CCAMERAS
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D5.2 Occupational profiles for educational instruments

February 2026

Deliverable No. 5.2 Educational instruments

Project Acronym		Grant Agreement #	Project Title	Deliverable Reference #	Deliverable Title
CCAM-ERAS		101147129	CCAM Employment Realisation through Acquisition of Skills	5.2	Educational instruments

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DISSEMINATION LEVEL

X	P	PUBLIC
	C	CONFIDENTIAL

Funded by the European Union

This project has received funding from the European Union's Horizon Europe programme, under grant agreement No 101147129.

Version History

Revision	Date	Authors	Organisation	Description
V0.1	26-02-2026	Karel Kans, Johan Coenen, Nick den Hollander, Maaike Koning, Anneke Westerhuis	CINOP	

Abbreviations

Abbreviation	Definition	Abbreviation	Definition
AV	Automated vehicle	OTA	Over the air
ADS	Automated driving system	PKI	Public key infrastructure
AGVs	Automated guided vehicles	PRO	Policy regulation officer
AI	Artificial intelligence	QA	Quality assurance
AR	Augmented Reality	ROCs	Regional operations centres
CCAM	Cooperative, connected and automated mobility	ROS	Remote operations specialist
EQF	European Qualification Framework	SDS	Self driving system
FSAs	First support Agents	SOP	Standard operating procedure
GIS	Geographic information system	TRL	Technology readiness level
HMI	Human machine interface	UI	User interface
ICT	Information and communication technology	UX	User experience
IT	Information technology	V2I	Vehicle to infrastructure
ITS	Intelligent transport systems	V2V	Vehicle to vehicle
KPIs	Key performance indicators	V2X	Vehicle to everything
ODDs	Operational design domains	VR	Virtual reality
OEMS	Original equipment manufacturers	VRU	Vulnerable road user
OT	Operational technology		

Executive summary

Enhancing the development of CCAM deployments in Europe, comes with human capital challenges. Based on a use case approach, this report provides a sound basis for the development of educational schemes and actions, that could address these challenges.

The six use cases cover a diversity of CCAM services in both passenger and freight transport: Ground transportation for last mile delivery; Bus depot; Port/terminal; Public (shared) transportation; Private (shared) transportation; Shared transportation targeting specific groups.

The use cases and evidence from other CCAM-ERAS deliverables indicate that the potential risk of unemployment due to CCAM deployment is not high, due to the tight European labour market. The use cases make clear what the challenges are in finding human capital to enhance CCAM deployment.

Between use cases, human capital needs seem to be rather similar. Human capital needs differ more based on the development phase of CCAM deployments. From the inventory of tasks that determine the work in the use cases, a longlist of twelve occupations was derived. The occupations were clustered based on both the phase of development as well as the kind of tasks.

Table 1: Occupations per cluster

Cluster	**Occupation**
CCAM operations	
Social, customer-oriented roles, including both general customer contact as well as incident handling	Customer Service Agents
Coordinating, analysing and monitoring of operations	Remote Operations Specialists
	AV Fleet orchestrators
Technical roles including maintenance	AV systems technicians and mechanics
	Safety drivers
Preparing and enabling CCAM	
Tasks related planning and preparing road infrastructure, (design, engineering, communication with digital infrastructure, training of infrastructure professionals)	AV road infrastructure cluster
Policy and regulations	Policy and Regulations officers
Conditional services: insurance underwriters, App interface developers & analysts	Insurance underwriters
	App interface developers & analysts
Developing CCAM systems	
Automotive AV system engineers AV system technicians / vehicle mechanics	AV systems engineers
Safety and security: compliance officers, AV cybersecurity specialists	Compliance Officers
	AV Cybersecurity specialists

This longlist shows a diversity of occupations: both technical (mechanics, engineers) and non-technical (customer services agents, drivers, legal and governance specialists, data scientists, etc.), and both for middle level educated and highly educated professionals.

Co-creation sessions and additional interviews gave further content to these occupations, insight in the background (work experience, education) of the professionals in these professions and in skills gaps between requirements and backgrounds. General profiles of longlist of occupations are included in this report. We can roughly distinguish between technical occupations (mechanics, engineers) and non- (or less-) technical occupations (e.g. customer services, legal and policy development professionals). The mechanics and engineers have a strong basis in formal, technical education and need to stay updated with fast developing technologies. These occupations could benefit from both adaptations in formal education as well as educational provision on new technologies via short courses.

Professionals in non-technical occupations need an extra layer of CCAM competences in addition to their core competences. Non-formal and informal ways of learning, like short courses, training-on-the-job and learning-by-doing could contribute to the development of the competences more than adaptations on formal training schemes.

Backgrounds of professionals working with new technologies and services are diverse. This means that a variety of learning pathways is needed to serve the diverse group of potential CCAM professionals. The formulation of learning outcomes is an important basis for the development of educational provision for the occupations at key positions in CCAM deployment. Learning outcomes describe the competences individuals should have for certain tasks or occupations.

Based on experts' inputs and validation, two occupations from the longlist were selected for further elaboration into occupational profiles with learning outcomes. The Remote Operations Specialist (EQF level 3) and the Policy & Regulation Officer (EQF level 6) are seen as occupations at pivotal positions. CCAM development would greatly benefit from the development of educational provision for these two occupations. Employers, sector organisations, governments and especially educational providers can develop tailored educational schemes that lead to the acquisition of competences laid down in these profiles. Furthermore, the longlist of occupations with general profiles can serve as a basis for further human capital development.

