STAFFER
EUROPEAN RAIL SKILLS ALLIANCE

Identification of current and future skills and competence needs

DELIVERABLES D1.1 AND D1.2

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of the European Union

Deliverable Status	
Deliverable Leader	TUD/SIEMENS
Internal Reviewer 1	IZS
Internal Reviewer 2	SNCF
Internal Reviewer 3	UNIGE
Type	Document
Work Package	1
ID	D1.1 - Analysis of the state of art D1.2 - Development of methodology for assessing and monitoring the skill needs
Due Date	April 30th, 2021
Delivery Date	June 14th, 2021
Status	Submitted
Dissemination Level	Public

Document History	
Contributions	TUD, SIEMENS, all partners
Track Change	V2.0

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EXECUTIVE SUMMARY

In WP 1, the trends relevant for the railway sector were identified and a research on assessment methodology for the evaluation/identification of employee's competences and skills was conducted.

In order to identify trends, the literature research and a survey of railway operators and railway suppliers using a questionnaire were carried out. The results and findings of the literature research of 43 sources (projects/studies/initiatives) provided an overall view of the development of the railway sector and showed the close interaction of several trends. However, the sources evaluated are not focused on the rail sector as a whole, but each have a specific focus of investigation. For this reason, only a few trends could be identified on the basis of the literature research. The prioritization of trends in general and for railway operator and railway supplier in particular was not possible.

This gap was closed in WP 1 by conducting a survey. In this way, the level of impact of each macro trend and micro trend on the working field of railway supplier and railway operator could be determined. Due to the low number of responses and different numbers of railway suppliers and railway operators participating in the survey, it was not possible to identify differences or similarities between suppliers and operators in terms of trends on the basis of surveys. Nevertheless, the survey provided a general insight into perceptions of trends, professional profiles and assessment methods and thus fulfilled the requirements set for it by the project partners.

In order to benefit from the findings of WP1 in WP2 and WP3, it is recommended to relate the trends and their assessment to the Vision 2030-2050, which is the task of WP2/3. The trends to be highlighted are those that are linked to the operator/supplier vision. This can be used to underpin or correct the course of the vision. In addition, it is advisable to look at the survey results on occupational profiles. These give an overview of the occupational profiles that are affected by the transformation for railway operator, railway supplier and both. The results of the literature research should provide guidance in the interpretation of trend impact and trend significance.

As a second part WP1 analyzed the state of the art of assessment methodologies that can be used for assessing skills. Like the trends topic a literature research was conducted. The analysis was including 14 studies that refer to assessment of skills, but in a very generic form. So, the analysis was expanded to scientific literature that describes methods for assessment. The importance of re-skilling and up-skilling employees alongside the

transformation that is impacted by the trends was pointed out. In addition, different assessment practices were collected by the survey to provide an overview what is currently the state of the art for the companies and which methods companies apply to re-skill and up-skill. The analyses on assessment methodology carried out in WP 1 provide the basis and links for the comprehensive analyses in WP 2, 3 and 4.

1 AIMS OF WP 1

Rail Transport is a future-oriented industry, striving to offer an even more attractive, affordable, safe, clean, competitive, and reliable transport mode. The more competitive we envisage the sector to turn into, the more we need focused training and education programmes to support it.

The purpose of this report is at first to **identify trends in the railway sector** that will have an impact on the future competences and skills of railway employees in all categories. Secondly, this report aims to **identify the assessment methodology** for evaluating/identifying staff competences and skills.

For this reason, the report is divided into two parts regarding the task definition in the work package 1 (WP 1):

Task 1.1 ANALYSIS OF THE STATE OF ART: This task will analyze projects, studies, and initiatives aimed at evaluating the trends of the rail sector, and their effects on the new skills to be provided or adapted. Beside the existing pre-work, a second focus of this task will be on the know-how of companies on the operators', infrastructure managers' and suppliers' sides. For this reason, a survey will be developed and implemented.

Task 1.2 DEVELOPMENT OF METHODOLOGY FOR ASSESSING AND MONITORING THE SKILL NEEDS: This task will provide the state-of-the-art assessment methodologies that will serve as a framework, or toolbox, that could be applied in WP2 and WP3. In this context, the questions regarding occupation profiles and skill assessment are clarified in this task. Following methods are used in this task: assessment of sources and implementation of a survey.

One of the outcomes of Work Package 1 (WP 1) is also the **Project Glossary**, which is addressed in chapter 4.

The timeline for the implementation of WP 1 tasks is given in Figure 1.

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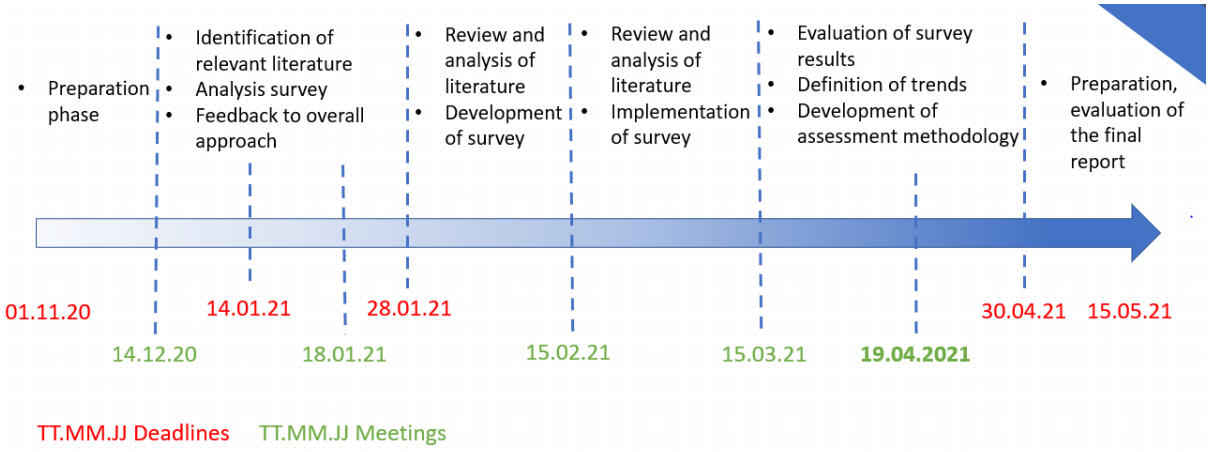


FIGURE 1: TIMELINE WP 1

The WP 1 provides the basis for work packages 2, 3 and 4. This relationship is shown in Figure 2. The objectives of WP 1 are outlined with a red frame.

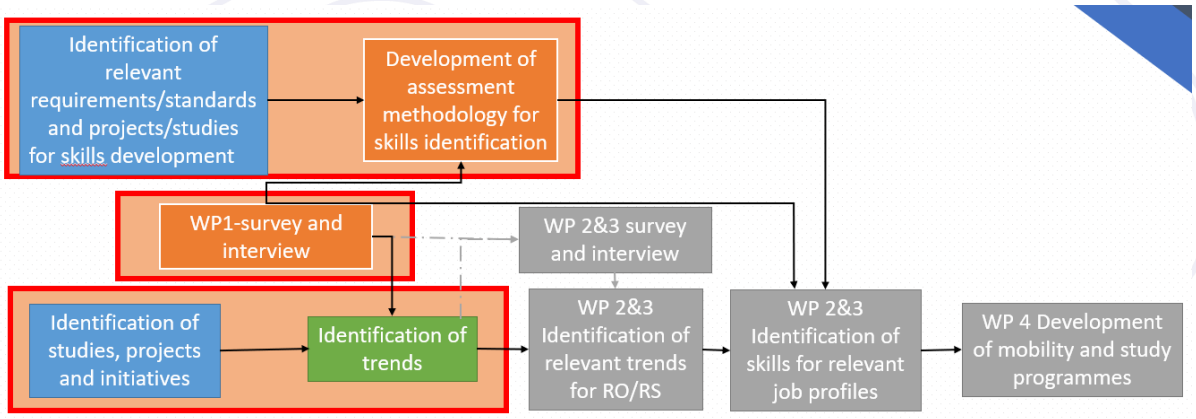


FIGURE 2 WORKFLOW WP 1 - WP 4

One of the important milestones in the STAFFER project is the development of mobility and study programmes in work package 4, taking into account the requirements of railway supplier and railway operator. These requirements are based on the skills for relevant job profiles for railway operator and railway supplier to be defined in work packages 2 and 3. Work package 1 in task 1.1. provides the basis for the identification of railway trends for railway operator and railway supplier. On the other hand, work package 1 in Task 1.2 provides a method for the continuous assessment of the skill needs during and beyond the project lifetime.

2 TASK 1.1 ANALYSIS OF THE STATE OF ART

2.1 Railway trends: Assessment of sources

2.1.1 Assessment strategy

2.1.1.1 List of documents to assess

In WP 1 34 different studies, initiatives, etc have been analysed. The studies have been distributed among the project partner (evaluator group, see chapter 2.1.2) to analyse and give a summary. Please find here the documents listed:

Nr.	Project	Link
1	Horizon 2020: SKILLFUL - Skills and competences development of future transportation professionals at all levels, 2019	https://skillfulproject.eu/
		https://cordis.europa.eu/project/id/723989
2	Flammini, F.: Roadmaps for AI Integration in the Rail Sector – RAILS, 2020	https://rails-project.eu/research-areas/taxonomy-of-ai-state-of-the-art-review/
		https://cordis.europa.eu/project/id/881782
3	Duvenci-Langa, S.: Minimum knowledge for the railway system, 2021	Source of SNCF
4	Romeriao, M.: Blueprint Cybersecurity Skills Alliance - A New Vision for Europe, 2020	https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/621701-EPP-1-2020-1-LT-EPPKA2-SSA-B
5	VŠB-TUO: Blueprint AUTOMOTIVE project DRIVES Development and Research on Innovative Vocational Educational Skills project, 2018	https://www.project-drives.eu/en/home

6	CPU: Blueprint DIGITALISATION project EDDIE Education for Digitalisation of Energy, 2019	http://www.eddie-erasmus.eu/
7	STICHTING STC-GROUP: Blueprint MARITIME SHIPPING project SKILLSEA Futureproof Skills for the Maritime Transport Sector, 2019	https://www.skillsea.eu/
8	TRAFIKVERKET – TRV: IMPACT-2 Shift2Rail Project, 2021	https://projects.shift2rail.org/s2r_ipcc_n.aspx?p=IMPACT-2
		https://cordis.europa.eu/project/id/777513
	Metzger, U.: Shift2Rail - IMPACT-2 - Deliverable D8.3 -Final report: Job profiles and Customer-oriented design of mobility, 2020	https://projects.shift2rail.org/s2r_ipcc_n.aspx?p=IMPACT-2
	Tortensson, P.: Shift2Rail - IMPACT-2 - Deliverable D8.4 - Future Skills and	https://projects.shift2rail.org/s2r_ipcc_n.aspx?p=IMPACT-2
9	Shift2Rail: Catalogue of solutions, 2019	https://shift2rail.org/publications/catalogue-of-solutions/
10	THE UNIVERSITY OF NOTTINGHAM: SMARTI ETN Sustainable Multi-functional Automated Resilient Transport Infrastructures H2020-EU.1.3.1, 2021	http://www.smartietn.eu/
11	MAFEX: RAILACTIVATION - Activating Inclusive growth in Railway SMEs by Workplace Innovation H2020-INNOSUP, 2021	http://railactivation.eu/
12	THE UNIVERSITY OF NOTTINGHAM: RISEN- Rail Infrastructure Systems Engineering Network H2020-EU.1.3.3, 2020	http://www.risen2rail.eu/
13		http://www.near2050.eu

	IITF: NEAR 2050 Future challenges for the rail sector S2R-OC-CCA-01-2015, 2018	https://railistics.com/references/near2050-future-challengers-of-the-railway-sector-shift2rail/
14	TTI: EDU-RAIL Harmonised and Modernised Multidisciplinary Railway Education INTERREG Central Baltic Programme, 2018	https://trimis.ec.europa.eu/project/harmonised-and-modernised-multidisciplinary-railway-education
		https://tsi.lv/projects/harmonised-and-modernised-multidisciplinary-railway-education-edu-rail/
15	Ethniko Kentro Erevnas Kai Technologikis Anaptyxis: NEAR2 Network of European Asian Rail Research capacities FP7-SST-2012-RTD-1, 2014	https://cordis.europa.eu/project/id/314254
16	Associacao Do Instituto Superior Tecnico Para A Investigacao E Desenvolvimento: SKILLRAIL Training and Education for a more Competitive and Innovative Railway Sector FP7-SST-2008-RTD-1, 2011	https://cordis.europa.eu/project/id/233649
17	INSTITUTO SUPERIOR TECNICO Portugal: Job Opportunities for the Railway Community of Tomorrow FUTURAIL FP7-SST-2007-RTD-1, 2010	https://cordis.europa.eu/project/id/218596
Nr.	**Study**	**Link**
18	UIC: VERA Study - Study on the European employment market for railway companies, to identify areas of cooperation to meet the future challenges of the sector in the field of human resources, 2019	Source of WMP
19	Fraunhofer ISI: Business case for increasing female employment in the transport sector (FemTR), 2018	https://www.isi.fraunhofer.de/de/competence-center/nachhaltigkeit-

		infrastruktursysteme/projekte/femtr.html#1
20	CER: WiR - Women in Rail - Sixth Annual Report - 2019 annual reporting on the development of women's employment in the rail sector, 2019	https://www.cer.be/wir
21	Cannon, C.: Data analysis of current and emerging skills development and training schemes in the rail transport sector, 2019	http://www.sciencewebpublishing.net/jerr/archive/2019/March/Abstract/Cannon%20et%20al.htm
22	National Skills Academy for Rail: Back on Track - Gearing up to meet the increased demand for talent in the rail industry, 2020	https://www.cityandguildsgroup.com/research/back-on-track?utm_source=press-release&utm_medium=organic_pr&utm_campaign=back-on-track
23	DK: Rail training 2020 - Training needs and offers in the European railway area the next 10 - 15 years, 2007	Source of UNIROMA
24	Marinova, M.: Curriculum Development and Design for University Programmes in Rail Freight and Logistics, 2013	Source of MAFEX
25	UITP: Digital Transformation and Social Dialogue in Urban Public Transport in Europe, 2020	https://cms.uitp.org/wp/wp-content/uploads/2020/10/Final-report-Digital-transformation-and-social-dialogue-in-urban-public-transport-EN.pdf
26	UTP: State of the art of certification needs in the railway sector, 2018	Source of SNCF
27	IMU Institut Nürnberg: Mobility Siemens 2020, 2017	Source of SIEMENS

28	BMVI: Rail Freight Master Plan (Masterplan Schienengüterverkehr), 2017	Source of UASFHE
29	Office of the Federal Government Commissioner for Rail Transport (Geschäftsstelle des Beauftragten der Bundesregierung für den Schienenverkehr): Rail Transport Master Plan (Masterplan Schienenverkehr), 2020	Source of UASFHE
30	KCW: Railmap 2030, 2020	https://www.stiftung-mercator.de/content/uploads/2020/12/20_Railmap-2030_WEB.pdf
31	Val, V.: Development of jobs and skills – Infrastructure, 2021	Source of SNCF
32	Secrétariat d'état aux transports, à la mer et à la pêche: Action plan for future development of freight, 2016	https://www.ecologie.gouv.fr/sites/default/files/DP_-_Plan_d_action_pour_la_relance_du_fret_ferroviaire_-_06_10_16.pdf
33	SNCF: Tech4rail – A future vision of the railway system, 2020	Source of SNCF
34	Commission Expert Group: Final Report of Commission Expert Group on the competitiveness of the rail supply industry, 2019	https://ec.europa.eu/docsroom/documents/38025
35	ERRAC: Rail 2030 - Research and innovation priorities, 2019	https://errac.org/wp-content/uploads/2019/09/errac_rail_2030_research_and_innovation_priorities.pdf
36	ERRAC: Rail 2050 Vision, 2017	https://errac.org/wp-content/uploads/2019/03/1

		22017_ERRAC-RAIL-2050.pdf
Nr.	**Initiative**	**Link**
37	European Commission: European Year of Rail, 2021	https://ec.europa.eu/commission/presscorner/detail/en/IP_20_2528
38	European Commission: European Green Deal, 2021	https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
39	European Commission: Sustainable and SMART Mobility Strategy, 2020	https://ec.europa.eu/transport/themes/mobilitystrategy_en
40	European Commission: Strategic Transport Research and Innovation Agenda (STRIA), 2017	https://ec.europa.eu/info/research-and-innovation/research-area/transport/stria_en
41	United Nations: 2030 Agenda for Sustainable Development - Sustainable Development Goals, 2015	https://sdgs.un.org/goals
42	FIEC: Making BIM a global success, 2017	www.fiec.eu
43	Costa, S.: Vers un jumeau numerique du système ferroviaire (Digital Twin), 2019	Source of SNCF

2.1.1.2 Instruction for the evaluators

For the analysis of studies, project, initiatives an evaluator group was set up. This group consisted of the following project partners: academic institutions and SNCF, CER, WMP, MAFEX, SIEMENS.

The evaluator got an assessment sheet (seeTable 2) with the following instruction:

"Dear xxx,

the trends should be assigned to the following main groups (macro trends):

- ***society***
- ***technical changes***
- ***environment and politics***
- ***economics and market***

Please assign the micro trends to the respective macro trend. Please use the following examples of micro trends in the attached table as a guideline (Table 1).

TABLE 1 OVERVIEW OF MACRO AND MICRO TRENDS

Society	*Technical changes*	*Environmental and politics*	*Economics and market*
Silver Society	*5G and beyond*	*Politics*	*Platforms of digital eco-systems*
Gender Shift	*Digital Provisioning*	*Neo-ecology*	*Renewable Energy*
Health	*Distributed Ledger Technologies*	*Climatic-political regulation*	*New Mobility*
New Work	*Artificial Intelligence*	*Security*	*Sustainable Management*
Sustainability	*Quantum Computing*	*European Rail Area*	*Globalization*
Urbanization	*Embedded Payment*	*Smart and sustainable mobility strategy*	*Transnational rail freight corridors*
Knowledge Management	*Internet of Things*		*Transnational rail passenger corridors*
Talent shortage	*Location Technologies*		
Connectivity	*Digital Twin*		
Diversity	*Big Data Analytics*		

Data-based Business Models
Information veracity
Future Work
Human Immersion
Digital Ethics
Digital Automatic Coupling
Automatic Driving Railway
3D Printing
Drones & vertical Mobility

Please use the assessment sheet for the evaluation of trends, presented in Table 2.

In the field "Description trend" the trend should be described: please add the definition of the trend as it is described in the respective project/study/initiative. In what context is the trend mentioned? Please also include information on why this trend is mentioned in the study/project/initiative and how its importance for the rail sector is assessed (including assessment criteria). Please also include any other information that you consider relevant.

It is to be expected that each study/project/initiative may also contain further information relevant to the project and its work packages. For example, if a project mentions the methodology for skills development (WP1) or includes information on the development of study programmes (WP4), Identification of criteria and measurable indicators to evaluate employability and career opportunities (WP5), please list this under "Further project relevant information" (see Template_Assessment sheet). Please indicate the number of the relevant work package under "No.WP". I would also be very grateful if you could introduce some tags/keywords in the field "Keywords" that indicate the character of the information (e.g., development of study programmes, implementation of study programmes, student mobility, skills development, quality assurance, and so on).

TABLE 2 ASSESSMENT SHEET FOR IDENTIFICATION OF RAILWAY TRENDS

Source data		**Contact data evaluator**	
Title		**Name, Surname**	
		Email	
Type		**Phone**	
Trend			
Macro trend			
Micro trend			
Relevant for			
Description trend			
Further project-relevant information			
Nr. WP		**Key words**	
Description			
Nr. WP		**Key words**	
Description			

Please also note the following:

- *if the respective studies/projects/initiatives do not contain any information on trends, please continue the evaluation according to "Further project relevant information";*

- *If the respective studies/projects/initiatives are not related to the railway sector, please check how the results and findings can be transferred to the STAFFER project. Some macro or micro trends may be relevant in all transport sectors;*
- *It is also of interest how the trends have been categorized/grouped in other similar projects.*

To make it easier for you to find the contents and results of the respective study/project/initiative, I have referred you to the relevant websites. However, this does not exclude further research, e.g. in Google, or contacting the persons responsible for the project/study/initiative (in case of insufficient information on the websites and other sources). If necessary, you can also contact the persons who entered this study/project/initiative in the WP1 database.

Please upload the completed assessment sheets by DD.MM.YY in MS Teams folder. Thank you."

The assessment results are presented in the chapter 2.2.

2.1.2 Assessment results

This chapter only summarises information taken from the evaluated sources (projects, studies, initiatives). No prioritisation of trends is made. For this purpose, reference is made to the results of the survey of railway operators and suppliers, which are presented in chapter 3 "Railway Trends: Survey Results".

2.1.2.1 Social changes

Demographic, behavioural, cultural, and socio-economic factors will affect the railway sector in the coming years.

The shortage of qualified staff in the supply industry and in rail operation and infrastructure management is pointed out. This is justified by the fact that

- **many experts will retire in the coming years,**
- **the railway sector is generally perceived as unattractive,**
- **the share of women in total employment is small,**
- **qualification requirements are changing.**

Increasing system complexity places even higher skill requirements on staff, while working conditions and wages do not change. The transport sector is behind the average of the economy in the integration of women (Nr. 19 & 20). Taking measures to create flexibility for employees, to reduce a-typical working hours and contracts and to improve job perception are seen as possible measures to reduce the skills shortage (women and men) through a better compatibility of social and private life.

