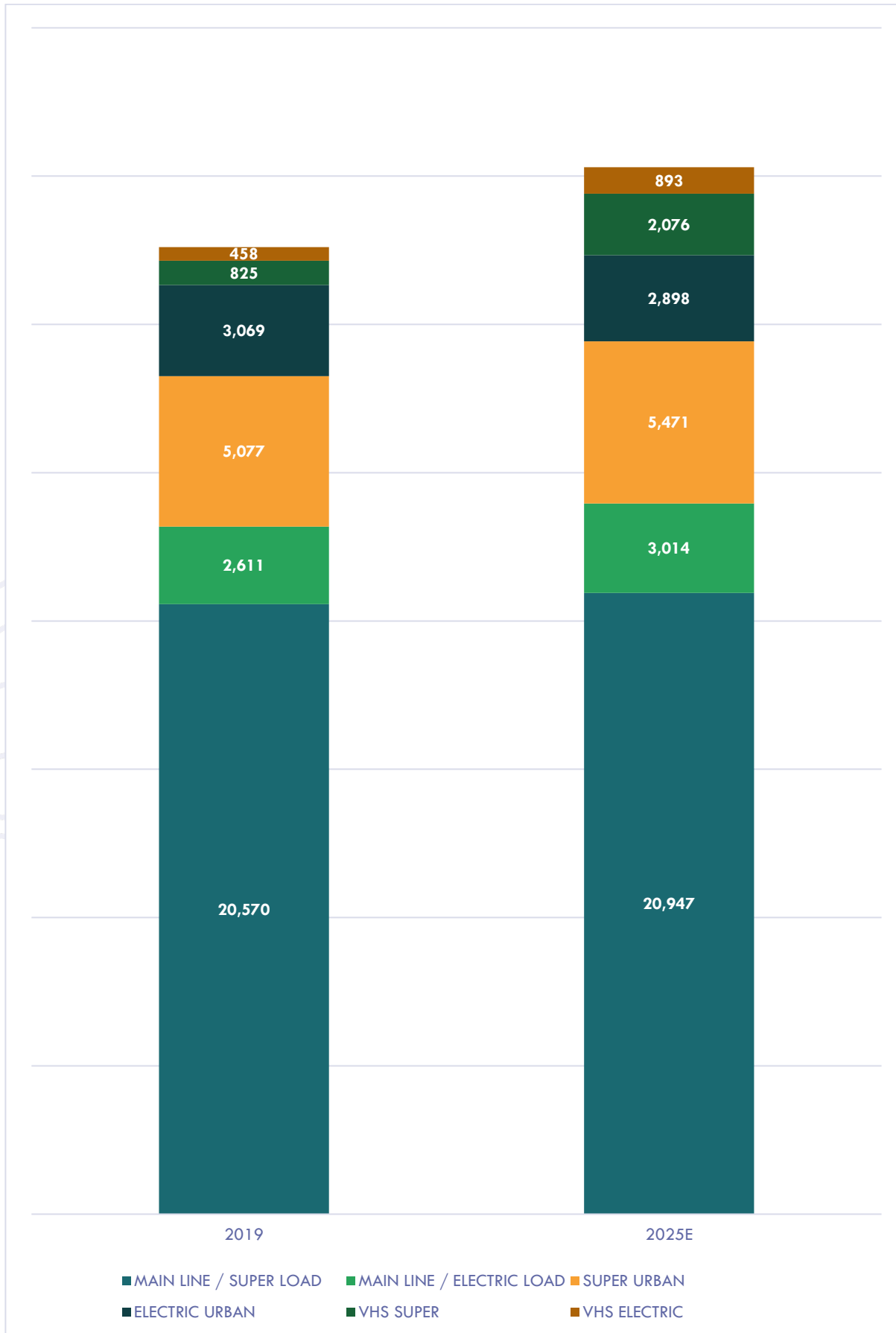The Smart and Sustainable Mobility Strategy, published at the end of 2020, sets the priorities of the European Commission for the transport sector in Europe until 2030 and 2050.

Among the objectives defined for the EU Rail Policy is the creation of a modern rail system, through research, development, and innovation, which is promoted by ERRAC through the publication of the European Strategic Rail Research Agenda 2050[9]. This document describes the today's rail sector in terms of the contributions it can make in tackling challenges and taking advantage of the opportunities arising from the more and more impacting societal, environmental, and economic changes.

4.1 Market drivers

The increasing urbanization of the planet as well as the people's awareness towards a more sustainable way of living is driving the growth of the rail market.

The global transportation sector accounts for nearly a quarter of energy-related carbon dioxide emissions. Air pollution emissions from transportation have been linked to nearly 400,000 premature deaths. Almost half of all deaths caused by air pollution from transportation are caused by diesel emissions, while people living near major traffic arteries are up to 12% more likely to receive a diagnosis dementia.

According to this, we are witnessing a more environmental-conscious awareness from industries, governments and, of course, society. Apart from health, also the higher impact of the urbanization must be taken into duly consideration. Over half of the world's population live in urban areas whose density is continuously increasing and changing our needs and habits.

On the other hand, we must not forget that rail transport is an enabler with a huge potential to link regions and connect society, and by doing so, to facilitate social and economic development. Our current problems and demands can find their solution in having a comprehensive rail system to be designed and developed so to meet the highest levels of dependability, resilience, and quality. This must be done in accordance with the actual trend of the liberalization of the sector as well as other more particular drivers such as servitisation of products, digitization, and automation. In this sense, the state-of-the-art of communication technologies and IT solutions must be implemented to improve connectivity, allow real time data availability, enabling smart

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[9] http://www.errac.org/wp-content/uploads/2018/01/122017_ERRAC-RAIL-2050.pdf

prediction, interoperable signalling systems, easier ticketing systems and IoT-based innovations at European scale.

The main drivers of the rail market are presented below.
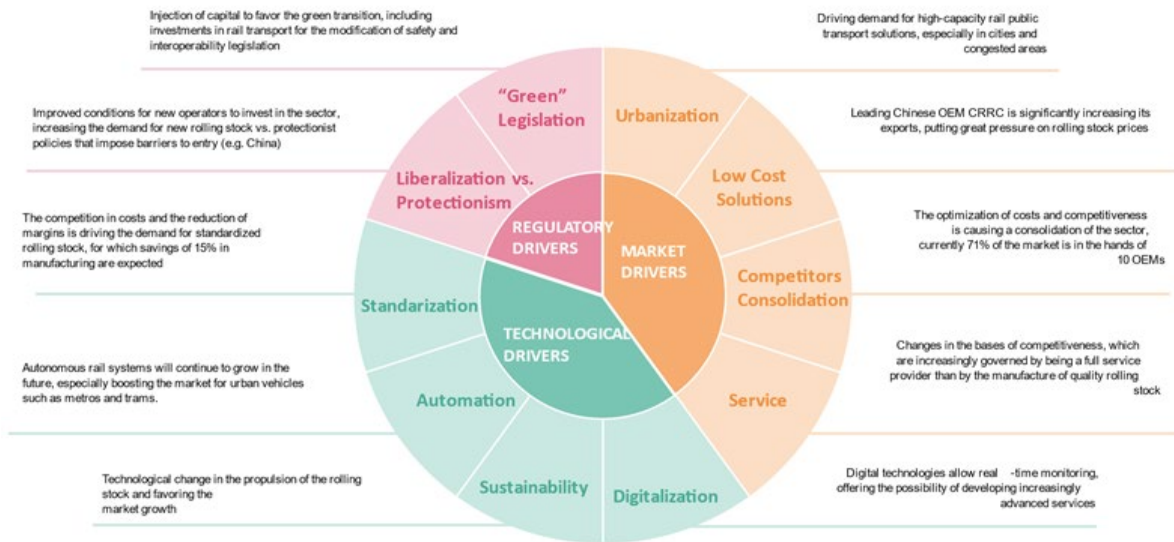
FIGURE 6 - MAIN DRIVERS OF THE RAILWAY MARKET. *SOURCE: MAFEX*