Contents

1 Introduction

1.1 Work package 5: developing tools for educational solutions

An essential element of CCAM-ERAS is to develop the necessary knowledge and prepare for the possibilities that potentially will arise from the deployment of CCAM. CCAM deployment creates labour market challenges. On the one hand, challenges refer to the availability of required competences within the work force to address skills needs that come along with CCAM deployments. On the other hand, the development of CCAM might lead to job losses and job relocations.

The starting point of work package 5 (WP5) lies in the use cases that were selected and described in WP3.[1] In each use case the labour market challenges and skills surrounding the deployment of CCAM are inventoried. This lies in the identification of tasks and occupations that are most crucial for new CCAM deployments. The aim is to provide actors on the labour market, like education providers or business associations, with a sound basis for the development of labour market policy and educational offer.

Both the use cases and evidence from other CCAM-ERAS deliverables indicate that the potential risk of unemployment due to CCAM deployment is not high, since the European labour market is, in general terms, characterised more by labour shortages than a labour surplus. In this report we therefore focus on the skills that are needed to support CCAM deployment.

1.2 General approach of work package 5

In this section we give the highlights of the approach used for this report. The approach is described in more detail in the following chapters. Of the each use case, that form the starting point of WP5, stakeholders were interviewed to determine relevant occupations, tasks, and skills needs.

A cross analysis over the use cases indicated the most prominent occupations, tasks, and competence needs. One of the major findings of this round of interviews was that tasks and occupations in all use cases show to a large extent similarity. Based on the use cases a **longlist of 12 relevant CCAM occupations** was selected and clustered, largely based on the CCAM value chain: developing CCAM systems; preparing and enabling CCAM deployment; operating CCAM.

In co-creation sessions in September 2025 content was gathered on the following topics:

- Developing the content of the clusters (task, occupations, competence needs)
- Background of professionals in the cluster (education, work experience)
- Skills mismatch
- Educational solutions

A first results of these sessions was the insight in the diversity of the backgrounds of professionals in CCAM occupations. This diversity requires multiple learning pathways. Drafting **profiles with learning outcomes** for the occupations with most urgent skills needs would offer a useful, long-lasting basis for the development of educational schemes.

[1] Deliverable work packages descriptions

Secondly, a further selection of profiles was made and brought into discussion in several rounds with stakeholders and experts. This led to a **selection of 2 occupations**, for which educational development was considered most urgent: **remote operations specialist** and **policy and regulations officer**.

1.3 Terminology

In this report, the terminology that is used to frame the work of professionals in CCAM is based on European Cedefop / ESCO framework. In this section we concretise how terminology is used.

A. **Task**: Specific actions or functions performed by a worker to complete duties.
B. **Occupation:** A grouping of jobs that involve similar tasks, duties, and skill requirements. Specific job titles can differ from name of the occupation. In this report we consider an occupation a cluster of CCAM tasks, identified in the use cases, which normally (but not necessarily) can be performed by one professional in a job.
C. **Competence:** ability to use knowledge, know-how, experience and – job-related, personal, social or methodological – skills, in work or learning situations and in professional and personal development. Competences are broader than skills. In this report, in chapter 2 and 3 we do not distinguish between knowledge and skills yet. In chapter 4 required competences will be broken down into skills, knowledge and autonomy, responsibility and complexity.
D. **Skill**: Ability to apply knowledge and use know-how to complete tasks and solve problems.

1.4 Reading and usage guide

How to read this report:

- Chapter 2 gives an overview of CCAM tasks, occupations and competences that were identified in the use cases.
- Chapter 3 shows generic profiles of 12 CCAM occupations (longlist).
- In chapter 4 two of these profiles are further developed into learning outcomes profiles.

How to use this report:

- The generic profiles presented in chapter 3 can serve as a starting point for educational providers, employers, sector organisations and other labour market stakeholders to take actions for labour market policy initiatives or consider and further develop training offerings.
- The learning outcome profiles in chapter 4 can be used directly by labour market stakeholders. Employers can use them for the professional development of their employees. Educational providers can build educational schemes based on these profiles. Based on learning outcomes, they can develop educational plans and activities. Apart from curricula for formal education, one could think of lifelong learning initiatives, like reskilling efforts to develop human capital in innovative mobility systems and services through education and training, flexible training pathways, including the use of micro credentials (the achievement and recognition of smaller parts of training pathways). This allows workers and job seekers to follow parts of training that are tailored to their needs and recognised by the sector.

How to use the information on occupational profiles provided in D5.2 and D5.3

- This project resulted in descriptions of profiles of twelve CCAM occupations, which are presented in this deliverable (D5.2). For two of these profiles, the Remote Operations Specialist and the Policy and Regulations Officer, the development of educational solutions is considered most urgent by stakeholders. For these occupations, core tasks and learning outcomes were developed in more detail in chapter 4 of this report.
- The profiles in chapter 3 contain challenges and solution approaches in general terms. In a subsequent validation round, these challenges and solutions were further elaborated in two webinars. For ten of the twelve occupations this generated additional, complementary information, which is documented in Deliverable 5.3 "Recommendations and conditions for success and further exploitation outside the context of the use cases". D5.3 therefore builds directly upon the profiles presented here and should be read alongside this deliverable.
- Stakeholders that wish to use the profiles for educational development are recommended to take the information in D5.2 as a starting point and use D5.3 as complementary information.