The skills shortage is to be addressed on the one hand by providing targeted training and education programmes and on the other hand by recruiting talent and qualified employees with ambitions to meet the challenges of the sector. Great importance is attached to the identification of the required skills and expertise for future jobs in the rail sector. For example, the following measures are mentioned for the railway freight sector:

- **modification of vocational training content,**
- **freight-specific training,**
- **training of employment agencies for better recruitment and management,**
- **support of rail job platforms,**
- **support of training measures for lateral entrants,**
- **mandatory rail content in logistics training,**
- **additional rail-related academic positions (Nr. 14, 23, 28, 29, 32).**

It is also pointed out that the use of new technologies for railway-specific operations will lead to a diversification of staff tasks and the improvement of human-machine interfaces (Nr 33). This highlights the interdependencies between the social changes and the technical changes The use of the Internet of Things, artificial intelligence, robotics, remote monitoring, and ERTMS are mentioned as examples. In the area of "signalling", it is pointed out that higher system complexity leads to the expansion of personnel skills. In the area of "maintenance work", the constant development and adaptation to new technologies and equipment (e.g., the increasing complexity of trains with more electronics and electrical engineering) influences the scope of personnel skills and personnel tasks. In this context, there is a discussion about the development of predictive maintenance and remote diagnostics.

2.1.2.2 Technical Changes

The use of digital technologies

- **enables the seamless monitoring of every phase of the life cycle of railway facilities and rolling stock,**
- **leads to an increase in the track capacities,**
- **contributes to increasing the safety of the railway lines and**
- **increases the availability of the railway system and its services (real-time monitoring of equipment and automated railway operations such as autonomous vehicles).**

Digital technologies focus on the use of accessible and interoperable data. The collection and management of this data lead to the creation of intelligent traffic management systems that support evidence-based decision-making and increase the capability of a transport system. This has the advantages for both internal system operations but also for traffic management between two and more transport systems (Nr. 38).

The following digital technologies including the intended use cases are explicitly mentioned in the evaluated studies/projects/initiatives:

- **Location Technologies** for the detection of train position including freight trains (Nr 32) as well as condition detection of railway infrastructure (e.g. for preventive maintenance).
- **Big data analytics**: a more comprehensive knowledge of the environment (inside and outside the company) will improve both operations and the customer experience (Nr. 33).
- **Internet of Things**: rolling stock, infrastructure (including stations), and operations control systems are becoming fully digitalised and networked components of the "Internet of Things". The ability to connect all elements of the rail system will lead to improvements in areas such as safety, security, and predictive maintenance.
- **Artificial Intelligence**: Each element is provided with local artificial intelligence, which gives it the ability to perform targeted tasks with a high degree of autonomy (No. 36) Artificial Intelligence enables the management of assets and operations under real-time conditions (Nr. 33).
- **5G and beyond**: The goal will be to maximise system coverage and its robustness and reduce physical infrastructures (Nr. 33, 42, 43).
- **BIM and Digital Twin:** Reduced costs and improvements for all phases of the life cycle, from design to the end of lifetime of rolling stock and infrastructure (Nr. 33, 42. 43)
    - for design: improvement of modelling tools, better analysis of interactions between subsystems, better knowledge of the network (Nr. 43).
    - For maintenance: more precise knowledge of the equipment and its intensity of use, allowing maintenance to be optimised in terms of costs, delays (better planning of maintenance work) and resources.
    - For the operator: The possibility to plan/reschedule the rotations; better analysis of complex incidents; greater reactivity and relevance of the decision in case of an incident.

Better sustainability through optimised energy management, higher system reliability through increased resilience, economic competitiveness through increased capacity, more flexibility

through real-time adaptation to demand are the benefits that automation and the use of digital technologies provide and will provide. This involves the development of advanced interoperable train control systems, the introduction of advanced traffic management systems (TMS) as well as the use of intelligent and autonomous vehicles and the automation of the logistics chain (Nr. 35).

Furthermore, the literature sources highlight:

- **the need to develop a standardised technical solution of an automatic coupler that is specific (functionality, weight, cost) to rail freight transport,**
- **the potential of automated shunting, automated brake control and wagon control, and**
- **the need to introduce payment mechanisms to facilitate easy transfers across different modes (embedded payment).**

2.1.2.3 Environment and Politics

In the field of environment and politics, the following two topics, in particular, are addressed in the literature sources analysed: green mobility and smart and sustainable mobility strategy, security and standardisation of railway standards and regulations within Europe.

Emission reduction is becoming the guiding issue of politics. To achieve climate neutrality, transport emissions must be reduced by 90 % by 2050. In the years leading up to 2050, there will be an urgent need to develop a wide range of complementary propulsion systems and fuel/energy types for vehicles and rail infrastructure, as well as sustainable and ethical procurement of materials, production, and waste disposal (zero-waste cycles) of products and production materials.

There is also a need for the design, construction, maintenance, and operation of climate change resilient infrastructure. The reduction of noise and vibration caused by a transport system should also be ensured.

The automation and digitalisation of transport offer further opportunities for reducing energy consumption.

The needs of end users/citizens are changing with the introduction of digital technologies. People are increasingly connected and expect mobility offers that are versatile, resilient, can be selected at the click of a button, with fully transparent information, that move more and more towards "on-demand" door-to-door mobility. The success of new "modes" of transport nowadays is largely based on their ability to meet these digital needs. To remain the backbone of mobility, railways must respond to these challenges and improve the integration of rail into

the new, comprehensive mobility system. Rail can be part of the smart and **sustainable mobility strategy** by

- **improving digital connections and availability with all other forms of transport,**
- **developing the tools for appropriate interface management, which allows a combined reaction in case of incidents/disruptions,**
- **developing the elements of a multimodal transport management platform.**

Further potential for improvement in the integration of the rail transport system into the comprehensive mobility system are the better access for older and disabled people as well as tariff flexibility.

The development of information and communication technologies has contributed to an increase in virtual threats. The security and safety of various transport sectors are to be ensured with priority. The aim is to ensure that each European rail network is properly secured and can efficiently detect security incidents. To achieve this, a precondition is to improve European cooperation.

One of the biggest challenges Europe still has to overcome is its fragmentation into different networks with different sets of rules and standards and different ways of railway operation. The planned **Single European Railway Area** and the establishment of an interoperable trans-European rail system can promote RSI by creating more demand. Combined with investment in the TEN-T core network corridors and in a unified European train control and communication system in the form of ERTMS, this can boost European railways and the industries.

2.1.2.4 Economics and Markets

The analysed literature sources highlight the importance of international rail freight and passenger transports. For example, the professional knowledge of train drivers and requirements for the licence are pointed out. The following are also noted:

- **the need for harmonisation and understanding of train control systems:** The understanding and harmonisation of train control systems of national railways, taking into account international railway traffic and the need to support the movement of passengers and goods between countries.
- **the logistical management and operation of rail transport:** providing knowledge and skills in the field of overall logistics management including rail technology and management (rail system, freight operations, management and technology required for the sustainable and intelligent design and operation of rail freight systems) (Nr 14).

- **use of innovations and new ways of thinking** based on the use of smart solutions, customer-oriented and adapted services.

In case of rail freight corridors, not only the importance of European corridors but also the increasing trade volume between Europe and Asia and the potential of the associated rail corridor is pointed out. Due to the history and current nature of this rail corridor, many problems need to be solved in order to bring the system to a modern level of infrastructure, services, and operations. In addition, to realise the full potential of the system, adaptation of new technologies, interoperability solutions, and optimised operations should be considered. Mentioned topics included: strategy and economics, operations, and system performance, rolling stock, product qualification methods, smart mobility, safety and security, energy efficiency, and infrastructure and signalling.

In addition, politics points to the reduction of track fees for rail freight corridors. Literature source Nr. 28 addresses the development of a financing model for RIM (providers) and RU (users) to benefit from reduced track fees.

2.1.2.5 Further project-relevant information

Some studies/projects/initiatives included further information relevant to the project and its work packages. This information is presented below for each WP separately. The numbers given in brackets refer to the numbers of literature sources listed in chapter 2.1.1.

WP 2

- Proper training and re-training need to be ensured and new skills or responsibilities need to be recognized and compensated for through pay increases (Nr. 25).
- Identification of current and future needs for skills and competences from the perspective of operators for freight traffic (Nr. 32):
    - Vision of the future of the railway sector from the perspective of railway undertakings and infrastructure managers.
    - Identification of skill needs and job profiles from the railway perspective of RUs and IMs.
- Human Resources professions: use more digital tools, automation of several processes. Legal environment to be taken into account. (Nr. 26)
- Railway traffic jobs: digital development, construction of centralized controls. Tools are diversifying and becoming more complex. Evolution of the profession with more monitoring and programming (Nr. 26)
- Administrative profession: tend to have more automatization (Nr. 26)

- The project Nr. 1 has information that might be relevant to later STAFFER work packages within its exploration of current and emerging training skills and future training requirements.
- System skills must be developed for each profession as a basic training. The system vision skills will make it possible to have a common vocabulary, an effective interaction with the knowledge of the interfacing professions (Nr. 3, 31).

WP 3

- Project Nr. 1 has information that might be relevant to later STAFFER work packages within its exploration of current and emerging training skills and future training requirements.

WP 4

- The level of skills and amount of responsibility required for each job group should be presented at a measurable comparison level; job categories requiring higher skill levels could have more collegiate courses provided while less planning-based jobs could have more non-collegiate courses provided; determining which job groups would actually benefit from having more diversified training schemes (Nr. 21).
- Undertaking further study to research the actual number of courses in all regions of the selected sample countries; comparison the data with both the number of workers trained in each sample country and how many workers the sample country needs to maintain their current workforce and determining specifically which courses need to be made more widely available (Nr. 21).
- To establish the close link between demand (rail industry and operators) and providers (Universities) of academic education and training (Nr. 17).
- To organise competitions between universities (also involving high schools) for innovative new education concepts/curricula that are capable to meet the future railway sector requirements (Nr. 17).
- Study Nr. 26 shows the different training/courses available for the different jobs in the rail sector. It identifies several micro-trends that will affect professional profiles (Nr. 26).
- Study Nr. 26 displays a map of what is in effect and classified by jobs and jobs categories. It shows the different training offer in France, the different possible diplomas possible that are directly or not directly related to the railway (Nr. 26).
- The main results of the project Nr. 14 are:

  - 5 modules and teaching methodology for railway engineering and logistics VET have been developed. They cover regional aspects and consider EU directives. The modules will be used by partner organisations both for full-time students and for in-service training programmes and will be disseminated to other railway education institutions in the neighbouring countries of the Central Baltic region in order to facilitate common understanding and cooperation.
  - Teaching and study materials necessary to carry out the modules.
  - E-learning methodology and e-learning materials to carry out the modules, with the support of partners' e-learning platforms.
  - Developed teaching methodology for using simulation tools.
  - Common study environment usage plan to enhance regional cooperation and more efficient use of resources of each partner organisation.
- Project Nr. 29: see detailed description in chapter 6 of the study
- Project Nr. 24: In this paper are described concepts, standards, and designs for innovative curricula for an MSc in Rail freight and Logistic. Development of an integrated (hybrid) curriculum model integrating subjects teaching and learning methods from four European Universities (UNEW, DICEA, VTU, HAW-Ingolstadt). Definition of different curricula and subjects.
- Study Nr. 23 is about the assessment of the training needs deriving from changes in the market/technological/social/legal framework. It describes the future of rail training in Europe, intended as the scenario in the year 2020.
- Study Nr. 18 is about the assessment of the training needs deriving from changes in the market/technological/social/legal framework. It describes the future of rail training in Europe, intended as the scenario in the year 2020.
- Project Nr. 1 proposes training curricula and courses and delves into trainer and trainee competence requirements.
  - Within project Nr. 1 several study courses including their description, objectives, correlation to trends/professions, methodologies, tools, and expected impacts are presented.
  - Within project Nr. 1 trainer competences and minimum trainee requirements are explored for the various courses that are developed under the framework of this project. While these are focused on the needs of these specific courses, it is believed that their methodology could prove useful while developing STAFFER courses and monitoring methodologies. This methodology includes templates containing information such as: Requested educational/vocational background,

Content knowledge requirements, Pedagogical Knowledge requirements, Language requirements, Content-related skills, Pedagogical skills, Soft skills, Transversal skills, Disposition considerations.

WP 5

- Initiative Nr. 41 identifies targets to be achieved in all the sectors and possible indicators to be considered.

WP 6

- The EU-funded project 'Job opportunities for the railway community of tomorrow' (FUTURAIL) supported the implementation of the EU's transport research programme by matching human resources with skilled labour from training institutions and relevant academic fields (Nr. 17).

WP 7

- Transforming the rail industry into a career destination, especially for young people It's vital that contractors and clients work together and continue to make the case that rail is an industry for everyone, with a diversity of roles and skills, rewarding benefits such as training and career progression and the potential to improve social mobility; involving educating the public about what a career in rail really looks like and showcasing the spectrum of opportunities from digital to customer services; raising awareness of opportunities in the sector among women, young adults and people from BAME backgrounds will play a key role (Nr. 22).
- Developing strong career paths to attract and retain talent and maximise productivity; investing in training and development for people at the start of their career will cut recruitment costs further down the line and maximises productivity (Nr. 22).
- Expecting to create new job openings, employers should look for ways to help people enter the industry mid-career; employers and training providers could work together to create a series of 'skills; government training grants and other bursary opportunities, such as the City & Guilds Foundation and Intertrain track employment programme (Nr. 22).
- To organise specifically tailored events to attract young people for academic jobs in the railway sector (Nr. 17)
- FUTURAIL contributed to upgrading the image of the rail industry in Europe, disseminating good practices and motivating staff (Nr. 17).

- Competences now required by the employers for the job are higher than before, while the working conditions and wages have not changed much in modes such road and maritime, leading in turn to shortages in those labour markets (Nr. 19).
- The initiative Nr. 41 reports the main general goals to be achieved in all the sectors and the areas that need urgent attention.

2.2 Railway trends: Survey results

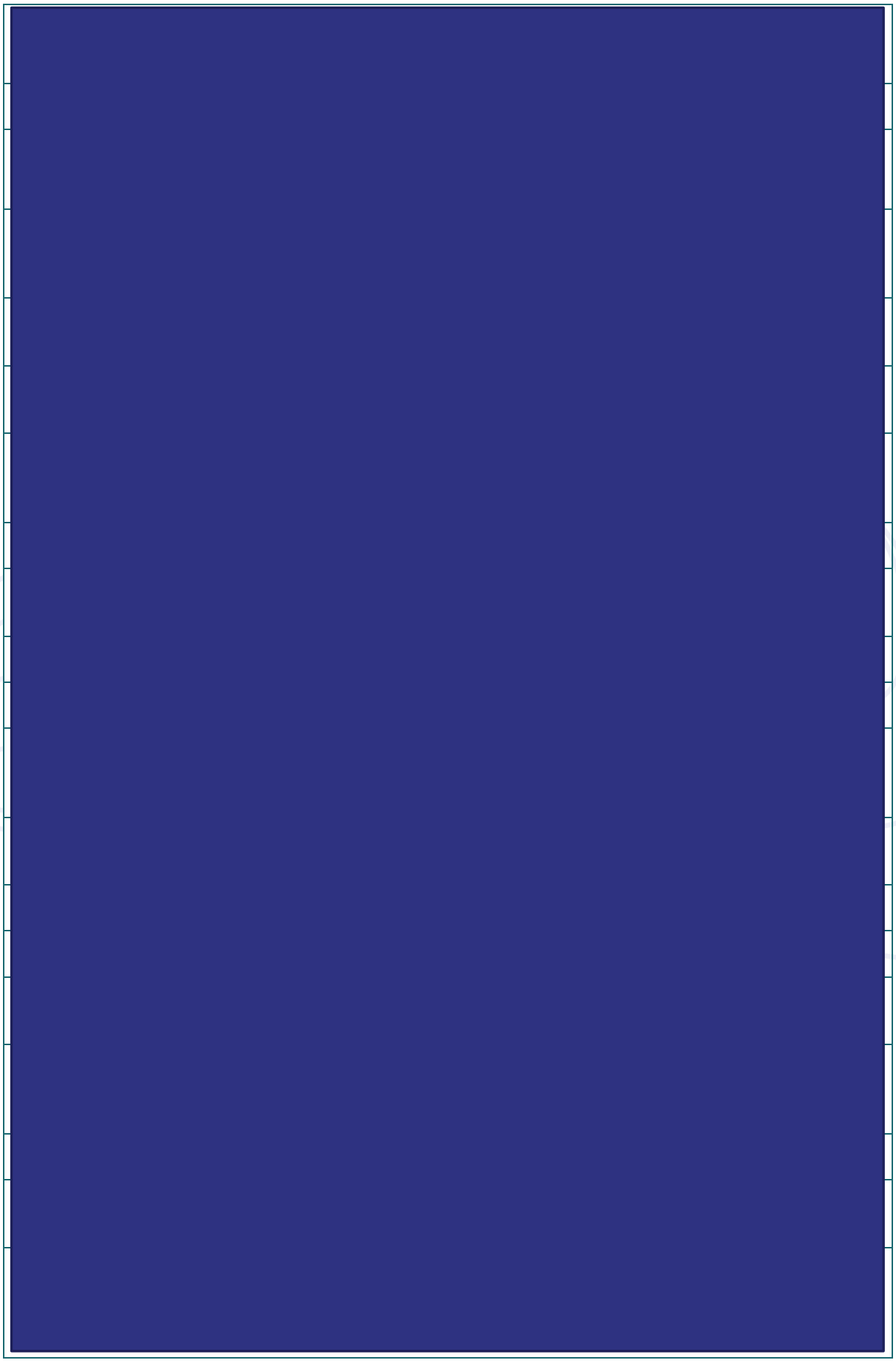
2.2.1 Introduction

To serve a comprehensive umbrella for WP 1 a survey on trends and skill development is conducted by the working group. This survey is distributed to all partners of the STAFFER project as well as to the associated partners of STAFFER. In addition, the target group is extend-ed to the UNIFE rail company community. The survey is designed to provide an overview of the impact of trends and skill situation in rail companies (rail operators as well as rail suppliers). The purpose of the questionnaire is to get transparency on current understanding of skills in the European rail industry and to receive insights in current skill analysis and development practices in Europe.

The following organizations received the invitation to take part in the survey: see Table 3.

TABLE 3 SURVEY PARTNERS

Survey Partners
To ensure the privacy and anonymity of the survey partners as guaranteed in the questionnaire, the workgroup has agreed to blacken this list.



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2.2.2 Methodology

The survey consists of six different chapters that tackles various aspects of skill development approaches:

- **Personal data of contact person/general business information**
- **Value chain of the business**
- **Technical and social changes (Society, technical changes, environment & politics, economics & markets)**
- **Occupational profiles**
- **Risk factors for workforce**
- **Future and current skills**

The survey is programmed in LIME Survey which is a tool to conduct surveys by universities. According to the LIME survey setting, the questions are clustered and marked with a letter and a number to identify the questions throughout the analysis. To explain all specific vocabulary of trends and skill management, WP 1 prepared a glossary in addition to foster same understanding of all participants. The glossary is sent together with the link for the survey to the target group. The filling time is three weeks in total and a reminder is sent out a week be-fore closing. The collected data is transferred to Excel and SPSS to conduct respective analysis and presentation of the results. The results are summed up in a report and shared with the entire group of Staffer partners to serve for further discussion in the WP's.

2.2.3 Survey results

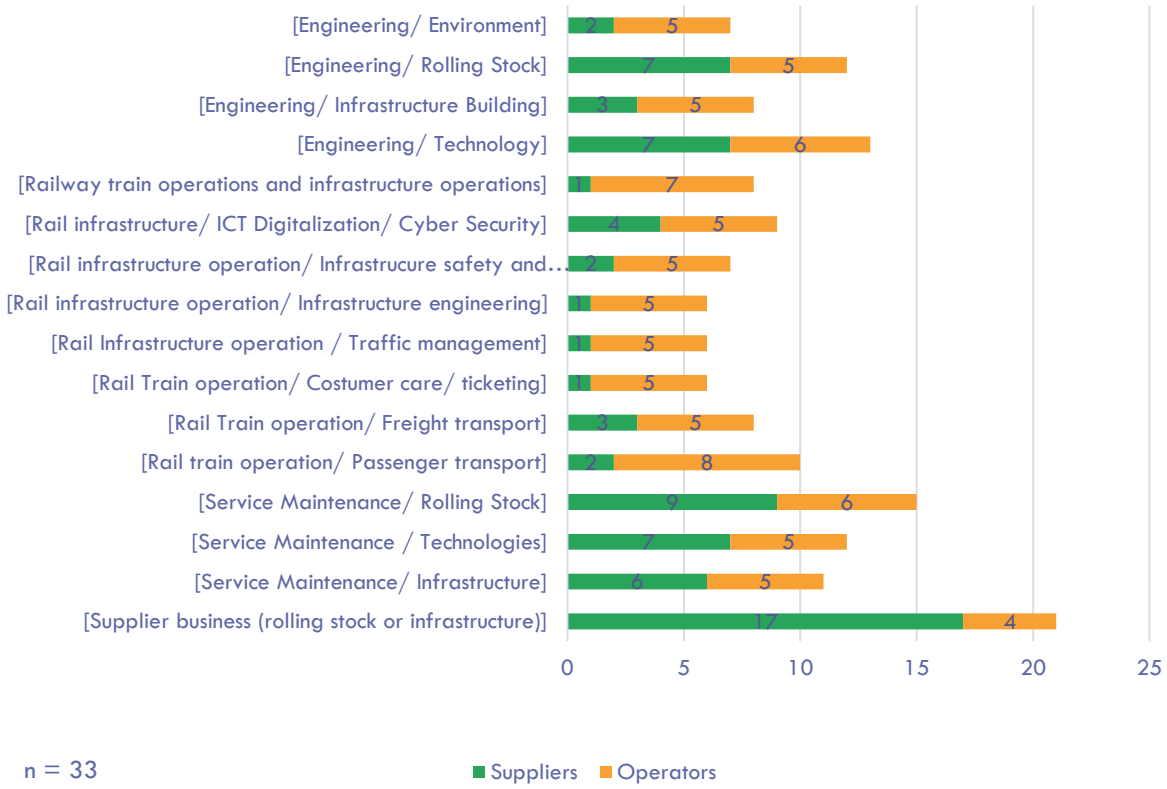
The presentation of the survey results is organized in line with the structure of the survey it-self. Please keep in mind that these results represent only a phenomenological description without any interpretation.

