STAFFER

EUROPEAN RAIL SKILLS ALLIANCE

Implementation of VET at EQF levels 6 to 8

DELIVERABLE D6.6

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LIST OF ABBREVIATIONS

AUTh	Aristotle University of Thessaloniki
CESI	École d'ingénieurs
CNAM	Conservatoire national des arts et métiers
CoVE	Centres of Vocational Excellence
CoVERED	CoVE for Railway Empowerment and Development
CTU	Czech Technical University in Prague
DB	Deutsche Bahn
DICEA	Department of Civil, Construction, and Environmental Engineering
EC	European Commission
EQF	European Qualification Framework
ESTACA	École Supérieure des Techniques Aéronautiques et de Construction Automobile
EU	European Union
FS	Ferrovie dello Stato Italiane spa
IMs	Infrastructure Managers
NDA	Non-Disclosure Agreement
PTS	Public Transport Systems
RFI	Rete Ferroviaria Italiana spa
RUs	Railway Undertakings
SGH	Szkoła Główna Handlowa / Warsaw School of Economics
STAFFER	Skills Training Alliance for Future European Railway system

TUD	Technische Universität Dresden / Dresden University of Technology
UB	Univerzitet u Beogradu / University of Belgrade
UNIGE	Università degli Studi di Genova / University of Genoa
UNIROMA1	Università degli Studi di Roma "La Sapienza" / Sapienza University of Rome
UASFHE	University of Applied Sciences Fachhochschule Erfurt
UASSP	Fachhochschule St. Pölten / St Pölten University of Applied Sciences
VET	Vocational Education and Training

1 INTRODUCTION

A key element of STAFFER is the development and implementation of training and educational programmes designed to meet the new skill needs of the European railway sector identified in the first part of the project, considering general trends in the sector and specific elaborations provided by railway operators, infrastructure managers and train suppliers.

The implementation of the training programmes carried out by WP6 as a whole covered a broad spectrum of European Qualifications Framework (EQF) levels (3 to 8), while Task 6.6 focused on Vocational Education and Training (VET) programmes at EQF levels 6 to 8, i.e. tertiary education consisting of bachelor, master and doctoral programmes.

This document presents results of STAFFER Task 6.6: Implementation of VET at EQF levels 6 to 8.

Eleven STAFFER partner universities actively participated in Task 6.6 by implementing new courses or adapting existing ones based on the training programmes designed in WP4 to meet the skills needs identified earlier (WPs 1, 2, and 3).

Of the courses identified to be implemented, the eight that the partners organised in the academic year 2023/2024 were selected as pilot projects and, as such, produced common teaching material and were evaluated according to the methodology developed in Task 6.1. To this end, questionnaires were drawn up for students, professors, the organisers of these courses and, if present, the students' in-company supervisors.

A ninth pilot project was the summer school on “The European Railway System” held at Sapienza University of Rome from 10 to 19 July 2024 with the participation of teachers at different partner universities (CNAM, UASFHE, UNIGE and UIROMA1) and the collaboration of partner companies (FS, Alstom and Hitachi Rail) for the organisation of educational visits.

The main objective of this deliverable report is to provide a detailed account of the activities, outcomes, and insights gained from Task 6.6 within the STAFFER project. This deliverable is structured as follows:

- Section 2 summarises the process that led, starting with the definition of the skills needs of the railway sector and the identification of 6 relevant groups of railway occupational profiles, to the design of the training programmes of WP4, which are the basis for the implementation of the training programmes and pilot VETs of Task 6.6.
- Section 3 describes the procedure used to assess the quality of the implemented pilot VETs according to the methodology developed in task 6.1, through the design and implementation of specific surveys addressed to students, professors, organisers and students' in-company supervisors.

- Section 4 presents a comprehensive overview of all the training programmes that the eleven partner universities have set up to be implemented, even after the end of STAFFER.
- Section 5 describes in detail the 9 pilot projects already fully or partially implemented under STAFFER Task 6.6, presenting their training objectives, teaching structure, evaluation results and the common teaching material they produced.
- The final Section 6 draws conclusions and offer recommendations for the future development and sustainability of these VET initiatives.

2 DEVELOPMENT OF TRAINING PROGRAMMES

2.1 OVERVIEW

A key element of STAFFER consisted of developing training and educational programmes designed to meet the skills needs identified earlier (WPs 1, 2, and 3) considering the general trends of the railway sector and the specific elaboration provided by train operators, infrastructure managers, and rail suppliers.

In WP 4 a detailed analysis was made to benchmark existing programmes and qualification systems and then to use this information to develop new programmes (e.g., courses, mobility programmes) designed to meet the sector's future skills needs.

In the context of Task 4.5, STAFFER partners designed new training contents and mobility programmes that reflect the skill and competence needs resulting from the skills analyses conducting in previous work packages and tasks, which considered the general trends of the railway sector, and the specific elaboration provided by train operators, infrastructure managers, and rail suppliers.

The adopted methodology for programme selection and definition consisted of four main phases:

- Phase 1. Skills and EQF Levels matching.
- Phase 2. Occupational profiles clustering and programme selection.
- Phase 3. Skills and programme matching.
- Phase 4. Programme finalisation.

2.2 Skills and EQF levels matching

The basis of new education, training and mobility programmes was the identification of topics and thematic fields that according to the results of previous WP1, WP2, WP3 are new or important fields impacting on the railway sector and their specialisation for each of the EQF levels 3 to 8 that the STAFFER project aimed to cover.

The approach of this first phase consisted in the following activities:

- Selection of innovative field/trend/skillset relevant for the railway sector.
- Identification of the subskills for each innovative field/trend/skillset.
- Subdivision of the subskills according to the different EQF levels.

The 14 identified fields/trends/skillsets are shown in Table 1 below.

TABLE 1: SELECTED FIELDS/TRENDS/SKILLSETS REGARDED AS HIGHLY RELEVANT FOR RAILWAY EDUCATION AND TRAINING PROGRAMMES

Fields / Trends / Skillsets
1. **Big Data & Artificial Intelligence (AI)** 2. **Cybersecurity & Internet of Things (IoT)** 3. **Global new energies & technologies** 4. **Formal methods for system design & verification** 5. **Living language** 6. **Networking and ICT technologies** 7. **Norms, standards and certification** 8. **Reliability, maintenance and life cycle management** 9. **Safety, dependability, security** 10. **Smart cities and smart station design** 11. **Transportation systems** 12. **Transversal skills in railways** a. **Learning skills** b. **Communication** c. **Soft skills** 13. **Virtual reality** 14. **Web development**

Source: STAFFER WP4, Deliverable 4.5

2.3 Occupational profiles clustering and programme selection

In addition to the identification of new skills and knowledge requirements, six groups of highly relevant occupational profiles in the fields of the rail supply industry and railway operation and infrastructure management were selected by WP2 and WP3 and analysed and clustered into six groups as shown in Table 2 below.

TABLE 2: THE IDENTIFIED SIX GROUPS OF RAILWAY OCCUPATIONAL PROFILES

Profile	Description	Main task	Keywords
Train drivers	Train drivers are responsible for driving the locomotive respecting all relevant safety, operational and communication regulations, and have full responsibility for the safety of passengers and cargo.	--> Driving train	Driving the locomotive; Checking safety aspects; Communicating and cooperating with TOCs, IMs and on-board staff
Rail traffic/ operations technicians	Rail traffic/operations technicians are responsible for controlling the movement of trains ensuring safe operations at all times (i.e., in normal, degraded, and emergency conditions).	--> Doing the work of train control / operations	Controlling traffic and train operations; Checking signalling and safety aspects; Coordinating logistics
Railway systems technicians	Railway systems technicians are responsible for constructing, installing, inspecting, testing, and maintaining railway infrastructure and rolling stock.	--> Doing work on the physical systems	Inspecting and maintaining infrastructure and rolling stock; Building, testing and installing infrastructure and rolling stock

Profile	Description	Main task	Keywords
Railway systems engineers	Railway systems engineers are responsible for designing and managing all types of railway infrastructure and rolling stock.	--> Designing and planning the physical systems	Designing - planning work on the physical systems; Planning maintenance, Dealing with signalling interoperability and digitalisation
Rail traffic/ operations engineers	Rail traffic/operation engineers are responsible for all aspects of railway operations (traffic) planning and management.	--> Designing and planning train control and operations	Designing timetable; Analysing and simulating rail traffic; Managing rail projects, Dealing with digitalisation
Rail transport engineers	Rail transport engineers are responsible for organising all aspects of the rail transport system (infrastructure, rolling stock, and operations) into an efficient and effective transport system also considering business aspects.	--> Putting it all together	Analysing rail performance; Applying a systemic approach; Planning integrated transport services; Managing staff; Evaluating rail attractiveness considering social, economic, and environmental factors; Analysing rail transport demand; Defining rail business strategy; Evaluating the compliance with regulations, standards, and certifications; Promoting innovation and digitalisation transition; Designing customer relations and services

Source: STAFFER WP4, Deliverable 4.5

In particular, Table 2 shows in light blue the three occupational profiles related to the highest EQF levels (6 to 8) and which, therefore, concerned the training programmes implemented in Task 6.6.

They consist in three specific railway engineer profiles introduced to overcome the traditional subdivision in engineering disciplines and develop multi-disciplinary training that meets the skills needs of the different roles that engineers play in railway companies:

- the **Railway systems engineer** responsible for designing and planning the physical rail systems (both infrastructure and rolling stock).
- the **Rail traffic/operations engineer** responsible for designing and planning train control and operations.
- the **Rail transport engineer** responsible for the organisation of all the aspects of the rail transport system (infrastructure, rolling stock, and operations) into an efficient and effective transport system, also considering business aspects.

2.4 Skills and programme matching

In this third phase, the specific skills identified for each of the 14 fields/trends/skillsets defined in Phase 1 "Skills and EQF Levels matching" were assigned to the selected six groups of railway occupational profiles described above.

From the analysis of the specific skills identified as necessary for the occupational profile groups, it was then possible to design the training programmes as described in the following section.

2.5 Programme finalisation

For each of the six groups of occupational profiles, training programmes were defined at the EQF levels which were considered the most relevant for that profile. The contents of the programmes were identified considering both the fields/trends/skillsets previously identified and the results of Task 4.4, specific in the field of cross-border railways communication and language. The list of the final nine programmes is reported in Table 3 below.

TABLE 3: DEVELOPED TRAINING PROGRAMMES

Programme title	EQF Level
Train driver	**EQF 3-4**
Rail traffic controller / operations technician	**EQF 3-4** **Post-master and mid-career training EQF 7**
Railway systems technician	**EQF 3-4**
Railway systems engineering	**EQF 7-8**
Railway traffic / operations engineering	**EQF 6** **EQF 7**
Rail transport engineering	**EQF 7** **EQF 8**

Source: STAFFER Deliverable 4.5

3 COMPREHENSIVE QUESTIONNAIRES FRAMEWORK AND EVALUATION MEHTODOLOGY

3.1 Comprehensive Questionnaire Framework for Evaluating Pilot Programmes

STAFFER WP6 focused both on implementing and testing training/education and mobility programmes and on the design of a method for assessing such programmes. The assessment methodology developed in Task 6.1 presents tools for monitoring training/education and mobility programmes. The methodology emphasises the need for continuous monitoring to ensure that programmes continue to meet the needs of the railway sector and increase staff employability.

In accordance with this methodology, common questionnaires were developed to be used to assess the quality of the pilot projects implemented in Task 6.5 (EQF levels 3 to 5) and Task 6.6 (EQF levels 6 to 8), through the design and implementation of specific surveys addressed to the following stakeholders:

- students,
- teachers,
- students' in-company supervisor,
- programme organisers (short term period),
- programme organisers (long term period).

Concerning the last two questionnaires, the first was used to evaluate the pilot VETs immediately after their implementation, which took place in the academic year 2023/2024. The second was developed to monitor and evaluate both the pilot VETs and the other training programmes that will be implemented after the end of STAFFER by analysing data, such as those relating to employability and career development of graduates, that can only be collected at least one year after the end of the course.

In addition, the questionnaires were designed to offer a comprehensive overview of each survey's objectives, the specific areas being evaluated, and the significance of participant feedback in improving the quality and relevance of the training programmes within the STAFFER project.

The following paragraphs present a summary of the objectives and contents of each of the five questionnaires mentioned above. The complete questionnaires can be found in Annex I to this Deliverable.

3.1.1 Student survey

The survey aims to gather valuable insights into the effectiveness and relevance of the pilot training programmes. Students are asked to evaluate their understanding of course content, clarity of objectives, adequacy of teaching methods and study materials, and the overall professional relevance of the course. Feedback is solicited on how the course contributes to their technical skills development and knowledge enhancement. Recommendations are sought regarding potential improvements and whether students would recommend the course to others. This feedback is crucial for refining and optimising future training programmes to better meet the evolving needs of the railway sector.

3.1.2 Teacher survey

For educators involved in delivering pilot training programmes under the STAFFER project, their feedback is essential in ensuring the alignment of educational offerings with industry requirements. The survey assesses the integration of transversal and digital skills, preparation of students for future roles in the railway sector, and the effectiveness of using realistic simulations and work-related activities. Teachers are asked to provide insights into the overall impact of the course on student performance and the level of support for student reflection and review. This information helps in identifying strengths and areas for improvement in curriculum design and teaching methodologies, thereby enhancing the quality and relevance of railway education.

3.1.3 In-Company Supervisor survey

Supervisors include both the company tutors of students on a STAFFER programme who carried out an in-company traineeship and the managers of workers in a company who have attended a STAFFER programme.

Supervisors are invited to share their insights and evaluations. The survey focuses on supervisors' satisfaction with the knowledge and skills acquired by learners, the effectiveness of support provided by the training institution, and the impact of the programme on learners' readiness and performance in the workplace. Supervisors are also asked to provide recommendations for enhancing the programme's effectiveness and improving the skills development of future learners. This feedback is crucial for maintaining strong partnerships with industry stakeholders and ensuring that training programmes adequately prepare learners for the demands of the railway sector.

3.1.4 Survey for Organiser – Short term

Organisers of pilot VETs within the STAFFER project are asked to evaluate the initial implementation and outcomes of these training programmes. The survey examines course participation and completion statistics, the application of internal quality assurance systems, programme accreditation status, and opportunities for students to customise their learning experience. Feedback on the clarity and comprehensiveness of information provided to students about employment and career opportunities, as well as engagement with local and foreign employers, is also sought. Organisers are encouraged to provide suggestions for enhancing programme accessibility and effectiveness in meeting industry demands, thereby ensuring continuous improvement and relevance of the training initiatives.

3.1.5 Survey for Organiser – Long term

Organisers of STAFFER training programmes are engaged in a long-term evaluation aimed at assessing the impact of training programmes on graduates' careers in the railway sector. The survey gathers information on graduates' employment outcomes, roles performed in professional settings, employer satisfaction with their skills and competencies, and mechanisms for identifying ongoing training needs. Organisers are asked to reflect on the effectiveness of the programme in meeting industry demands and to provide recommendations for programme improvement and alignment with future industry trends. This feedback plays a crucial role in shaping the strategic direction of future training initiatives and ensuring their sustained relevance and impact in the railway sector.