4.1.1 Urbanization

According to UNIFE World Rail Market study 2020 and Rail Strategic Research and Innovation Agenda developed by ERRAC (2020), by 2050 about 75% of the population world will live in cities. These urban centres face challenges related to urban planning, environmental pollution, or traffic management. This impact will be much more important in urban rail transport, which will grow at an annual rate of 5.3% between 2015 and 2025, compared to 3.2% of the rest of passenger rail transport.

Rail systems will play a fundamental role and the demand for urban transport solutions such as trams, subways or light rail will increase. Likewise, another challenge the future cities will face is the fast and safe intercity transport, which will mean a rapid growth of high-speed trains.

4.1.2 Servitisation of products

The bases of competitiveness are changing and are governed more and more by being a full-service provider than by just being a manufacturer of rolling stock. We can see an evolution of the rail sector towards servitisation. According to this concept, the rail industry is expected to re-direct their lines of business considering the provision of services on the basis of their products.

In the rail supply industry, this entails a transition from the manufacture of rolling stock and signalling towards a value-added proposal based on integrated transport systems that cover all phases of design, development, deployment, and management. This has led to the creation of new business models and the entry of new competitors and customers to the market:

- Design-finance-build-maintain schemes include studies of feasibility, cost-benefit analysis, financing channels, own construction of rolling stock and/or infrastructure (in consortium with third parties), maintenance, spare parts, and staff training.

- New value-added services, such as rehabilitation of both own products as well as those of the competition or updating of rolling stock.

- Auxiliary services, such as workshop design and management of logistics inventory for customers.

Therefore, the actual more valued proposals are based on a set of comprehensive services capable to cover the whole transportation system life cycle, from its conceptualization to its implementation and management. Digital technologies and analytics capabilities offer the possibility of developing increasingly advanced services and new business models.

4.2 Technological drivers

4.2.1 Digitalization

ICT is transforming the rail sector. The sector's main challenge is to move the users at the centre of the process. To achieve this, it is necessary to offer the so-called "door-to-door" services and, at the same time, to reduce environmental costs in line with society's expectations. There are different tools that allow the industry to analyse data and access a larger number of users, such as lifecycle costing reduction and the achievement of RAMS targets in terms of Reliability, Availability, Maintainability and Safety of the rail system as a whole.

Nowadays large volumes of data generated by users, train movements and infrastructure are available. For this very reason, a significant number of players from the Information Technology sectors are emerging by offering intelligent mobility solutions.

Sensor based systems, real-time data transmission and analysis capabilities are increasingly accessible at reasonable low cost, opening the opportunities to new business models and shifting maintenance management from time-and-use-based strategies to on-condition based maintenance.

Monitoring the assets' conditions by resorting to analytics algorithms is essential to perform predictive maintenance and optimize an overall maintenance management.

Into more detail:

1. **User-centred digitalization will focus on monitoring the passengers' comfort and safety:**

   - Adaptive temperature control based on the number of passengers boarding the train

   - Security monitoring through TVCC cameras and intelligent sensors

   - WiFi coverage and access

   - Real- time informative systems

   - Mobile Apps

   - Ticketing

2. **Operation-centred digitalization will focus on: - Infrastructure monitoring: improvement of infrastructure maintenance based on traffic system and environmental monitoring**

   - Obstacle's removal set by monitoring: monitoring of rolling stock

   - Optimization of Human Resources planning based on fleet status

   - Optimization of maintenance cycles based on the critical system status.

A blockchain platform that involves all the players in the value chain will provide the capacity to record information (manufacturing, tracking, delivery), working together with IoT elements (sensors, QR codes, among others).

Despite all the benefits of digitization, these digital solutions are increasingly vulnerable to cyber-attacks since any connected system is likely to be hacked. Therefore, it is also necessary to consider the importance of an early adoption of cybersecurity measures when increasingly digitized environments.

4.2.2 Sustainability

The growing environmental awareness is driving the electrification of rolling stock propulsion and it is favouring the growth of the market.

The goal of extending the trains' life cycle and then recycling materials and components is crucial in this respect with regard to the efficiency, the lightening of rolling stock plays a further central role. At European level, the sector is working on legislative support that allows reduce the Time to Market of these materials. Other areas for improvement in the design of trains are the use

of anti-graffiti paints, materials that improve sanitation in interior spaces and universal accessibility.

In terms of energy efficiency, access to alternative fuels suitable for each mode of transport is being promoted at a European level, highlighting the use of Liquefied Natural Gas (LNG) and hydrogen (medium/long-term) as the best alternative to diesel.

A transition to systems without fossil fuels is taking place, improving the environmental impact of the sector. However, electrification is costly and reaches its commercial limit on routes with low traffic density. The *Technische Universität of Dresden* has estimated the frequency limit necessary for economic viability in 30 minutes. Advantages and Key Applications of Diesel Alternatives:

	Electric batteries	Hydrogen batteries	Electrified catenary
Advantages	Easy recharging of batteries with pantographs in sections with catenary Little additional infrastructure necessary.	Greater autonomy without electrified sections. Greater number of charged trains for each charging infrastructure. Fast charging compared to batteries.	Unlimited access to electricity sand high power system possibility. No charging needs. Economic if costs are shared on a large number of trains.
Key applications	Multiple units or locomotives in 80-100 km lines maximum without electrification In handlings that causes significant stop times.	Handling and distribution of railway vehicles in distances up to 200 km Multiple unis and locomotives with more than 100 km lines without electrify	High speed Heavy and long Freight transport. Passenger trains with a minimum frequency of 2 trains per hour.

	Cross border traffic with different electric systems

TABLE 1 - ADVANTAGES AND KEY APPLICATIONS OF DIESEL ALTERNATIVES

Another trend that is influencing the rail sector from the sustainability point of view is the modal change to rail system. Rail transport is environmentally more sustainable than other mode of transport. The electrification of rail system has boosted the position itself when it comes to promoting environmental sustainability.