The table below shows, for each of the twelve CCAM occupations, where the profile description, the elaborated challenges and solutions, and, where available, the learning outcomes with EQF level indication can be found across D5.2.

Table 2: Overview of CCAM job profiles and corresponding sections in D5.2 and D5.3

Profile	Content of the profile	Challenges and solutions	Learning outcomes & EQF level indication
Customer Service Agents	D5.2, §3.2.1	D5.3	–
Remote Operations Specialist	D5.2, §3.2.2	D5.3	D5.2, §4.3
Fleet Orchestrator	D5.2, §3.2.3	D5.3	–
AV Mechanics & Technicians	D5.2, §3.2.4	D5.3	–
Safety Driver	D5.2, §3.2.5	D5.3	–
AV Road Infrastructure	D5.2, §3.2.6	D5.3	–
Policy and Regulations Officer	D5.2, §3.2.7	D5.3	D5.2, §4.4
Insurance Underwriters	D5.2, §3.2.8	D5.3	–

App Interface Developers & Analysts	D5.2, §3.2.9	D5.2, §3.2.9	–
AV Systems Engineers	D5.2, §3.2.10	D5.2, §3.2.10	–
Compliance Officers	D5.2, §3.2.11	D5.3	–
AV Cybersecurity Specialists	D5.2, §3.2.12	D5.3	–

2 Identifying occupations, tasks and skill needs

The goal of this chapter is to sketch the emerging occupations, tasks and skills needs in CCAM, building on information gathered in six use cases, both in freight transport and passenger transport. These use cases are:

- Ground transportation for last mile delivery
- Port and terminals
- Bus depot
- Public shared transportation
- Private shared transportation
- Transportation for specific target groups

The results provided in this chapter are based primarily on interviews with use case stakeholders and, additionally, on other CCAM-ERAS reports[2]. The use case approach allowed us to gather information on a variety of CCAM deployments. In this chapter we do not present an exhaustive overview of all occupations, tasks and competences related to CCAM deployment. We focus on what is most important for the further development and upscaling of the use cases. The available information differs per use case and should not be treated as a complete picture of each use case. All in all, the information does provide a thorough picture of the human capital challenges of CCAM deployments in general.

Use cases are described in the CCAM-ERAS reports *D3.3 Final selection of use cases* and *D5.1 Report analysing the impact of CCAM each use case*. Furthermore, evidence from both interviews with stakeholders in the use cases, as well as evidence on jobs coming from the *D3.2 Ad hoc Innovation Radar* report, is used to further elaborate on the occupations identified in the use cases.

For this chapter, emerging tasks, occupations and competences were inventoried. These results are listed in Annex 1 of this report. A cross analysis over the use cases provides anchor points for the further determination of needs for education and training for the next chapters. In the following sections we present the tasks, occupations and competences that appeared relevant in the use cases. The variety of CCAM deployments described in the use cases, provides a solid

[2] Clarke, M., C. Byrne, I. Kourounioti (2025) D5.1 Report analysing the impact of CCAM on each use case; Hermann, H.G., Sidorov, V., Wahl, R. (2026) D3.2 Brief ad hoc Innovation radar report.

basis for a robust general picture of human capital challenges related to CCAM. The information does not provide an exhaustive picture per use case.

2.1 Emerging tasks

In this section, we present a cross analysis of the relevant occupations in the six use cases. In Table 3, tasks in the use cases are thematically clustered. It becomes clear that tasks related to the operations of CCAM are prominent in all use cases. **Operational** tasks include:

- Overseeing vehicle movements and operations.
- Monitoring vehicle behaviour.
- Intervening and managing operations by using dashboards and handling systems, including handling in crisis situations.

These operational tasks are closely related to coordination tasks (fleet orchestration) and analytical tasks.

In the majority of the use cases **technical** tasks are mentioned. These tasks are mostly operational and related to the vehicles' systems, such as sensor calibration and its software diagnostics. But technical tasks also include contributions to system development and optimisation.

The importance of safety and security is reflected in tasks related to the work of the safety driver and cybersecurity, which includes testing of both the vehicle and software.

Tasks related to customer contacts are mentioned in some of the passenger transport use cases, but also in the last mile delivery use case. They are mostly related to assisting customers with special needs and to incident management.

The table below shows the information on tasks gathered in interviews with use case stakeholders, clustered per group of tasks. The table should not be understood as an exhaustive overview of tasks per use case. Also, tasks mentioned in one use case may be relevant for more use cases.

Table 3: Cross analysis of Tasks in use cases

	1 Last mile delivery	**2 Bus depot**	**3 Port/terminal**	**4 Public (shared) transportation**	**5 Private (shared) transportation**	**6 Transportation for specific groups**
(Remote) Operational tasks on CCAM-deployment.	**Oversee/supervise** vehicle operations (several AVs simultaneously) which includes monitoring surroundings and vehicle behaviour; respond to anomalies via digital systems and make safety calls; parcel loading.	**Monitor** and analyse vehicle behaviour.	**Remote operation** of quay cranes requiring interaction with human-machine interfaces from secure control rooms.	**Monitor and intervene** in AV operations from a centralised control centre.	**Monitor** and manage operations remotely, anticipate autonomous vehicle behaviour by monitoring both road traffic and live system feedback.	**Oversee** vehicle operations, monitoring vehicle behaviour and surroundings
			Oversee autonomous navigation in varied weather and operational conditions.	Provide **oversight** of automated vehicle fleets and supporting them during exceptions	**Intervene**: coordinate crisis response remotely across diverse data sources (vehicle telemetry, weather, bookings). Proactive customer intervention (incident management).	