3.2 Evaluation framework and methodology

The analysis and evaluation of the above-mentioned surveys for the implemented training programmes can be based on several key indicators to ensure a comprehensive assessment. These indicators include:

- **Participant Satisfaction:** Evaluating how satisfied the participants are with various aspects of the training programmes.
- **Learning Outcomes:** Assessing the extent to which the training programmes have achieved their educational objectives and enhanced the participants' knowledge and skills.
- **Relevance and Applicability:** Determining how relevant and applicable the course content is to the participants' current and future professional roles.
- **Instructor/Trainer Effectiveness:** Reviewing the effectiveness of the instructors and trainers in delivering the course content and facilitating learning.

- **Programme Design and Structure:** Analysing the overall design and structure of the training programmes to ensure they are well-organised and conducive to learning.
- **Engagement and Participation:** Measuring the level of engagement and participation from the students throughout the course.
- **Impact on Performance:** Assessing the impact of the training on the participants' performance and professional development.
- **Feedback and Suggestions for Improvement:** Collecting and analysing qualitative feedback from participants to identify areas for improvement and enhancement.

Quality values can include:

- **Effectiveness:** Measuring how well the training achieves its intended outcomes.
- **Efficiency:** Evaluating the cost-effectiveness of the training.
- **Relevance:** Ensuring the training content meets the needs of the participants and the organisation.
- **Sustainability:** Assessing the long-term benefits and applicability of the training.

Based on these evaluations, a series of recommendations are provided at the end of the survey analysis to further enhance the training programmes and ensure they continue to meet the evolving needs of the railway sector and its workforce.

4 IMPLEMENTATION OF TRAINING PROGRAMMES

4.1 Overview

In February 2023, a survey was launched among the STAFFER partner universities for the implementation of the programmes designed in Task 4.5 and briefly summarised in section 2 above.

Eleven partners universities (AUTh, CESI, CTU, ESTACA, SGH, TUD, UASFHE, UASSP, UB, UNIGE and UNIROMA1) responded and planned to implement new courses or adapting existing ones at EQF levels from 6 to 8 (bachelor, master, PhD programmes) based on the training programmes designed by WP4 for the following groups of occupational profiles:

- Railway systems engineer,
- Rail traffic/operation engineer,
- Rail transport engineer.

A total of 24 training programmes will be implemented, during or even after the end of STAFFER project, the detailed descriptions of which can be found in Annex II.

Figure 1 and Table 4 below provide an overview of the higher educational institutions involved in programme development and implementation, as well as the number of programmes planned to be implemented for each of the EQF levels 6 to 8 and the total number of trainees expected to participate in these courses in comparison with the number considered appropriate in the STAFFER work plan.

It can be noted that the expected numbers of participants are significantly higher than the indicative planning in the STAFFER work plan, except for EQF level 6 (bachelor's degree courses), for which it is slightly lower.

FIGURE 1: IMPLEMENTATION OF TRAINING PROGRAMMES AT EQF LEVEL 6 TO 8

Number of partners involved in the implementation	11
Total number of programmes to be implemented	24
Number of programmes to be implemented at EQF level 6	5
Number of programmes to be implemented at EQF level 7	15
Number of programmes to be implemented at EQF level 8	4
Total number of expected learners from implementation	>760
Number of expected learners at EQF level 6	>129
Number of expected learners at EQF level 7	>635
Number of expected learners at EQF level 8	>36

TABLE 4: TRAINING PROGRAMMES TO BE IMPLEMENTED PER PARTNER AND EQF LEVEL

Educational partner	Number of programmes	EQF levels covered		
		6	7	8
AUTh (Aristotle University of Thessaloniki)	**2**	-	1	1
CESI (CESI École d'ingénieurs)	**4**	2	2	-
CTU (Czech Technical University in Prague)	**1**	-	1	-
ESTACA (École Supérieure des Techniques Aéronautiques et de Construction Automobile)	**2**	-	2	-
SGH (Warsaw School of Economics)	**4**	1	3	-
TUD (Technische Universität Dresden)	**2**	1	1	-
UASFHE (University of Applied Sciences FH Erfurt)	**1**	-	1	-
UASSP (St Pölten University of Applied Sciences)	**1**	1	-	-
UB (University of Belgrade)	**1**	-	1	-
UNIGE (University of Genoa)	**2**	-	1	1
UNIROMA1 (Sapienza University of Rome)	**4**	-	2	2
Total number of programmes	**24**	**5**	**15**	**4**
Total number of expected learners from implementation	**>760**	**>129**	**>635**	**>36**
Total number of expected learners from STAFFER work plan	**-**	**200**	**50÷60**	**few**

Table 5 shows the number of programmes planned to be implemented for each of the four groups of occupational profiles mentioned above and for EQF levels 6 to 8. It should be noted that course "Innovation and the European Railway Mindset", being developed at UASSP, is mentioned separately, because it consists in the implementation of a new teaching module, which can be used in many existing and future academic and training programmes aimed at all four previous groups of occupational profiles. It is interesting to note that most of the programmes being implemented are at EQF level 7 (15 out of 24 programmes), confirming the fact that generally in the European university system, railway topics are dealt with as part of master's degrees, mainly in civil and transport engineering.

TABLE 5: TRAINING PROGRAMMES PER GROUP OF OCCUPATIONAL PROFILES AND EQF LEVEL

Group of occupational profiles	Number of programmes	EQF levels covered		
		6	7	8
Railway systems engineering	**6**	0	5	1
Rail traffic/operations engineering	**2**	0	2	0
Rail transport engineering	**13**	2	8	3
Railway systems technicians	**2**	2	0	0
Innovation and the European Railway Mindset	**1**	1	0	0
Total n. of programmes	**24**	**5**	**15**	**4**

4.2 Training programmes to be implemented

Table 6 shows the full list and main features of the 24 training programmes that the eleven STAFFER partner universities have planned to implement individually by setting new courses or adapting existing ones at EQF levels from 6 to 8.

Specifically, the following features are listed for each training programme:

- the EQF level,
- whether the programme is new or an adaptation of an existing one,
- the language in which it is taught,
- the duration in academic years or semesters,
- the number of ETCSs it issues,
- the specific course/module(s) to be implemented within the programme, if any,
- the number of learners expected to participate in the programme,
- the academic year in which the implementation is planned to take place,
- the group of occupational profiles at which the programme is targeted,
- the specific section of Annex II in which the full description of the programme can be found.

Interestingly, of the 24 programmes chosen for implementation, five are new. Of these, the bachelor's degree in Rail Vehicle Technology offered by the St Pölten University of Applied Sciences is of particular importance because, as seen above, there are not many existing programmes at EQF level 6 related to the railway sector.

In addition, for each of the 24 programmes to be implemented, Table 7 shows which of the 14 fields/trends/skillsets selected by STAFFER WP4.5 as highly relevant for railway education the programme aims to develop. It can be noted that all 14 fields/trends/skillsets will be developed by the programmes being implemented.

Finally, it should be noted that in both Table 6 and Table 7 the programmes that were selected to be pilot projects are highlighted in light blue, as are the partner universities that have implemented them. These pilot programmes are described in detail in section 5 below.

TABLE 6: LIST AND MAIN FEATURES OF THE TRAINING PROGRAMMES THAT THE STAFFER PARTNER UNIVERSITIES HAVE PLANNED TO IMPLEMENT

Educational partner	Partner programme name	EQF level	New/existing programme	Language	Duration of the programme	N. of ECTS of the programme	Specific course(s) to be implemented	Expected learners' number	Planned A.Y. of implementation	Group of occupational profiles	Full description in Annex II, section:
AUTh	Civil Engineering Diploma (Integrated Bachelor's and Master's Degree)	7	Existing	Greek	1 semester	4	"Railway Infrastructure"	80	2023/24	Rail transport engineering	II.1.1
	PhD Course	8	Existing	Greek or English	3 academic years	180	-	Maximum 8 per Supervisor	2023/24	Rail transport engineering	II.1.2
CESI	Bachelor of Science and Engineering specializing in BIM *(Bachelor en sciences et en ingénierie spécialité BTP (BIM) en apprentissage)*	6	Existing	French	3 academic years	180	-	25	2024	Railway systems engineering	II.2.1
	Bachelor of Science and Engineering in maintenance and data *(Bachelor en sciences et ingénierie spécialité maintenance & data apprentissage)*	6	Existing	French	3 academic years	180	-	24	2024	Railway systems engineering	II.2.2
	Post Master Degree BIM construction project manager *(Mastère Spécialisé® Management de Projets de Construction, Option BIM)*	7	Existing	French	1 academic year	75	-	100	2023/24	Railway systems engineering	II.2.3
	Post Master Degree Manager of construction projects option Urban Transport *(Mastère Spécialisé® Management de Projets de Construction, Option Transports Ferroviaires, Urbains et Nouvelles Mobilités)*	7	Existing	French	1 academic year	75	12 teaching modules	20	2023/24	Railway systems engineering	II.2.4
CTU	Transportation Systems and Technology	7	Existing	English	2 academic years	125÷132	module "ITS - Intelligent transport systems"	200	2023/24	Rail traffic/operations engineering	II.3.1
ESTACA	Transport engineering / Operation & Maintenance	7	Existing	French, English	5, 4 or 3 academic years	300	-	30÷70	2023/24	Rail traffic/operations engineering	II.4.1
	Transport engineering / System design	7	Existing	French, English	5, 4 or 3 academic years	300	modules "Cybersecurity" and the "Internet of Things (IoT)"	30÷70	2023/24	Railway systems engineering	II.4.2

Educational partner	Partner programme name	EQF level	New/existing programme	Language	Duration of the programme	N. of ECTS of the programme	Specific course(s) to be implemented	Expected learners' number	Planned A.Y. of implementation	Group of occupational profiles	Full description in Annex II, section:
SGH	Management, undergraduate, full time	6	New	English	3 academic years	180	3 ECTS course on Sustainable Mobility Management	20	2024/25	Rail transport engineering	II.5.3
	International business, graduate, full time	7	New	English	2 academic years	120	3 ECTS course on Sustainable Mobility Management	20	2024/25	Rail transport engineering	II.5.3
	Postgraduate course in "Railway Manager"	7	New	Polish	2 semesters	32	-	20	2024/25	Rail transport engineering	II.5.2
	Postgraduate course in "Ogranistation of extra-urban public transport"	7	New	Polish	2 semesters	32	-	20	2023/24 + 2024/25	Rail transport engineering	II.5.1
TUD	Transport Engineering *(Diplomstudiengang Verkehrsingenieurwesen)*	6 and 7	Existing	German	5 academic years	300	-	40÷50	2023/24	Rail transport engineering	II.6.1
UASFHE	Master of Science "European Railway Systems"	7	Existing	German (in the future partly also in English)	2 academic years	120	-	15÷30	2023/24	Railway systems engineering	II.7.1
UASSP	Innovation and the European Railway Mindset	6	New	English	1 semester	?	3 x 20 minute videos with discussion notes	Many	2023/24	-	II.8.1
	Rail Vehicle Technology	6	New	German	3 academic years	180	-	20	2025/26	Railway systems engineering	II.8.2
UB	Master of Science in "Traffic Engineering"	7	Existing	Serbian (in the future also in English)	1 academic year	60	-	10÷15	2024/25	Rail transport engineering	II.9.1
UNIGE	Master of Science in "Safety engineering for transport, logistics and production"	7	Existing	English	2 academic years	120	Rail Transport, Sustainable Rail and Road Infrastructure	30	2023/24	Rail transport engineering	II.10.1
	PhD Course in "Transport and Logistics"	8	Existing	English	3 academic years	180	-	6	2023/24	Rail transport engineering	II.10.2

Educational partner	Partner programme name	EQF level	New/existing programme	Language	Duration of the programme	N. of ECTS of the programme	Specific course(s) to be implemented	Expected learners' number	Planned A.Y. of implementation	Group of occupational profiles	Full description in Annex II, section:
UNIROMA1 SAPIENZA UNIVERSITÀ DI ROMA	Master of Science in "Transport Systems Engineering"	7	Existing	English	2 academic years	120	Railway Engineering, Public Transport Management	30	2023/24	Rail transport engineering	II.11.1
	Mobility programme in Signalling Systems	7	New	English	10 days	5	-	20	2023	Railway systems engineering	II.11.2
	Post-Master course in "Railway Infrastructure and Systems Engineering"	8	Existing	Italian (some lectures in English)	1 academic year	60	12 teaching modules	20	2023/24	Railway systems engineering	II.11.3
	PhD course in "Infrastructure and Transports" - Curriculum "Infrastructures, Transport Systems and Geomatics"	8	Existing	Italian or English	3 academic years	180	-	2	2024/25	Rail transport engineering	II.11.4

TABLE 7: LIST AND MAIN FEATURES OF THE TRAINING PROGRAMMES THAT THE STAFFER PARTNER UNIVERSITIES HAVE PLANNED TO IMPLEMENT

		Fields/trends/skillsets															
Educational partner	Partner programme name	Cybersecurity & Internet of Things (IoT)	Big Data & Artificial Intelligence	Global new energies & technologies	Safety, dependability, security	Norms, standards & certification	Transportation systems	Formal methods for system design & verification	Networking & ICT technologies	Smart cities & Internet of Things (IoT)	Reliability, maintenance & life cycle management	Web development	Virtual reality	Living language	Learning skills	Communication	Soft skills
AUTh	Civil Engineering Diploma (Integrated Bachelor's and Master's Degree)			X	X		X				X						X
	PhD Course				X		X				X						X
CESI	Bachelor of Science and Engineering specializing in BIM *(Bachelor en sciences et en ingénierie spécialité BTP (BIM) en apprentissage)*									X	X			X	X	X	X

		Fields/trends/skillsets															
Educational partner	**Partner programme name**	**Cybersecurity & Internet of Things (IoT)**	**Big Data & Artificial Intelligence**	**Global new energies & technologies**	**Safety, dependability, security**	**Norms, standards & certification**	**Transportation systems**	**Formal methods for system design & verification**	**Networking & ICT technologies**	**Smart cities & Internet of Things (IoT)**	**Reliability, maintenance & life cycle management**	**Web development**	**Virtual reality**	**Living language**	**Learning skills**	**Communication**	**Soft skills**
	Bachelor of Science and Engineering in maintenance and data *(Bachelor en sciences et ingénierie spécialité maintenance & data apprentissage)*			X	X		X				X				X	X	X
	Post Master Degree BIM construction project manager *(Mastère Spécialisé® Management de Projets de Construction, Option BIM)*									X	X			X	X	X	X
	Post Master Degree Manager of construction projects option Urban Transport *(Mastère Spécialisé® Management de Projets de Construction, Option Transports Ferroviaires, Urbains et Nouvelles Mobilités)*			X	X	X	X			X	X			X	X	X	X
CTU	Transportation Systems and Technology			X			X			X				X	X		X
ESTACA	Transport engineering / Operation & Maintenance	X	X	X		X										X	X
	Transport engineering / System design	X	X	X		X										X	X
SGH	Management, undergraduate, full time						X										
	International business, graduate, full time						X										
	Postgraduate course in "Railway Manager"						X									X	X
	Postgraduate course in "Ogranistation of extra-urban public transport"						X									X	X

		Fields/trends/skillsets															
Educational partner	**Partner programme name**	**Cybersecurity & Internet of Things (IoT)**	**Big Data & Artificial Intelligence**	**Global new energies & technologies**	**Safety, dependability, security**	**Norms, standards & certification**	**Transportation systems**	**Formal methods for system design & verification**	**Networking & ICT technologies**	**Smart cities & Internet of Things (IoT)**	**Reliability, maintenance & life cycle management**	**Web development**	**Virtual reality**	**Living language**	**Learning skills**	**Communication**	**Soft skills**
TUD	Diplomstudiengang Verkehrsingenieurwesen (Transport Engineering)			X	X	X	X		X		X		X	X	X		X
UASFHE	Master of Science "European Railway Systems"				X	X	X	X			X			X	X	X	X
UASSP	Innovation and the European Railway Mindset			X	X		X		X	X	X					X	X
	Rail Vehicle Technology			X	X	X	X				X						
UB	Master of Science in "Traffic Engineering"				X		X										
UNIGE	Master of Science in "Safety engineering for transport, logistics and production"		X	X	X	X	X				X						
	PhD Course in "Transport and Logistics"		X	X	X	X	X				X						
UNIROMA1	Master of Science in "Transport Systems Engineering"				X	X	X				X						
	Mobility programme in Signalling Systems					X	X									X	
	Post-Master course in "Railway Infrastructure and Systems Engineering"				X	X	X			X	X						X
	PhD course in "Infrastructure and Transports" - Curriculum "Infrastructures, Transport Systems and Geomatics"		X	X	X	X	X		X	X	X						

5 IMPLEMENTATION OF PILOT VETS

5.1 OVERVIEW

As previously mentioned, among the 24 programmes that the STAFFER partners decided to implement individually taking into account the inputs of WP4 of the project, the 8 listed in the following Table 8 were taken as pilot projects, as they were scheduled to be implemented in the academic year 2023/2024 and, therefore, offered the possibility of pooling the teaching material developed for them and being evaluated, in accordance with the procedure developed in task 6.1, within the STAFFER deadline.