4.2.3 Automation

Autonomous rail systems will continue to grow in the future, especially boosting the market for urban vehicles such as metros and trams.

Autonomous rail systems have increased exponentially in the last 20 years, having today already dozens of fully automated rail systems already in (autonomous) operation across Europe. A further increase towards the so-called AS (Automated Systems) is expected in the coming years, especially in the segment of local means of transport such as subways and light trams, evolving.

It should be noted that Europe and Asia are the regions with the largest number of autonomous rail systems, based mostly on subway and light rail systems.

4.2.4 Standardization

The competition in costs and the consequent reduction of margins is driving the demand for standardized rolling stock, for which the benefits obtained in terms of savings would be around 15% in manufacturing. The financial investors as the Railway Undertaking in the rolling stock market have increased competition but increasing opportunities in after-sale services market are now available for the rail industry. These two changes are promoting the manufacturing of standardized vehicles to be supplied for non-specialized RU's.

The systems with the greatest impact on saving in standardization are interior elements, with a potential cost reduction of 20%.

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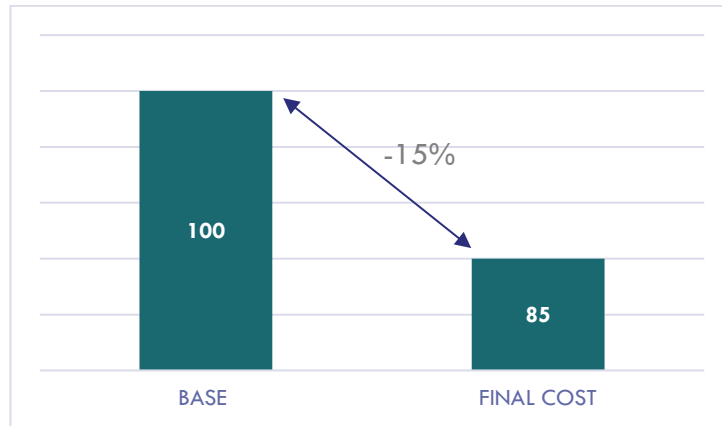
FIGURE 7 - APPROXIMATE SAVINGS IN COMPONENT STANDARDIZATION (INDUSTRIAL COST PER VEHICLE, %, 2019). *SOURCE: ANALYSIS FROM UNIFE WORLD RAIL MARKET STUDY 2020 AND RAIL STRATEGIC RESEARCH AND INNOVATION AGENDA DEVELOPED BY ERRAC (2020)).*

It is estimated that the main savings in the standardization of components will occur in the interior elements (-20%) and, to a lesser extent, in the doors and bogies (-15%), the chassis and electronics being the elements with the lowest savings (-10%)
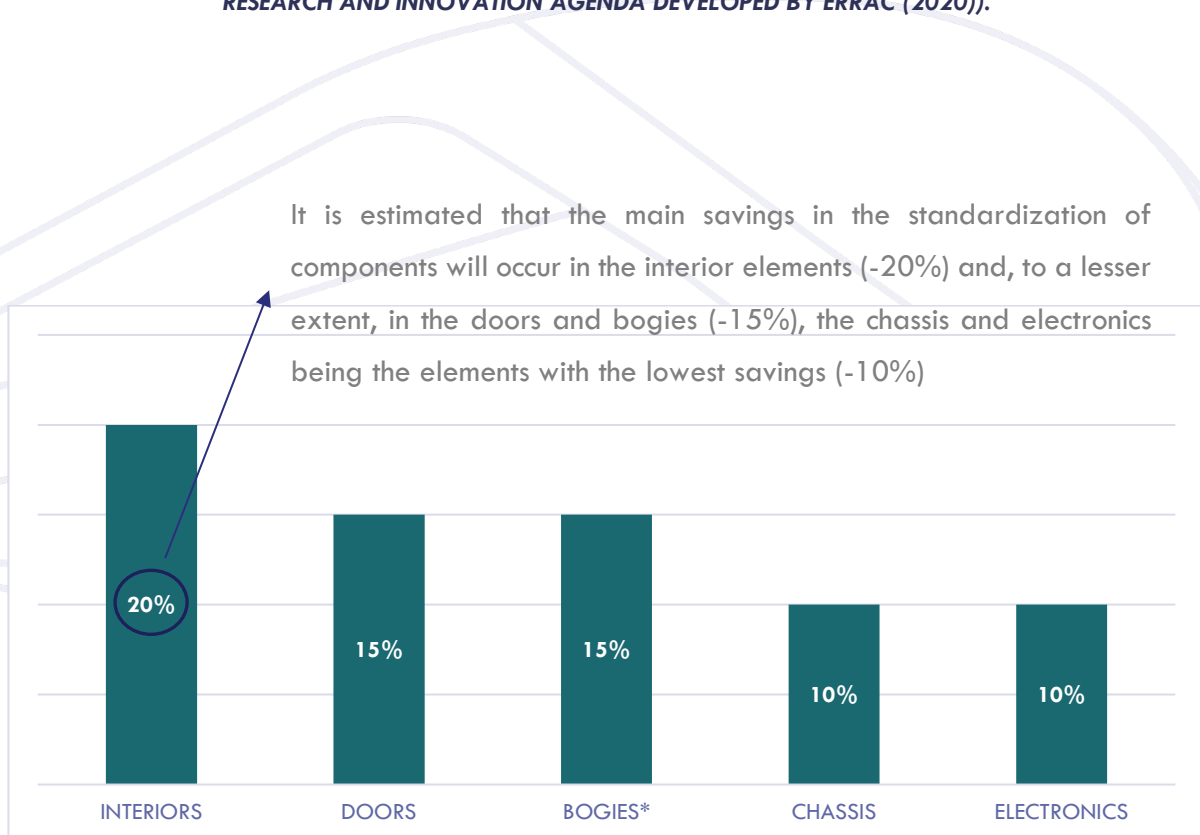
FIGURE 8 - STANDARDIZATION. *SOURCE: ANALYSIS FROM UNIFE WORLD RAIL MARKET STUDY 2020 AND RAIL STRATEGIC RESEARCH AND INNOVATION AGENDA DEVELOPED BY ERRAC (2020)*

All the above, together with other factors, constitute emerging needs for the development of the European rail system. As a result of the dynamism of the European's Research and Innovation and, consequently, the increasingly introduction to the market of new technologies and services, it is then essential to enhance the skill and the competency of the European's rail workforce needs.

Within WP3 of STAFFER Project, a comprehensive analysis on existing and emerging trends in rail has been undertaken. This analysis aims at assessing the impact of digitalization and automation. From a wider perspective, it also considers the impact on the whole value chain. For instance, among others, it addresses the required skills of technical maintenance and service staff of electrification, the required skills for operating rail systems according to the concept of "Mobility as a Service (MaaS)" (concept which is already influencing the development of the mobile applications as well as the target business models in the rail organizations), circular economy. The future of the rail sector's jobs requirements is strongly aligned with the trends at all levels (blue collar, white collar, managers, operators, researchers...)