				Handle escalations across mobility services		
				Handle more **advanced system supervision** roles, often involving dashboards, incident response tools, and mobility analytics		
Coordination /fleet management	**Coordinate and manage**. Coordinate routes and logistics across partially automated networks.		**Multimodal logistics flow coordination**, V2X integration, port-road synchronization, cross-border regulation alignment		**Coordinate**: fleet orchestration across operators	Supervision of mobility, **coordinate** routes and logistics across partially automated networks.
Analytical			**Analyse automated driving performance**, analyse infrastructure and V2X communication impacts, examine logistics process flows, regulatory requirements, and	**Interpret** rider behaviour, vehicle performance, and system-level patterns to optimise fleet operations and service design	**Assess** sensor reliability, traffic behaviour, and safety-critical events to ensure consistent autonomous operation. It also involves evaluating user behaviour, infrastructure readiness, data	

			ecosystem dependencies		flows, and regulatory implications	
Technical - operational	**Technical tasks**. AV-specific diagnostics, sensor calibration, vehicle preparation, retro fitting existing vehicles.	**Technical** tasks: maintain sensors, combine mechanics with systems and software, servicing.		**Technical** tasks are characterised by combining hands-on vehicle servicing with the ability to manage sensor systems, software updates, and diagnostics	**Technical tasks**: conduct sensor calibration, software diagnostics, and passenger interface verification.	
Systems development			**Systems** development: Optimizing AI-powered robotic systems		Continuous **software development**: provide real-time software performance input to engineering teams, vehicle training and software validation	
			Systems development Integration of AR and VR			
Cybersecurity					**Cybersecurity**: manage data governance and cybersecurity in cooperation with	

					public transport authorities	
Safety driving	**Safety driving**: ensure operational continuity and risk mitigation.				**Safety driving**, including secure operational safety and software testing	
Social domain, customer	**Direct customer interaction**			Assisting vehicles and passengers on-site when needed (a critical role during early deployment phases). Off-site: handle app-based rider requests and real-time updates.	Proactive customer intervention (incident management).	Offer in-vehicle or stop-based **support** for elderly, disabled, or anxious passengers, helping build public trust and ensure inclusive access.
Public domain	Train **public authorities** in AV interaction.			Tasks related to **policy** development are to integrate CCAM systems into broader urban mobility strategies, addressing accessibility, equity, and user experience across communities		

2.2 Occupations

The tasks mentioned in section 2.1 are performed by various professionals. Although exact names of occupations, roles or job titles differ per use case, some similarities and differences between the use cases can be identified when they are compared. Occupations are clustered in Table 4.

The table reveals that:

- Remote operations and technical, operational occupations are seen as important in all use cases.
- In the bus depot and the ports/terminals use cases the least number of CCAM- related new occupations are mentioned. A logical explanation for this is that there are, in principle, no contacts with the general public: these use cases are not located in public spaces, therefore occupations concentrate on technical-operational aspects of CCAM.
- Clusters of activities and occupations can be linked to various parts of the CCAM value chain;
    - Identified occupations are largely operational, e.g. remote operations, safety drivers, fleet coordination and analysis of data produced by the operations.
    - Some occupations are related to the public domain, like roles related to adapting road infrastructure.
    - Occupations related to the development of AV systems and vehicles are mentioned less. This also has its logic, as our perspective comes from use cases, drawing our attention to deployment instead of development.

Furthermore, in some use cases the importance of policy makers was stressed. To gain a broader understanding of the roles and knowledge and skills required in CCAM deployment, additional interviews were held with representatives of public authorities. The results are presented in section 2.4.

The table below shows the information on occupations gathered in interviews with use case stakeholders, clustered per group of occupations. The table should not be understood as an exhaustive overview of occupations per use case.

Table 4: Cross analysis of occupations in use cases

	1 Last mile delivery	**2 Bus depot**	**3 Port/terminal**	**4 Public (shared) transportation**	**5 Private (shared) transportation**	**6 Transportation for specific groups**
Remote operations	Remote Automated Vehicle Supervisors	Depot teleoperator	Control room operators; remote operation of quay cranes; Warehouse IT specialists overseeing AGVs	Remote operations specialists; Remote supervisors; Tele-assistants	Remote operations specialists; AV Remote monitor / safety operator	Remote Vehicle Supervisors
Fleet coordination	AV fleet coordinator			Operations coordinators	Fleet orchestrators	
Data analysis		Fleet data analyst		Mobility data analysts	Data Analyst / IT Translator	
Technical (operational)	Retro fitting existing vehicles	Automation technician; Maintenance integrator	Robotics and automation technicians	AV maintenance technicians	AV systems technicians; Site Crew Technician (focusing on data and sensor systems)	Maintenance & Support Staff
Technical (development of systems)			Optimizing AI-powered robotic systems		App interface developers & analysts	Driving engineering jobs