A partial exception is the prototype course "Innovation and the European Railway Mindset", being developed at the St. Pölten University of Applied Sciences (UASSP), because it does not consist in the implementation of a new course or the modification of an existing one, but in the creation of a new teaching module, consisting of video lectures and study material, which can be used in many existing and future academic and training programmes. Therefore, the importance of this course lies primarily in the creation of the common teaching material and not so much in its evaluation according to the procedure defined in task 6.1, which can be conducted when this is implemented within specific courses of study.

TABLE 8 - OVERVIEW OF THE 8 PILOT VETS THAT THE PARTNER UNIVERSITIES IMPLEMENTED INDIVIDUALLY IN A.Y. 2023/2024

Educational partner	Partner programme name	EQF level	New/existing programme	Duration of the programme	N. of ECTS of the programme	Specific module(s) to be implemented
CESI	Post Master Degree Manager of construction projects option Urban Transport *(Mastère Spécialisé® Management de Projets de Construction, Option Transports Ferroviaires, Urbains et Nouvelles Mobilités)*	7	Existing	1 academic year	75	12 teaching modules
CTU	Transportation Systems and Technology	7	Existing	2 academic years	125÷132	ITS - Intelligent transport systems
ESTACA	Transport engineering / System design	7	Existing	5, 4 or 3 academic years	300	Cybersecurity and the Internet of Things (IoT)
SGH	Postgraduate course in "Ogranistation of extra-urban public transport"	7	New	2 semesters	30	-

Educational partner	Partner programme name	EQF level	New/existing programme	Duration of the programme	N. of ECTS of the programme	Specific module(s) to be implemented
UASSP	Innovation and the European Railway Mindset	6	New	60 minutes	NA	3 x 20 minute videos with discussion notes, to be given as part of an existing class
UNIGE	Master of Science in "Safety engineering for transport, logistics and production"	7	Existing	2 academic years	120	Rail Transport, Sustainable Rail and Road Infrastructure
UNIROMA1	Master of Science in "Transport Systems Engineering"	7	Existing	2 academic years	120	Railway Engineering, Public Transport Management
	Post-Master course in "Railway Infrastructure and Systems Engineering"	8	Existing	1 academic year	60	12 teaching modules of 4 ECTS each

A ninth pilot project was the summer school on "The European Railway System" held at Sapienza University of Rome from 10 to 19 July 2024 with the participation of teachers of different partners (CNAM, UASFHE, UNIGE and UIROMA1), the European Union Agency for Railway, FS, Alstom and Hitachi Rail for the organisation of educational visits.

The implementation of the 9 pilot projects is described in detail in the following sections.

5.2 CESI – Post Master Degree Manager of construction projects option Urban Transport

5.2.1 Introduction

CESI is a professional training and higher education group, which specializes for 50 years in training managers and technicians. It trains over 22 000 people each year on civil and industrial engineering and IT in 25 campuses in France. CESI offers Meng and Post executive Masters' degrees with a specialization in Railway and urban Transport.

The Specialized Post-Master's Degree in Construction Project Management (MS®) at CESI aims to equip apprentices with the competencies necessary to manage rail, urban transport, and sustainable mobility projects throughout their life cycle, both in France and internationally. The programme responds to the increasing complexity and demands of contemporary projects by emphasizing a multifaceted managerial approach that incorporates technical, technological, economic, legal, regulatory, and safety considerations.

The Specialized Post-Master's program in Construction Project Management consists of 10 Teaching Units (TUs, or Unités d'Enseignement - UEs) and one final professional thesis. Each TU contains several teaching modules. The total number of credits for the training program is 75 ECTS, distributed as follows:

- Project Management – 4 ECTS
- BTP and BIM Project Management – 6 ECTS
- Challenges and Organization of Railway and Urban Transport – 5 ECTS
- Management of People in Transitions – 4 ECTS
- Design of Railway Infrastructure – 6 ECTS
- Design of Railway Equipment – 5 ECTS
- Strategic and Economic Management of Projects and Companies – 4 ECTS
- Legal and Construction Law – 5 ECTS
- Intermodal Integration into the Transport System – 6 ECTS
- Methodologies and Professional Tools – 0 ECTS
- Mission and Professional Thesis – 30 ECTS

5.2.2 Implementation

With reference to the 9 training programmes designed in WP4.5 for the six groups of occupational profiles identified in STAFFER, the "Railway systems engineering" at EQF level 7

was selected as the one that best reflected the training objectives of the Post Master Degree Manager of construction projects.

In alignment with the objectives of STAFFER Task 4.5, the training programme has integrated various inputs, ensuring it meets the evolving needs of the railway sector. Key themes from the task, including global new energies and technologies, safety, dependability, security, norms, standards, and certification, are embedded within the curriculum. The programme encompasses several courses, for example:

- Project Management (Project Management and Project Culture): This course focuses on developing essential soft skills, fostering a project-oriented mindset, and enhancing team dynamics.
- Management of Project BTP and BIM: This course addresses innovations in project management, incorporating digital modelling technologies that align with global trends in the industry.
- Legal and Construction Law: This course covers relevant norms and standards, ensuring that apprentices are well-versed in compliance and certification processes essential for project acceptance and execution.
- Design of Railway Infrastructure: This course incorporates principles of reliability, maintenance, and life cycle management, enabling apprentices to design sustainable and efficient infrastructure.
- Intermodal Integration within the Transport System: This course emphasizes soft skills and collaboration, preparing apprentices to manage multimodal transport systems and effectively lead teams through transitions.
- Rolling Stock: This module highlights new energies and technologies applied in railway rolling stock.

Furthermore, the programme prioritizes the optimization of maintenance strategies and operational management, reflecting the input from Task 4.5 regarding reliability and maintenance. This comprehensive approach ensures that graduates are not only skilled in project management, as soft skills, but also equipped to address the pressing challenges of safety and sustainability in the railway sector.

5.2.3 Common study material

As part of the teaching material produced for the new Postgraduate course in "Organisation of extra-urban public transport", the following three lectures were selected as common teaching material:

- The support material for a signalling systems case study on the creation of an IPCS (installation permanente de contre-sens), which is a technical device used in France that allows trains to travel in the opposite direction on both tracks of a double-track section of line.

- The teaching material for the introductory lecture, which aims to provide an overview of the "Railway System" course.
- The support material of the t course "Logistical support/maintenance of the rail transport system".

All material can be found in Annex IV, section IV.1.

5.2.4 Conclusion

The implementation of this programme contributes to the goals of the STAFFER project, aligning educational outcomes with the future demands of the railway sector.

The course evaluation questionnaire was answered by students and lecturers of 12 courses, by the in-Company supervisors of 7 trainees attending the course and by the organiser.

The programme received generally positive feedback from the students who filled in the evaluation questionnaire. More specifically the course received very good scores in both the overall evaluation (an average score of 95.08 out of 100 for the 12 assessed courses) and on the final question "Would you recommend this course to your friends and family?" (an average score of 95.28 out of 100 for the 12 assessed courses).

In addition, it is noteworthy that all supervisors felt that the course adequately prepared students for their role in the company (the score on this question was 96.43out of 100) and that they would recommend the course to other of their colleagues (the score on this question was 94.29 out of 100).

The full results of the evaluation survey can be found in Annex III, section III.1.

5.3 CTU – Transportation Systems and Technology

5.3.1 Introduction

The Czech Technical University in Prague (CTU) is a leading technical university in Czech Republic providing BSc, MSc and PhD studies in all fields of transportation education at faculties of civil, mechanical, electrical and transport engineering. The university has more than 17,500 students in total, and nearly 3,600 academic staff. Faculty of Transportation Sciences has almost 1,000 students.

The pilot implemented by CTU concerns the Intelligent Transport Systems (IS) study field as a part of the Master of Science in "Transportation Systems and Technology" (EQF level 7), which is a two-year programme equivalent to 120 ECTS that can be attended with a bachelor's degree equivalent to 180 ECTS. The Intelligent Transport Systems (IS) study field, which combines information and telecommunication technologies with transport engineering, is offered either as a single degree programme at the Czech Technical University in Prague or as a joint degree programme with its partner Linköping University in Sweden, offering students the possibility to obtain a degree also from the foreign university.

5.3.2 Implementation

With reference to the 9 training programmes designed in WP4.5 for the six groups of occupational profiles identified in STAFFER, the "Rail traffic/operations engineering" at EQF level 7 was selected as the one that best reflected the training objectives of the Master of Science in "Transportation Systems and Technology" in general and the Intelligent Transport Systems (IS) study field in particular.

Moreover, concerning the "fields/trends/skillsets" regarded as highly relevant for railway education and training programmes by STAFFER, those selected as relevant to the training aims of the course are as follows:

- Transportation systems
- Smart cities & Internet of Things (IoT)

The designed implementation concerns the study module 3711R004 – "ITS - Intelligent transport systems", which is intended to be a part of the degree programme in "Transportation Systems and Technology" within the scope of educational network for students/railway employees being proposed as an output of the STAFFER project.

The structure of the study field Intelligent transport systems consists of the following parts:

- 20AIMI-E – Application of ITS in Urban Engineering

- 20BITS-E – Safety and reliability of ITS Systems
- 20GINS-E – Geographical, information, localization and navigation systems
- 20HEI-E – Evaluation and Economics of ITS
- 20ITSR-E – ITS-R
- 20MZZ-E – Modern techniques of safety control of moving railway vehicles
- 20PRZP-E – Computer aided railway traffic control
- 20SYIN-E – System Engineering
- 20TSJ-E – Telematic systems and their design
- 20TVHD-E – Telematics in Public Transport

The whole module could be divided into two individual parts (submodules): (20AIMI, 20GINS, 20HEI, 20SYIN, 20TSJ) and (20BITS, 20ITSR, 20MZZ, 20PRZP, 20TVHD). These submodules can be studied concurrently or sequentially as they are not directly related to each other.

With a degree and expertise in intelligent transport systems and technologies, graduates of the educational module will have a wider choice of challenging career opportunities. Most graduates are more likely to find employment as railway experts and engineers who can be employed either directly in rail operations or as consultants. They may also become managers in transport companies or work in technology fields that develop transport and transportation systems. Finally, they will also be well prepared for a career in science and research.

Preparations for the general design of the study module "Intelligent Transportation System and Technologies" include determining the scope of the study matter to ensure the acquisition of as much experience and skills applicable in practice as possible. An internal faculty meeting of educators will be held for this purpose.

5.3.3 Common study material

The last point will be the preparation of study materials to best suit the needs of the study module "ITS - Intelligent transport systems". These will be created by adapting/revising existing study literature (textbooks, scripts and presentations), which can be found in Annex IV, section IV.2.

5.3.4 Conclusion

The design of the concept will also take into the account the views of students and teachers who have already taken the subject as part of their regular undergraduate studies. The processed results of the survey in which they participated are available in Annex III, section III.2. The course received an excellent overall rating (95.00 out of 100) from the students who filled in the evaluation questionnaire.

5.4 ESTACA – Transport engineering / System design

5.4.1 Introduction

ESTACA is a HEI providing continuous training in all fields of transport industry (aeronautical, automotive, railway, shipping, space) with engineering programmes. IT ha 2 sites in France (Paris and Laval), 2160 students, 340 graduates each year, 2 Research Divisions (Mechanics and Systems), 57 International University Partnerships, 8500 alumni.

With reference to the railway sector ESTACA offers a 5-year programme (equivalent to 300 ECTS), consisting of the first 2 preparatory years and 3 characterising years, enabling specialisation as Railway and Guided-transport Engineer. The course is delivered in French and can be attended by French or foreign students holding a general Baccalaureate or an equivalent qualification.

In each of the last three years there is a group of modules relating to railway engineering (called *Transport engineering cluster*), covering all areas of railway engineering, and particularly in the 5th and final year, the *Transport engineering cluster* provides two pathways:

- Option 1: Systems Design
- Option 2: Operation and Maintenance

The pilot implemented by ESTACA within STAFFER concerned the 5th and final year of the degree programme in "Transport engineering" / pathway "Systems Design" through the design and realisation of the two new modules in "Cybersecurity" and the "Internet of Things (IoT)".

These two modules are described in the next sections. Instead, the full description of the programme in "Transport engineering" / "Systems Design" can be found in Annex III, section III.3.

5.4.2 Implementation

With reference to the 9 training programmes designed in WP4.5 for the six groups of occupational profiles identified in STAFFER, the "Railway systems engineering" at EQF level 7 was selected as the one that best reflected the training objectives of the programme in "Transport engineering" / "Systems Design".

Moreover, concerning the "fields/trends/skillsets" regarded as highly relevant for railway education and training programmes by STAFFER, those selected as relevant to the training aims of the course are as follows:

- Cybersecurity & Internet of Things (IoT)
- Big Data & Artificial Intelligence (AI)

- Global new energies & technologies
- Norms, standards and certification
- Communication
- Soft skills

Among these subjects, which will continue to be implemented also after the end of STAFFER, the one selected for the pilot was "Cybersecurity & Internet of Things (IoT)".

In fact, as part of STAFFER, ESTACA offered two modules on "Cybersecurity" and the "Internet of Things (IoT)" aimed at providing the skills and knowledge needed to work in the transport industry in general and rail in particular. These modules covered a wide range of topics from technical aspects to management, safety and maintenance. The following is a general overview of the components of the two courses.

Cybersecurity

This hands-on course introduces the basics of computer security and network hacking. It consists of practical work with a minimum of theoretical background. Several practical examples are offered to students to enable them to understand the challenges of the security of systems using computers.

The first part of the practical work is devoted to computer attacks. These can take many forms, ranging from simple online attacks to sophisticated cyberattacks. Students are made aware of attacks, on the server side, on the client side and outside the local server and the hacking of websites with.