The constantly changing environment therefore leads to new opportunities for the rail supply industry in different areas such as:

- Introduction of new services which are driven by the massive data analysis technologies, the cloud data storage, and the Internet of Thing (IoT) technologies.

- Development of new interfaces, ICT technologies based on 4G (LTE) and 5G and even more performing technologies (e.g., technologies based on the Global Navigation Satellite System (GNSS) aimed at precisely locating the trains for the safe control of circulation.

- New European R&D projects related to the future of ERTMS (ATO, GPRS or LTE, Galileo, N3) and international projects related to freight transport.

- Increasing demand for mobility, population growth and concentration in urban areas.

- Need to modernize railway infrastructures with new technologies.

- Implementation of the Smart Electricity Grid concept.

- Inclusion of renewable energy sources and storage systems.

5 OCCUPATIONAL PROFILES AND EUROPEAN WORKFORCE GAPS

On the supplier side a consolidation of the big supplier companies has taken place under the high attention of European competition interests to protect diversity of supplier landscape and secure competition from small and middle-sized companies all over Europe.

According to the McKinsey's paper "Which industries are most digital?" transportation is reaching its tipping point of digitalization as one of the last five industries. Although the COVID-19 pandemic is also pushing these late industry's transformations, the rail supply industry needs to start the homework of preparing the workforce to analyse and cover possible skill gaps.
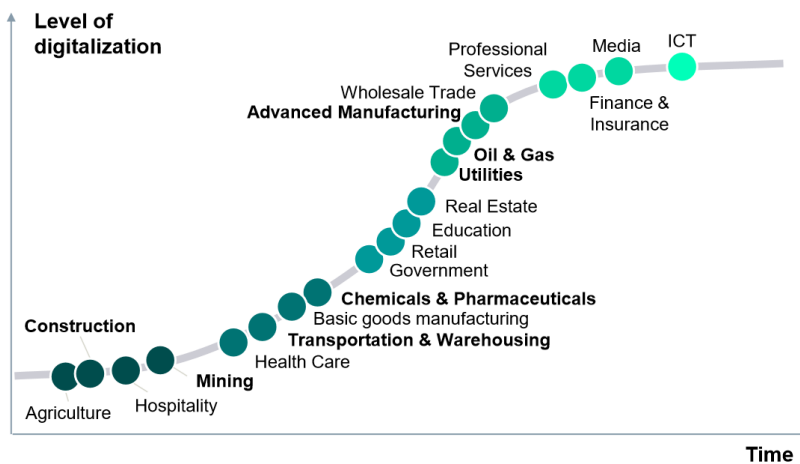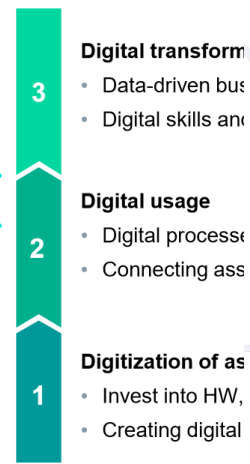
FIGURE 9 - WHICH INDUSTRIES ARE MOST DIGITAL?

Employability is of course a key and strategic concept for the European Rail Industry, and involves not only the industry itself but also educational and training institutions at any level, but also trade unions, etc. There still is a long way ahead to fulfil with the demands and challenges to be faced in the coming years, ant it must be paved based on social, industrial, and educational dialogue. Transformation in all areas is required to maintain local and international competition.

As per the "Study on the competitiveness of the Rail Supply Industry" (written by Ecorys in cooperation with VVA and TNO, September 2019): "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".

This study also states that "as in most technical engineering sectors, the supply of technical engineers may become a bottleneck in maintaining a competitive position". So, the industry itself has identified this need to strongly support and promote technical education not only in engineering but in many other connected areas and to urgently make the sector more attractive.

As far as railway operators and infrastructure managers are concerned, another important issue is the moral obligation to increase the share of women in technical professions, whose underrepresentation is clear, establishing the necessary forums with key stakeholders. CER's "6th Annual Report on the Development of women's employment in the European railway sector Data of 2018" sets the average share of women employed in European rail companies in 21.41%.

5.1 Occupational profiles

STAFFER consortium members held several discussions to define the future rail profiles.
Below it is shown briefly the concluding remarks of the consultations, and this gives an overview of all occupational profiles used in the rail industry:

SECTOR	SUB-SECTOR	PROFESSIONAL PROFILES AND/OR SKILLS (EQF 6-8, bachelor, master, PhD)	PROFESSIONAL PROFILES AND/OR SKILLS (EQF 3-5, specific courses and secondary level schools)
OPERATIONAL/RAIL TRANSPORT SERVICES	Traffic management Intelligent transportation systems Mobility as a service	Network engineers System engineers Transportation system engineer's Artificial intelligence engineering Human Machine interface Process engineers Information technology engineers Economists	Train Drivers Traffic management staff (e.g., train dispatchers) Programmers Skilled worker in the specific fields addressed in the third column Multifunctional worker in Mobility services

RAIL SUPPLY/MANUFACTURING	Infrastructure Technologies Rolling stock	Railway engineers Welding engineers Civil engineers Vehicle architecture Ram/LCS engineers and ILS manager Computer engineers Robot engineers Automation; Signal processing, telecommunications, Software engineers	Skilled worker in the specific fields addressed in the third column Welding technicians Electrical technicians
MAINTENANCE/ ASSET MANAGEMENT	Infrastructure Technologies Rolling stock	Electrical engineers Mechanical engineers Civil engineers RAM/LCS engineers & ILS Manager Safety engineers	Skilled worker in the specific fields addressed in the third column Maintenance operators

TABLE 2 - OCCUPATIONAL PROFILES USED IN THE RAIL INDUSTRY

This overview is showing the typical variety of roles that are very specific in the rail supply industry. Most roles are based on a mechanical or electrical knowledge and are undergoing a specification over the career development. Career progression includes a high degree of experience necessary to gain deeper inside into the system rail and to understand the complexity and interconnections. The common 70-20-10 approach from Morgan McCall, Robert Eichinger and Michael Lombardo of Center for Creative Leadership applies. 70% of learning is related to problem solving in being involved in challenging task. Employees learn from own success and failures. 20% is dedicated to learning from others. Especially the exchange with other more experienced experts is considered as a string layer to understand more about the complexity of the rail system. In particular when it comes to interfaces. 10% is formal learning.