The results represent total 33 completed surveys (13 operators and 20 suppliers). In total the survey had been passed out to 113 companies (15 to the consortium of STAFFER and 98 be-yond the consortium).

2.2.3.1 Business Structure

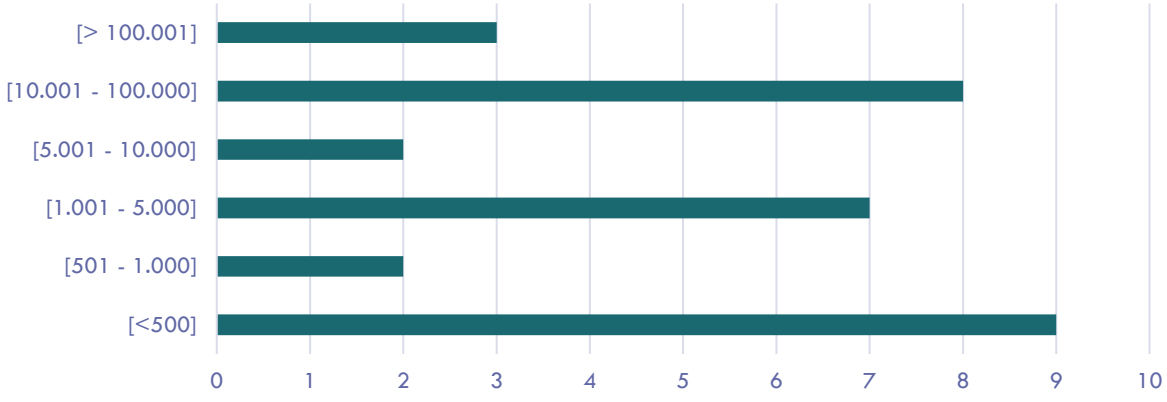
The first section collects information about the basics of the business structures of the participating Company.

(B1) In which business area does the company you represent operate in?



n = 33

(B2) How many employees does your company have?



n = 28

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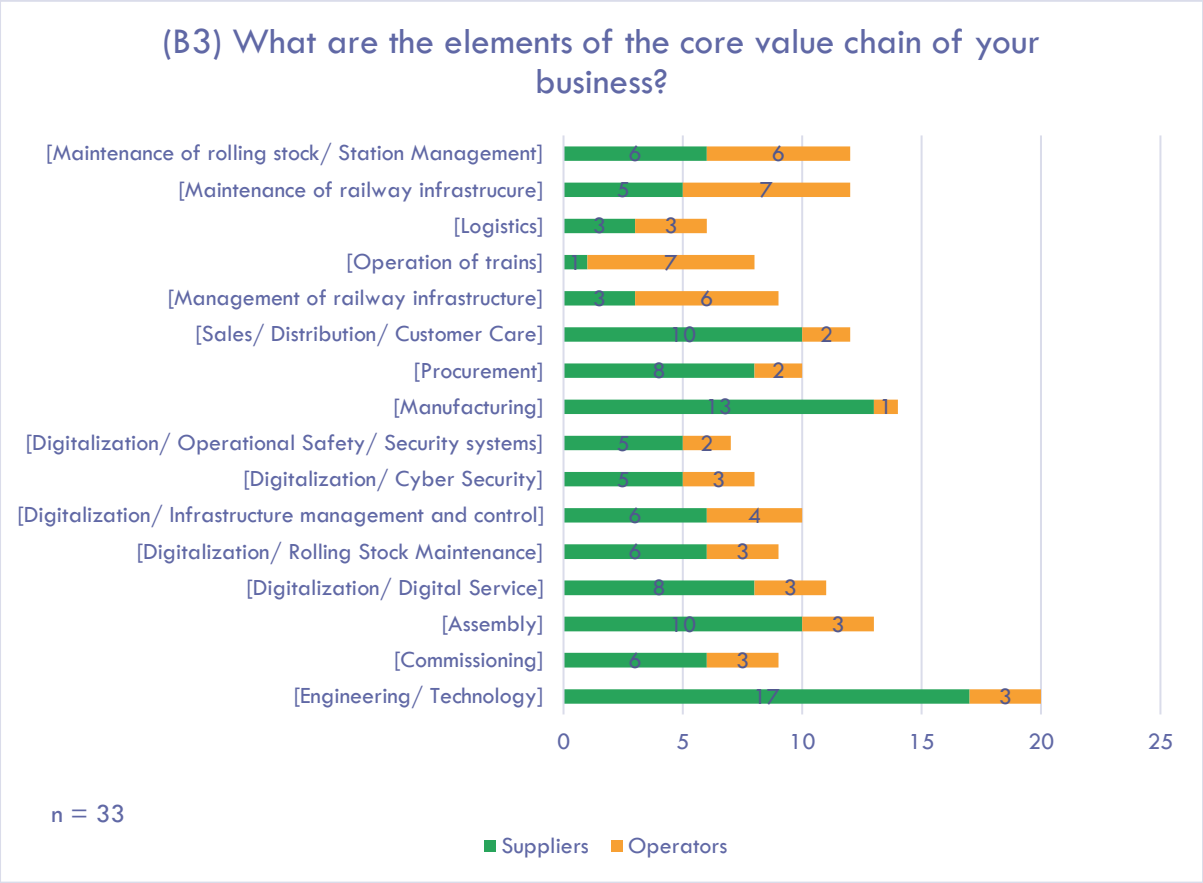


2.2.3.2 Technical and Structural Changes

(C) What kind of micro trends (changes/ disruptions) will impact the rail business of your company in the year to come?

In this section the micro trends, clustered in four blocks (macro trends), are subject of discussion. The blocks are arranged in: Social Changes; Technical Changes; Environment and Politics; Economics and Market. The evaluation proceeds the following scale:

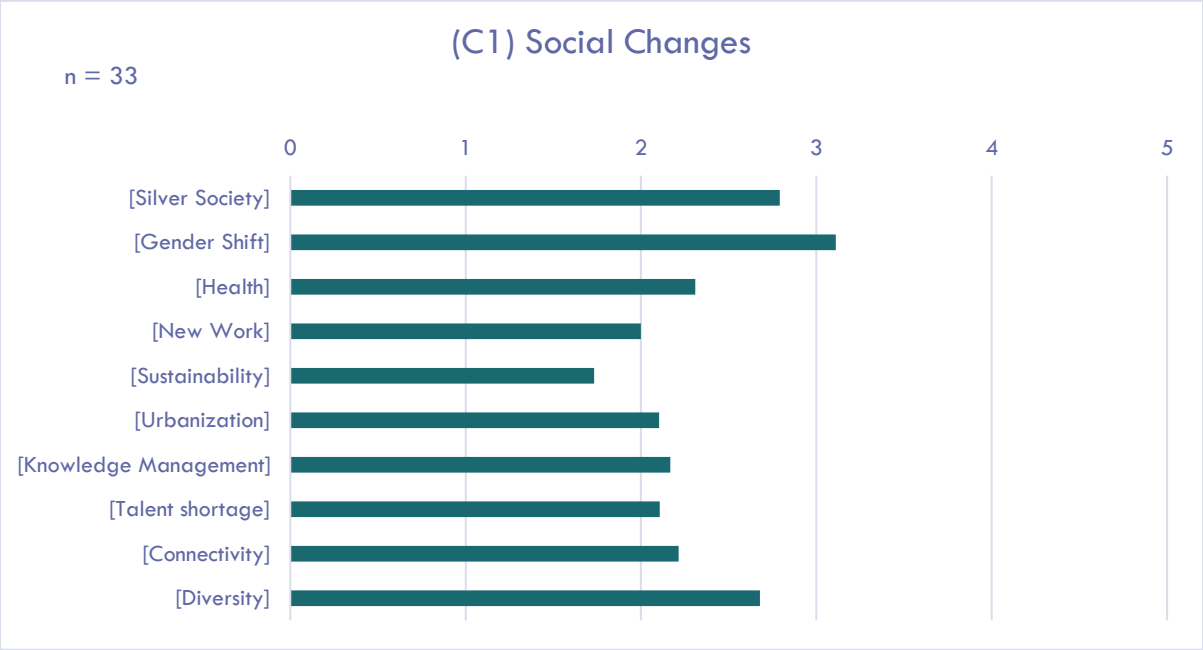
1 = extremely important 2 = very important 3 = quite important

4 = somewhat important 5 = unimportant

The following analysis of the results is split into the operator´s and supplier´s view – unfortunately, a true statistical comparison of the results between operators and suppliers was not possible because of the small statistical sample of n = 33.

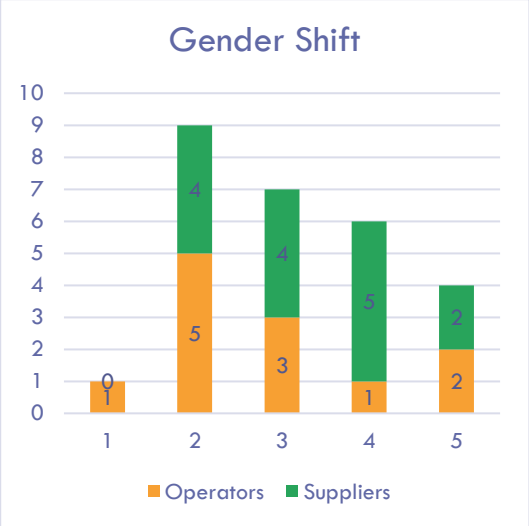
The first graphic will show an overall frequency distribution for every macro trend, the following ones are dealing with the single items of each block of macro trends.

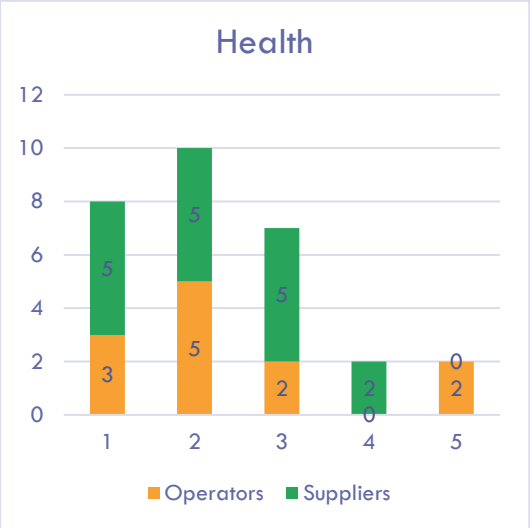
Social Changes

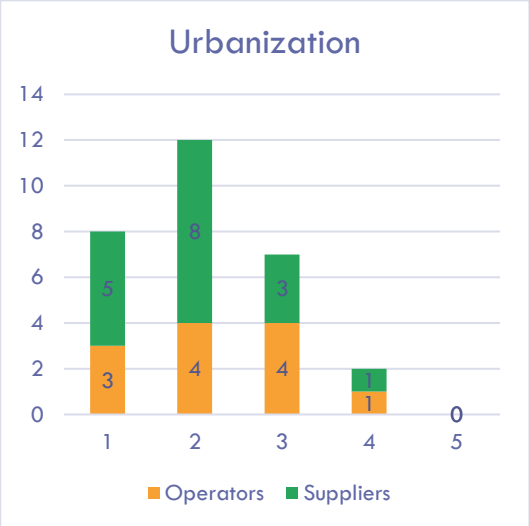


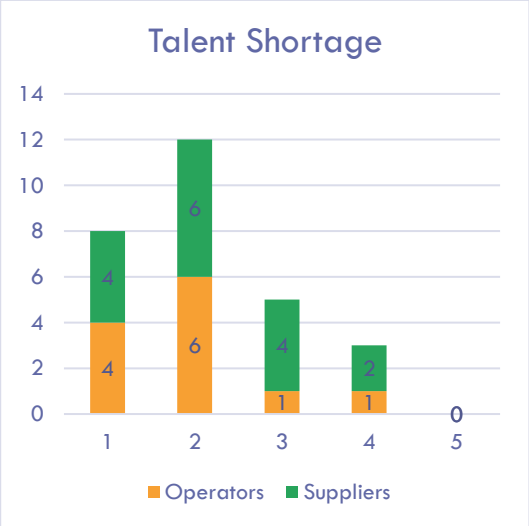
Please note the ranking: 1 = extremely important; 2 = very important; 3 = quite important

The lower the value shown in the graph the more important is the trends









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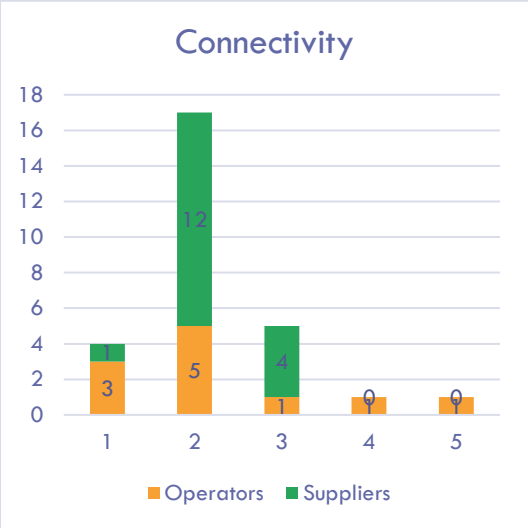
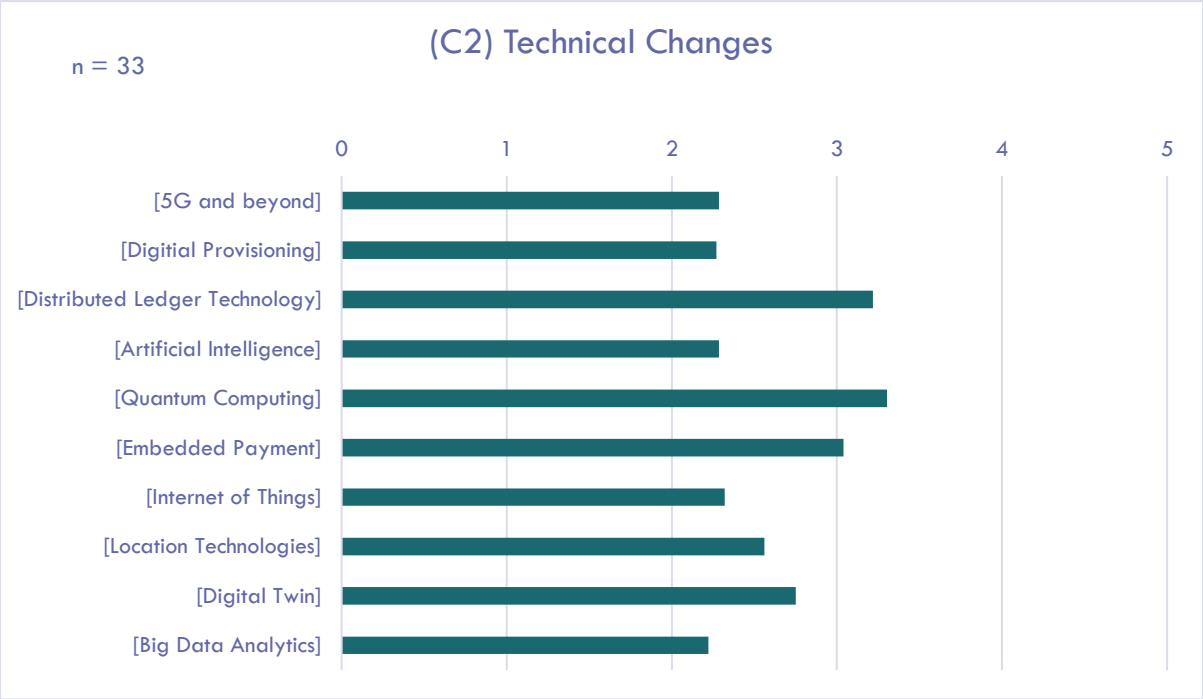
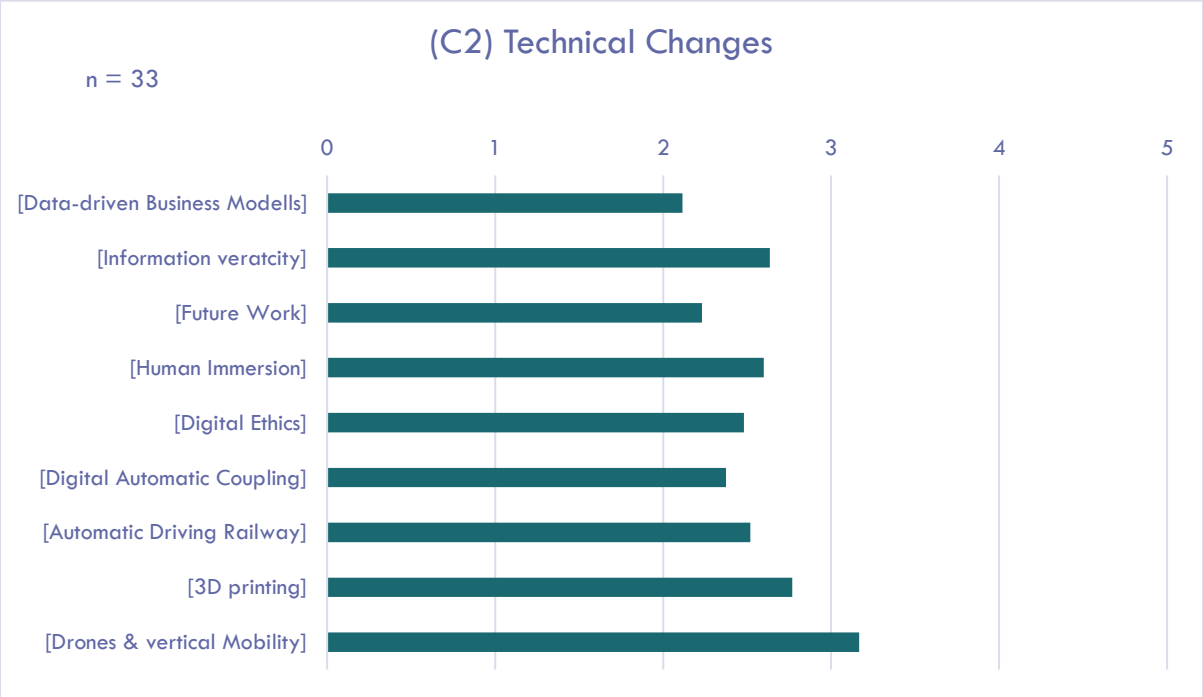


According to the frequency distributions of all items, the factors sustainability, new work, urbanization, and talent shortage are meant to be most important.

Due to the descriptive distribution of rating between operators and suppliers, it could be assumed, which item could play a more important role for each actor. Please keep in mind, that this is only a descriptive perspective, but no a representative graphic which allows to make conclusions between operators and suppliers.