The second part of the practical work focuses on offensive cybersecurity, covering topics such as social engineering, post-exploitation, and access maintenance.

Internet of Things (IoT)

The second course covers several aspects, ranging from the basic concepts of IoT to their specific application in the industry in general and rail in particular, with an overview of the challenges and opportunities related to this integration.

The module focuses on two main axes. On the one hand, it explores the Internet of Things (IoT) in depth by examining wireless sensor networks (WSNs) with a focus on their applications, structure and roles. It also offers in-depth details on the IPv6, 6LoWPAN, CoAP, and MQTT protocols, which are essential for cloud computing.

On the other hand, the course is dedicated to vehicle-to-vehicle networks, addressing Vehicle-to-Everything (V2X) and wireless technologies, while analysing routing, safety issues and

simulation approaches. The labs enrich the learning by covering the manipulation of the Contiki-NG operating system, wireless use under Contiki-NG, as well as the implementation and performance evaluation of an ad hoc V2X application (IEEE 802.11p) under real-time Linux. Several other examples deal with IoT in smart cities and a large part is devoted to intelligent transport, namely:

- Smart building structure equipped with advanced systems.
- Monitor and optimize the energy consumption of trains by analysing real-time consumption data.
- Anticipate equipment failures through the continuous collection of data on critical components (engines, brakes, wheels, signalling systems).
- Track train conditions in real time, such as speed, temperature, brake wear, or excessive vibrations.

5.4.3 Common study material

The course material was produced in French. An English summary of the teaching material, presented in the form of slides, can be found in Annex IV, section IV.3.

5.4.4 Conclusion

The two implementations described above achieved their objectives and received a very good overall rating from the students who participated in the survey (see Annex III, section III.3).

Both courses provided comprehensive coverage of the fundamental concepts of cybersecurity and a broad understanding of IoT principles and applications in the field of mobility in general and rail transport in particular, while allowing students to acquire practical and theoretical skills.

5.5 SGH – Postgraduate course in "Organisation of extra-urban public transport"

5.5.1 Introduction

SGH Warsaw School of Economics is a leading economic university in Poland, ranked in FT European Business Schools, member of CEMS The Global Alliance in Management Education. During the last years our activity included i.e. dedicated postgraduate studies for PKP Intercity and DB Cargo Poland management staff (over 100 students).

Two postgraduate programmes have been developed by the SGH Warsaw School of Economics as part of the STAFFER project:

1. **Organization of Extra-Urban Public Transport** – This program was approved by the SGH Senate on November 29, 2023. The first cohort, consisting of 30 participants, began on 20 April 2024, and has currently completed the first semester. The second cohort, with approximately 20 participants, will start on September 21, 2024.
2. **Railway Manager** – Approved by the SGH Senate on July 3, 2024, this program has not yet started, as focus has been directed toward the second cohort of the Organization of Extra-Urban Public Transport program.

Since the Postgraduate course in "Organisation of extra-urban public transport" has already been delivered for the first of the two semesters, this programme has been adopted as a pilot project and is described in more detail in the following sections, especially with regard to the teaching material produced and its evaluation by the students.

Postgraduate studies in Poland are classified at EQF Level 7, designed for professionals. These programmes span two semesters, comprising 160 hours of workshops and lectures, and require 30 ECTS credits of workload. While these programmes do not confer degrees (such as Bachelor's, Master's, or Ph.D.), participants must hold at least a Bachelor's or Engineer's degree. The programmes must be approved by a university's senate. Since these studies are often co-financed by employers, less emphasis is placed on introducing participants to potential new employers compared to other educational programmes.

As the first cohort of the Postgraduate course in **Organization of Extra-Urban Public Transport** completed its first semester, produced teaching material and was evaluated by the students, this programme was adopted as a **pilot** project and is described in more detail in the following sections.

The **Organization of Extra-Urban Public Transport** postgraduate program addresses the growing issue of social exclusion in Poland due to inadequate suburban transport. Its main objective is to develop managerial staff for public transport systems outside urban areas. This includes training organizers for interregional, regional, county, municipal, and county-municipal passenger transport. Graduates of the program will be equipped to create and manage attractive public transport systems for passengers in suburban and rural areas.

A partnership has been established with the Association of Polish Counties to promote the program and gather input on its content. Additionally, SGH graduate and Arriva Bus Poland manager, Jakub Burdziński, has visited all classes to gather feedback. An informal pizza and beer event was also organized after the first semester to encourage further feedback.

The lecturers include Arriva Bus Poland, Association of Polish Counties, PKS Gdynia, PTC Public Transport Consulting professionals and SGH staff.

The **Railway Manager** program aims to develop a managerial staff for the railway sector, providing comprehensive knowledge of the economic, technical, and legal aspects of railway operations. The program places a strong emphasis on understanding the full scope of railway activities, including passenger transport, freight, and infrastructure management.

While the program is original, it builds on collaborations with PKP Intercity and DB Cargo Poland that began in 2015, as well as on SGH's cooperation with PKP Polskie Linie Kolejowe SA, the Polish railway infrastructure manager.

Both postgraduate programmes include exams covering all subjects, as well as final presentations with a defence component. A minimum of 70% attendance is required for successful completion.

Finally, in addition to the two postgraduate programmes described above, a single 3 ECTS course on **Sustainable Mobility Management** has also been designed as part of the STAFFER project. The course has not yet been implemented but is part of SGH's training offering for the 2024/2025 academic year. The aim of the course is to provide sustainable mobility management knowledge and skills to students interested in transport, mobility an urban planning topics.

5.5.2 Implementation

5.5.2.1 Postgraduate program in Organization of Extra-Urban Public Transport

With reference to the 9 training programmes designed in WP4.5 for the six groups of occupational profiles identified in STAFFER, the "Rail transport engineering" at EQF level 7 was

selected as the one that best reflected the training objectives of the Postgraduate course in Organisation of extra-urban public transport.

Moreover, concerning the "fields/trends/skillsets" regarded as highly relevant for railway education and training programmes by STAFFER, those selected as appropriate to the training aims of the course are as follows:

- Transportation systems
- Transversal skills in railways (Communication and Soft skills)

The course syllabus and related teaching materials were designed and implemented in the light of the content proposed by STAFFER programme "Rail transport engineering" at EQF level 7 in with reference to the following modules:

- Transport economics
- Company Management
- Project and team Management
- Communication theory and practice

The main objective of the studies is to build a managerial staff for public transport (other than urban communication) – in particular, the staff of organizers of interprovincial, provincial, county, municipal, and county-municipal passenger transport.

Specific objectives of the studies include:

- providing knowledge and developing skills related to management sciences (e.g., project management, marketing management, team management), essential for managing both project and permanent teams organizing public transport;
- providing specialist knowledge necessary for contracting operators, obtaining financing within the framework of the Bus Transport Development Fund (FRPA) as well as investment grants.

As a result, the staff trained under the study program will be able to create and develop attractive public transport systems for passengers outside cities, thus contributing to combating transportation exclusion, social inclusion, and promoting low-emission and energy-efficient public transport. The following tables show the general topics of the course (Table 9), the technical (Table 10) and soft skills (Table 11) that students can acquire and, finally, the detailed syllabus (Table 12). The full course description can be found in Annex II, section II.5.1.

TABLE 9: SGH POSTGRADUATE PROGRAM IN "ORGANISATION OF EXTRA-URBAN PUBLIC TRANSPORT" - GENERAL TOPICS

No.	Description
W1	Elements of management theory relevant to the organization of public transport systems (PTS) – particularly in the areas of marketing management, project management, and leadership.
W2	Principles of organizing PTS networks.

W3	Legal basis for the activities of PTS organizers.
W4	Methods and sources of PTS financing along with their implications for transport organization and enterprises.

TABLE 10: SGH POSTGRADUATE PROGRAM IN "ORGANISATION OF EXTRA-URBAN PUBLIC TRANSPORT" - TAUGHT TECHNICAL SKILLS

No.	Description
U1	Launch PTS in a municipality, county, or province.
U2	Prepare and conduct the procedure for selecting a PTS operator.
U3	Lead the process of obtaining external financing to co-finance the PTS system.
U4	Manage a PTS system, especially by shaping the PTS offer according to marketing management principles.

TABLE 11: SGH POSTGRADUATE PROGRAM IN "ORGANISATION OF EXTRA-URBAN PUBLIC TRANSPORT" - TAUGHT SOFT SKILLS

No.	Description
K1	Be a leader or member of a team managing the PTS system.
K2	Cooperate with the operator to efficiently organize PTS.
K3	Recognize and consider the needs of different PTS stakeholders.

TABLE 12: SGH POSTGRADUATE PROGRAM IN "ORGANISATION OF EXTRA-URBAN PUBLIC TRANSPORT" - SYLLABUS

No.	Subject / Thematic block	Practical Hours	Theoretical Hours	ECTS Points
1	Inaugural lecture	0	2	0
2	Legal conditions for PTS operation	12	12	5
3	Bus transport technology and market	4	4	1.5
4	Railway transport technology and market	8	8	3
5	Management of a transport company's finances	8	4	2.5
6	Sources of PTS financing	4	4	1.5
7	PTS infrastructure	4	4	1.5
8	Network planning and organization of transport	16	12	5.5
9	Negotiation training	12	4	3.5
10	Project and team management	19	5	5
11	Marketing management	6	4	2
12	Seminar	4	0	1

5.5.2.2 Postgraduate program in Railway Manager

Although this program has not yet started and therefore cannot be considered as a pilot project, it has already been designed and can be described as follows.

The studies are aimed at the current and future management staff of companies in the railway sector – including employees of operators, infrastructure managers, regulators, and suppliers.

The main objective of the studies is to build a management staff for railways that will comprehensively understand the economic, technical, and legal conditions of railway companies' operations and actively use modern management tools. A strong emphasis will be placed on

understanding the entire spectrum of railway activities (passenger carriers, freight carriers, infrastructure), which will facilitate mutual understanding among employees of various departments and enable so-called "horizontal promotions." Another important aspect of the studies is shaping ethical attitudes in business and developing personal and social competencies.

Specific objectives of the studies include:

- shaping managerial knowledge and skills (especially for individuals with technical and legal education);
- providing the legal basis and regulatory framework for the organization of railways;
- supplementing technical knowledge (familiarizing with modern technologies and current solutions – also useful for individuals with technical education).

The following tables show the general topics of the course (The full course description can be found in Annex II, section II.5.2.

Table 13), the technical (Table 14) and soft skills (Table 15) that students can acquire and, finally, the detailed syllabus (Table 16). The full course description can be found in Annex II, section II.5.2.

TABLE 13: SGH POSTGRADUATE PROGRAM IN "RAILWAY MANAGER" - GENERAL TOPICS

No.	Description
W1	Selected management science theories, particularly in strategic management, team management, project management, and managerial accounting.
W2	Selected economic theories regarding the organization and operation of rail transport.
W3	Principles of logistics and mobility systems operation and the role of railways in these systems.
W4	Legal and regulatory basis for the operation of railways in the European Union and Poland.

TABLE 14: SGH POSTGRADUATE PROGRAM IN "RAILWAY MANAGER" - TAUGHT TECHNICAL SKILLS

No.	Description
U1	Participate in the creation of a railway company's strategy.
U2	Participate in managing a passenger or freight carrier's product, identifying customer needs, co-creating attractive offers to meet them, and determining the costs of satisfying those needs.
U3	Use the data resources available to the railway company and interpret them in line with the latest achievements in management science.
U4	Carry out assigned tasks with an understanding of technical possibilities, the efficiency of typical solutions, and in compliance with railway market regulations, understanding the conditions under which they were created.
U5	Critically evaluate solutions used in other railway companies and creatively implement them.

TABLE 15: SGH POSTGRADUATE PROGRAM IN "RAILWAY MANAGER" - TAUGHT SOFT SKILLS

No.	Description
K1	Consciously and empathetically, but also critically, collaborate with employees from other departments and divisions of the railway company and other railway companies.
K2	Manage a team and consciously participate in teamwork (project team or permanent organizational unit), understanding the diversity of character and competencies of other participants in the project or team members, but also critically addressing inappropriate actions.
K3	Adapt well to other roles in the railway sector - in case of horizontal or vertical promotion or when changing jobs.

TABLE 16: SGH POSTGRADUATE PROGRAM IN "RAILWAY MANAGER" - SYLLABUS

No.	Subject / Thematic block	Practical Hours	Theoretical Hours	ECTS Points
1	Inaugural lecture	0	2	0
2	Digital transformation	2	2	0.5
3	Strategic and marketing management	16	8	5
4	Project, team, and change management	22	10	7
5	Communication, negotiation, and presentation training	20	4	5
6	Managerial accounting	4	4	1.5
7	Economic regulations of rail transport in Poland	4	4	1.5
8	Organization and marketing of passenger transport	8	8	3
9	Organization and marketing of freight transport	8	8	3
10	Management and regulations concerning railway infrastructure	8	8	3
11	EU funds in rail transport	4	4	1.5
12	Seminar	4	0	1

5.5.2.3 Single course on Sustainable Mobility Management

The aim of the course is to provide sustainable mobility management knowledge and skills to students interested in transport, mobility an urban planning topics. This includes i.a. the concepts of sustainable development and mobility, foundations of spatial planning, and transport management. The course will be based on the Sustainable Urban Mobility Plans concept, adopted by the European Commission and currently required in order to get EU support for urban transport investment in the TEN-T nodes. The course also considers specific issues connected with the digital transformation, as a chance to reduce transport demand, gain better data and improve user friendliness of public transport. The course will be offered within the project to the foreign and Polish students.

The main topics covered in the course will be as follows:

1 The idea of Sustainable Mobility
2 Spatial planning in Sustainable Mobility
3 Transport infrastructure planning
4 Railway public transport management
5 Urban public transport management
6 Rural public transport and Demand Responsive Transport management
7 Mobility as a Service, shared transport services and digital transformation of transport
8 Bikeability and walkability
9 Sustainable Urban Mobility Plans - designing research and participation
10 Electromobility and its efficiency
11 Transport and emissions modelling
12 Green and urban logistics
13 New means of managing transport demand
14 Presentation of case studies (1)
15 Presentation of case studies (2)

The full course description can be found in Annex II, section II.5.3.

5.5.3 Common study material

As part of the teaching material produced for the new Postgraduate course in "Organisation of extra-urban public transport", the following three lectures were selected as common teaching material:

- Technology and market of bus transport.
- Network planning and transport organisation.
- Financing of transport operation and FRPA (Bus Transportation Development Fund) settlement.

The teaching material was produced in Polish, but an English summary of all lectures delivered as part of the course can be found in Annex IV, section IV.4.

5.5.4 Conclusion

Currently, the first cohort has completed its first semester, and a survey was conducted among students and faculty. The course received generally positive feedback from the students who filled in the evaluation questionnaire. More specifically the course received very good scores in both the overall evaluation (88.10 out of 100) and on the final question “Would you recommend this course to your friends and family?” (99.00 out of 100). Although some improvements have been made for the second cohort. The full results of the evaluation survey can be found in Annex III, section III.4.

5.6 UASSP – Innovation and the European Railway Mindset

5.6.1 Introduction

One of the key themes running through the STAFFER project is the need to develop training and education programmes that support cross-border railway transport. The theme's importance is made clear by its selection as one of the three key pillars in the STAFFER long-term railway sector skills strategy (STAFFER D7.1). Pillar 3 of the skills strategy called specifically for activities designed to facilitate transformation from a national to European mindset in railways.