Employees participate in a course or in training session to learn more hard and soft skills and technical understanding of the rail system. This logic makes clear that skill development cannot only rely on training but needs to incorporate on the job learning as well to reflect the specifics of the rail system. New learning methodology might help to create more agile and adaptive forms in combination with rail industry.
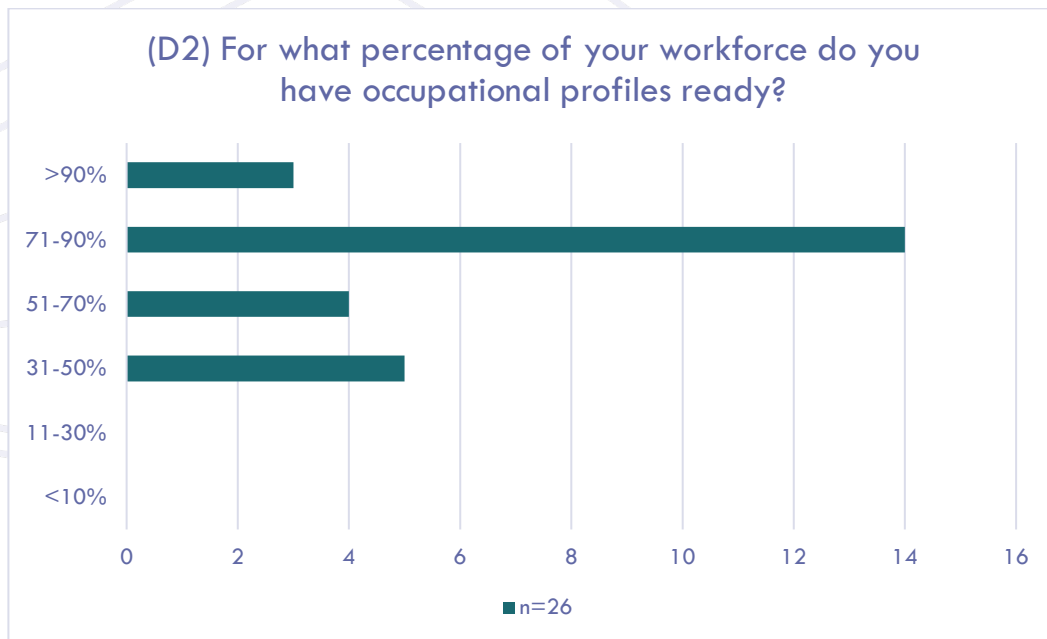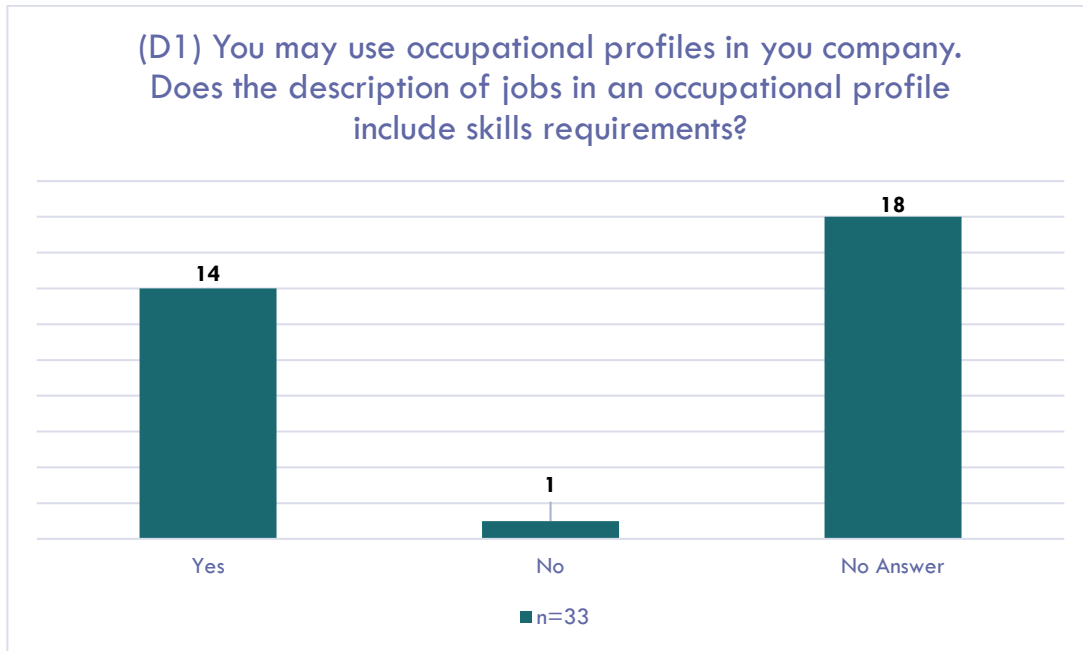
6 RESULTS FROM THE SURVEY

Employability is of course a key and strategic concept for the European Rail Supply Industry, and involves not only the industry itself but also educational and training institutions at any level, but also trade unions, etc. However, there still is a long ahead to fulfil with the demands and challenges to be faced in the coming years, ant it must be paved on the basis of social, industrial, and educational dialogue. Modernization in all areas is required in order to maintain local and international competition.

As per the "Study on the competitiveness of the Rail Supply Industry" (written by Ecorys in cooperation with VVA and TNO, September 2019): "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"

This study also states that "as in most technical engineering sectors, the supply of technical engineers may become a bottleneck in maintaining a competitive position". As a result, the industry itself has identified this need to strongly support and promote technical education not only in engineering but in many other connected areas and to urgently make the sector more attractive.

The survey of WP1 includes questions on occupational profiles and how they are impacted by the transformation on the rail industry. Most of the companies work with occupational profiles to describe responsibilities, tasks and required skills. However, the occupational profiles are highly specific to the business and not comparable from one company to the other although the job roles titles sound similar (reference to D1 and D2).

(D1) You may use occupational profiles in you company. Does the description of jobs in an occupational profile include skills requirements?

Yes: 14
No: 1
No Answer: 18

n=33

(D2) For what percentage of your workforce do you have occupational profiles ready?

n=26

A major interest of STAFFER is to figure out how the trends impact the skills development in companies and which skills are most critical. So, the survey asked for different generic levels like occupational area, occupational profiles, and skills level. Therefore, the participants in the survey are asked to name their most critical ones first.

(D)3 Which three occupational profiles (or more) would you consider to be critical/demanding for your organization or business area in terms of required skills?

This question was asked as an open question. The question was analysed according to qualitative content analysis with n = 33.