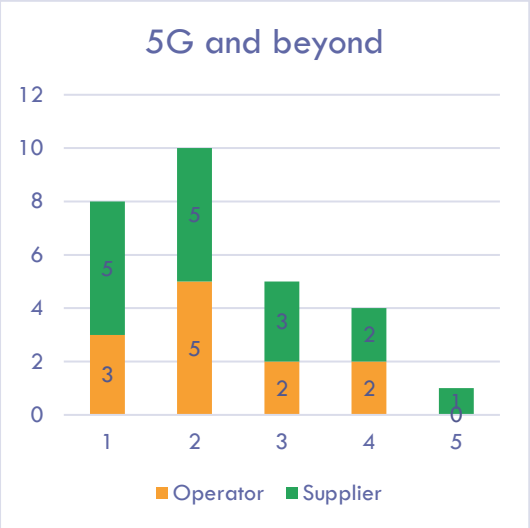
Technical Changes

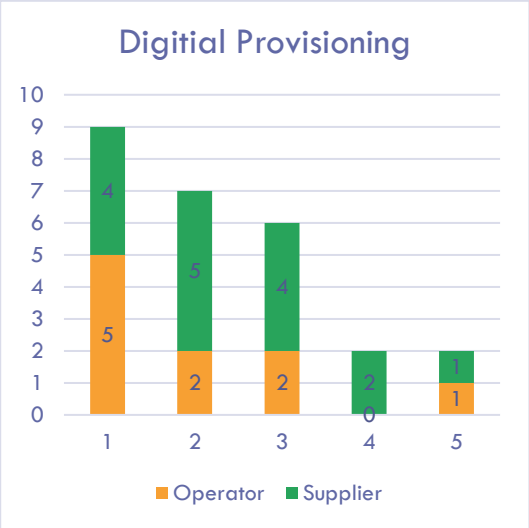


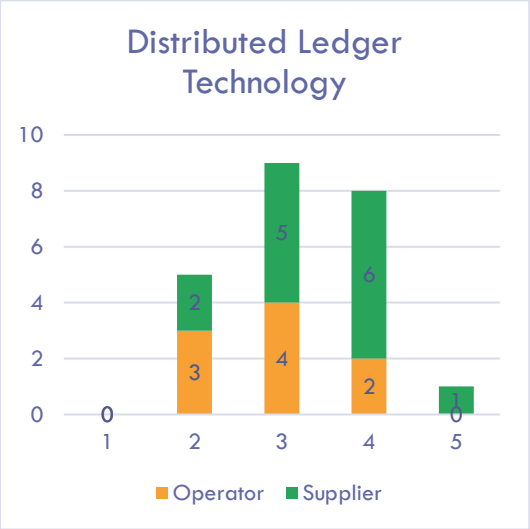


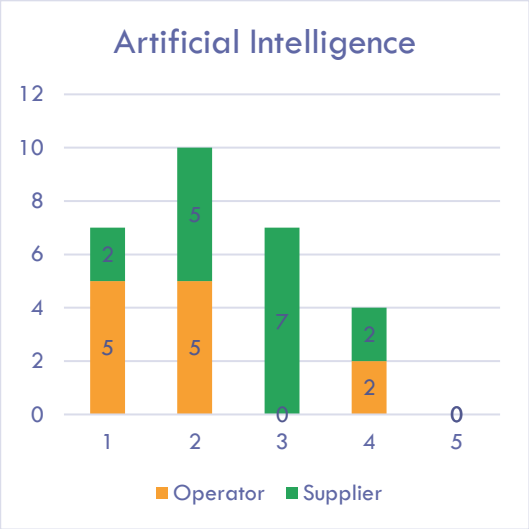
Please note the ranking: 1 = extremely important; 2 = very important; 3 = quite important

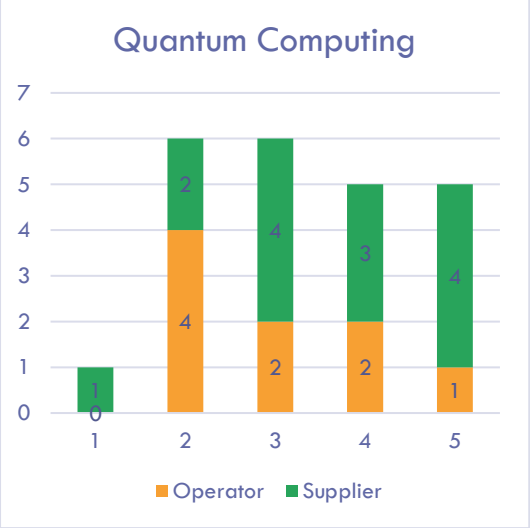
The lower the value shown in the graph the more important is the trends.

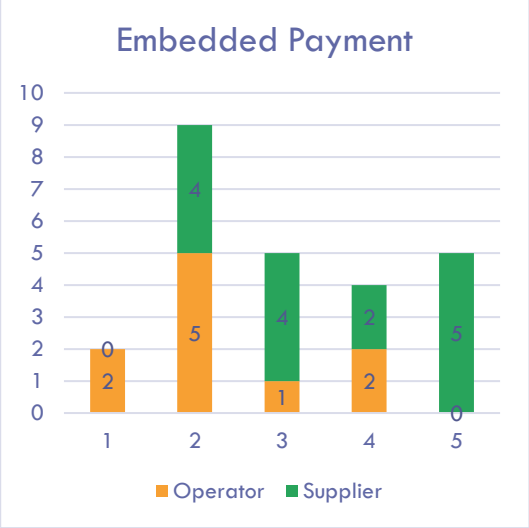












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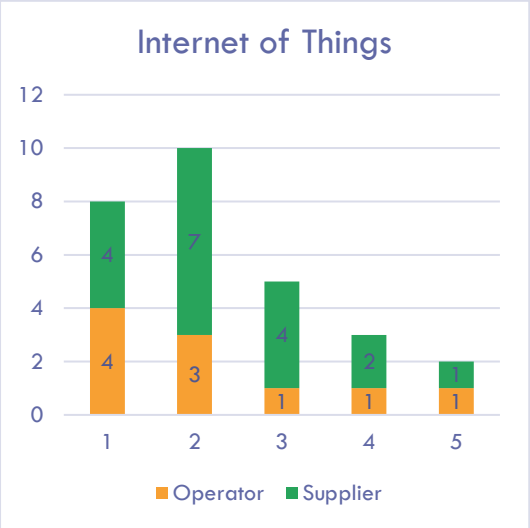
Internet of Things
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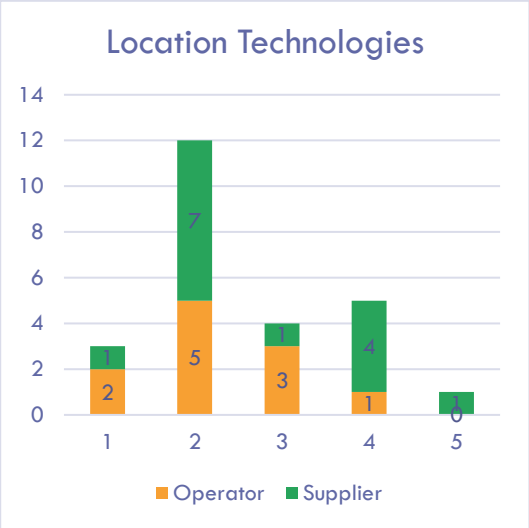
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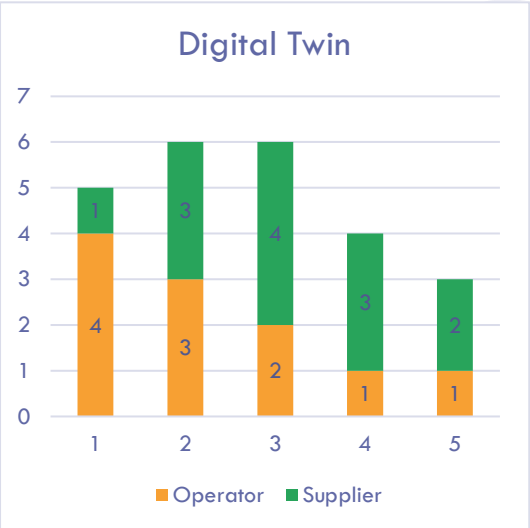
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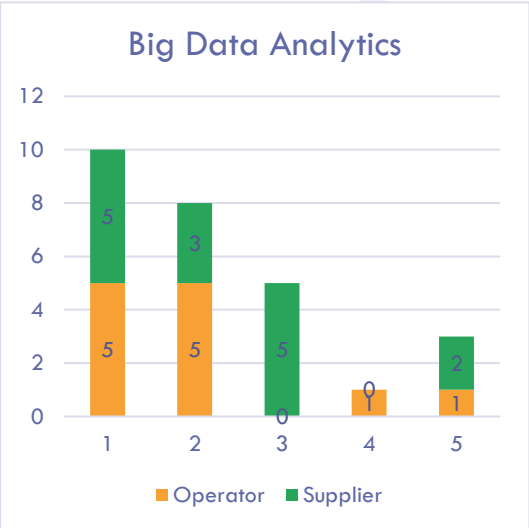
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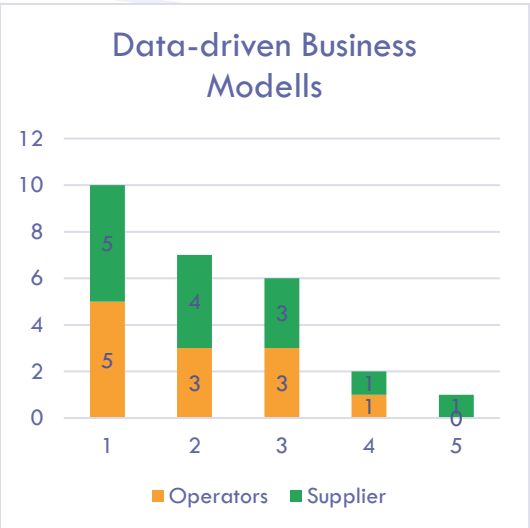
Data-driven Business Modells
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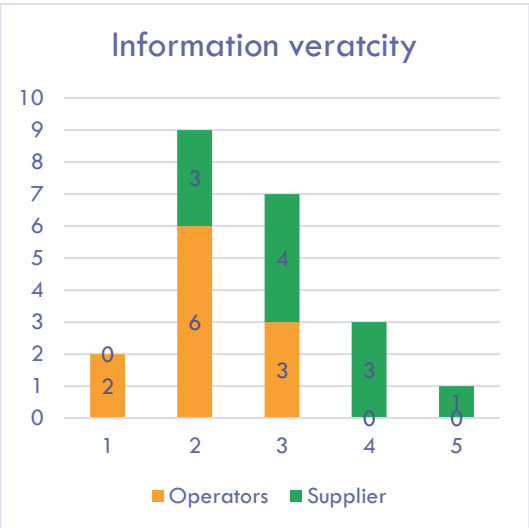
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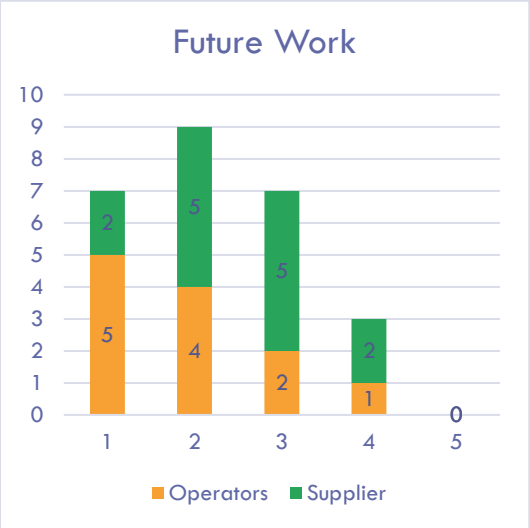

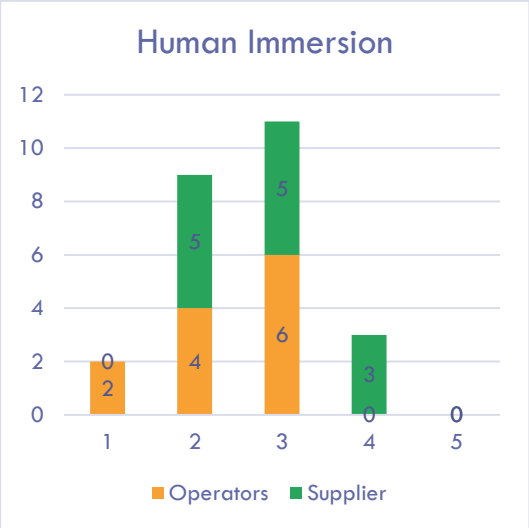

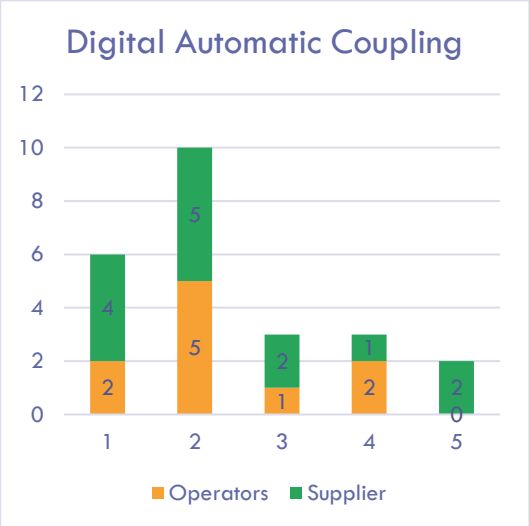

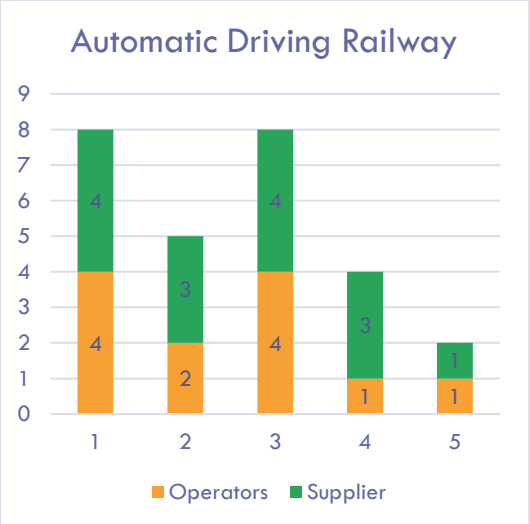

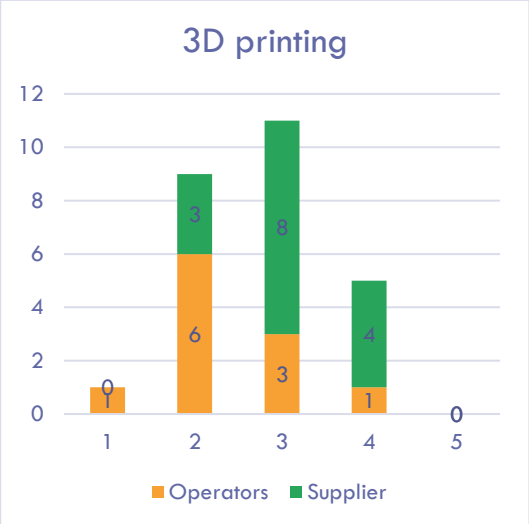

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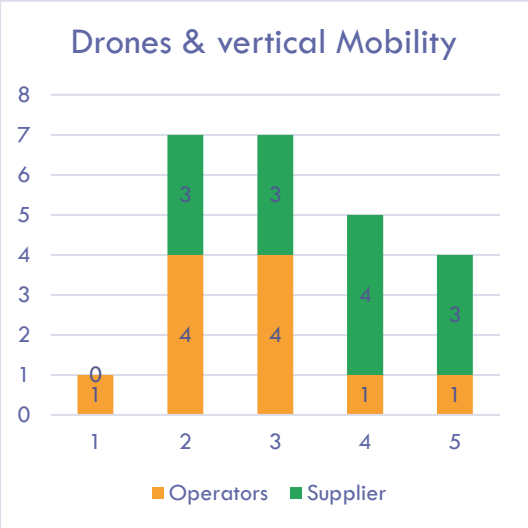
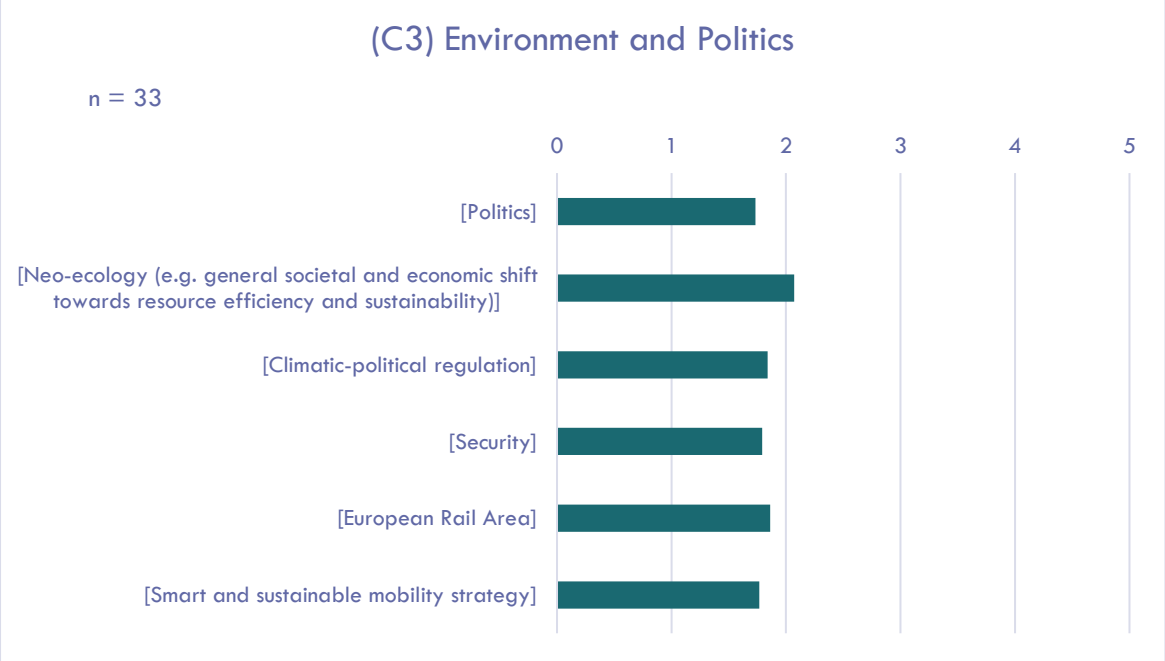


The overall graphic shows no item to be extremely important. All named items are rated between very and quite important.

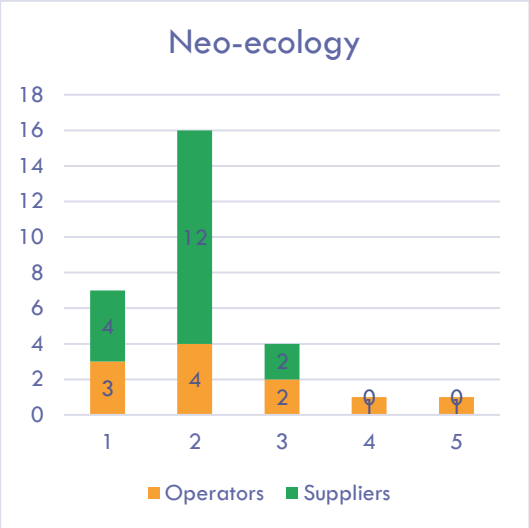
Environment and Politics

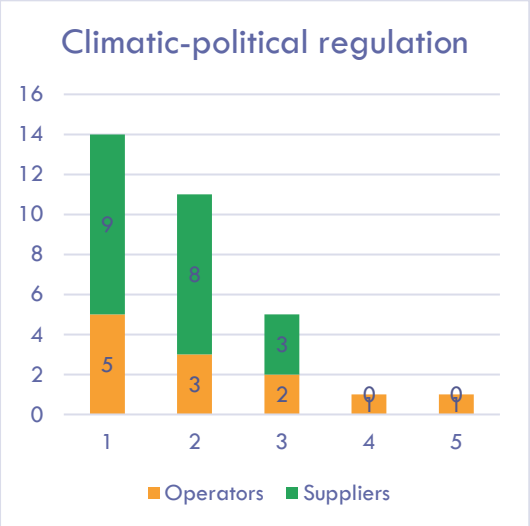


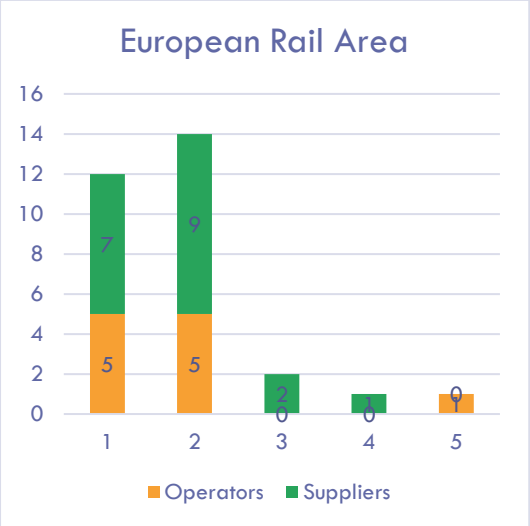
Please note the ranking: 1 = extremely important; 2 = very important; 3 = quite important

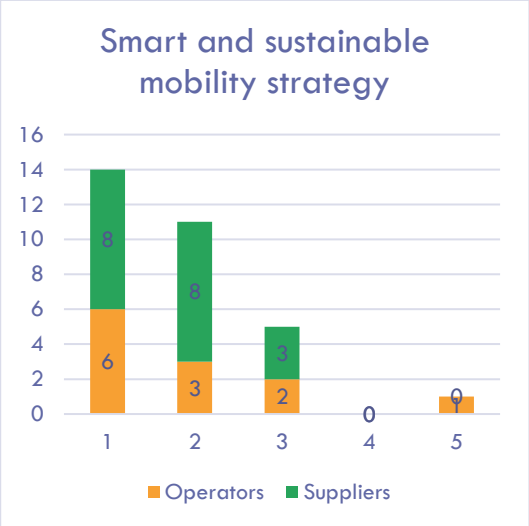
The lower the value shown in the graph the more important is the trends

In comparison to social and technical changes, all items of environment and politics are assumed to be extremely until very important.