In STAFFER Task 4.4 specific ideas were developed for training and education activities in the field of cross-border railways, communication and language. In terms of academic programmes Task 4.4 developed a list of 11 categories of academic program and a total of 32 specific courses which could be offered in these categories. The list is "intended to serve as a source of ideas for universities and other higher education institutions" (Deliverable 4.4: Template Academic Modules).

The prototype course being developed at the St Pölten University of Applied Sciences (UASSP), **Innovation and the European Railway Mindset**, most closely fits into the first category: guest lecture as part of a study course. The guest lecture in this case is a set of three medium-length video presentations which could be used in many existing and future academic and training programmes. The prototype course is consistent with the four specific courses are listed in the guest lecture category and therefore should be a useful resource for future academic programmes.

The prototype is designed to be a set of educational materials placed online for use by teachers, trainers and other interested parties designed to introduce the concept of an integrated "European" railway system (as opposed to a set of "national" systems) and encourage participants to think about innovation can be used to create such a system.

The course contains:

- Video lectures presenting the content
- Additional information, references, and ideas for using the content (web pages)
- Course evaluation survey (online)

An initial version of the course was developed as part of the STAFFER project by the St Pölten University of Applied Sciences working in close cooperation with other STAFFER partners and interested outside parties.

A prototype version of the course will be available for use in the autumn semester (October 2024). The prototype will be three approximately 20-minute video lectures with some of the

online material. The prototype will be evaluated in October 2024 and made available on the internet.

5.6.2 Course Outline

The prototype will consist of three approximately 20-minute lectures:

Lecture 1: Introduction

- About the course
- What is innovation? A general overview.
- Exercise: identify and discuss innovations

Lecture 2: Railway as a Disruptive Innovation

- The railway innovation (history of railway development)
- Exercise: Are they disruptive innovations? (maglev, hyperloop,)

Lecture 3: Innovation for Cross-border Railways

- Problem Statement: Supporting a European Railway Mindset
- Tools for a European Railway Mindset
- Exercise: Develop ideas for using innovation to support a European Railway Mindset.

5.6.3 Course Focus

The course objective is to introduce the concept of innovation and encourage students to consider how innovation could be used to support a European Railway Mindset. Here the focus is on "mindset" which is taken to mean "way of thinking and acting". This mindset is designed to encourage students to think like entrepreneurs focusing on how technologies and social systems are implemented rather than the traditional engineering approach of focusing on technology development. The focus on entrepreneurial thinking was chosen because many courses already teach students about developing technology, and because a key problem in cross-border railways is implementation – we already know many of the strategies, we just don't implement them to the degree we "should".

The course describes innovation at a very general level. It is designed to encourage students to think about the building blocks needed to implement changes to railway systems by looking at the history of railways and considering the success or lack thereof for several transport related innovations. The course is only intended to give students an overview, we hope interested students will pursue the subject in more detail.

5.6.4 Course Use

The course is designed to be flexible. The videos can be shown in class or assigned to students in advance, and then discussed by the instructors. Exercises are optional. The railway history might be used in a history class. The videos could be useful for training programmes as well as academic programmes.

5.7 UNIGE – Master of Science in "Safety engineering for transport, logistics and production"

5.7.1 Introduction

The pilot implemented by the University of Genoa concerns the Master of Science in "Safety Engineering for Transport, Logistics, and Production" (EQF level 7), which is a two-year programme equivalent to 120 ECTS. The course is delivered in English and can be attended with a bachelor's degree in engineering equivalent to 180 ECTS, and an adequate knowledge of the English language equivalent at least to the B2 level.

The course is designed to provide students a high level of advanced training, to enable graduated students to operate in the following areas related to safety engineering:

- transportation systems,
- logistics,
- industrial production,

so as to realise the acquired ability to conceive, plan, design and manage complex, innovative systems and processes, with particular attention to safety aspects.

With reference to railway topics, these are covered in two modules.

The first module is "Rail Transport", which is a compulsory 5 ECTS module. Its aim is to provide the basic knowledge about the characteristics of rail transport systems both from the technical and functional point of view. A focus on the relevant sustainability is also provided.

The second module is "Sustainable Rail and Road Infrastructure", which is an elective 6 ECTS module. The aim of the course is to provide knowledge regarding the design and management of rail and road infrastructure with a particular reference to the application of innovative technologies and sustainability aspects. New trends such as automation and digitalisation are addressed focusing on users' perspective and acceptability.

These two modules were both chosen for the implementation of the STAFFER project, which is described in the next sections. Instead, the full description of the MSc in "Safety Engineering for Transport, Logistics, and Production" can be found in Annex II, section II.10.1.

5.7.2 Implementation

With reference to the 9 training programmes designed in WP4.5 for the six groups of occupational profiles identified in STAFFER, the "Rail transport engineering" at EQF level 7 was selected as the one that best reflected the training objectives of the MSc in "Safety Engineering for Transport, Logistics, and Production".

Moreover, concerning the "fields/trends/skillsets" regarded as highly relevant for railway education and training programmes by STAFFER, those selected as relevant to the training aims of the course are as follows:

- Big Data & Artificial Intelligence (AI)
- Global new energies & technologies
- Norms, standards and certification
- Reliability, maintenance and life cycle management
- Safety, dependability, security
- Transportation systems

Among these subjects, which are already covered in the course, it was felt that the following three topics needed to be further developed:

- Rail energy management
- Sustainable and green rail transport
- Railway market regulation and liberalisation framework

through the implementation of the two specific lesson cycles, which are described below.

5.7.2.1 Sustainable Powertrains and Green Mobility in Rail Transport

This course was implemented with the collaboration of Prof. Khaled Itani from CNAM (Conservatoire National des Arts et Métiers), who gave a series of lectures, for a total of 11 hours, as part of the "Rail Transport" module mentioned above.

Rail transport stands as a highly secure and eco-friendly mode of transportation, playing a pivotal role in accomplishing the strategic objectives of smart, green, and sustainable transport systems outlined in the European Green Deal and the 2030 Climate Target Plan, with the ultimate goal of establishing Europe as the first climate-neutral continent.

With railways anticipated to serve as the backbone of the entire European transportation network, this course addressed the technical challenges that arise in response to the future sustainability and green mobility strategy.

More specifically, the course provided an introduction to energy transition and energy storage systems in rail, covering the following topics:

- Energy transition and environmental aspects of rail transport
  - Understanding energy transition and sustainability in the rail sector
- Introduction to electrotechnical and energy storage systems in rail
  - Overview of electrotechnical systems in rail transportation

        - Exploration of energy storage and supply systems in railways
    - Sustainable rail energy management
        - Introduction to electric traction and motors
        - Fundamentals of traction power in rail transport

In conclusion, this course offered an in-depth understanding of energy transition and sustainability in the rail sector, focusing on energy storage and supply systems for electric traction. By the end, students were able to gain a solid comprehension of new energy storage technologies, electrical traction systems and sustainable energy management strategies in modern railways.

5.7.2.2 Design and modelling of the "track access charges system" for the use of rail infrastructure

This course was implemented with the collaboration of Prof. Mirjana Bugarinovic from UB (University of Belgrade), who gave a series of lectures as part of the "Sustainable Rail and Road Infrastructure" module mentioned above.

The main goal of the course was to provide learners with the basic elements needed to design to and modelling the track access charges system for the use of the infrastructure, which is one of the instruments for the regulation of the railway market and open access to the railway infrastructure.

Indeed, the introduction of competition on the railway infrastructure required, in addition to the restructuring of the historical railway companies, the introduction of completely new market regulation instruments that did not exist in the monopoly era. One of them is the track access charges for the use the railway infrastructure.

In more detailed, with these restructuring of railway, the railway infrastructure ceases to be only a technical system and a cost category in the traffic management and operation of rail service. It becomes a special system which should be managed on a commercial basis. Now operators have to pay the access charges for railway infrastructure use to infrastructure managers. At the same time, these charges represent the infrastructure managers' instrument for achieving business operations efficiency.

Knowledge of the concept of track access charges (TAC), the historical development of strategic documents that led to the introduction of TAC, the legal framework that regulates the area of TAC as well as its basic solutions, classification of infrastructure services to be supplied to the train operators, economics principles for determining TAC as well as the structure of TAC will

enable students to understand one of the essential instrument for the transport services market regulation on the infrastructure.

The detailed course syllabus is outlined below.

1. Introductory part on track access charges: Between limitations (regulations) and freedom in determining track access charges: (TAC) (2 hours)
    - Why TAC for the use of the railway infrastructure appeared
    - What are the limitations arising from EU legislation and why there is still great freedom in determining the model and level of TAC
    - What is the problem with defining the model and the level of TAC
    - Why charges and not prices, fees
2. System of the track access charges: (2 hours)
    - Services to be supplied by the infrastructure manager
    - Service/TAC system with elements within them. - Directive 2012/34- annex II;
    - Examples of TAC systems and how to "read" them (Italy, Montenegro as a country with small railway network, one country with medium-sized railway network)
3. Economic principles for setting track access charges for the minimum access package. (2 hours)
    - General approaches and principles for TAC definition
    - A brief presentation each of the economic principles
    - Selection of TAC principles
    - Overview of TAC principle's choices in Europe.
4. Structure of track access charges (1) – THEORY (1 hour)
    - What does the term track access charge's structure mean? (What is TAC structure?)
    - What to charge: capacity or infrastructure wear and tear?
    - Importance and impact of fee structure on train operators
    - Development of the TAC structure. Overview of the TAC system in EU countries
5. Structure of track access charges (2) – REVIEW (1 hour)
    - Classification of TAC structure
    - Overview of TAC structure for EU and non-EU countries (for 2021)
    - Development of the TAC structure (from 2010 onwards)
6. The difference in TAC levels in the EU - why is it so? (1 hour)

- Levels of TAC for a standardized average freight and passenger train (given for a recent date)
- Changes in the amount of TAC: When and how

7. Practical work 1 (1 hour)

- Modelling of charges for a small railway network, example of the Montenegro railway network (modelling and dilemmas)

5.7.3 Common study material

As part of the implementation of this pilot VET, both the course **Sustainable Powertrains and Green Mobility in Rail Transport** and course **Design and modelling of the "track access charges system" for the use of rail infrastructure** produced common teaching materials were produced.

Regarding the course **Sustainable Powertrains and Green Mobility in Rail Transport**, part of the produced common teaching material was also used in part for the Summer School described in Section 5.10. This is attached to the present Deliverable in the section dedicated to the Summer School (Annex IV, section IV.10), while attached to the section dedicated to the present pilot project implemented by UNIGE (Annex IV, section IV.5) are the slides from the last lecture of the course on the "Sustainable rail energy management".

About the course **Design and modelling of the "track access charges system" for the use of rail infrastructure** a summary of the introductory can be found in Annex IV, section IV.4.

5.7.4 Conclusion

The two implementations described above achieved their objectives and received an overall very good rating from the students who participated in the survey (see Annex III, sections III.5 and III.6).

In particular, by attending the course on "Sustainable Powertrains and Green Mobility in Rail Transport" students were able to gain valuable insights into the cutting-edge advancements in sustainable rail energy management, which are propelling the railway industry towards enhanced sustainability and green mobility solutions.

Finally, the course on the "Design and modelling of the track access charges system for railway infrastructure" provided students with knowledge of a fundamental tool for the rail transport services market regulation, which can play an important role in supporting modal shift towards more sustainable modes of transport within the European Union.

5.8 UNIROMA1 – Master of Science in "Transport Systems Engineering"

5.8.1 Introduction

The Master of Science in "Transport Systems Engineering" (EQF level 7) is a two-year programme equivalent to 120 ECTS. The course is delivered in English and can be attended with a bachelor's degree preferably in engineering equivalent to 180 ECTS. The course is designed to provide students with high-level knowledge and skills to enable them to perform and manage a wide variety of activities related to the planning, programming, operating, monitoring transport systems and their components.

The programme covers all modes of transport through 4 compulsory modules related to core transport disciplines, each of them equivalent to 12 ECTS, and a number of other modules, including 2 compulsory modules related to integrative disciplines and 11 elective modules related to transport disciplines.

Within the Master's programme, railway transport is covered almost exclusively in the "Railway Engineering" module, which is a compulsory 12 ECTS module, and was therefore chosen for the implementation of the STAFFER project.

The module in "Railway Engineering" aims at providing students with basic elements of knowledge concerning the railway transport system and the educational elements to study the railway complex system operation, as well as the design criteria of infrastructure, vehicle and operation itself.

The other module chosen for implementation is "Public Transport Management", which is a 6 ECTS elective module, which aims at providing students with a basic knowledge of both rail and road-based public transport systems along with the educational elements for studying the operation and management of public transit and the design criteria related to vehicles and services.

The implementation of these two modules, according to the findings of STAFFER's WP4, is described in the following section, while the full description of the MSc in "Transport Systems Engineering" can be found in Annex II, section II.11.1.

5.8.2 Implementation

With reference to the 9 training programmes designed in WP4.5 for the six groups of occupational profiles identified in STAFFER, the "Rail transport engineering" at EQF level 7 was selected as the one that best reflected the training objectives of the MSc in "Transport Systems

Engineering", although the approach of the course is to provide its graduates with a sound knowledge of basic railway technology in order to enable them to interact effectively with specialist railway engineers with the goal of solving the issues that may arise during transport system planning and operations. For this reason, the Master's programme contains common topics that STAFFER's WP4.5 developed for the training programme "Railway systems engineering" at EQF level 7.

Moreover, concerning the "fields/trends/skillsets" regarded as highly relevant for railway education and training programmes by STAFFER, those selected as relevant to the training aims of the course are as follows:

- Norms, standards and certification
- Reliability, maintenance and life cycle management
- Safety, dependability, security
- Transportation systems

The implementation of these topics took place within the two modules mentioned above ("Railway Engineering" and "Public Transport Management") and is described below.

It is worth noting that, although within the MSc the general aspects of safety engineering are covered by the 6 ECTS compulsory module "Safety and Risk Analysis", it was considered appropriate to include some specific aspects of railway safety in the implementation.

5.8.2.1 Railway Engineering

The implementation of this module consisted of the revision of its syllabus and related teaching material in the light of the content proposed by STAFFER in the following modules:

- programme "Railway systems engineering" at EQF level 7 – modules "Fundamentals of railway engineering" and "Advanced elements of railway engineering";
- programme "Rail transport engineering" at EQF level 7 – modules "Integrated rail transport services", "Rail transport reliability" and "Rail transport regulations".

The syllabus has been structured in two parts, the first relating to railway infrastructure and operation, the second to railway vehicles, and is shown in the Table 17 below.