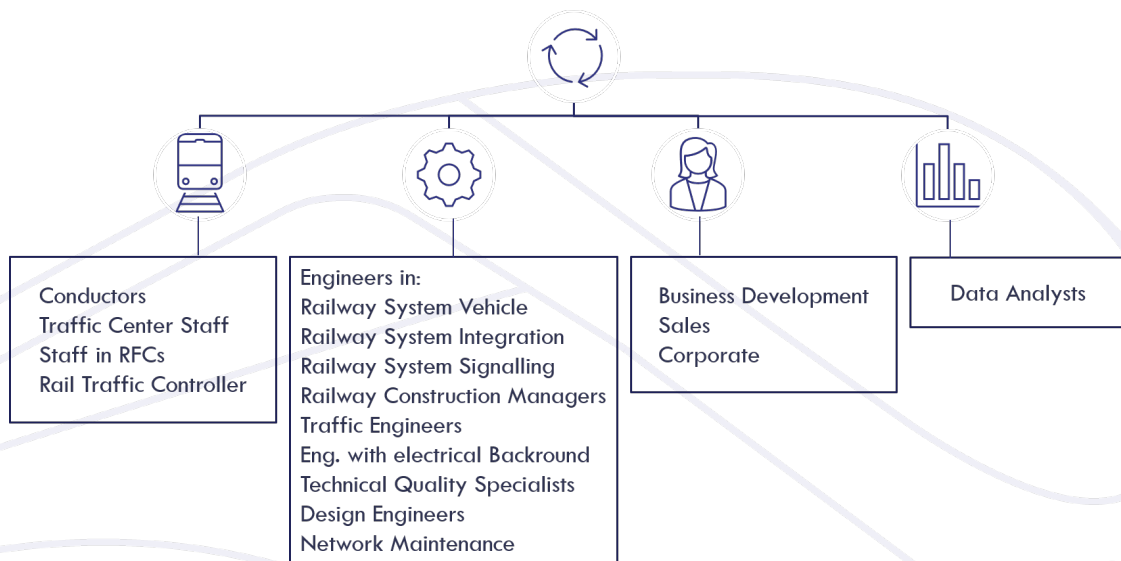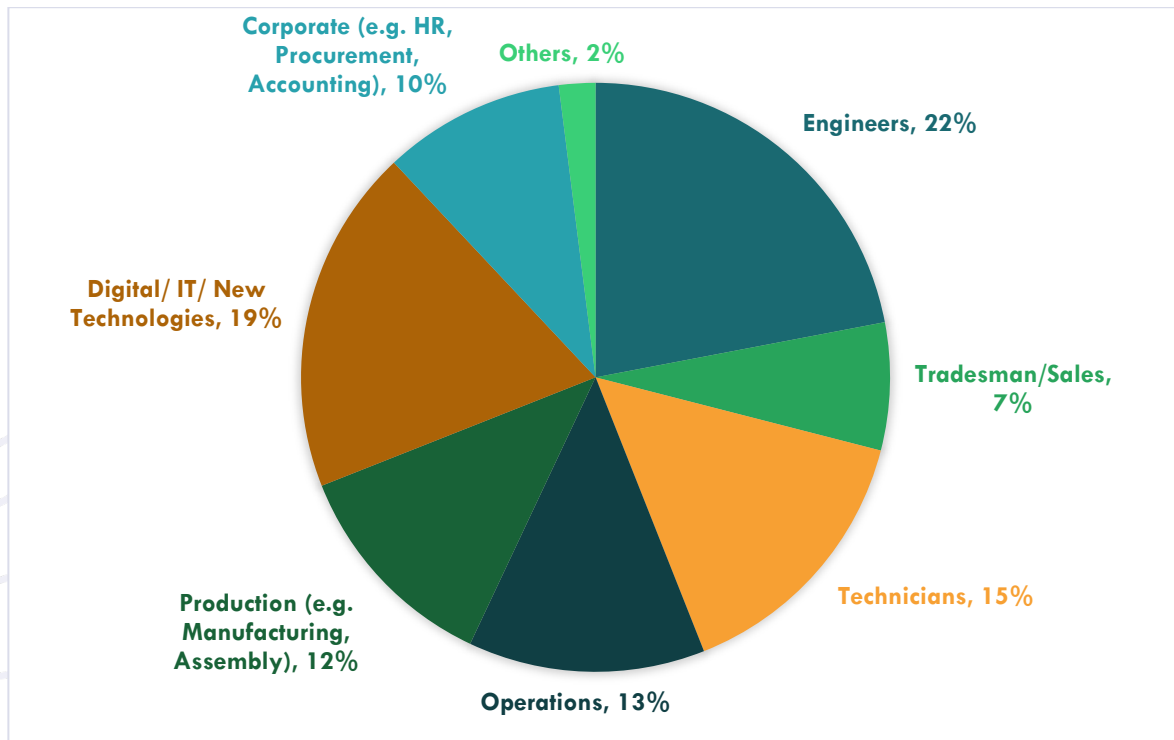By analysing the answers, the following groups have been identified:

| Conductors Traffic Center Staff Staff in RFCs Rail Traffic Controller | Engineers in: Railway System Vehicle Railway System Integration Railway System Signalling Railway Construction Managers Traffic Engineers Eng. with electrical Backround Technical Quality Specialists Design Engineers Network Maintenance | Business Development Sales Corporate | Data Analysts |

FIGURE 10 - RAIL OCCUPATIONAL PROFILES.

Referring to D3 companies named the most critical occupational profiles in terms of required skills. In the following discussion in the supplier consortium, partners pointed out the clear focus on profiles in engineering that are seen as most critical. Only few digital profiles have been addressed. Profiles from the production area are missing in the list of most critical profiles. Same for homologation. This result shows that the focus is still on traditional, experienced engineering roles that are not easy to find in the labour market. The broad impact of the digital transformation and its need to re-think business models is not considered in the naming of profiles yet. So, for example, contract management also needs adaption and requires new skills.

Then the question was asked in a similar way but with a given set of job areas like engineering, technicians, sales, etc. and not to specific occupational profiles. Participants in the survey have been requested to name the ones with the biggest need for adaption.

(D4) For which occupational groups/working areas do you see the biggest need for skills adaption?

This question was organized in two parts. Specific occupational groups/ working areas were given to be chosen as with the biggest need for skills adaption. Afterwards participants were asked to comment their decision (n = 33).

Corporate (e.g. HR, Procurement, Accounting), 10%

Others, 2%

Engineers, 22%

Digital/ IT/ New Technologies, 19%

Tradesman/Sales, 7%

Technicians, 15%

Production (e.g. Manufacturing, Assembly), 12%

Operations, 13%

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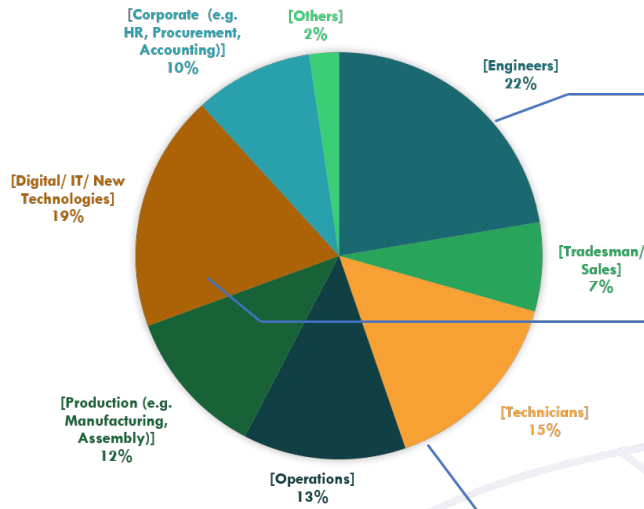
Engineers:
- New digital tools
- Adaption to changing situations and solutions
- Interfaces between systems
- Shift to digitalization and autonomous trains
- Higher rail complexity level and stringency
- Keeping up with the technological evolution