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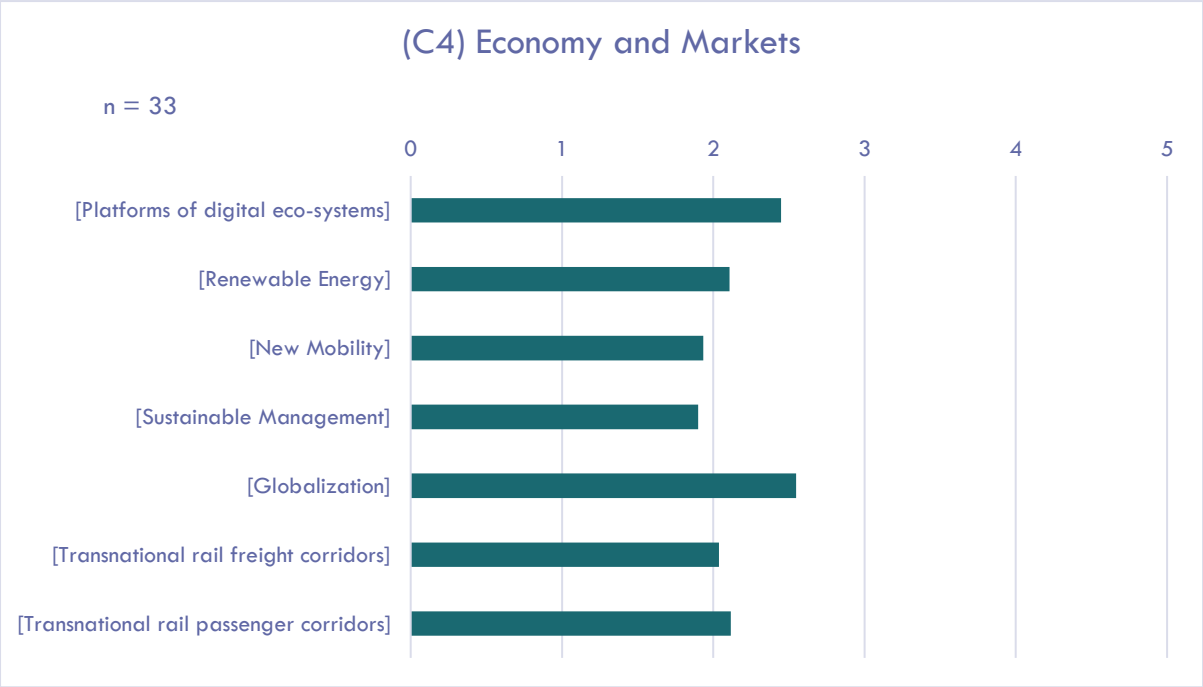
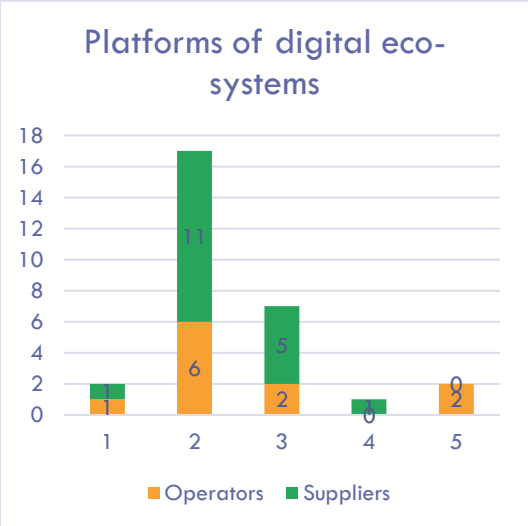
Economy and Markets

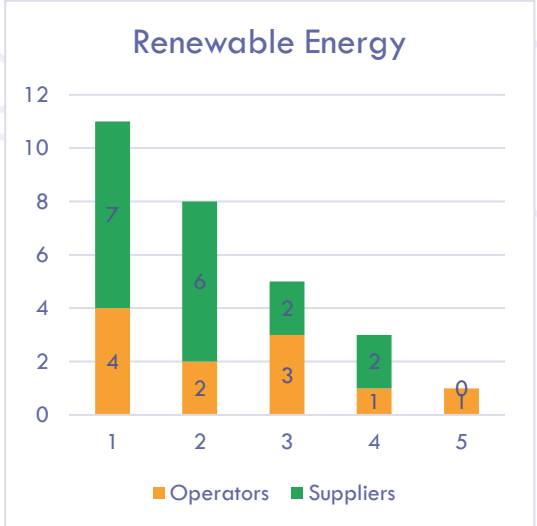


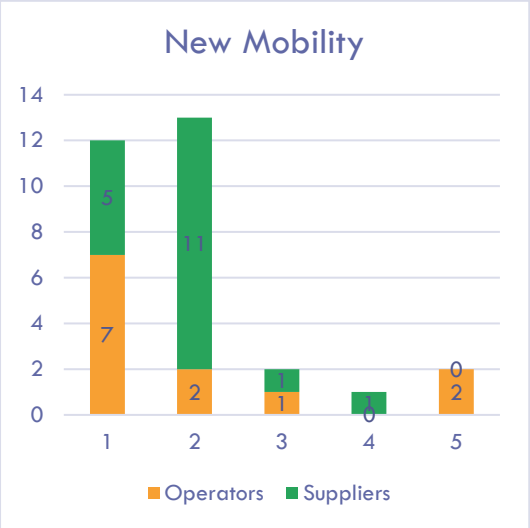
Please note the ranking: 1 = extremely important; 2 = very important; 3 = quite important

The lower the value shown in the graph the more important is the trends

Similar to environment and politics, almost all items are assumed to be very important.






New Mobility
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1
2
3
4
5
7
5
2
11
1
1
0
2
Operators
Suppliers


Sustainable Management
14
12
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8
6
4
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3
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5
4
8
3
8
3
3
0
1
Operators
Suppliers


Globalization
16
14
12
10
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6
4
2
0
1
2
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4
5
1
1
3
12
3
6
4
1
0
Operators
Suppliers


Transnational rail freight corridors
12
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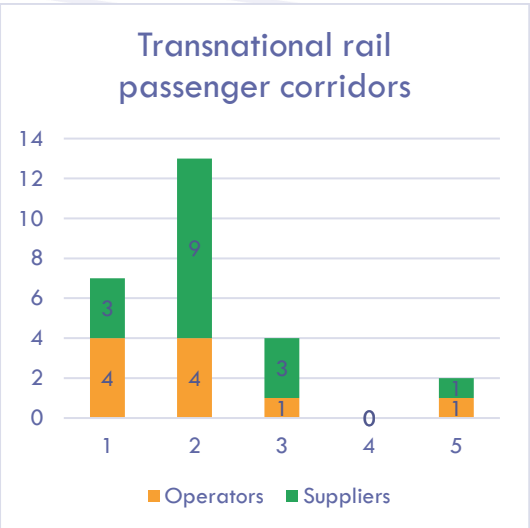
Operators
Suppliers


Transnational rail passenger corridors
14
12
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1
Operators
Suppliers

Open Question

(C5) Due to the business transformation in the rail industry some employee groups will need to change to different skill sets or new jobs. What kind of transitions of the current workforce do you expect in terms of:

- **requested competencies (to broaden the skill base)**
- **re-skilling (people learn a new job)**
- **up-skilling (employees to reach a different skill level)**
- **turn over (demographic changes force new hires)**

Please write down some concrete examples from your business. (Answers in open text format)

requested competencies (to broaden the skill base)

- Depending to the positions and jobs, appropriate required training is offered
- Decreasing level in electronics skills in new generations and anticipation of a significant shortage of qualified technicians in electronics
- Combination of re-skilling, up-skilling, soft skills and keeping traditional skills and their meaning; between the development of skills are forms of hybrid systems which need to be handled during transformations
- Facing new work systems, organizations, and models as well as data world and evolution of technologies expects appropriate handling

re-skilling (people learn a new job)

- Acquisition of new skills autonomously (e.g., tutorials)
- Managing new machinery and develop digital skills (cnc and maintenance operators)

up-skilling (employees to reach a different skill level)

- Training, seminars, professional literature, education at school
- Technicians need to reach a new skill level in mechatronics
- Conversion of cross-functional/ transversal functions to rail production jobs

turn over (demographic changes force new hires)

- Different approach to recruiting, benefits and salaries
- Challenge to transfer the knowledge between generation and the up-date of new skills
- Replacing high-level experts is seen as a challenge
- Forces to move toward globalized resources pool

2.3 Railway trends general considerations

From the analysis carried out, it can be concluded that social changes, technical changes, economic and environmental requirements affect the rail sector. Furthermore, it is evident that the mega- and micro-trends do not act separately, but affect each other and intensify each other's impact. For example, the use of new technologies leads on the one hand to a shortage of skilled workers with the necessary competences, but on the other hand, has a positive influence on the reduction of emissions in rail transport. Urbanization and environmental requirements support the use of sustainable, intelligent, networked mobility systems and are therefore linked to the further development of technology for production and operation approaches. The harmonization and standardization of technical systems and the creation of intelligent logistics management systems are essential to ensure intelligence logistic management systems.

3 TASK 1.2: DEVELOPMENT OF METHODOLOGY FOR ASSESSING AND MONITORING THE SKILL NEEDS

3.1 Analysis of the state of the art

Like any other industry the rail industry is also affected by the so called Fourth Industrial revolution. Technical and operational innovations transform products and services.

- Digitalization and automation impact the rail system.
- Business models are expanded from pure rail service to mobility service considering door to door.
- Sustainability is getting more importance.
- And newly Health and Safety is more becoming crucial as ever before. (Source: ERRAC)

Naming only these few major influences on the rail industry the impact on the workforce is already becoming clear. When business models, technology, products, and services are changing new skills from the labour market are required and need to be integrated into the working processes. Other traditional skill sets lose their importance and value. Companies must take severe decision either to invest or exchange – both very costly in time and money.

Staying relevant in the labour market becomes most crucial from an employee perspective and consequently, a constant work on skill and learning is becoming an imperative. From a company's perspective the key strategic direction focuses on the question how to make your organization and workforce resilient against these changes, how to adapt changes fast and in a highly

flexible and agile way. Re-skilling and up-skilling embedded in a proactive and strategic effort gains more and more importance the more the transformation need raises.

Re-skilling: as many occupational profiles loses their relevance for the company workers learn a completely new skill set or a new role to be able to contribute to a changed work environment

Up-Skilling: learning additional skills to enlarge own skill set to enhance the ability and advance towards changing work processes and task

Numerous studies and reports analyze and describe the impact of different trends on the industries, analyze the cost impact and recommend practices that might help to close the skill gap. All studies end with the strong appeal to become pro-active, tackle the skill gap from a strategic perspective and invest in re-skilling and up-skilling. So true on the one hand side, so general is this approach on the other hand side because it is exactly the point of struggle. How can companies do the projection from the current skill level today towards a strategic future skill set of tomorrow. This implies business decisions that have often not been taken as also the evolution of business is not straight and many companies probe different approaches for to see what works in the market and have future potential. Secondly, the approach is underestimating the impact of the hybrid state, when traditional technologies and new technologies are existing in parallel. Many companies still have a strong stand in the traditional portfolio and explore the opportunities of technologies, digitalization and automation and their market acceptance. For some businesses this means to extend the current portfolio of products and services instead of replacing traditional products and services by new technologies. The portfolios rather expand then change from one to the other. This affects in some way the skill capacity of companies that is rather be expanded and enriched instead of changed from one to the other. The skill capacity is rather to be enlarged and enriched in the overall to have the flexibility to manoeuvre according to business needs. Strategic direction and with this the projection of future needs and skills is not a black-white decision, it is marked by exploration, customer centric approaches and solution finding.

3.1.1 Assessment strategy

The evaluator got an assessment sheet (Table 4) with following instruction:

Table 4*"Dear xxx,*

The purpose of the assessment is at first to identify the assessment methodology for the evaluation/identification of employee's competences and skills. Some examples of assessment methodologies are given below: self-evaluation, company evaluation, Interviews, tests, peer-evaluation, audit. It is expected from WP1 to deliver a good overview of current assessment

methodology. We need to describe how companies can identify their current skill sets (by which methodologies) and how they can evaluate the gap towards the skills needed. This can be either done on a generic company level or it could be done more at an individual level. It is important for your analysis to collect the information on the specific assessment way that is described in the study/project/regulation or if you can derive and insights from the study that are helpful for our project.

For the assessment, please use one assessment sheet for each regulation/project (see Table 4*). Please follow the comments to assist you in completing the assessment.*

It is to be expected that each regulation/project may also contain further information relevant to the project and its work packages. For example, if a project mentions the methodology for skills development (WP1) or includes information on the development of study programmes (WP4), please list this under "Further project relevant information" (see Template_Sources_AsMeth). Please indicate the number of the relevant work package under "No.WP". I would also be very grateful if you could introduce some tags/key words in the field "Key words" that indicate the character of the information (e.g. development of study programmes, implementation of study programmes, student mobility, skills development, quality assurance and so on).

Please also note the following:

- ***if the respective regulation/project do not contain any information on assessment methodology or occupational profiles, please continue the evaluation according to "Further project relevant information";***
- ***If the respective regulation/project is not related to the railway sector, please check how the results and findings can be transferred to the STAFFER project.***

To make it easier for you to find the contents and results of the respective regulation/project, I have referred you to the relevant websites. However, this does not exclude further research, e.g. in Google, or contacting the persons responsible for the regulation/project (in case of insufficient information on the websites and other sources). If necessary, you can also contact the persons who entered this regulation/project in the WP1 database.

Please use project Glossary if some terms are not clear.

Please upload the completed assessment sheets by DD.MM.YY in MS Teams.

Thank you."

TABLE 4 ASSESSMENT SHEET FOR IDENTIFICATION OF ASSESSMENT METHODOLOGY

Source data		Contact data evaluator	
Title		Name, Surname	
		Email	
Type		Phone	
Assessment methodology			
Description			
Further project-relevant information			
Nr. WP		Key words	
Description			
Nr. WP		Key words	
Description			

In Task 1.2 34 different studies, initiatives, etc. have been analyzed during the discussion of the working team. The studies have been distributed among the partner to analyze and give a summary. Further project-relevant information was taken from these 14 evaluated literature sources given below:

Nr.	Source	Link
44	Carretero, S.: DigComp 2.0 - The Digital Competence Framework for Citizens, 2017	https://publications.jrc.ec.europa.eu/repository/handle/JRC101254#:~:text=The%20European%20Digital%20Competence%20Framework%20for%20Citizens,%20also,Member%20State%20levels.%20This%20document%20introduces%20DigComp%202.0.
		https://ec.europa.eu/social/BlobServlet?docId=15688&langId=en
45	OECD: Skills for Jobs database, 2017	https://www.oecd.org/els/emp/OECD%20Skills%20for%20Jobs%20Definitions.pdf
46	Dhondt, S.: Shift2Rail - Human Capital report series (project n°060.32480)- Bridging the Skills Gap for the Rail Sector: Analysis of Six Measures and Recommendations, 2019	https://shift2rail.org/wp-content/uploads/2019/07/Human-Capital-Report-Series_Bridging-the-skills-gap.pdf
47	Dhondt, S.: Shift2Rail - Human Capital report series (project n°060.32480) - Building Blocks for a New Skills Ecosystem in the Rail Sector: Assessment of the state of play in employment in the railway sector, 2019	https://shift2rail.org/wp-content/uploads/2019/07/Human-Capital-Report-Series_Building-block-for-new-skills-ecosystem.pdf

48	Dhondt, S.: Shift2Rail - Human Capital report series (project n°060.32480) - Employment and skills in the rail sector: Impact analysis of Shift2Rail's innovation programmes, 2019	https://shift2rail.org/wp-content/uploads/2019/07/Human-Capital-Report-Series_Impact-Analysis.pdf
49	Violi, V.: NetWBL - Needs and gaps report, 2015	www.wbl-toolkit.eu http://www.net-wbl.eu/wp-content/uploads/2015/03/NetWBL_NEEDS_GAPS-report_final.pdf
50	BUSINESS ACADEMY SOUTHWEST: InnovatiVET - Evidence Gathering Report, 2017	https://www.innovativet.eu/
51	European Commission: ECVET, European Credit system for Vocational Education and Training, 2009	https://ec.europa.eu/education/resources-and-tools/the-european-credit-system-for-vocational-education-and-training-ecvet_it
52	UNESCO: ISCED, International Standard Classification of Education, 2011	http://uis.unesco.org/en/topic/international-standard-classification-education-isced
53	UIC: Talent & expertise development at UIC, 2019	https://uic.org/IMG/pdf/uic_talent_expertise_development_2019.pdf
54	European Commission: A NEW SKILLS AGENDA FOR EUROPE: Working together to strengthen human capital, employability, and competitiveness, 2016	https://ec.europa.eu/social/main.jsp?catId=1223
55	European Commission: EUROPE ON THE MOVE - An agenda for a socially fair transition towards clean, competitive, and connected mobility for all, 2017	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52017DC0283

56	European Parliament: Competitiveness of the European rail supply industry, 2015	https://www.europarl.europa.eu/doceo/document/TA-8-2016-0280_EN.html
57	European Commission: Vocational mobility in Europe - analysing provision, take-up, and impact, 2019	https://op.europa.eu/en/publication-detail/-/publication/88f66119-d906-11e9-9c4e-01aa75ed71a1/language-en

Especially report 46 (Shift2Rail – Human Capital report series) provides interesting information and different examples about skill assessment and its application. In the UK, the "SkillsID database" was developed by NSARE in 2013 to provide employees with the possibility to follow more closely their own skill development – at its core is a full list of all relevant qualifications, skills, and competencies, which is accessible by the employers themselves and their sponsors/ employers, but still hidden to others. Another approach has been adopted in Germany in which previous diploma or certificates are not anymore, the criterion to be selected for job interviews. With such a measure, everyone is allowed to apply for a job. From 2014 on, students can fill out an online test if they want to start a vocational training or a dual study with DB ('Neues Bewerberverfahren bei der Deutschen Bahn' – 'New Application Process at Deutsche Bahn'). Thus, the DB eliminates the preselection of school grades. Strengths and abilities of the individual take center stage, according to the group. All applicants will be invited without pre-selection. These approaches help to open up the labour market supply.

Report 46 also takes a closer look to the Role Based Competency (RBC) methodology, a new method developed by Network Rail Training (NRT) to identify required skills in roles by re-verse engineering use of skills and competences in practice. RBC helps to break up tasks into components and identifies trainings needed for these components.

The report gives two concrete company examples: DB Training and SNCF have developed methods to identify the skill level of employees. SNCF has a test to identify digital skills. SNCF is currently experimenting with digital matching tools to evaluate the competences of its employees. They need to report their motivations for tasks, benefit from personality tests, etc., all information required to build a personal profile. This profile is used to help compare the abilities of employees with their current job requirements, but also with other job profiles. The profiles help the employee to start thinking about their career path and the development of

their competences. The matching tool uses algorithms developed by suppliers. Trade unions have been engaged in the development of these tools. The whole tooling is supportive of the employability of SNCF's workers.

DB Training has developed several sets of questions that can be used to explore which skills need an up-date and also helps to connect the employee to training components. To find the right training, DB Training has invented a specific 'fitness test' that helps identify skill gaps. During this procedure, the employee can conduct the test and receive a personal feedback, with no other feedback to anyone (also not to the manager). An employee needs to complete 40-50 questions (randomized). The test indicates which gap exists and indicates which courses help to close the gap. The training can be long, short, connected to certification, etc. In 80% of the training, a blended training (face-to-face, digital) approach is used. This whole approach allows that the training selection only focuses to what really has to be trained and is not affected by not needed topics.

Many studies address how the rail industry or other can become more attractive to talents and bring more attention towards a rail industry (e.g. Back on Track - gearing up to meet the increased demand for talent in the rail industry) or focus on specific topics like gender distribution in the rail industry. The issue of skills is directly connected with learning and the importance of investment in learning is pointed out. Furthermore, requirements for specific skill are described. Other studies focus on specific trends like interoperability (Vera Study) and its consequence on skill development in general.

However, for further advice on which methodologies on skill development could be applied the studies have not been sufficient and need to be underpinned with more scientific literature from psychology or human resource faculties. Another method used in the project was the sur-vey. The findings from the survey are presented in the following chapter.

3.1.2 Further project-relevant information

Some studies/initiatives included further information relevant to the project and its work packages. This information is presented below for each WP separately. The numbers given in brackets refer to the numbers of literature sources listed in chapter 3.1.1.

WP 2, WP 3

- The OECD Skills for Jobs Database provides country-level (and subnational) information on the alignment between the demand and supply of a wide range of dimensions, including cognitive, social, and physical skills disaggregated into around 150 job-specific Knowledge areas, Skills and Abilities and for more than 40 OECD countries and

emerging economies. Among the abilities, one can find finger dexterity, memorization abilities or inductive reasoning. Programming, negotiation, writing, and time management belong to the "skills". Along the knowledge areas, one can find psychology, sales and marketing, fine arts or education, and training. Each ability, skill or knowledge area is succinctly described (Nr. 45).

- the OECD Skills for Jobs indicators exploit time series values for the above-mentioned sub-indicators across 33 occupational groups (ISCO-08 2digit). For each indicator and occupation, the time series is compared to the corresponding economy-wide trend to detect whether each specific occupational group is growing/shrinking with respect to the rest of the economy and by how much. This strategy allows identifying whether jobs in each occupational group are hard-to-fill (i.e. in shortage, where firms struggle to find workers with adequate skills) or not (i.e. in surplus, whereby skills are easy to find and no recruitment bottlenecks emerge) (Nr. 45).
- Report Nr. 47 presents the dynamic skills ecosystem approach:
    - this approach allows making us to understand that the possible skills gap in the future requires much more than a static equilibrium perspective. A better solution is to build more resilience into the rail skills system. Younger (and older) workers need to have the ability to change jobs if needed, or at least be able to adapt to new tasks in the future. The discussion with the partners in the rail organizations has given the perspective that to achieve technological change in the future, a broad set of old and new skills will be required at the same time, and possibly for longer periods of time. This may require that young workers need to get acquainted with old technologies too.
    - UK example Network Rail for skills-monitoring and use: in the UK, a lot of experimentation has taken place to support or connect to the development of methods and methodologies to allow individualization and personalization of training and development. A first example is the SkillsID database. This provides employees with the possibility to follow more closely their skill development and make their progress clearer to new employers. NR has supported this initiative. At its core is a full list of all relevant qualifications, skills, and competences, accessible by the individual and their sponsor/employer, but hidden to others. A second example is found in the Skills Swap schemes: employees are offered the possibility to enlarge their skill set by working in different settings with other companies. Apprentices from one company and another will be swapping places throughout a month as part of a cross-organizational skills exchange.