TABLE 17: UNIROMA1 MSC IN TRANSPORT SYSTEMS ENGINEERING – REVISED SYLLABUS OF THE "RAILWAY ENGINEERING" MODULE

"Railway Engineering" Module – Syllabus outline
Part 1 - Railway Infrastructure and Operation
IN0 - Historical introduction and educational aims
IN1 - Infrastructure and superstructure
IN2 - Timetable definition and train composition
IN3 - Signalling functions and typologies

"Railway Engineering" Module – Syllabus outline
IN4 - Train integrity equipment and level crossing protection IN5 - Station layouts IN6 - Station interlocking systems IN7 - Criteria and methods for maintenance IN8 - Operation regularity IN9 - Lines operation IN10 - Simple nodes operation IN11 - Complex nodes operation IN12 - Stations capacity calculation IN13 - Marshalling yards IN14 - Metro systems IN PROJECT WORK 1 - Calculation of maximum speed along curves IN PROJECT WORK 2 - Determination of horizontal and vertical transition curves IN PROJECT WORK 3 - Timetable design IN PROJECT WORK 4 - Signals positioning IN PROJECT WORK 5 - Minimum headway and capacity calculation by UIC 405 method IN PROJECT WORK 6 - Station routes schematisation, occupation and interdiction times calculation IN PROJECT WORK 7 - Traffic assignment and station capacity calculation IN TECHNICAL VISIT 1 - Roma San Pietro station
Part 2 - Railway Vehicles VE0. Getting to know each other; learning objectives and syllabus; rail sector companies VE1. Vehicle types and architecture VE2. Wheel-rail contact VE3. Vehicle lateral dynamics on straight and curved track VE4. Suspension systems and vertical dynamics VE5. Running quality VE6. Longitudinal dynamics VE7. Commercial speed VE8. Electric Traction VE9. Diesel Traction VE8. Braking System

5.8.2.2 Public Transport Management

The implementation of this module consisted of the revision of its syllabus and related teaching material in the light of the content proposed by STAFFER in the following modules:

- programme "Rail transport engineering" at EQF level 7 – modules "Rail safety and security management", "Rail transport regulations", and "Transport economics".

In particular, specific aspects of railway safety were implemented through a lecture by the visiting professor Danijela Barić from the University of Zagreb, which dealt with design and safety aspects of level crossings, and a lecture on the tram-train.

This mode of transport was also chosen because it constitutes a very interesting case study for highlighting interoperability issues between two different railway infrastructures (an urban tramway and a conventional suburban railway).

Interoperability in rail traffic management was addressed in a lecture by another visiting professor, prof. Juraj Čamaj from the University of Žilina, while the liberalisation of rail passenger transport was addressed in his colleague's lecture, prof. Jaroslav Mašek.

Finally, a technical visit to the operating rooms of the main Italian infrastructure manager (RFI) and the main passenger railway undertaking (Trenitalia) allowed the students to experience first-hand the real-time management of rail transport.

The module syllabus, updated as described above, is shown in Table 18 below.

TABLE 18: UNIROMA1 MSC IN TRANSPORT SYSTEMS ENGINEERING – REVISED SYLLABUS OF THE "PUBLIC TRANSPORT MANAGEMENT" MODULE

"Public Transport Management" Module – Syllabus outline
• Public transport system and its environment: decision-making problems, system layout, price elasticity of demand, consumer surplus. • The physical, operational, and economic-financial dimensions of public transport. • Public transport: classification and characterization of rail and road-based transport modes, main non-conventional transport systems. • Fundamentals of transit line operation: headway, frequency, stop spacing, load factors, fleet size. • Public transport performances: capacity, productivity, efficiency. • Customer-oriented transport management: the concepts of accessibility and comfort. • Public transport costs appraisal in a twofold perspective: operating costs, transit fare levels and structures; the generalized transport cost. • Fundamentals of mechanics of locomotion: rolling, rotational and translational motions of the wheel, friction and adhesion phenomena, resistance forces. • Traction characteristics of a land vehicle; ideal traction characteristics, stability of traction characteristics. Motion Equations and diagrams. • **The tram-train system: technical interoperability and safety issues.** • **Level crossings: design and safety issues (prof. Danijela Barić - University of Zagreb - Faculty of Transport and Traffic Sciences).** • **Liberalisation of passenger transport, open access, focus on Slovakia and Czech Republic (prof. Jaroslav Mašek, University of Žilina - Department of Railway Transport).** • **Railway traffic management system in the conditions of the Slovak infrastructure manager; actual problems with TAF TSI in Slovak conditions (prof. Juraj Čamaj, University of Žilina - Department of Railway Transport).** • **Technical visits to Guided visit of Trenitalia and RFI operation control rooms.** • Role game: assessment of possible solutions (road and rail-based) and selection of the optimal choice according to the best "trade-off" (technical – economic – environmental) to connect 2 zones, separated by a distance of 20 km, of an urban area affected by phenomena of vehicle congestion, through a new Public Transport line.

5.8.3 Common study material

As part of the implementation of this pilot VET, several common teaching materials were produced. All teaching material of the "Railway Engineering" module, consisting of the slides of

all lectures, is attached to this Deliverable and can be consulted in Annex IV, section IV.7. Regarding the "Public Transport Management" module, the slides of the "Tram-train system" lecture can be found in Annex IV, section IV.8.

5.8.4 Conclusion

The two modules described above were implemented as pilot projects in the academic year 2023/2024: the "Railway Engineering" module in the first semester (September to December 2023) and the "Public Transport Management" module in the second semester (February to May 2024). The first, as a compulsory module, was attended by 31 students, of whom 16 responded to the evaluation questionnaire. The second, which is an optional module, was attended by 9 students, of whom 8 participated in the evaluation survey.

Both these modules achieved their objectives and received an excellent overall rating from the students who participated in the survey: 92.12 out of 100 for the "Railway Engineering" module and 93.75 out of 100 for the "Public Transport Management" module. The full results of the evaluation survey, aimed at both students and teachers, can be found in Annex III, sections III.7 and III.8.

5.9 UNIROMA1 – Post-Master course in "Railway Infrastructure and Systems Engineering"

5.9.1 Introduction

The postgraduate course in "Railway Infrastructure and Systems Engineering" is an annual course (the actual duration is 9 months), equivalent to 60 ECTS. Course entrance requirements are to have both a bachelor's and a master's degree in engineering, the first issued after a 3-year course equivalent to 180 ECTS and the second issued after a 2-year course equivalent to 120 ECTS. Any degree in engineering is admissible (transport, civil, environmental, mechanical, electrical, electronic, chemical engineering, etc.).

The course is designed to provide young engineers with the highest possible systemic know-how in the railway sector and in general in transport systems, through a multidisciplinary training which joins together technical, legal and economic subjects, since a railway engineer should be able to face both the specific topics and the connections between railway system components in order to optimize the whole system performances.

This demonstrated to encounter the needs of a large set of railway companies, such as infrastructure managers, freight and passenger train operators, industries providing rail systems, subsystems and components, public and private bodies planning investments, endorsing certifications, etc.

For this purpose, the course is articulated in:

- 13 modules (all equivalent to 4 ECTS, except 2 which are equivalent to 2 ECTS) with theoretical lessons, seminars, tests and technical visits (at the end of each module students have to pass an exam);
- a work experience of at least 250 hours (equivalent to 6 ECTS) at one of the partner Companies;
- a final examination (equivalent to 6 ECTS).

As can be seen in the table below, the 13 teaching modules cover a very wide range of topics in the field of railway engineering as a mark of the multidisciplinary of the course.

TABLE 19: UNIROMA1 POST-MASTER COURSE IN "RAILWAY INFRASTRUCTURE AND SYSTEMS ENGINEERING" - CONTENTS OF TEACHING MODULES

Module's title	Module's content	ECTS
1. Principles of railway engineering	In this module students are provided with the fundamental elements necessary to face in a profitable way the study of railway infrastructure and systems and to understand the technical and economic peculiarities and operating dynamics (interaction between components) of rail transport-	4

Module's title	Module's content	ECTS
2. Railway track and fixed installations	The aim of this module is to provide students with the basic elements of the railway track, fixed installations for electric traction, signalling and telecommunications.	4
3. Traction systems and vehicle dynamics	The aim of this module is to provide students with the basic elements of traction systems on board of railway vehicles and vehicle dynamics.	4
4. Infrastructure design and construction	The aim of this module is to provide students with an overview of the main aspects of the design and construction of rail infrastructure.	4
5. Railway traffic technology	The aim of this module is to provide students with principles and rules that govern railway traffic, carrying capacity of lines and stations, command, control and signalling systems.	4
6. Management of railway safety	The aim of this module is to provide students with theoretical principles of safety, risk analysis and its applications to rail transport, Safety Management Systems of railway operation developed by the different actors of rail transport (Infrastructure Mangers and Railway Undertakings), technologies to ensure the safety of both railway lines and rolling stock.	4
7. Passenger and freight terminals	The aim of this module is to provide students with theoretical principles underlying the dimensioning and design of passengers and freight railway stations, also with reference to interchange design and modal integration; case studies related to new stations, the upgrading of existing and the transformation of disused railway areas.	4
8. Freight transport and logistics	The aim of this module is to provide students with the basic elements of logistics, techniques of freight transport with particular reference to rail and multimodal transport, information systems to support rail freight transport, international regulations for the transport of dangerous goods.	4
9. Service planning and quality	The aim of this module is to provide students with the theoretical principles underlying the planning of transport systems in general and railway systems in particular, the timetable planning, quality management principles and their applications to rail transport; operational management of the rail traffic; rail transport costs assessment.	4
10. Railway works planning and legislation	The aim of this module is to provide students with the main technical, regulatory, procedural, and administrative issues related to the planning, design and construction of new transport infrastructures with a view to integrated mobility.	4
11. Economic and Environmental impact assessment of railway projects	The aim of this module is to provide students with main technical and legislative issues underlying the economic and environmental impact assessment of railway projects.	2
12. Economics and Soft skills	The teaching objectives of the module are to provide, in a concise and concrete manner, useful information to develop a basic knowledge and awareness of the economic-financial dynamics of a company and to develop sensitivity to the main soft skills (principles of communication, negotiation and persuasion techniques, public speaking, team working and time management) required to work in a company.	2
13. Exchange of internship experiences	In this module, students present the work they made during the period of internship at one of the Companies which support the Course to the other students, the Academia and Corporate Tutors and the HR Managers of partner Companies. Then they respond to any questions of their colleagues and others in the room.	4

The Post-Master course in "Railway Infrastructure and Systems Engineering" (Master di II livello in "Ingegneria delle Infrastrutture e dei Sistemi Ferroviari") is taught in Italian, although some lectures may be in English.

Peculiarities of this programme, resulting as key success factors are:

- Close collaboration with companies supporting the course: customising the contents of the modules, collaborating to selection of participants, teaching activities and examination of students, hosting technical visits and internships, issuing scholarships for students;
- High flexibility: the presented scheme of the course, based on a 9-month full time formula, equivalent to 60 ETCS, is modular by the definition and easily adaptable to needs of supporting companies, e.g. through the selection and specialisation of modules, adapting the formula to specific needs in terms of duration, entry requirements of participants, intensity of training activities;
- High placement rate: natural consequence of the two previous points, which makes Railway Engineers from this course very attractive for companies supporting the course, which can invest on them after a period of reciprocal knowledge and professional integration, as well as for other companies beyond them.

In particular, the close cooperation between universities and partner companies in designing and teaching the courses is ensured by the fact that each teaching module has at least two coordinators, one from academia and one from industry, who together define the module programme, choose the lecturers and examine the students at the end of the module.

5.9.2 Implementation

With reference to the 9 training programmes designed in WP4.5 for the six groups of occupational profiles identified in STAFFER, the "Railway systems engineering" at EQF level 7-8 was selected as the one that best reflected the training objectives of the Post-Master course in "Railway Infrastructure and Systems Engineering".

Moreover, concerning the "fields/trends/skillsets" regarded as highly relevant for railway education and training programmes by STAFFER, those selected as relevant to the training aims of the course are as follows:

- Norms, standards and certification
- Reliability, maintenance and life cycle management
- Safety, dependability, security
- Smart cities and smart station design
- Transportation systems
- Transversal skills in railways (Soft skills)

The implementation of these topics took place within the 13 modules mentioned above and is described below.

The implementation of the course consisted of the revision of its syllabus and related teaching material in the light of the content proposed by STAFFER programme "Railway systems engineering" at EQF level 7 with reference to the following modules:

- Fundamentals of railway engineering
- Advanced elements of railway engineering
- RAM (Reliability, Availability, Maintainability) applications for railway systems
- Asset management and LCC
- Rail safety management
- Risk analysis
- Technical norms
- National and European Regulations
- Standards for rail "control-command and signalling" systems
- BIM for rail infrastructure & Smart station design
- Soft skills for railway systems engineers

The implementation concerned the A.Y. 2023/2024 edition of the Course, which is organised by Sapienza University of Rome, in cooperation with 13 Companies (Almaviva, Alstom, BPS Deployment, ETS, Ferrotramviaria Engineering, Ferrovie dello Stato Italiane, For.Fer, GCF, Hitachi Rail, IDOM, Salcef Group, Siemens Mobility, ZF) of which 4 are STAFFER partners: Alstom, FS, Hitachi Rail and Siemens.

The course started on 26 February 2024 and the lectures of the first 12 teaching modules ended on 5 July 2024. The students will finish their internship on 11 October, will carry out the "Exchange of internship experiences" module at the end of October and will conclude the course with the final examination on 8 November 2024.

Therefore, the table below already shows the syllabus for the first 12 teaching modules, which was updated as described above.

TABLE 20: UNIROMA1 POST-MASTER COURSE IN "RAILWAY INFRASTRUCTURE AND SYSTEMS ENGINEERING" - REVISED SYLLABUS OF THE FIRST 12 TEACHING MODULES

Module 1. Principles of railway engineering (4 ECTS – 40 hours)
• Introduction and basics of railway engineering • The network, vehicles and railway staff • The railway organisation. The railway market and its rules. • Locomotion of rail vehicles • Rail vehicle running diagram and performance

- Architecture of railway vehicles
- Diesel and electric traction systems
- Focus on railway electric motors
- Laws of vehicular outflow in linear and point installations
- Schematisation of transport supply and demand
- Group Work 1: running diagram of a train on a given section of line
- Group Work 2: setting a train timetable and calculating the theoretical capacity of a railway line
- Educational visit to the RFI railway station of Roma Tuscolana

Module 2. Railway track and fixed installations (4 ECTS – 40 hours)

- Fixed installations for electric traction
- Design of fixed installations for electric traction
- Fixed installations for signalling and telecommunications
- Fixed installations for level crossings
- Railway superstructure, track components, switches and crossings
- Thermal stresses of continuously welded rail track
- Track laying and renewal
- Track inspection and maintenance
- Principles of railway asset management
- Group Work 1: voltage drops in overhead power contact lines
- Group Work 2: analysis of the static and dynamic behaviour of different types of railway superstructures

Module 3. Traction systems and vehicle dynamics (4 ECTS – 40 hours)

- Introduction to the course. Evolution of scientific thinking on railway traction. The railway system
- Rail vehicle kinematics and running dynamics: simplified calculation models
- Wheel-rail interaction
- Railway bogies: technical evolution, design and type testing. References to type approval regulations
- Tilting trains: tilting system characteristics and dynamic behaviour
- Advanced test and diagnosis systems for mechanical systems in rail vehicles
- Railway rolling stock maintenance: failure analysis, experience returns, FMEA, FMECA and FRACAS method, CBM and Asset Management
- Exercise on principles of electrical engineering and electronics for railway traction
- Railway electric traction: technical evolution and regulations, traction converters. High speed in Italy: technical evolution, concentrated and distributed power. Design and validation of a traction system
- Mechanical characteristics and thermal regimes of traction motors: calculation models
- Train Control Management System: system evolution, command and control unit, management software, "type testing" and "soft train". Architecture and functions of the tele-diagnostics system
- On-board signalling, telecommunications and passenger information systems
- Educational visit to the Trenitalia rolling stock maintenance plant in Firenze Osmannoro