Digital/ IT/ New Work:
- Data Security
- Digital impact analysis for value chains
- Interconnection

Technicians:
- Increasing demand for Data Analysis
- Missing knowledge of expectations of our industry
- Missing understanding about the functioning of technical needs and the associated whole system
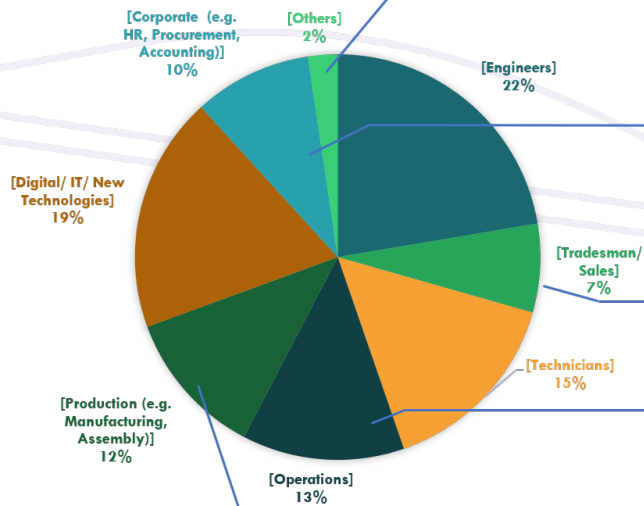
Other:
- Strengthen the understanding of digital requirements
- Rolling Stock Maintenance

Corporate (e.g. HR, Procurement, Accounting):
- Obsolete mindset
- Digital laggards

Tradesman/ Sales:
- Increasing value based selling
- Development towards solution sales and consultative selling

Operations:
- Urgent need for Adaption of Digital Skills
- Language Skills

Production (e.g. Manufacturing, Assembly):
- Automation and digital industry
- Handling diversity of work methods and skill management
- Integration of digital tools in production processes

The question D4 offered the participants in the survey a framework to evaluate which occupational areas have the strongest need for skills adaption. Survey participants tick mark the ones with the strongest need. Engineering is seen as the occupational area with the strongest need, followed by Digital/ IT/New Technologies, followed by technicians. It becomes obvious that the focus of companies' perspective is currently clearly on technical roles. In the open text comments, companies have indicated the qualitative aspects of the skills needs like adaptation to higher complexity, shift to autonomous driving, etc.

Changes in technologies and innovation have been for long time the main drivers for growth and changes and for gaining market shares. That digital disruption affects business models, and the fundamental setting of companies' strategies is not reflected yet in a dimension how this will impact the change in business and consequently the skills base. Technicians are expected to lift on a higher skills level and incorporate more and more data and digital competencies into their role profile. Similar expectations are indicated for occupational profile from production. Also, here an upskilling towards applying digital competencies and automation competencies is crucial for future development.

One point that could be understood as an overarching theme for all occupational profiles is the understanding of digital business as well as a basic understanding of digital technologies and their consequences on customers and coming to new solutions. This understanding is necessary in the management team to become a driver for the transformation and understand the option how future business could be relevant and resilient.

The last question D6 addresses the skills level directly. Participants were asked which skills will become most important as future skills. The question differentiates between soft and hard skills.

All in all, the result from the survey goes in line with the fact that the rail industry is entering late into the digital transformation process and is approaching this with first attempts and insights. The major impact on skills is not yet reflected in the results to a full degree. Benchmarking with other industries that are already ahead in the transportation sector would be helpful to get better insight in how deep the transformation can affect the business. Especially for smaller companies, this might be helpful to do this in a joint effort or start co-creations for the prediction on how the trends and transformation can affect their business.

(D6) When you think of the transformation in rail and necessary future skills, which skills (hard skills and soft skills) and competencies do you see as particular important?

This was asked as an open question. The question was analysed according to qualitative content analysis with n = 33. By analysing the answers, it has been tried to order the answers in the following clusters:

Soft Skills
Attitude
Adaptability to Changes
Continuous Training & Lifelong Learning
Responsibility
Resilience
Emotional Intelligence
Leadership & People Management
Cultural Skills
Team Skills

Digital Skills
Digital Competence
Applying and handling digital technologies
Digital Understanding
e.g.
BIM; data and decision science rearch; prototyping and robotics testing;
Specific: different interfaces; digital communication

Data Analytics
Cyber Security

Hard Skills
Project Management
Language Skills
Engineering Skills (e.g. systems, processes)
Metallurgical Skills

Soft Skills

Digital Skills

Hard Skills

Other Topics
New Collaboration Forms
New Business Modells and their consequences in all company areas
Fostering customer value creation
Skills and knowledge about the whole railway system
Competence in Energy
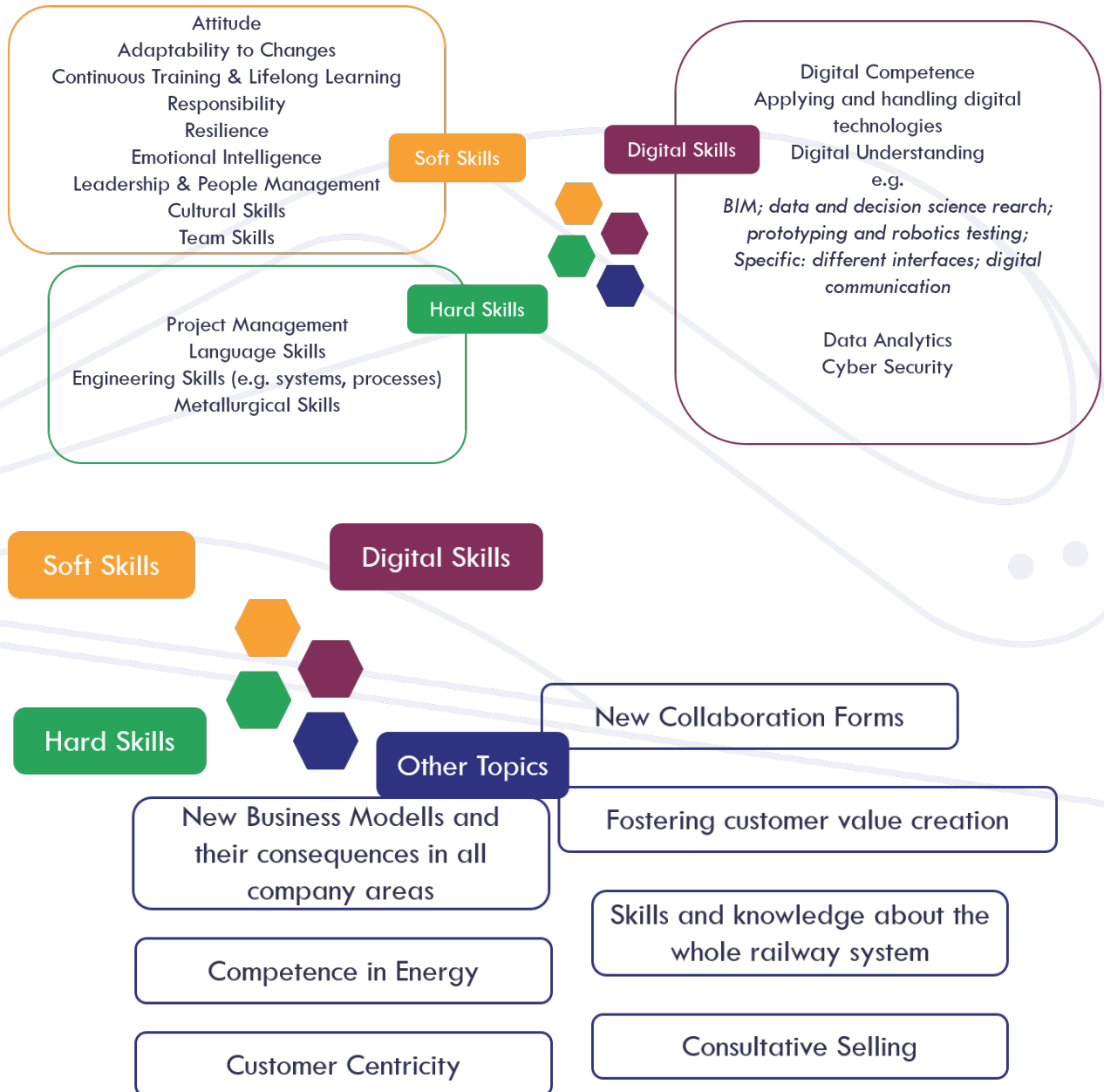Consultative Selling
Customer Centricity