- Report Nr. 47:
  - Future Health and Safety Practices in Rail Companies: many jobs in the rail sector are still confronted with high physical and mental job demands. The challenge for rail companies is to speed up the improvement of the ambient working environment.
  - Transfer of Personnel: different companies present their view for the transfer of personnel, both for attracting new entrants or reintegration.
- Report Nr. 48:
  - Four directions in (conflicting) job demands are visible in the future: more standardization of work, less standardization of work/more demands, less psycho-social risks, and more Information and Communication Technology (ICT) support. The conflicting demands in the new working environment result in different skill impacts:
    - At the level of task environment, there is a shift towards more use of ICT, systems, materials and production processes (ICT, ICT tool usage, system specifics, materials use, production process), but also tendencies to simplification of tasks and even redundancy of jobs;
    - At the level of Science, Technology, Engineering and Mathematics (STEM), social, communicative, and organizational skills, most of the changes are related to STEM-skills needed in the future. The different IP-programmes demand different technical knowledge to be developed. Next to STEM, there are rising social demands, communicative demands, and demands on organizational capabilities. All demands are rising in all jobs, except for train drivers. For each of the job categories, the required competencies (or abilities) needed in the future to deal with these technologies have been judged separately. 'Common sense logic' dictates that operations and management have limited ICT-knowledge, but a lot of (traditional) operational knowledge. Engineers should be up to date, whatever the technology may be.
  - Required (new) STEM-knowledge areas for rail professionals: Information technology, Communication technology, Automation, Management systems
  - The report goes on with the analysis of changes in eight major job categories, with major possible skill changes and an overview of the impact of the changes at the level of the rail value chain.

- Report Nr. 54 provides the following information:
    - Key Competences Framework: Recommendation on Key Competences for Lifelong Learning.
    - Digital skills and jobs coalition tackles the need for digital skills of four broad groups: Digital skills for all, Digital skills for the labour force, Digital skills for ICT professionals, Digital skills in education.
    - European Qualifications Framework promotes the comparability of qualifications between the countries: European Quality Assurance Reference Framework for Vocational Education and Training (EQAVET) and the European Credit System for Vocational Education and Training (ECVET).
    - Skills Profile Tool for Third Country Nationals to help to map the skills, qualifications, and work experiences of the third-country nationals.
    - Europa Framework for documenting and sharing information on skills and qualifications.
- Report Nr. 55:
    - identifies the need for a skill change in the mobility sector, due to technological innovation and the digital revolution. The workforce reskilling is required in the medium to long-term, focusing on IT skills and green skills. This trend needs to be anticipated and accompanied by a stronger social dialogue as well as support mechanisms to help people make the best of the new opportunities.
    - defines the main trends that have to be considered in the definition of the study program contents. In particular, the following topics are mentioned: interoperability and cross-border infrastructure, multimodal travel information services, combined transport services, user's behavior and demand patterns, energy efficiency and low-emission mobility, accessibility and inclusiveness, digitalization, connectivity and 5G technology, cooperative intelligent transport systems, modern mobility infrastructure, and maintenance.

WP 3

- Report Nr. 56 - the Parliament resolution, mentions the main topics for the rail supply industry: manufacture of locomotives and rolling stock, and track, electrification, signaling and telecommunication equipment, as well as maintenance and parts services. Three main focuses are identified:

- The first focus is digitalization, automation, sensors and monitoring tools, interoperability, for example through ERTMS/ETCS, use of space technologies, use of big data, and cybersecurity.
- The second focus is resource- and energy-efficiency, for instance through more lightweight materials and alternative fuels.
- A third focus is on advancements that make rail transport more attractive and accepted (e.g. improved reliability and noise reduction, seamless multimodal transport, integrated ticketing).

WP 4

- Report Nr. 47 presents some examples for virtual learning.
- Report Nr. 49 provides the following information:
  - professional mentoring of students is highly important (guidance through professional environment/career paths) – p.16
  - teachers and professionals should regularly change positions to better adapt to student's needs (teachers 2 work, professionals 2 teach) – p.15
  - for SME possibility to "share" VET students to offer a multitude of perspectives and tasks; for big companies this translates to a multitude of departments and subsidiaries/positions for professional trainings and internships – p.7
  - educational partners and industry should develop (future oriented) curricula together – p. 15.
- Report Nr. 54:
  - defines the approaches to modernise VET and Higher education:
  - provide a learning offer, responding to the specific needs of individuals and of local labour markets.
  - provide opportunities to have skills validated and recognised.
  - promote work-based learning and business-education partnerships.
  - support learners' mobility.
  - focus on Digital and Green skills.
- Project Nr. 53:
  - Set criteria for excellence of education and training centers and programmes based on international best practice and benchmarking
  - Implement the recommendations of VERA (Virtual European Rail Academy) study and other international studies.

- Report Nr. 51:
  - ECVET was designed as one of a series of European instruments each targeting improvement in learning recognition and transparency.
  - Provides a framework for the assessment, validation, and recognition of learning outcomes, alongside a series of common tools and instruments able to support quality in mobility.
  - Promotes the integration of mobility into existing learning pathways.
  - Supports the valorization of key competences (such as foreign language skills or intercultural competence) alongside those that are more technically - or vocationally - oriented.
  - Contributes to the development of a common language for use by different VET stakeholders and promotes mutual trust within the wider VET community.
- The International Standard Classification of Education (ISCED 2011) provides a comprehensive framework for organizing education programmes and qualification by applying uniform and internationally agreed-upon definitions to facilitate comparisons of education systems across countries. For any further information, the following resources might be of interest: ISCED Mappings, ISCED 2011 Operational Manual, ISCED Fields of Education and Training 2013 (Nr. 9).

WP 6

- The study Nr. 57 identified more than 100 VET mobility programmes/schemes implemented at a national/regional level or led by enterprises.

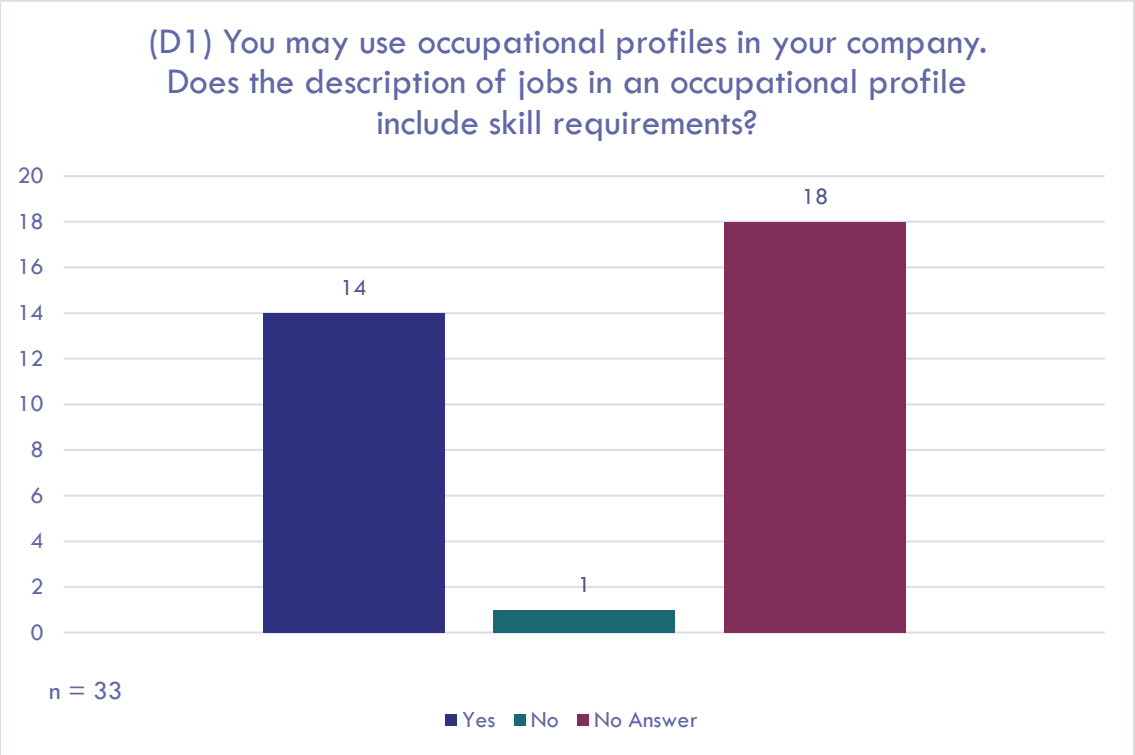
WP 7

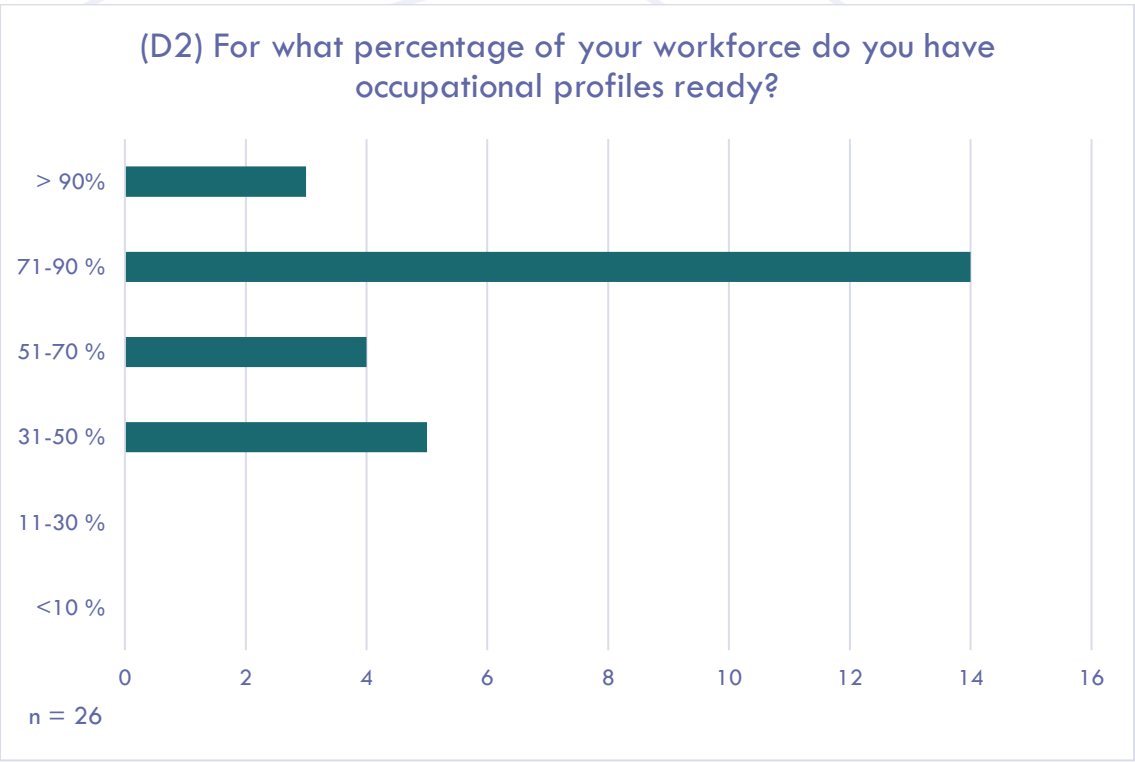
- Project Nr. 53 makes railways attractive for the younger generation and develop young rail professionals through networking, exchanges, and contests.

3.1.3 Survey

3.1.3.1 Occupational Profiles

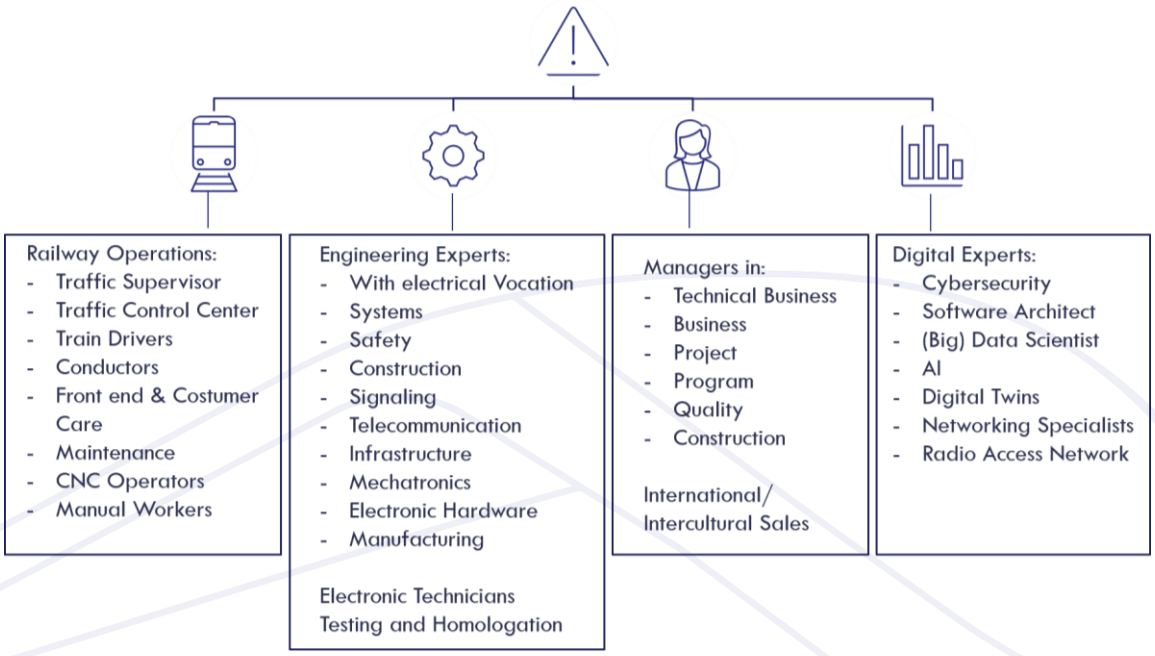
Occupational Profiles are describing job, its tasks, skills, and competencies. This section deals with occupational profiles in companies.


(D1) You may use occupational profiles in your company. Does the description of jobs in an occupational profile include skill requirements?
20
18
16
14
12
10
8
6
4
2
0
14
1
18
n = 33
Yes
No
No Answer


(D2) For what percentage of your workforce do you have occupational profiles ready?
> 90%
71-90 %
51-70 %
31-50 %
11-30 %
<10 %
0
2
4
6
8
10
12
14
16
n = 26

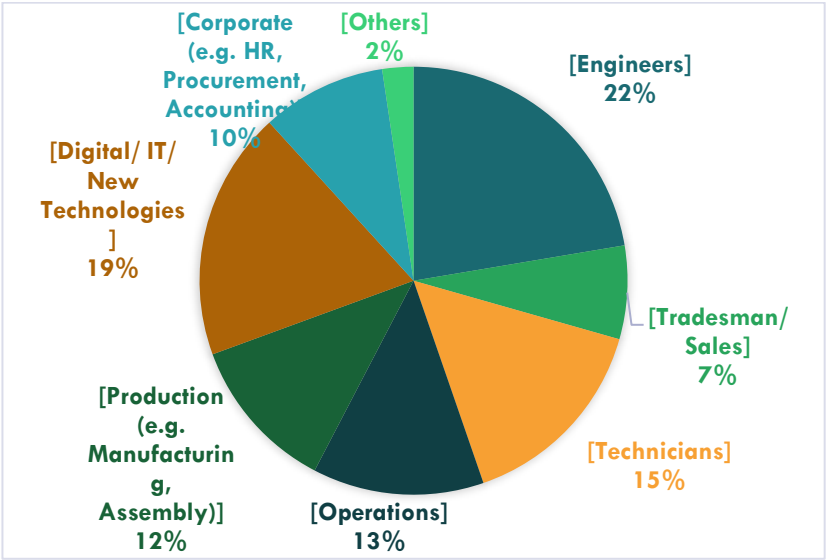
(D3) Which three occupational profiles (or more) would you consider to be critical/ demanding for your organization or business area in terms of required skills?

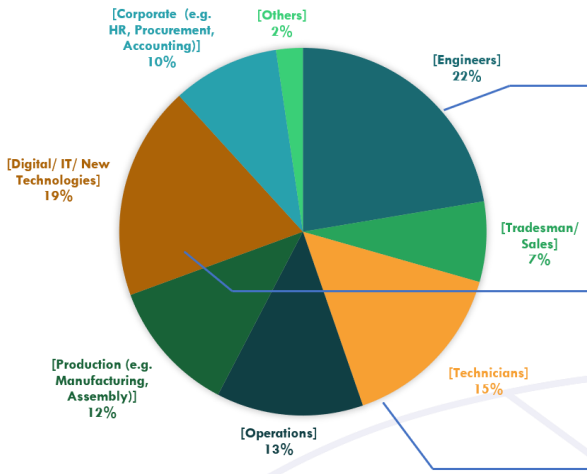
This question was asked as an open question. By analyzing the answers, the following groups have been identified:



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

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

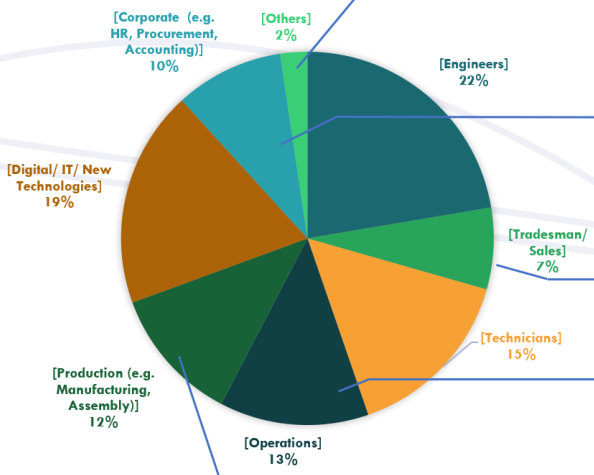




Engineers:
- New digital tools
- Adaption to changing situations and solutions
- Interfaces between systems
- Shift to digitalization and autonomous trains
- Higher rail complexity level and stringency
- Keeping up with the technological evolution

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

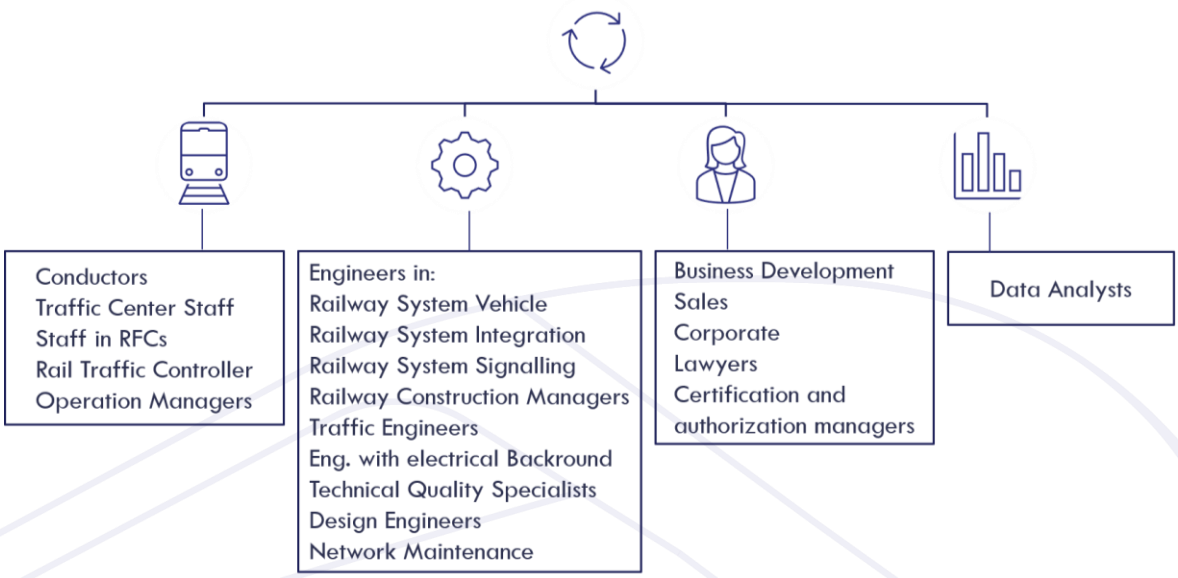
Operations:
- Urgent need for Adaption of Digital Skills
- Language Skills

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

Co-funded by the Erasmus+ Programme of the European Union

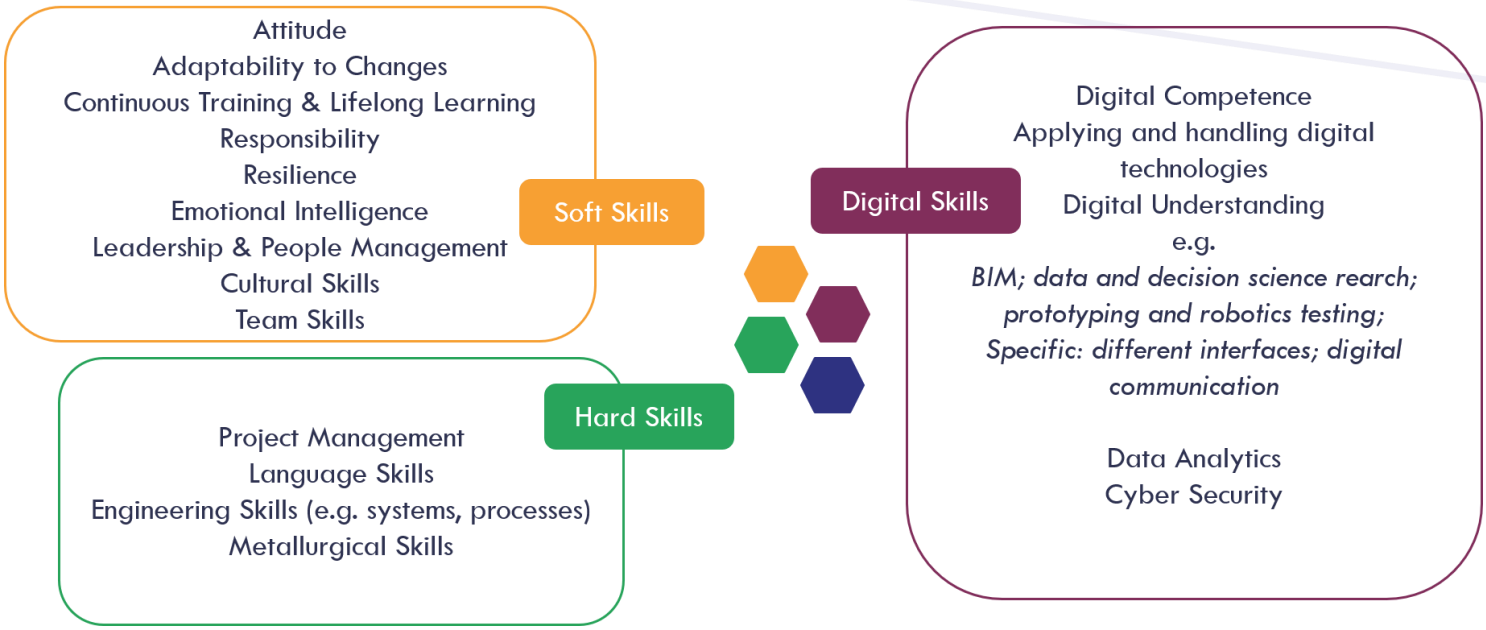
(D5) Which occupational profiles within your organization are or will be affected by the increase in interoperability and the Single European Railway Area?