Security					AV Cybersecurity specialists	
Public domain	Public infrastructure trainers				Program Manager Public Transport Authority (data and compliance); urban integration planners; Compliance Officer (digital safety and regulatory oversight)	Road infrastructure design
Drivers	Safety / test drivers				Safety Driver (hybrid operator and system tester)	Safety Drivers
Social				Socio-technical mobility planner; Engagement & outreach coordinators; Field support agents; Stewards / Bus ambassadors. Remote customer service staff	Rapid-response intervention teams; Hybrid customer service and technical support roles; customer service managers	Stewards / Bus ambassadors to help vulnerable target groups and help building trust in technology
Other	Micromobility (e.g. scooter based parcel delivery), parcel loading.				Simulation and AI training engineers	

2.3 Competences

When it comes to required competences for tasks and occupations in the use cases, we see some competences that can be best described as **technical**. On the one hand this refers to basic engineering knowledge. On the other hand, we see technical competences related to human-machine interaction, working with semi-automated systems and interfaces. Closely related are **digital** skills, that are necessary for several tasks, from software diagnostics to communication.

Another group of competences is headed under business, **management** and coordination skills, including fleet coordination. Decision making is often data driven, what makes data literacy and important asset.

The importance of safety and security is reflected in the importance of both **situational and cybersecurity awareness** and in competences related to safety driving. Safety drivers combine driving skills with knowledge on AV systems, software and communication technology.

Communication skills are important when being in contact with customers, but also between professionals, for example in the communication from a safety driver to the engineering team. Empathy is needed when dealing with customers with specials needs and in crisis situations.

Finally, mostly before a use case can get started, a variety of competences in the **public domain** is crucial. This includes legal knowledge, planning, procurement and insights about infrastructural conditions or consequences.

In the table below the information on gathered in interviews with use case stakeholders, is clustered per group of competences. The table does not provide an exhaustive overview of competences per use case.

The table below shows clustered information on competences gathered in interviews with use case stakeholders. The table should not be understood as an exhaustive overview of competences per use case. Also, competences mentioned in one use case may be relevant for more use cases.

Table 5: Cross analysis of competences in use cases

	1 Last mile delivery	**2 Bus depot**	**3 Port/terminal**	**4 Public (shared) transportation**	**5 Private (shared) transportation**	**6 Transportation for specific groups**
Technical	Basic engineering knowledge	Maintain sensors; combine mechanics with systems and software	Understanding of robotics and automation	Sensor calibration and diagnostics; software/hardware interfacing	Sensor calibration and diagnostics competences. sensor diagnostics (camera, radar, lidar); software/hardware interfacing; OTA (over the air) update execution; system calibration under TRL-level constraints	Basic engineering knowledge
	Technical proficiencies for the human - vehicle interface	Human-machine interaction understanding	Human-machine interaction understanding	Basic knowledge of AV systems and the ability to switch between automated and manual control	Basic AV sensor awareness	Basic human-machine interaction understanding
Digital skills	Digital communication skills and general digital readiness	Shift from manual to digital: more software diagnosis instead of hardware maintenance		Adaptation to the use of digital platforms (such as MaaS platforms) integrating multiple transport modes.	Interface development: mobile UX/UI design for on-demand AV services; A/B testing	Digital literacy
	Computer science	Data literacy and analytics	Basic digital skills			

Coordination, management, business skills			**logistics** knowledge	Generic business management skills such as marketing, billing, and fleet organisation.	**Fleet and operations coordinator**: agile planning, dispatch optimisation; oversight of vehicle routing; fluency with platform interfaces	Supervision skills (supervision of technology instead of people)
					Remote operations: Real-time AV fleet supervision; edge case assessment and decision-making; deep understanding of AV limitations and behaviour; coordination with FSAs.	
Data	Data interpretation	Probabilistic modelling instead of rule-based decision making			**IT and data analysis:** user data monitoring and being able to combine vehicle, user and environmental inputs.	
Safety driving	**Safety driving:** basic driving skills combined with the			Skills for **drivers**: being able to work with automated	**Safety driver**: advanced situational awareness under AV	

	awareness of automated systems' behaviour.			systems, monitor vehicle sensors, and recognise system malfunctions, strong V2I and vehicle-to-vehicle (V2V) communication proficiency and a good understanding of wireless communication systems.	supervision; understanding of automated driving systems' (ADS) behaviour and limits; manual intervention readiness; communication and reporting of system anomalies; communicating with engineering teams.	
Safety and situational awareness skills	Situational awareness					Situational awareness with sensitivity to unprotected traffic participants and vulnerable road users (VRU)
						Stress resistance (for safety drivers and remote operators).
Cybersecurity		Cybersecurity awareness	Cybersecurity			
		Data literacy				
Public domain					**Public domain**: Innovative	Knowledge about **legislation** in case of

					procurement, infrastructure adaptation and road system analysis; multimodal planning with AV fleet integration.	incidents like collision with persons
Communication, social skills					**Customer services and incident management:** communication skills for (remote) interaction with passengers; service empathy care skills for assisting passengers;	Communication and empathy for target groups are important in customer services.
					In general: crisis management and incident coordination; knowledge of protocols and procedures for safety, triage and escalation; behaviour coordination with FSAs.	

					In general: English proficiency for cross-border operations, training, and systems.	