Module 4. Infrastructure design and construction (4 ECTS – 40 hours)

- Railway line layout design
- Cartography. Measurement of track geometry
- Track definitions. Railway curve design
- Standards on track geometry
- Tracing and correction of railway lines
- Railway infrastructure design
- Design and construction issues of railway bridges
- Design and construction issues of railway tunnels
- Design and construction issues of embankments, trenches
- Hydraulic issues of railway lines
- BIM & Information Management in Railway Design
- Geotechnical monitoring of railway lines
- Infrastructure verification and monitoring

- Organisation of construction sites
- Group Work: design of a railway line layout
- Educational visit to construction sites of the new Napoli-Bari high-speed railway line

Module 5. Railway traffic technology (4 ECTS – 40 hours)

- Introduction.
- Principles of railway traffic management in stations. Entry and exit routes
- Simple nodes operation and capacity calculation
- Principles of traffic management on railway lines
- Train spacing. Blocking systems. Signalling. Line capacity calculation
- Interlocking: functions, operating times and effects on rail traffic
- Interlocking types: mechanical, electro-mechanical, electronic/computer-based
- Types of computer-based interlocking systems
- Software safety criteria for rail command, control and signalling systems
- Italian Railway Operating Regulations - RCF: principles, ordinary operation, degraded operation
- Italian Railway Signalling Regulations
- Line/station signalling: ERTMS L1, L2, L3 moving block systems and technologies. Functional and technological aspects
- Line signalling systems. Italian automatic train protection systems SCMT and SSC: functional and technological aspects. ERTMS applications in RFI railway network
- Safety and control systems in fully automated metros: CBTC signalling system
- Educational visit to RFI computer-based interlocking at Roma Termini station
- Educational visit to Alstom "command, control and signalling systems" laboratory in Rome
- Group Work 1: interlocking reliability
- Group Work 2: operating logic of a switch

Module 6. Management of railway safety (4 ECTS – 40 hours)

- Introduction to Risk Analysis Models: glossary, definitions
- Risk Analysis Models and acceptance criteria
- Principles of Safety. Safety as measurable performance
- Risk analysis in RFI: infrastructure monitoring for risk analysis and railway safety management
- European and national regulatory framework of the Safety Management System (SMS)
- Evolution of targets and methods in the European and national regulatory framework
- The Single Safety Certificate and the SMS of a Railway Undertaking: the Trenitalia example
- The Safety Authorisation and the SMS of an Infrastructure Manager: the RFI example
- Trenitalia's system for the acquisition and maintenance of skills for railway operators with safety roles
- Insight into some SMS processes: internal auditing, management review, management of interfaces with external parties
- Regulatory framework and design requirements for railway vehicle safety
- Process for application for authorisation for placing in service: vehicle safety risk analysis
- Group Work 1: quantitative risk analysis of a railway tunnel
- Group Work 2: error hunting in an SMS manual
- Group Work 3: Trenitalia Risk Analysis and Assessment
- Educational visit to Trenitalia train driving simulator at Roma Sana Lorenzo maintenance facility

Module 7. Passenger and freight terminals (4 ECTS – 40 hours)

- Station layouts
- Functions and basic diagrams of transit and overtaking stations
- Functions and basic diagrams of junction stations, crossing stations and terminus stations
- Complex nodes operation
- Stations capacity calculation and dimensioning
- Marshalling yards
- Freight terminals. Container and semi-trailer transhipment facilities
- Passenger stations: functional and design issues

- The renewed centrality of railway stations in RFI's business strategy
- Railway station management
- The investment process for railway station maintenance and renovation
- Stakeholder engagement
- Railway station accessibility
- Railway stations as urban mobility hubs
- Group Work: dimensioning a track bundle
- Educational visits to the RFI railway stations of Roma Tiburtina and Roma San Pietro

Module 8. Freight transport and logistics (4 ECTS – 40 hours)

- The main concepts of logistics. Logistics systems. Main trends
- Challenges of the logistics market
- Communicating Logistics: messages, tools and stakeholders
- Case study: the effects of the pandemic on global logistics systems
- Transport modes, transport nodes and market areas in Europe
- Case study: freight transport on the Barcelona - Civitavecchia route
- Prospects and criticalities of rail freight transport in Europe
- Case study: optimising the fashion logistics system
- City Logistics
- Case study: Hotel logistique in Paris
- Supply Chain supporting Trenitalia's rolling stock maintenance activities
- The Mercitalia Pole: the role of the Logistics Holding in the FS Group
- The national and international regulatory framework and funding opportunities for the railway sector
- Mercitalia's international strategy and the challenge of sustainability
- Mercitalia Rail and the freight railway undertakings in Italy
- Planning and scheduling of the commercial offer of rail freight transport
- Asset management of rolling stock
- The evolution of professional skills in the logistics sector
- Digitalisation, innovation, technological challenges in logistics
- Projects for the digitisation of the rail vehicle fleet and operational processes in Mercitalia Rail

Module 9. Service planning and quality (4 ECTS – 40 hours)

- Rail transport planning
- Rail infrastructure capacity allocation
- Transport demand models
- Intelligent Transport Systems for integrated mobility
- Design of the railway timetable: technical and commercial constraints
- Planning of maintenance work on railway lines with an impact on the railway timetable
- Design of the railway timetable from the railway undertaking's point of view
- Designing a timetable for multimodal transport
- Rail fleet and crew planning
- Punctuality of rail services calculation
- The services of the infrastructure manager to passengers and railway undertakings
- Service quality measurement indicators
- Quality management systems
- Cost evaluation in rail transport
- Sustainability and innovation in urban transport
- Sustainability and innovation in rail transport
- Educational visit of RFI traffic control centre at Roma Termini station
- Educational visit of Trenitalia and RFI operation control rooms

Module 10. Railway works planning and legislation (4 ECTS – 40 hours)

- Railway and transport planning in Italy from after the Second World War to the present day
- The planning of urban and metropolitan railways
- The implementation of innovative transport systems in urban areas

- Sources of financing for the realisation of railway infrastructure
- From planning to design and contracting: public procurement rules
- The technical-economic feasibility project
- The final project
- Consensus on the realisation of works: from project to public debate
- The Public Contracts Code for the awarding of Services and Works
- Planning, programming and design phases of tenders
- Public works implementation systems. Types of contracts
- Construction management, testing, site safety
- Project management
- Authorisation for the placing in service of fixed installations (trackside control-command and signalling, energy and infrastructure subsystems)

Module 11. Economic and Environmental impact assessment of railway projects (2 ECTS – 20 hours)

- Introduction to impact assessment. Balance of the environmental system and externalities
- Life cycle and environmental capacity of railway transport systems
- Guidelines for sustainable design of rail vehicles: eco-design criteria
- Environmental regulation and sustainability. The management of excavated soil and rocks in RFI projects.
- Noise from transport infrastructures: National and EU regulatory framework. RFI's National Noise Remediation Plan and action plan under the European Directive.
- Criteria for drafting acoustic studies and designing mitigation measures. Vibrations produced by rail traffic.
- Energy consumption and emissions of rail transport
- Railway systems and ecological footprint. Carbon footprint simulation
- Group Work 1: calculation of the energy consumption of a metro train with different driving styles
- Group Work 2: calculation of energy consumption and emissions for international freight transport over 1000 km

Module 12. Economics and Soft skills (2 ECTS – 20 hours)

- Benefit-Cost Analysis. Multi-criteria analysis
- Tools for assessing economic sustainability:
    - an application case: the definition of a railway infrastructure project
    - financial indicators for monitoring a business unit
    - from industrial planning to financial planning in railway infrastructure
    - key efficiency indicators
- From Economics to Performance Management: an application case
- Working in a railway company. Mind setting
- Top skills required by railway companies
- From values to acted behaviour: application in a multinational transport company

5.9.3 Common study material

As part of the implementation of this pilot VET, several common teaching materials were produced. A summary of the teaching material for the 12 modules described above, presented in slide form, can be found in Annex IV, section IV.9.

5.9.4 Conclusion

The implementation concerned the A.Y. 2023/2024 edition of the Course, which was attended by 17 students, who all responded to the evaluation questionnaire.

The course achieved its objectives and received a very good overall rating (86.76 out of 100) from the students who participated in the survey and an excellent score of 97.06 out of 100 on the question “Do you think this course will be beneficial for your job, professional aspirations or academic pursuits?”.

Very good results also come from the survey addressed to the teachers (for each of the 12 teaching modules the questionnaire was filled in by a coordinator) and the survey addressed to the organiser, which show the strong professional vocation in the railway sector of the course.

Unfortunately, it has not yet been possible to submit the questionnaire to the in-company supervisors, because at the time of the release of this deliverable, the students are still doing their internship in the company, which will end on 11 October 2024.

The full results of the evaluation survey can be found in Annex III, section III.9.

5.10 STAFFER – Summer school on "The European Railway System"

5.10.1 Introduction

As mentioned above, in addition to the pilot VETs implemented individually by the various Universities, the STAFFER partners designed and implemented the pilot of a summer school on "The European Railway System".

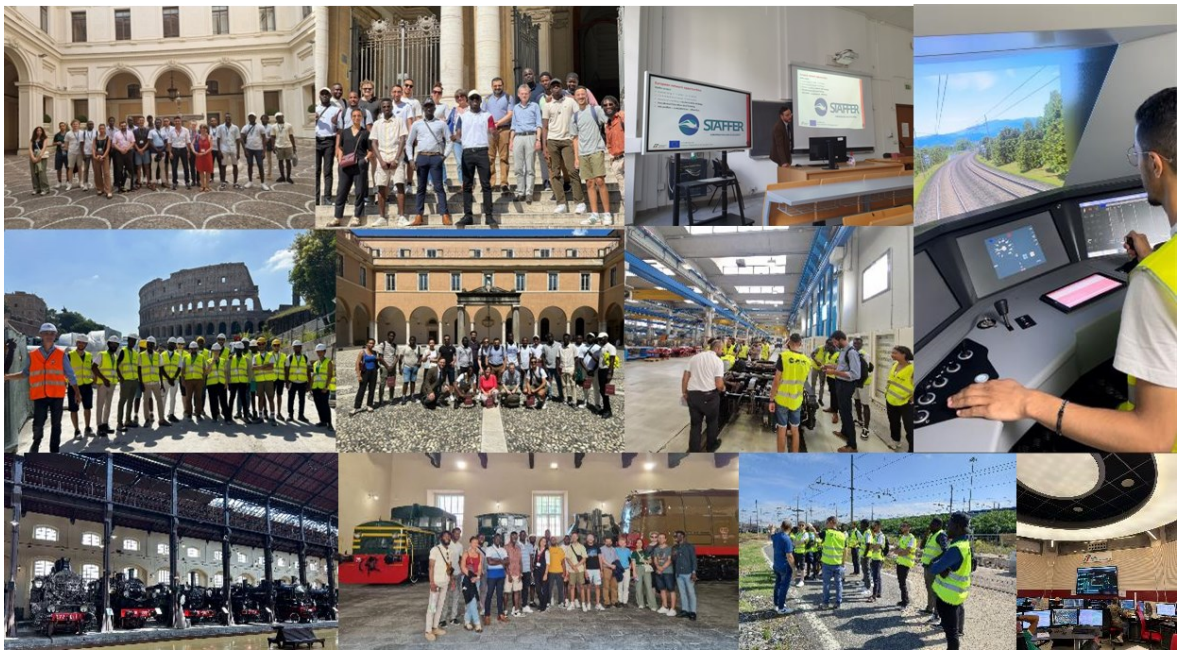
The aim of this initiative, which is expected to become an annual event beyond the STAFFER term, is to provide university students from different backgrounds with a systemic view of the European rail transport and instil in them a passion for this sector.

A kind of dress rehearsal for the summer school was the **Signalling Systems mobility programme** designed and implemented, at EQF level 7, by UNIROMA1 expressly for a group of 17 students in Electronic Engineering - Specialisation Railway Signalling from Le Cnam.

The mobility programme, organised in close cooperation between UNIROMA1 and CNAM, was held in Rome from 26 June to 5 July 2023 and included lectures held by Sapienza professors, seminars by representatives of FS Group and technical visits organised in collaboration with various companies. Some photos from the course are shown in Figure 2, while the full programme can be found in Annex II, section II.11.2.

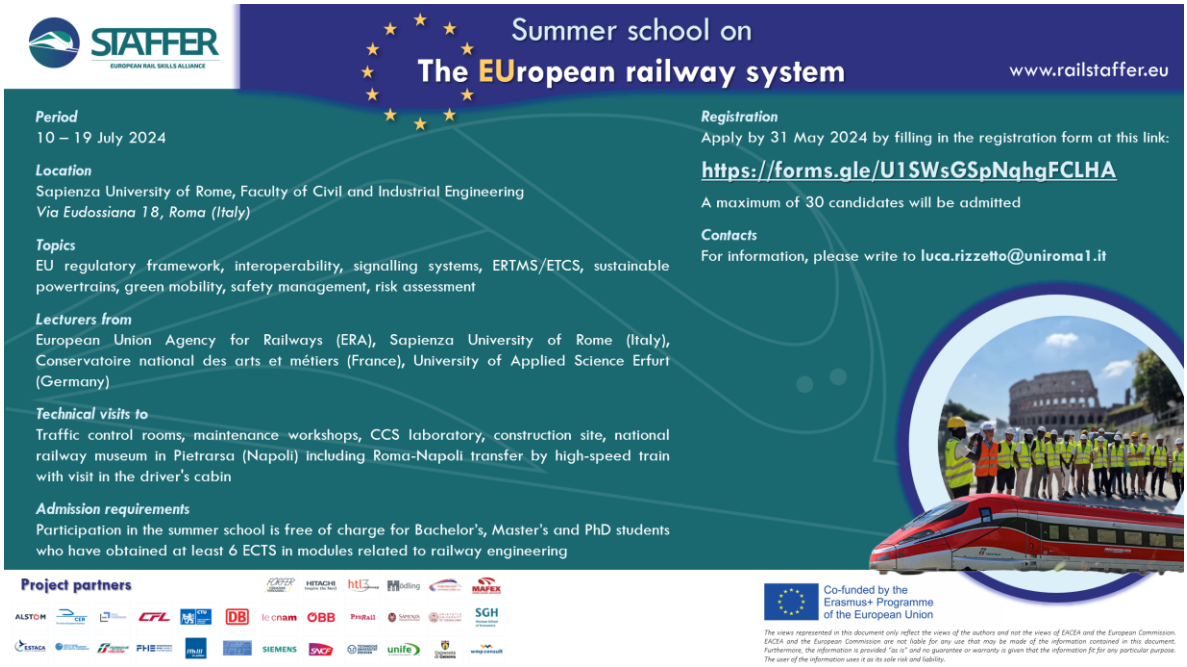
The initiative aimed to provide Le Cnam students with a comprehensive understanding of signalling systems in the railway industry, with a focus on the Italian context. Through seminars, guided tours and interactive sessions, participants gained valuable knowledge about the historical, technical and operational aspects of railway infrastructure in Italy.