FIGURE 11 - SKILLS CLUSTERS

As soft skills, participants designate in essence the skills that are associated to adaption to new environment and challenges like attitude and resilience. In addition, people skills in terms of leadership or team gain increasing importance. Those skill may not differ from other industries that also undergo transformations. On the digital skills side, many digital technologies like robotics, digital communications are named. The overarching theme here is to foster the digital understanding of the entire workforce to be able to understand changes and to evaluate how digital technologies affects their own working area. Data Analytics and Cybersecurity have been named in addition as main topics.

More interesting are the skills labelled under others. Here two different clusters can be seen: one on sales to train, a more customer centricity and consultative selling. The other is related to modern forms of collaboration and how becoming an agile organization. In addition, the importance of understanding new business models that are opening with digital products like data driven business or making use of platforms.

7 CONCLUSIONS

Employability is of course a key and strategic concept for the European Rail Supply Industry, and involves not only the industry itself but also educational and training institutions at any level, but also trade unions, etc. However, there still is a long ahead to fulfil with the demands and challenges to be faced in the coming years, and it must be paved on the basis of social, industrial, and educational dialogue. Modernization in all areas is required in order to maintain local and international competition.

This section focuses on the challenges to workforce capability that were raised during the rail industry consultations and survey reports.

The industry deep dive consultation process described in the Methodology section identified a range of issues that are impacting workforce capability now and into the future.

We could say that the rail supply was lagging behind other industries in terms of adapting training approaches, in relation to taking advantage of new technologies that allow new ways of capabilities. In this sense, the lack of standardization is one of the main barriers in the sector. The progressive substitution of electronic components for mechanical components and the reduction in the useful life of assets, has promoted standardization, therefore, the sector's ability to match skills offer with the future skills demand.

In depth discussions from the rail supply industry and online survey looked at which skills would likely see stronger demand over the next decades. While in-depth discussion involved people from different parts of the rail sector, rail suppliers have been able to give their views on which skills shortages the sector could experience:

- Systems engineering

- Cloud based signalling

- Cybersecurity

- Remote condition monitoring

- Virtual reality simulators and trainers

- Different customer service skills (for autonomous services)

- Big data analysis

In addition, the rail supply industry believes there will also be needed some "generic" skills as rail transforms into a more modern, technology driven industry with stronger links and integration

with all transport networks, education providers, manufacturing, and government. We could highlight in this area:

- Problem solving skills

- Communication skills

- Association skills

As mentioned in section 4, a key driving force for future new skills in the rail supply industry is technological innovation, which can deliver more optimised asset management and operations, offer greater energy efficiency, and deliver stronger safety outcomes. New technologies, including automation, digitalization and 'big data', remote operations and augmented or virtual reality systems, have the capacity to significantly change the type of skills required by rail suppliers.

New technologies will influence railway maintenance activities and labour activities since these systems will facilitate the demand for these operations. New technologies will allow better monitoring, diagnosis and communications that will lead to an increase in preventive and predictive measures instead of reactive measures as has been done until now. Above all, these technologies will drive the digitalization of the sector and learning techniques.

New technologies are likely to constrain demand for 'hands on', labour intensive operations and maintenance activities in rail, with new systems favouring less direct intervention through enhanced monitoring, diagnostics and communications which will lead to an uplift in preventative rather than reactive measures, and a focus on digital rather than physical rail infrastructure and learning techniques.

While this may be a challenging transition in terms of skills, it may also provide opportunities for increasing the diversity of the rail workforce.

We could say that, in the coming years, the combination of technological systems to guarantee proper operation will drive a strong demand for systems engineers. In the coming years, we will also see changes in communication systems. Given the technological advances in signalling networks, new capabilities will also be necessary to operate and maintain them. The sector is moving towards digital communication technologies "in the cabin", gradually moving away from the physical signalling infrastructure. This will lead to a growth in demand for electrical and signalling engineers, as well as maintenance personnel.

Another aspect to highlight from the consultations carried out are the non-technical capacities. The non-technological skills influence the workplace attitude towards flexibility, adaptation to

change and a commitment to continuous learning derived from the variety of technologies that will impact the industry in the coming years. Leaders of rail organisations will need to be skilled in effective change management strategies to navigate through the uncertainties and risks.

Apart from this attitudes, other key of non-STEM skills is defined as key for the future, the communication. This skill helps knowledge transfer and information within rail organizations, therefore will boost the future of rail. The demand for communication skills is boosted by the continuous evolution of rail, focusing more on the customers and stakeholders. We could say there is a clear need to raise the branding of the rail sector. The industry should effectively communicate the benefits of the rail to the economy, the benefits of working in the rail supply industry and the need for railway services of the society. However, the communication skills may be considered as a part of a multidisciplinary skills set.

Finally, having a collaborative or partnering mindset was seen as vital for the rail supply industry, now and in the future. Partnering is seen as critical to solving rail's myriad education and training issues, where no one part of the training system (operators, asset owners, contractors, VET, and governments) will be able to deliver 'whole of industry' solutions unilaterally.