2.4 Role of the public domain

Several interviewees point out that, with use cases as a starting point, the focus lies on the end of the value chain. Tasks, and consequently occupations and competences, are therefore focused on the deployment phase of CCAM. What remains underexposed are the activities that precede deployment of CCAM. Policy and regulatory developers have an important role to play in this regard.

Several interviewees highlighted that CCAM's main challenges are institutional and organisational rather than technological. It is not the absence of technologies or standards, but the difficulty of cooperation across actors, organisations and administrative levels that is hampering the growth of CCAM deployments. Lack of knowledge and a low sense of urgency are said to be major obstacles, leading to a lack of regulatory and policy pushes. One interviewee went further, arguing that lobbying activities for competing technologies and standards has blocked decision making at European level.

In this section we focus on the several roles in the public domain. Information gathered in additional interviews with authorities that were not directly related to one of the use cases, is added to the outcomes considering the CCAM related occupations that can be identified in the public domain.

2.4.1 Tasks

Emerging tasks at the public level are related to the following topics.

- **Infrastructure.** Establishing and managing Public Key Infrastructure (PKI) for secure vehicle-to-infrastructure communication.
- **Collecting, validating, and distributing data**. Integrating V2X data with traffic management centres and other data platforms; sharing real-time and operational data across actors (traffic managers, fleet operators, ports, public transport).
- **Safety and security**. Ensuring authenticity, integrity, and trustworthiness of CCAM data; ensuring physical safety.
- **Adapting existing procedures.**

2.4.2 Occupations

Several roles and occupations relevant for CCAM deployment can be found at governmental bodies or are closely related to public policy.

- CCAM **policy and regulation** specialist (public authority).
- Multimodal **traffic management** specialist, traffic orchestrator.
- CCAM **trainer** / knowledge disseminator.
- **Data** and platform manager (national access points (NAP) specialists).

2.4.3 Competences

Competences linked to the occupations in the public domain include:

- Capacity to **organise cooperation** between public and private stakeholders and cross-organisational coordination and stakeholder engagement.
- Knowledge of EU **regulatory frameworks** and their national translation.
- Ability to align CCAM with **urban mobility** plans.
- Skills in dynamic regulation and performance-based governance.
- Systems thinking and understanding of network effects.
- Ability to balance investments, safety impacts and societal benefits.

2.5 Conclusion

Although the use case descriptions do not offer an exhaustive account of tasks, occupations, and competences for each individual case, the set of use cases as a whole—covering a broad range of CCAM deployments—provides a robust foundation for identifying and analysing overarching human capital challenges. Striking similarities between the use cases can be found in the role of remote operational operators and mechanics and technicians; considered crucial in all use cases. Additionally, the role of policymakers in governments and authorities should not be overseen. Policy and regulations are crucial for the development and upscaling of CCAM pilots.

All clusters of activities can be related to the steps or parts of the value CCAM chain. Clustering the occupational roles under these headings enables us to target precisely when reaching out to experts for the next steps described in the following chapter. This clustering leads to the following longlist of occupational roles or clusters of activities.

A. Operational occupations in CCAM
   - Social, customer-oriented occupations, including both general customer contact as well as incident handling
   - Coordinating, analysing and monitoring operations
   - Technical occupations, including maintenance

B. Preparing and enabling CCAM
   - Tasks related to road infrastructure (design, engineering, public infrastructure trainers)
   - Policy and regulations
   - Conditional services: insurance underwriters, App interface developers & analysts

C. Developing CCAM systems
   - Automotive AV system engineers, AV system technicians / vehicle mechanics
   - Safety and security: compliance officers, AV cybersecurity specialists

3 Longlist of occupational profiles

In this chapter, the information collected from the use cases and presented in Chapter 2 is synthesised into an overview of human capital challenges related to CCAM development in a broad sense. This results in a longlist of occupations considered relevant for further CCAM development. For each occupation, a concise description is provided, highlighting the key aspects and challenges.

3.1 Approach

The approach we followed after finalizing the interviews with use case stakeholders consisted of two following steps:

- Co-creation sessions.
- Interviews for validation of the outcomes.

In September 2025 two online **co-creation sessions** were organised (9/9; 17/9). Three clusters of occupations or activities, as defined in chapter 2 of this report, were discussed. The first session focused on (nine) **operational** clusters divided into a social, managerial/monitoring and technical cluster. The second session covered two clusters of occupations/activity clusters. We looked at the cluster of activities directed at **preparing and enabling CCAM deployment**, which entails roles in the public domain and conditional services (insurances, app developers). The last cluster refers to **developing CCAM systems**, defining roles in the automotive sector and touching upon the roles related to safety and security.

The aim of the sessions was twofold. First, prioritising from a wide variety of emerging occupations and activity clusters to be added to existing occupations, the most relevant ones (in terms of crucial for the adoption of CCAM). Secondly, potential training needs were sketched per cluster by defining the highest challenges in performing the competences needed in this cluster. At this stage, we did not distinguish between activity clusters and professions, as it was not certain in all cases which CCAM-related developments would lead to one or several new occupations, or would be added to existing occupations.

The result of the sessions is therefore a general outline for the longlist of occupational roles and a shortlist of occupations for further development.

During the co-creation sessions, an online tool, Miro, was used to support data gathering and proactive knowledge sharing by participants. The sessions were divided into five sections.