FIGURE 2: PHOTOS FROM THE SIGNALLING SYSTEMS MOBILITY PROGRAMME – ROMA, JUNE - JULY 2023



Back to the Summer School, participation in the course was free of charge for students and open to Bachelor's, Master's and PhD students who have obtained at least 6 ECTS in modules related to railway engineering. The course was announced in April 2024 and the deadline for submitting applications was 31 May 2024 (see Figure 3).

FIGURE 3: THE CALL FOR APPLICATIONS OF THE SUMMER SCHOOL ON "THE EUROPEAN RAILWAY SYSTEM"



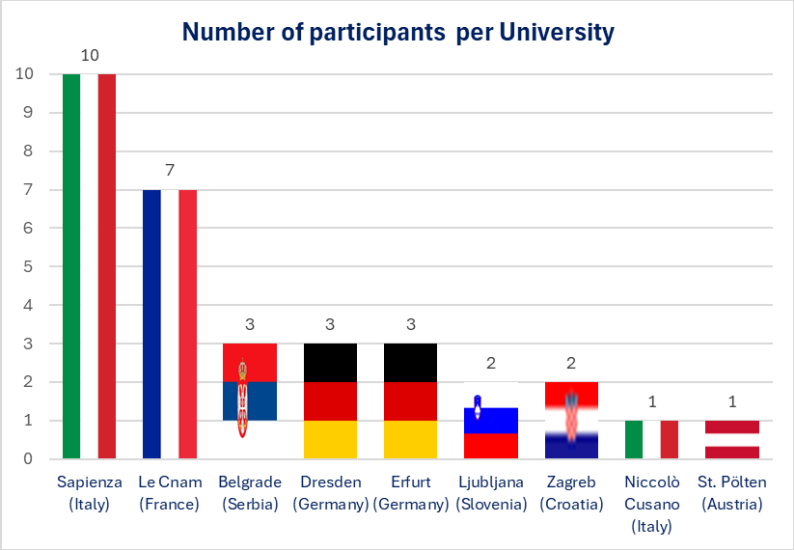
The initiative met with great interest as 55 applications were received from students from 7 European countries and 10 different universities.

Although the maximum number of students was set at 30 due to organisational issues, 32 students were admitted to the course due to a tie of 3 students in the admission ranking. The 32 students were from 7 countries (Italy, France, Germany, Austria, Serbia, Croatia, and Slovenia) and 9 universities, 6 of which are STAFFER partners (le Conservatoire National des Arts et Métiers of Paris, Dresden Technical University, the Universities of Applied Sciences of Erfurt and Sankt Pölten, the University of Belgrade and Sapienza itself), as can be seen in Figure 4.

Regarding the level of the students, 7 of them were Bachelor students, 20 Master students and 5 PhD students. As for their background, except for the seven Le Cnam students, who were all electrical engineering students specialising in railway signalling, the others almost all had a transport engineering background.

The course was organised by Sapienza University of Rome (UNIROMA1) and was held in Rome from 10 to 19 July 2024 with the participation of teachers of different STAFFER partners (CNAM, UASFHE, UNIGE and UIROMA1), the European Union Agency for Railway, FS, Alstom and Hitachi Rail for the organisation of educational visits.

FIGURE 4: UNIVERSITIES AND COUNTRIES OF ORIGIN OF STAFFER SUMMER SCHOOL STUDENTS



5.10.2 Implementation

With reference to the 9 training programmes designed in WP4.5 for the six groups of occupational profiles identified in STAFFER, the purpose of the summer school was not to cover one in particular, but to offer a course that would appeal to students with different types of backgrounds and instil to them a systemic vision of the railway sector and stimulate them to think not on a national but on a European scale. This objective was pursued both through lectures on the main topics common to all European railways and through the exchange of experiences that the students were able to have with both the professors and the managers of the companies that hosted them during the numerous educational visits organised, as well as with other students from different countries and with different backgrounds.

Moreover, concerning the "fields/trends/skillsets" regarded as highly relevant for railway education and training programmes by STAFFER, those selected as relevant to the training aims of the course are as follows:

- Global new energies & technologies
- Norms, standards and certification
- Safety, dependability, security
- Transportation systems

The implementation of these topics was done through a rich schedule of lectures and technical visits. Specifically, the programme will be introduced by the opening speeches of Angela Di Febbraro, professor at the University of Genoa and Coordinator of the STAFFER project, Luca Rizzetto, researcher and lecturer at the Sapienza University of Rome, and representatives of

STAFFER Italian partner companies, including Vito Pagliarisi of Ferrovie dello Stato Italiane, Marco Barale of Alstom and Pietro Marmo of Hitachi Rail.

The introductory lecture was given by Anna Gigantino, Head of the Analysis and Monitoring Unit of the European Union Agency for Railways (ERA), which provided participants with a general presentation on the construction of the European Union, the evolution of transport policies, Trans-European Networks (TENs), the Single European Railway Area (SERA), with a final focus on the main challenges for research and training in the European railway sector. All this to explain the 'raison d'être' of EU legislation and the role of the railway engineer in this historical, political, economic and social framework. The aim was to arouse the participants' interest in what their professional mission will be "in the big picture". Thus, a philosophical and motivational introduction, which stimulated the dialogue during the following social dinner.

FIGURE 5: PHOTO OF THE OPENING DAY OF THE SUMMER SCHOOL ON "THE EUROPEAN RAILWAY SYSTEM"

In the following day's lecture, again Anna Gigantino went into the technical details of European Railway System Interoperability, explaining the new approach to technical harmonisation, conformity assessment, Notified Bodies (NoBos), architecture and general principles of Technical Specifications for Interoperability, with some practical examples.

The following lecture, delivered by Riccardo Licciardello, researcher and lecturer at the Sapienza University of Rome, focused on railway signalling interoperability, through an overview of the historical evolution of railway signalling in Italy towards ERTMS/ETCS.

After these lectures on the topic "Norms, standards and certification", the next lecture, given by Marco Antognoli and Luca Rizzetto, both lecturers at Sapienza, dealt with the safety approach of the European railway system. More specifically, the lecture focused on the evolution of European Union legislation on railway safety, the Safety Management Systems of Rus and Ims, the European Common Safety Methods (CSMs), Common Safety Indicators CSIs and Common Safety Targets (CSTs). Finally, the Common Safety Method for risk evaluation and assessment methods.

In addition to the introductory speech by Angela Di Febbraro, who explained to the participants the aims and results of the STAFFER project, Prof. Stefano Ricci from Sapienza University of Rome provided an interesting overview of recent Erasmus+ projects on railway engineering education.

Finally, the topic of "Global new energies & technologies" was addressed by the two lectures given by Khaled Itani, professor at le Conservatoire National des Arts et Métiers of Paris, and by Michael Lehmann, professor at the University of Applied Science Erfurt. The first dealt with "Sustainable Powertrains and Green Mobility in Rail Transport", specifically exploring the following topics:

- Energy transition and environmental aspects of rail transport
- Introduction to electrotechnical and energy storage systems in rail
- Sustainable rail energy management

The second lesson, through a highly engaging exercise for the participants, provided a methodology to evaluate possible alternatives for converting rail diesel traffic to carbon-neutral traffic based on the specific railway application (type of traffic planned for the railway line to be converted).

In addition to theoretical lectures, the programme included several technical visits, to railway traffic control rooms, maintenance workshops, signalling system laboratories, construction sites and the Italian railway museum of Pietrarsa (Naples). The Summer School also offered socialising moments, such as a social dinner, a guided tour of the monuments of ancient Rome and a concluding interactive session with the students' individual impressions.

The complete summer school programme is given in Table 21 below.

TABLE 21: SCHEDULE OF STAFFER SUMMER SCHOOL ON "THE EUROPEAN RAILWAY SYSTEM" HELD AT SAPIENZA UNIVERSITY OF ROME FROM 10 TO 19 JULY 2024

STAFFER
EUROPEAN RAIL SKILLS ALLIANCE

SAPIENZA
UNIVERSITÀ DI ROMA

Summer School on "The European Railway System" at Sapienza University of Rome

SCHEDULE

Day	Time	Activities

Wednesday 10/07/2024	15-16.30	**Room 1 - Welcome event**
		• Introductory speeches by:
		  ○ Francesco Napolitano *(Sapienza University of Rome)*
		  ○ Angela Di Febbraro *(University of Genoa and STAFFER Coordinator)*
		  ○ Italian STAFFER partner companies: Vito Pagliarisi *(Ferrovie dello Stato Italiane)*, Pietro Marmo (*Hitachi Rail*), Marco Barale *(Alstom)*
		• Reciprocal presentations by students and teachers

	16.30-18.30	Room 1 - "A sustainable, safe European transport system without frontiers" – Anna Gigantino (*ERA - European Agency for Railways*)
	19-20.30	Faculty Cloister - Social dinner
Thursday 11/07/2024	9-13	Room 15 - "Interoperability of the European railway system" – Anna Gigantino (*ERA - European Agency for Railways*)
	15-18	Guided visit of RFI traffic control centre at Roma Termini station
Friday 12/07/2024	8-19	• Roma-Napoli transfer by high-speed train • Seminar on historical, cultural and touristic activities of Fondazione FS with a focus on the adaptation of historic rolling stock to modern control command and signalling systems • Guided visit of the historical-technical national railway museum in Pietrarsa • Transfer Napoli-Roma transfer by high-speed train
Monday 15/07/2024	9-13	Room 15 - "Historical evolution of railway signalling system in Italy towards ERTMS/ETCS" – Riccardo Licciardello *(Sapienza University of Rome)*
	15-18	Visit to Alstom "command, control and signalling systems" laboratory in Rome
	21-22.30	Forum of Caesar show: journey through ancient Rome
Tuesday 16/07/2024	9-12	Room 15 - "Safety management and risk assessment in European railways" – Marco Antognoli, Luca Rizzetto *(Sapienza University of Rome)*
	12-13	Room 15 - Railway Engineering Education in Europe: experiences from Erasmus+ projects, Stefano Ricci *(Sapienza University of Rome)*
	15-18	Guided visit of Trenitalia and RFI operation control rooms
Wednesday 17/07/2024	9-11	"Sustainable Powertrains and Green Mobility in Rail Transport" – Khaled Itani *(Le Cnam)*
	11-13	"Difficult choices – which alternative for which application?" – Michael Lehmann *(University of Applied Science Erfurt)*
	15-18	Guided technical visit of control centre and depot of the fully automated metro line C
Thursday 18/07/2024	9.30-17.30	Roma- Napoli Afragola transfer by high-speed train Guided visit to construction sites of the new Napoli-Bari high-speed railway line Napoli Afragola-Roma transfer by high-speed train
Friday 19/07/2024	9-13	Guided visit of Trenitalia maintenance facility and regional train dynamic driving simulator at Roma Smistamento
	14-16	Room 15 - Interactive session with individual impressions of students

5.10.3 Common study material

This Deliverable is accompanied by all the teaching material produced as part of the Summer School, which consists of the slides of all the lectures. They can be found in Annex IV, section IV.10.

5.10.4 Conclusion

The participants expressed high levels of satisfaction with the course content and structure, as reflected in their enthusiastic feedback. One student shared “This course has helped me to have a greater vision of railways, especially on the scale of the European Union”. Another remarked “This summer school has inspired me to apply for more such courses”. Another group of participants noted “we discovered a part of the railway we didn't know, as our formation primarily focuses on the technique of railway signalling. Thanks to the STAFFER program, we gained a global view of organizing the railway, whereas we are more specialized in day-to-day field maintenance”.

Both these modules achieved their objectives and received an excellent overall rating (89.58 out of 100) from the students who participated in the survey and a score of 96.88 out of 100 on the final question “Would you recommend this course to your friends and family?”. The full results of the evaluation survey can be found in Annex III, section III.10.

The success of the Summer School on the European Railway System demonstrates the importance of international collaboration in advancing railway education and highlights the critical role that such initiatives play in shaping the future of transportation in Europe.

6 CONCLUSION

The STAFFER project has made significant progress in establishing a skills alliance within the European rail sector. Task 6.6 specifically targeted the implementation of training programmes at EQF levels 6 to 8 (bachelor, master, PhD programmes) mainly on the basis of the programmes that were designed in task 4.5 to train three specific railway engineer profiles introduced to overcome the traditional subdivision in engineering disciplines and develop multi-disciplinary training that meets the skills needs of the different roles that engineers play in railway companies:

- the **Railway systems engineer** responsible for designing and planning the physical rail systems (both infrastructure and rolling stock).
- the **Rail traffic/operations engineer** responsible for designing and planning train control and operations.
- the **Rail transport engineer** responsible for the organisation of all the aspects of the rail transport system (infrastructure, rolling stock, and operations) into an efficient and effective transport system, also considering business aspects.

All the eleven STAFFER partners universities (AUTh, CESI, CTU, ESTACA, SGH, TUD, UASFHE, UASSP, UB, UNIGE and UNIROMA1) actively participated in the implementation by developing new courses or adapting existing ones. A total of 24 training programmes will be implemented, during or even after the end of STAFFER project.

Of the courses identified to be implemented, the eight that the partners organised in the academic year 2023/2024 were selected as pilot projects and, as such, produced common teaching material and were evaluated according to the methodology developed in Task 6.1. A ninth pilot project was the summer school on "The European Railway System" held at Sapienza University of Rome in July 2024 with the participation of teachers at different partner universities (CNAM, UASFHE, UNIGE and UIROMA1) and the collaboration of partner companies (FS, Alstom and Hitachi Rail).

This Deliverable begins with an overview of the key findings of Work Package 4, highlighting the educational needs and skills specific to the railway sector. The report then illustrates the evaluation methodology, describing the use of comprehensive questionnaires to assess the effectiveness of the programmes to be implemented. It also offers a detailed description of the 9 pilot programmes already implemented. In addition, the document includes an evaluation of these pilot programmes, focusing on participant satisfaction and learning outcomes.

The experience of the pilot projects confirms that close cooperation between the higher education institutions offering the courses and the railway industry is essential so that the courses can be designed and implemented to meet the skills needs of the railway sector and its

workforce. To this end, it is important that these programmes are high flexible to adapt to the new training needs of railway engineers, which change rapidly driven by the constant evolution of technology applied to the sector. This need clashes with the university course accreditation processes, that for bachelor's and master's degree courses are very complex and time-consuming, taking more than one academic year to set up, and therefore would need to be revised and speeded up.

Furthermore, it should be emphasised that the implementation carried out under task 6.6 already constitutes a considerable achievement in terms of training programmes capable of intercepting the present and future training needs of railway engineers. Indeed, given the resources available, STAFFER focused on the more technical job profiles, requiring engineering degrees.

New profiles related to administration, and management jobs, requiring other types of degree, could be added as the Railway Sector Skills Strategy is refined and improved in the future. To this end, it can be replicated the virtuous process of creating training programmes starting from an in-depth analysis, shared by all stakeholders, of the railway sector's training needs, which STAFFER has adopted for the implementation of its pilot programmes. This educational programme development process is clearly defined in task 7.3.

Finally, it should be noted that several initiatives carried out under STAFFER task 6.6, such as the summer school on "The European Railway System", the new course "Innovation and the European Railway Mindset" but also the standardised content and teaching materials created within the pilot projects, are also aimed at fostering the cooperation between higher education institutions and industry at European level for mobility programmes, which can shape a new class of high-level managers and technicians with a deep systemic vision of the European railway sector, capable of making a decisive contribution to the implementation of the Single European Railway Area.