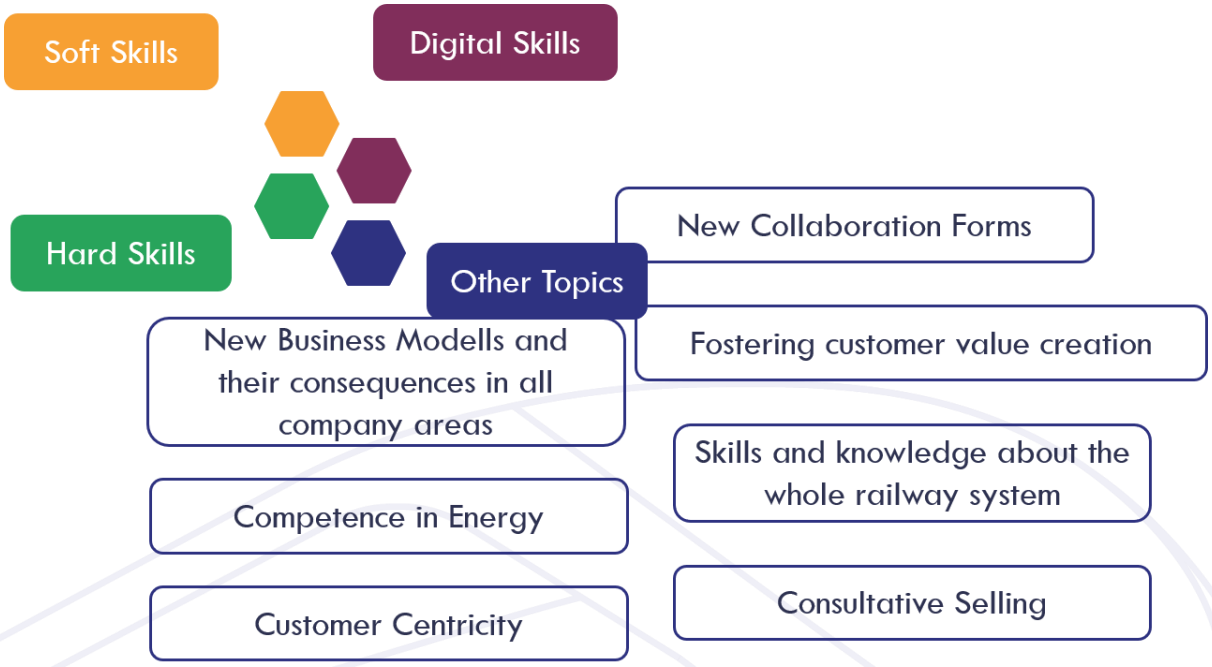
This question was asked as an open question. By analysing the answers, the following groups have been identified:



(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 question was asked as an open question. By analysing the answers, it has been tried to order the answers in the following clusters:

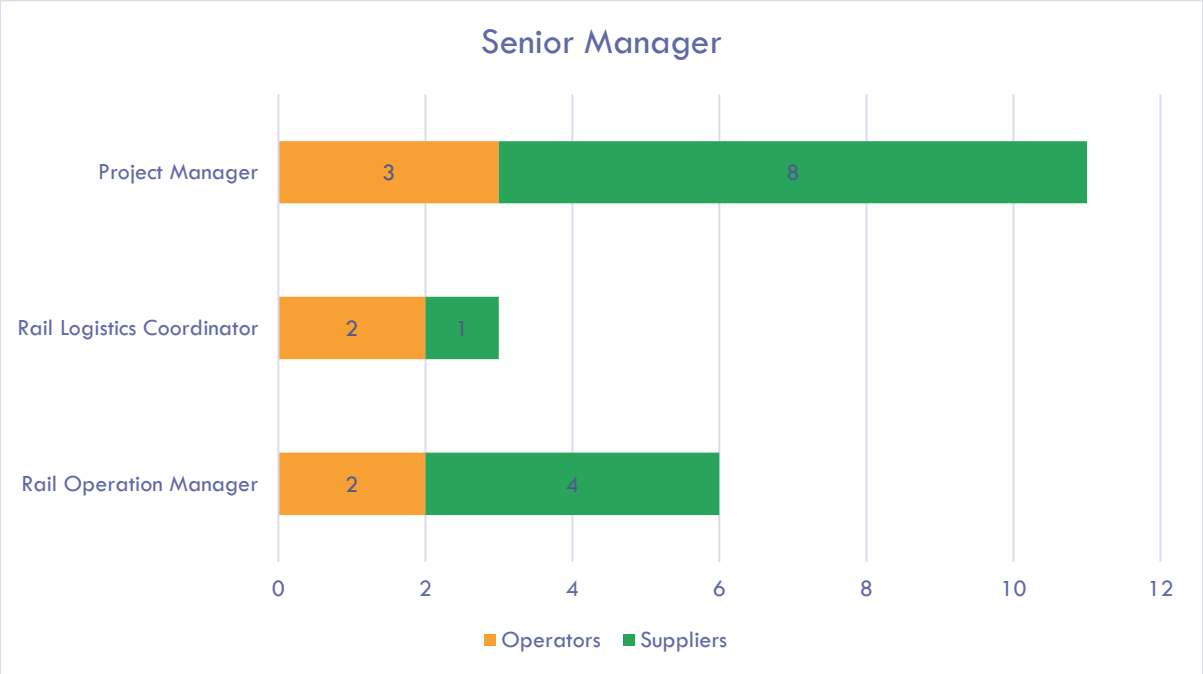


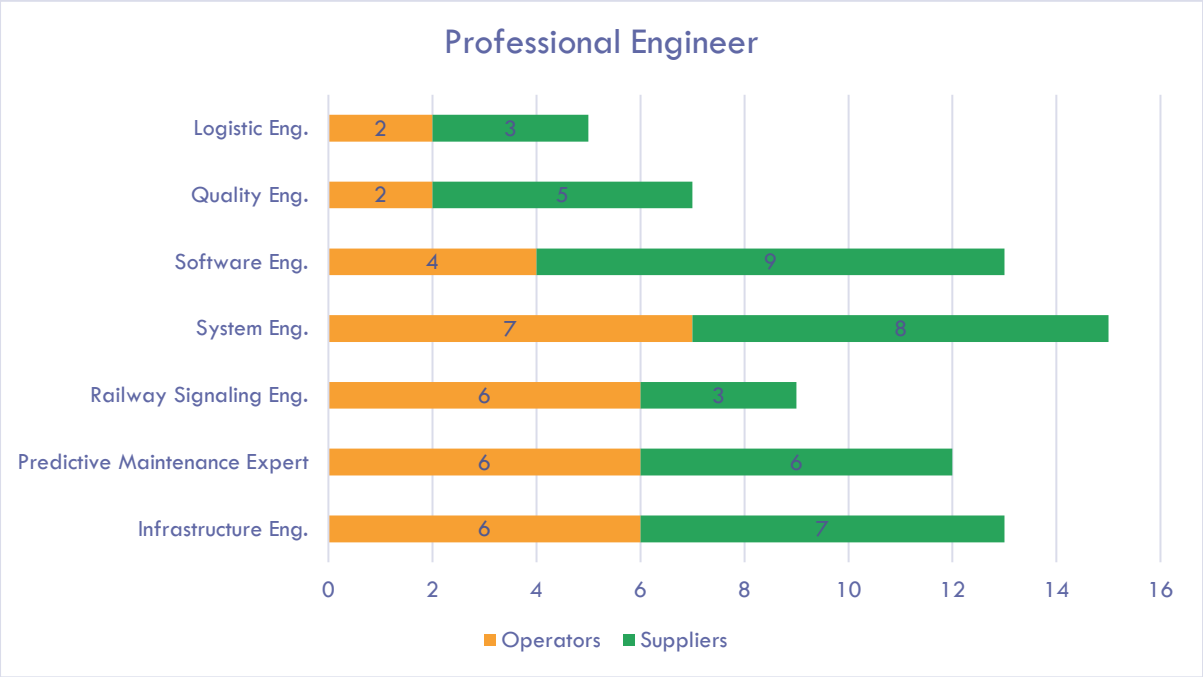


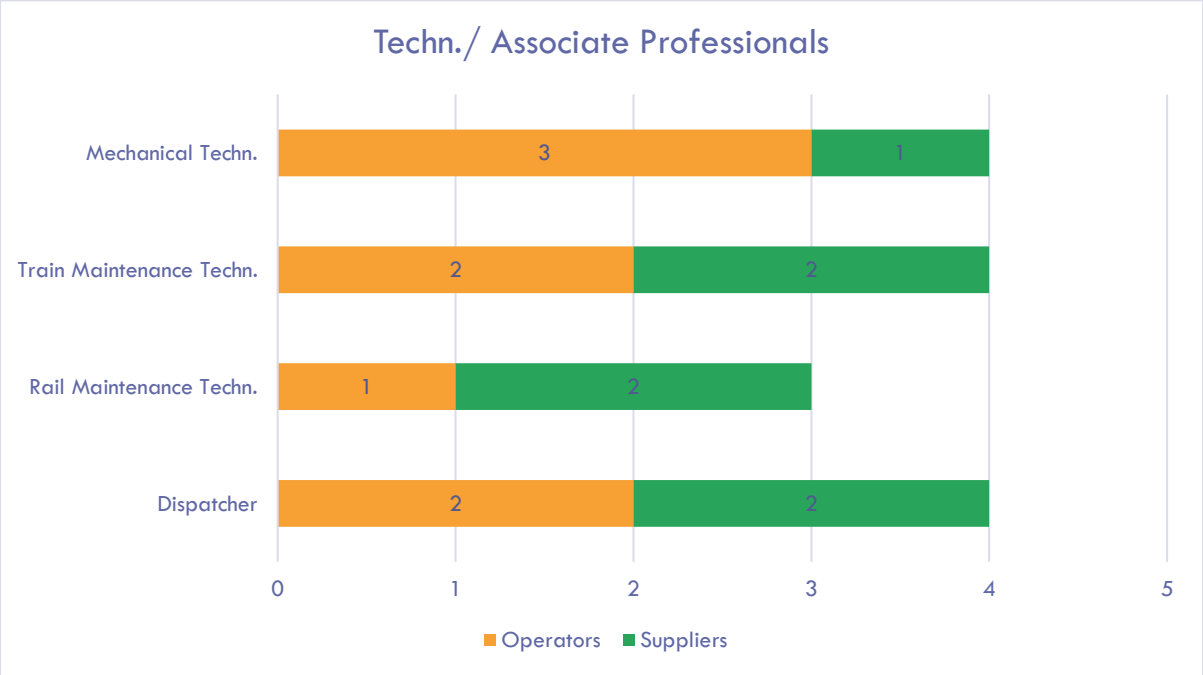
3.1.3.2 Risk Factors for Workforce

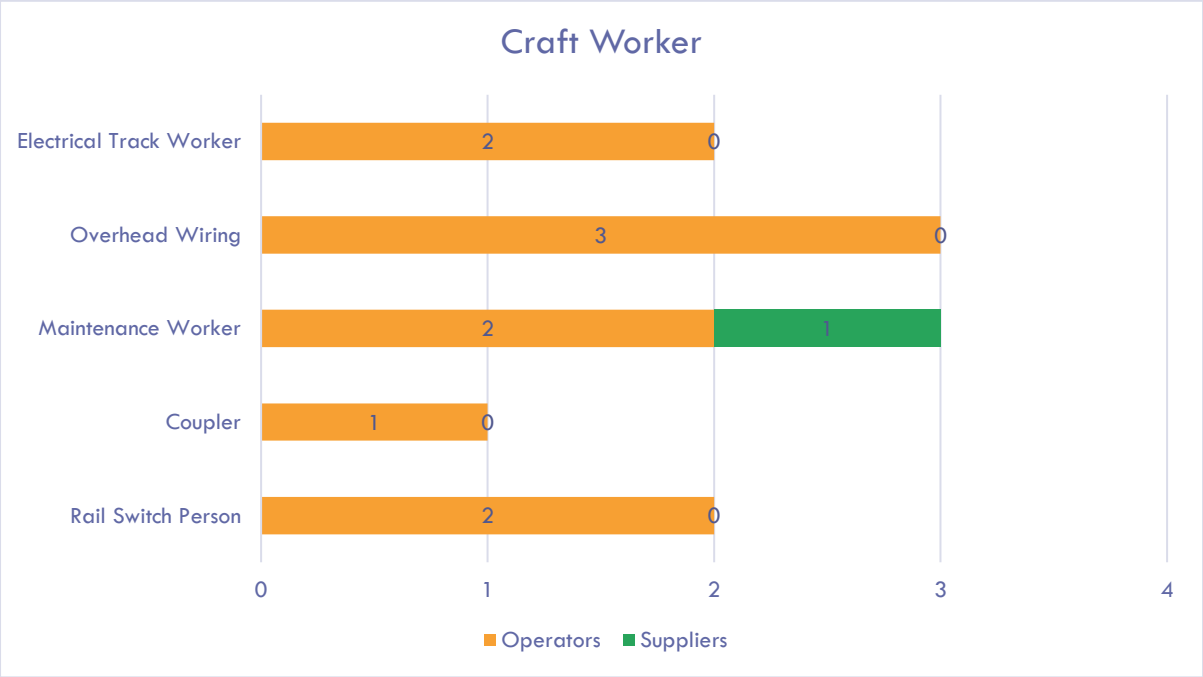
The questions of this section are focused on the market supply for job groups in rail.

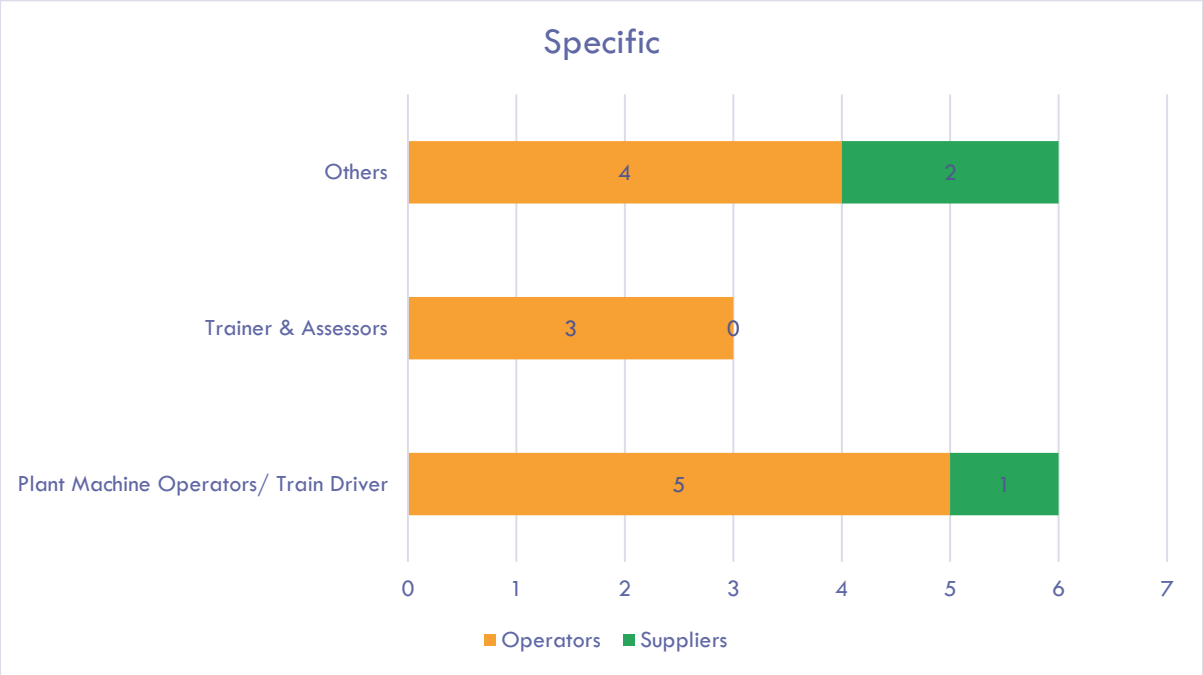
(E1) Which are the occupation groups with especially high recruitment difficulties?




Professional Engineer
Logistic Eng.
Quality Eng.
Software Eng.
System Eng.
Railway Signaling Eng.
Predictive Maintenance Expert
Infrastructure Eng.
2
3
2
5
4
9
7
8
6
3
6
6
6
7
0
2
4
6
8
10
12
14
16
Operators
Suppliers


Techn./ Associate Professionals
Mechanical Techn.
Train Maintenance Techn.
Rail Maintenance Techn.
Dispatcher
3
1
2
2
1
2
2
2
0
1
2
3
4
5
Operators
Suppliers

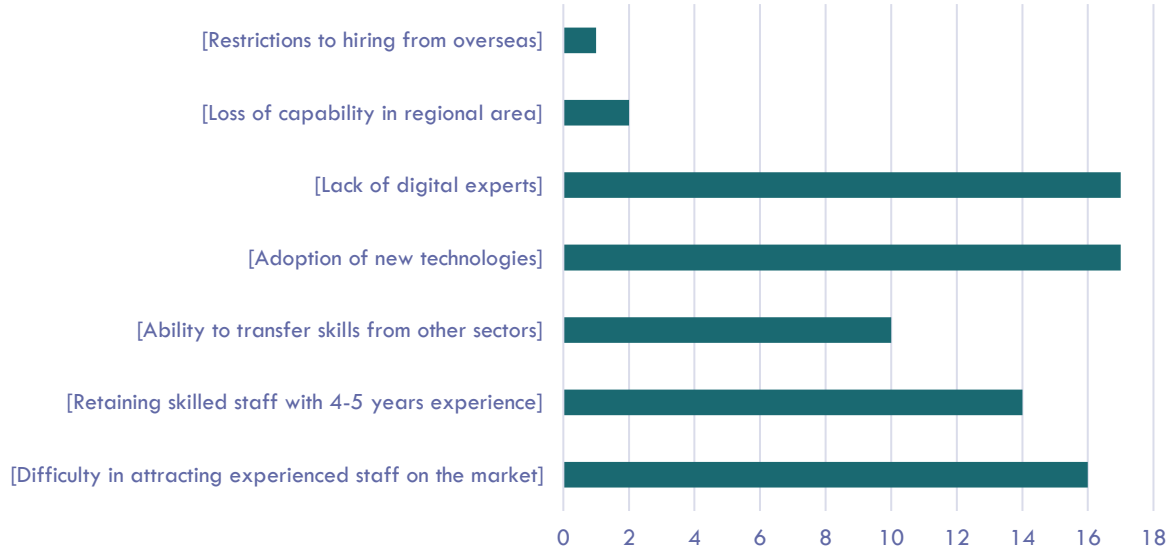

Craft Worker
Electrical Track Worker
Overhead Wiring
Maintenance Worker
Coupler
Rail Switch Person
2
0
3
0
2
1
1
0
2
0
0
1
2
3
4
Operators
Suppliers


Specific
Others
Trainer & Assessors
Plant Machine Operators/ Train Driver
4
2
3
0
5
1
0
1
2
3
4
5
6
7
Operators
Suppliers

(E2) Which are the main difficulties that you are facing regarding the hiring of rail staff?

n = 33

(E3) Which key risk factors do you see for rail workforce capability over the next 10 years?



n = 33

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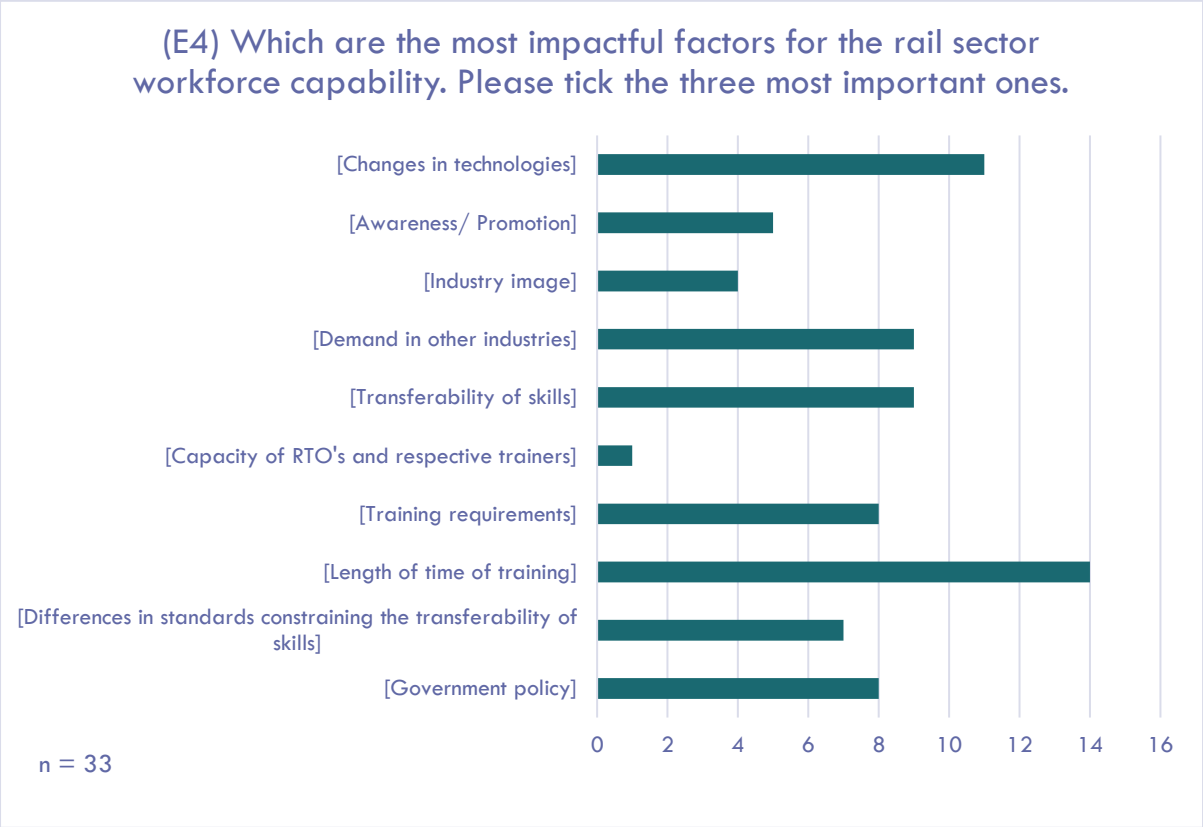


RTO = Research Technology Organization

3.1.3.3 Skill Assessment

One aim of the survey was to get transparency and a holistic overview on current applications and use-cases in skill analysis and practices in the European Railway industry as well as insights and presumptions of further development of the applicated methodologies required by up-coming trends and future skills.