Section 1: Sharing preliminary outcomes (clusters of occupations/activities)

- Goal: validation.
- Outcome: validated sets of occupations/activities prioritised for developing schemes and actions.

Section 2: Converting validated sets of occupations/activities into sets of tasks/key competences.

- Outcome: list of key competences.

Section 3: Knowledge sharing on what is known about educational and work experience backgrounds of professionals in prominent CCAM positions

- Defining challenging competences (Competence gap).
- Outcome: list of challenging competences (training priorities).

Section 4: Solutions: suggestions for solutions/interventions for bridging competence gaps

- Prioritizing potential educational and labour market interventions.

Section 5: Open space

- What other information we should take into account?

The outcome of the sessions is a more detailed description of the occupational roles and a provisional prioritisation of the most relevant profiles.

3.2 Generic occupational profiles (longlist)

In this section we elaborate in general terms on the occupations as identified in the use cases[3]. During the co-creation sessions, and in other Work Packages, suggestions were made regarding the urgence, required competences and challenges (competence gaps) and the nature of the educational schemes relevant for specific professions/activity clusters.

During the sessions, and in other work packages, suggestions were made regarding the nature of educational programs relevant to other specific professions/activity groups. These suggestions are also presented in this chapter. There is broad agreement that the work of human drivers (taxi, truck/haulage, bus, train, forklift and crane operators) in particular, is becoming redundant. Suggestions will also be presented for educational and labour market solutions for people in these positions.

The occupations identified in the use cases derive from clusters based on the place in the value chain and kind of tasks. In Table 6, the occupations of the longlist are clustered into three groups. Table 5 presents the key characteristics of each occupation.

Table 6: Occupations per cluster

Cluster	**Occupations**
CCAM operations	
Social, customer-oriented roles, including both general customer contact as well as incident handling	Customer Service Agents
Coordinating, analysing and monitoring of operations roles	Remote Operations Specialists
	AV Fleet orchestrators
Technical roles including maintenance	AV systems technicians and mechanics
	Safety drivers

[3] Stakeholders who wish to use the profiles for educational development are recommended to use additional information provided in chapter 4 for of this deliverable and in the CCAM-ERAS Deliverable 5.3 “Recommendations and conditions for success and further exploitation outside the context of the use cases”.

Preparing and enabling CCAM	
Tasks related to road infrastructure (design, engineering, public infrastructure training)	Road infrastructure engineers
Policy and regulations	Policy and Regulations officers
Conditional services: insurance underwriting, Developing and analysing app interfaces	Insurance underwriters
	App interface developers & analysts
Developing CCAM systems	
Automotive AV system engineering	AV systems engineers
Safety and cybersecurity compliance	Compliance Officers
	Cybersecurity specialists

Table 2: Key facts per occupation

Occupation	Main Job Titles	Core Content & Dynamics	Key Competences	Typical Backgrounds	Main Challenges	Suggested Educational Solutions
Customer Service Agents	Customer service staff, bus ambassadors, field support agents	Assist passengers, handle incidents, provide guidance, support accessibility needs, feed back into system improvement.	Empathy, digital communication, incident handling, accessibility awareness, basic AV understanding.	Customer service, hospitality, transport support roles.	Need technical literacy and ability to explain system behaviour.	On-the-job training, short AV courses, roleplay.
Remote Operations Specialist	Teleoperator, Remote supervisor	Monitor/assist AVs remotely, interpret multi-stream data, intervene in anomalies, support drivers and engineers.	Situational awareness, system knowledge, cybersecurity awareness, incident management, communication.	Former drivers with ICT affinity, dispatchers, gamers.	Shortage of applicants; uneven cybersecurity awareness.	Accredited training, on-the-job learning, modular courses.
Fleet Orchestrator	Fleet orchestrator, Fleet data analyst	Coordinate multi-operator AV fleets; traffic management, optimise routing; manage complex multistakeholder operations	Data interpretation, real time decision making, orchestration, communication, adaptability	Engineering, mobility/transport planning, ICT	Complex, fragmented responsibilities; immature tech.	Cross disciplinary training, soft skill development, on-the-job learning.
AV Mechanics & Technicians	AV systems technicians,	Maintain sensors, calibrate systems, perform digital	Mechanical + digital system skills, sensor	Automotive engineering, EV	Lack of sensor/electronics knowledge;	Formal technical education +

	Maintenance mechanics	diagnostics, combine mechanics and electronics.	knowledge, diagnostics.	mechatronics, robotics.	transition from mechanical to digital.	continuous upskilling.
Safety Driver	Safety driver/test driver	Operate AVs during testing, monitor ADS behaviour, perform manual takeovers, log anomalies.	High situational awareness, strong driving skills, fast reaction times, reporting skills, basic IT competence.	Professional drivers with basic IT affinity.	Difficulty finding candidates with both driving + software skills.	Advanced driving courses + supplier provided software training.
Road Infrastructure Engineers	Infrastructure designers, public infrastructure trainers	Adapt and design AV ready infrastructure; train authorities; integrate AV-friendly traffic management.	Traffic engineering, ITS knowledge, planning, systems thinking.	Engineering, urban mobility planning, ITS backgrounds.	Need updated AV specific infrastructure knowledge.	Formal technical education + targeted in-house training.
Policy & Regulations Officers	Policy developers, Regulatory specialists	Develop CCAM policies, handle permits, harmonise regulations, develop and interpret standards, integrate AVs into mobility systems.	Data literacy, regulatory interpretation, communication, stakeholder coordination.	Law, public administration, data science, system design.	Gaps in AV-specific regulation, multimodal integration, ITS knowledge.	Formal education, on-the-job training, continuous learning, scenario based policy training.-