This section´s aim is to exploit methodologies to assess, develop and train skills in the workforce.

According to the results of the survey question F1 as mentioned below, four different main clusters of most frequently used assessment methodologies could be identified. Within these main clusters several forms of application depending on target group and/ or target setting have been listed in the survey.

1.) **Interviews**
2.) **Tests and Certifications**
3.) **Assessment**
4.) **Analysis**

Most of these assessment methods address the individual employee level and ensure a skill gap analysis for single workers that is then translated to training needs.

(F1) Which assessment methodologies are you using?

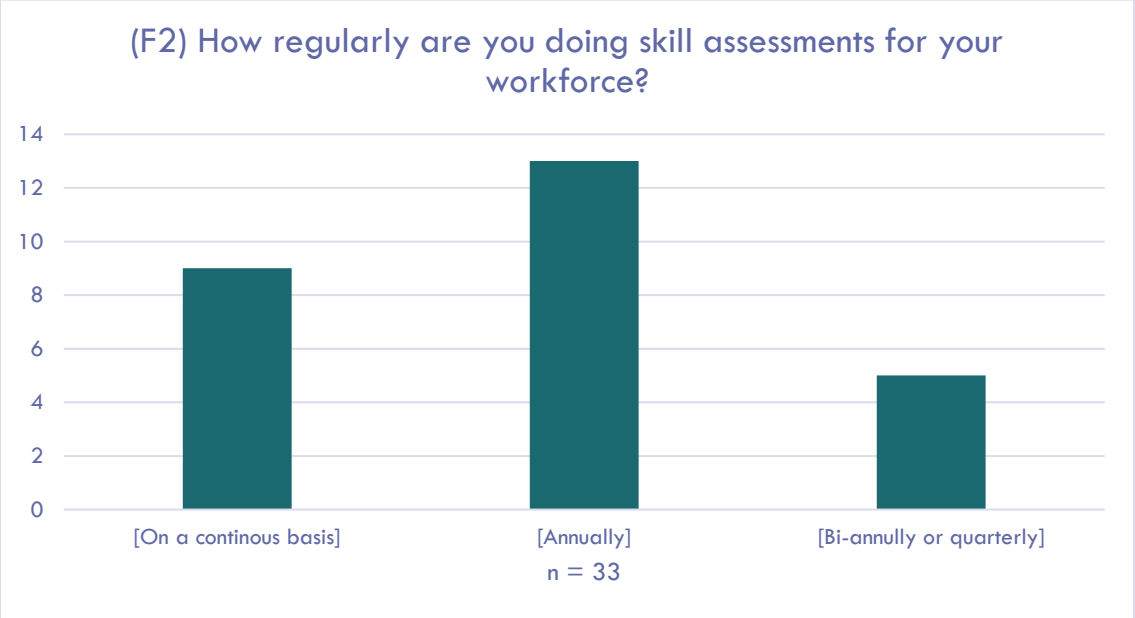
After evaluating the answers to this open question, 4 general blocs of assessment methodologies could be identified, which are most frequently used, but in different forms. The question was analysed according to qualitative content analysis with n = 33 ("n" signifies the statistical population).

(1) **Interviews:** Talent Acquisition; Technical Interviews with Technical Tests, Interviews via Phone Screen; Annual interviews (based on a repository of technical and cross-functional skills (hard and soft skills)

(2) **Tests and Certifications:** Certification on certain profiles; Aptitude Test; Evaluation through Testing; Regulation based Exams; repeated proof of practical work in certain roles; Knowledge test and observation of the practice with evaluation afterwards

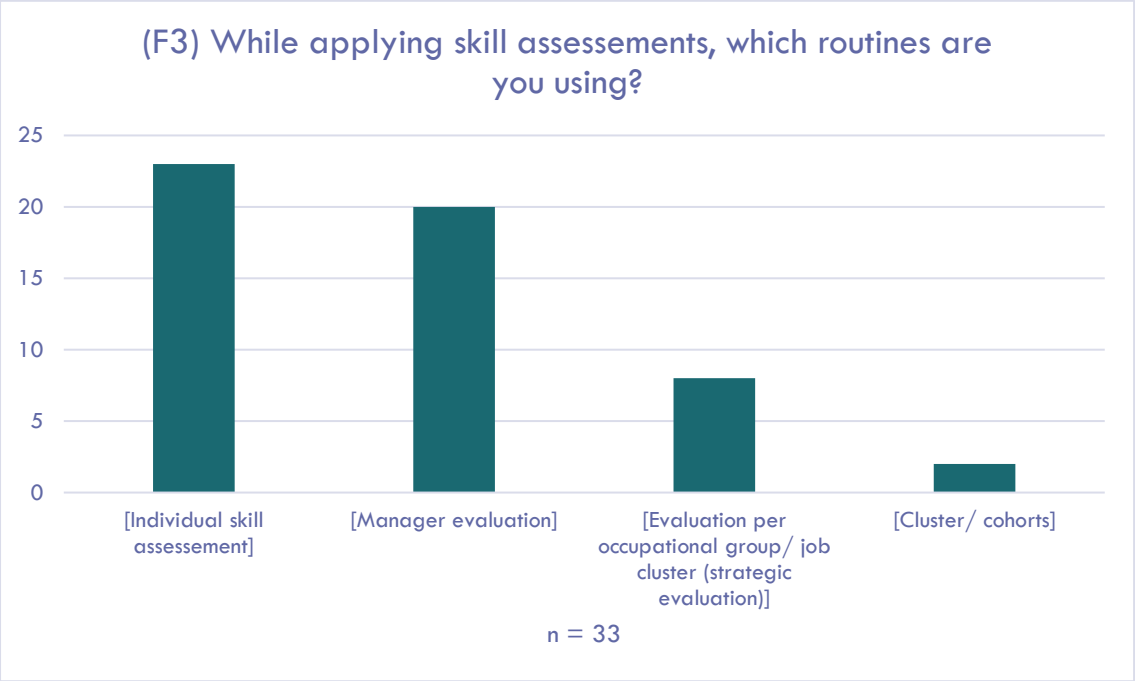
(3) **Assessment:** Business needs assessment; Job assessment; Assessment Centers; Manager Assessment; Competency Assessment; Career Develop Assessment; Use of assessments during times of hiring

(4) **Analysis:** Skill analysis on the base of occupational profiles (self-evaluation, manager evaluation, gap analysis); Analyzing by giving more demanding tasks and evaluating



Other: *"Annual Training Plans"; "Only when necessary"; "Variation depending on occupational profiles and job roles"*

Most of the survey participating companies are applying their skills assessments (F2 and F3) in an annual time routine, followed by a continuous routine and less are doing bi-annually or quarterly. Besides the temporal routine, survey participants mostly use routines of individual skill assessments and manager evaluations while applying skill assessments.



Other: *"Follow-Up by trainers and coaches"*

Identifying or acquiring expertise, operators as well as suppliers have special campaigns (F4) with different strategic goals and target groups. Both use internal and external strategies to recruit new talents and develop the own workforce towards necessary skills and specific work fields.

(F4) Do you have anything in place to identify or acquire/ cultivate expertise or experts on special focus topics? (for example: recruiting campaign for digital talents, technical Master programs, job rotation, etc)

The question was analysed according to qualitative content analysis with n = 33.

Operators (train operators and infrastructure managers): Most of the operators use special campaigns with different strategic goals and to accomplish specific target groups. Several examples have been named, e.g., recruiting campaigns to reach for digital talents or campaigns in use to identify special points and involve people in specific processes.

In other companies these questions are embedded in a dedicated leadership and career development department and a talent scouting division.

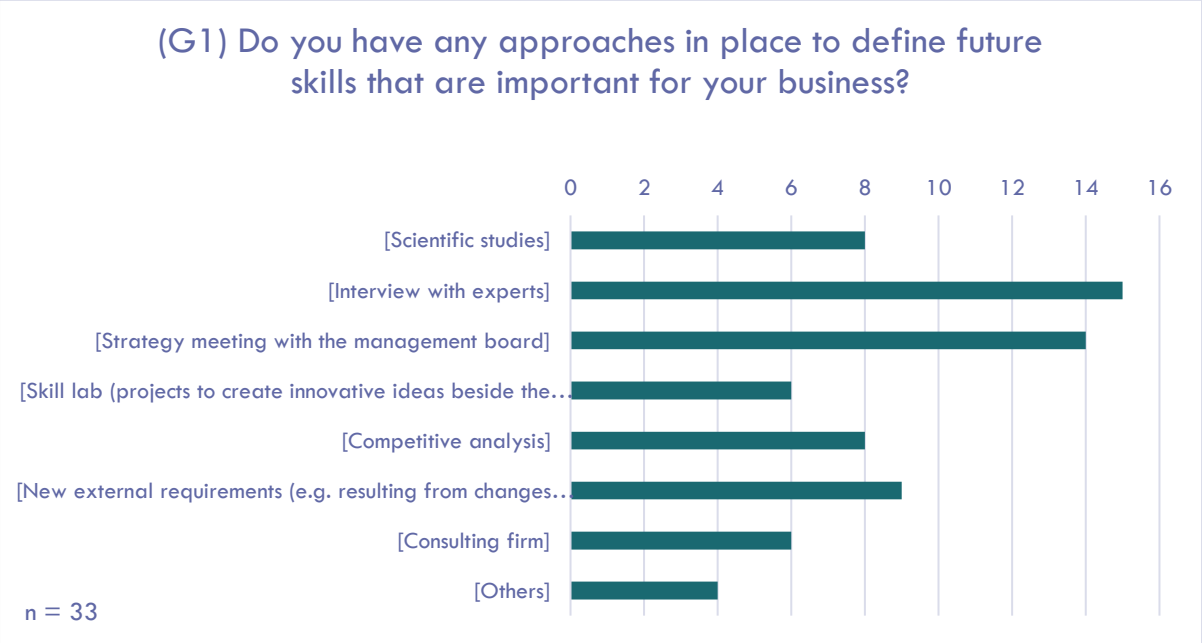
Operators also apply internal strategies such as job rotation and trainee and master programs or offering courses of acquiring key skills in specific fields. Another internal strategy are events or presentations made by experts of a specific field to attract other experts.

Suppliers: Internal and external training programs are also used by suppliers as well as adapted recruiting strategies (special campaigns e.g., social media campaigns, cooperation with universities). The answers of suppliers frequently include the development of their own experts: recognize and reward the expertise level, enabling employees to have an expert career, cooperation with universities and trainee programs, cooperation with external institutes, dedicated training programs, competency networks.

Unfortunately, the results did not allow to deduce concrete differences between operators and suppliers because of the small number of surveys.

3.1.3.4 Skill Development & Training

The last section contains questions around future skills and their reflection in training and development.

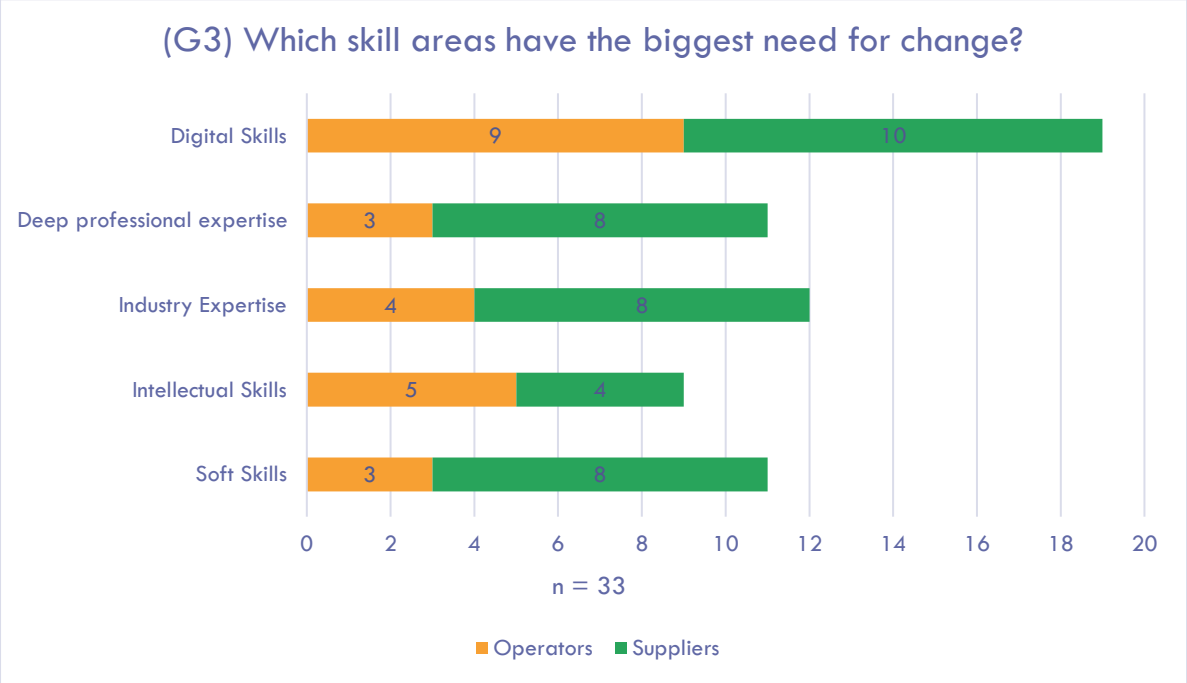


(G2) Are you lacking any trainings for future skill? If yes, please indicate what topics you are missing.

Several trainings for future skills and topics, which have been named, are listed in the following:

- **Digital Training:** Participants mentioned the lack of digital training for production and sales staff. It has been expressed that new skills for digital training and innovative training (e.g., E-Learning, virtual reality training) need to be developed.
- **Training for future competencies:** Training of hybrid qualification profiles

- **Training for missing competencies:** There is a need of several skills which have to be trained and developed, e.g., managerial skills, skills related to corporate governance, skills of employees in electrical / traffic/ civil engineering.
- **Training for Soft Skills**
- **Training itself:** Lack of training tools, lack of trainers for all areas



(G4) Which future skills do you consider as most important for the business?

This question contains a broad range of answers. Digital skills have been the most frequently named in every field of operators (systemic approach; signalling; Rolling Stock knowledge) and suppliers (data analysis; new business models). Qualification, expertise, and language skills are also seen as an important topic. A number of soft skills are as well specified to be important: leadership skills, communication, flexibility, adaptability, continuous learning, resilience, and the appropriate attitude for change. Furthermore, skills on green economy and sustainability might be possible future topics.

3.1.4 Assessment Blueprint

Talking about skill development the in-principle-approach that every consultant praise includes the following main steps:

1. **Analyse micro and macro trends affecting the market and the industry**
2. **Project and evaluate the impact of the trends on respective business products/ services and processes**

3. **Break down the evaluated products/ services and processes in corresponding tasks and evaluate the changes on a task level**
4. **Assign relevant occupational profiles to the task level and discuss the skill gap**
5. **Decide on workforce adaptions: re-skilling/up skilling or separation/ new hiring**
6. **Skill Development/ Start analysis on an individual level and break down workforce adaptions into actions**

The analysis of micro and macro trends (point 1) could be done with many different methodologies: Expert interview, survey, analysis of results from comparable industries or analysis of pre-existing studies.

The crucial step in this workforce planning approach is the second step (point 2) when it is about to project the impact of trends on the own business and take decisions. The projection of the future development needs on the one hand side interdisciplinary competencies from management, business development, market know how, human resource and technology and innovation. The projection of the future development of business especially in volatile times implies many risks to take wrong decisions and therefore a stepwise approach make manager to play it safe. However, with only stepwise decisions it is difficult the evaluate the skill gap in consequence.

Point 3 is addressing what the consequences on product/ services and processes are. Tasks build the connector between the strategic business decision and how these impacts the workforce. Here a structured analysis is necessary that could relate to point 4 to assign the respective occupational profiles to the task level.

Taking decision on the workforce capacity strategy (point 5) needs further analysis and input. Internal workforce data like demographic data on retirement and attrition rate could be helpful to predict the workforce development over a midterm time span. In addition, external employment market data like expert availability and supply, occupation by location, earnings, hiring costs, diversity, etc ensures a solid analysis of risks and opportunities.

The sixth point addresses the original skill development on an individual level in which the current skills of employees are matched against the future skills and individual measure are defined to close the gap. The matching could be done with different methods: self-evaluation, manager evaluation, a combination out of both, knowledge and capability tests, assessments, etc. The choice of the methodology is dependent on the kind of skill that needs to be analysed. The most common skill gap analysis methods are self and manager evaluation what you also see in the results from our survey.

Workforce planning addresses the more strategic perspective on analysing the strategic skill gap incorporating future skills. It needs strategic business input and even sometimes professional consultancy, but in any case, it could only be done with high involvement and backing of the management and further interdisciplinary faculties. The strategic discussion can be ground-breaking depending on the disruptions a business is taking. Management needs to take a clear ownership for the discussion and combines this with vision/ mission and strategy insights. Human resource can support with methodology.

A proper discussion on workforce planning cannot be undertaken as one process among many others. It needs attention and room for out of the box thinking. A new approach is to establish a Lab (laboratory). In a Lab many faculties including external experts come together and open a space for thinking beyond regular business processes. It is about exploring scenarios, probing practices, and designing new approaches.

3.2 Assessment methodology general considerations

Considering the many micro and macro trends that influences skill and the relevance of jobs the results so far clearly show that skill development becomes more and more a strategic layer for sustainable the business development. The capacity of companies to adapt to trends and changes in the social, technical, political and market environment is strongly influencing the resilience of the business. Some adaptions need to be taken very fast as the pandemic situation demonstrated in the last month, some adaptions must be refined on a continuous base as the prediction of the future direction is still blur and not yet clear, e.g., new technologies to apply. The so far status of many companies conduct skill development with traditional HR tools like self- and manager evaluation, interview, or assessments. The basis for all methods is occupational profiles that describe in detail the required skill set as well as the necessary experiences someone needs for successful job fulfillment. The matching between required skills and current skills needs time and resources. Changes come with higher velocity and any prediction of the future is getting more and more difficult. A more open approach towards skill development would be advisable. Skill development should go beyond the clearly described skills in the occupational profile. Opening up learning opportunities, establishing a learning culture and mindset and allow exploration for people to find their strength create a broader skill base that helps to keep the workforce more resilient against disruptive changes with high impact.

4 PROJECT GLOSSARY

The project glossary is attached to this report (see Annex 1).

Annex 1

Glossary

The Glossary is presented in the separate report.