Insurance Underwriters	Insurance underwriters	Apply new, data driven risk models; understand supplier liability; handle real time risk modelling. driven risk models	Probabilistic modelling, legal knowledge, data literacy, cybersecurity awareness.	Data engineers, lawyers, system engineers.	Lack of AV-specific liability & cybersecurity expertise.	Mix of formal education + on-the-job learning.
App Interface Developers & Analysts	App developers, UX/UI designers, platform analysts	Design and manage mobility apps; integrate user data; ensure secure interfaces for AV services.	Cybersecurity, programming, UX/UI, data skills.	Software engineers, designers, data analysts.	Need AV specific cybersecurity depth.	On-the-job training + applied problem-solving practice.
AV Systems Engineers	AV systems engineers, robotics/AI engineers	Develop AV systems, integrate robotics, AI, and control logic; troubleshoot AV tech.	AI/robotics integration, system architecture, diagnostics.	Software/IT, robotics, mechatronics, automotive engineering.	Shortage of AV specific expertise (AI perception, LiDAR, AV cybersecurity).	Formal engineering education + in company applied training.
Compliance Officers	Digital safety officers, Regulatory compliance specialists	Oversee safety and cybersecurity compliance; manage audits; ensure integrity in incident handling.	Regulatory awareness, risk assessment, communication, integrity, technical literacy.	Law, risk management, cybersecurity, safety engineering.	Limited AV specific system knowledge; unclear regulatory landscape.	Formal legal/technical training + AV-specific on-the-job training.

AV Cybersecurity Specialists	Cybersecurity analysts, AV security engineers	Threat modelling, software/hardware hardening, monitoring vulnerabilities in AV ecosystems.	Cybersecurity skills, programming, risk modelling, integrity, troubleshooting.	Computer science, cybersecurity, mechatronics.	Immature AV-specific security standards; skill shortages.	On-the-job training + specialised AV security modules.

In the remaining part of this section for each occupation the following topics are discussed:

- Job titles
- Content and dynamics of the occupation
- Required competences
- Educational and professional backgrounds of professionals working in these occupations
- Challenges
- Suggested solutions in training and education

3.2.1 Customer service agents

Job titles
Customer Service (Digital & On-site), Steward / Bus Ambassador, Field support agents.

Content and dynamics
In general, customers service agents (digital and on-site) as well as on-site stewards or bus ambassadors handle passenger inquiries, providing guidance, provide real-time updates, bridge communication between passengers and technical teams, handle app-based rider requests. They ensure passenger safety and comfort. They support passengers in-vehicle or at stops, especially those with accessibility needs. Secondly, they handle incidents. Some professionals in this cluster perform basic troubleshooting and ensure smooth operation during service interruptions.

By doing so, these workers have an important contribution to building public trust in automated services, focussing on user experience and the social acceptance of autonomous mobility.

They are able to feed customer experiences and operational incidents back into system improvement ("feedback loops" to technical teams: customer service staff should be able to relay recurring issues back to technical teams for system improvement). They support continuous learning and service optimisation.

Competences

- Customer Orientation: empathy and patience; ability to provide clear, reassuring communication.
- Strong digital communication skills (chat, remote assistance, etc.).
- Conflict management: resolution and de-escalation skills.
- Clear and accessible explanation of technical or operational issues to non-experts.
- Multi-language support for international passengers.
- Awareness of accessibility and inclusivity needs (elderly, disabled users, etc.).
- Managing incidents, providing guidance, and ensuring passenger safety and comfort.
- Basic Technical Understanding: Knowledge of how AV systems respond in different scenarios (without needing to code or repair them). Ability to interpret simple error messages or data for troubleshooting or escalation; understanding software reactions.
- Feedback and improvement mindset.

Educational and professional background
People in social or customer-oriented CCAM roles often come from:

- Customer service or hospitality backgrounds, such as call centres, mobility support, or public transport assistance.
- Driving or transport-related roles, for instance, professional drivers transitioning into service or assistance roles.
- General administrative or communication backgrounds, where interpersonal and coordination skills are key.

Challenges

- Some basic understanding of vehicle systems and software is important to handle customer questions or incidents effectively. As one participant noted: "You need to know how the system works overall… not very deep into the technical aspects, but enough to answer customers' questions."
- A general technical literacy (e.g. familiarity with connected systems, AV behaviour, or teleoperation basics) is beneficial, but no deep technical expertise.

Educational solutions

More than formal technical education, suggested ways to train staff in this context are

- On-the-job training
- Short courses in AV basics & digital communication
- Role-play for handling incidents

3.2.2 Remote operations specialist

Job titles

Remote Operations Specialist / supervisor / teleoperator.

Content and dynamics

Monitor and control AVs from a central location, intervening, when necessary, in case of safety or anomalies. Supporting operational colleagues on the road in unplanned scenarios. In this occupation, one needs to understand the situation to decide what to do/how to act; whether it is an incident or a routine situation.

Over time, the use and application of software will become more important than controlling the hardware (vehicles); the software will take over. Analysis and operation of the software will increasingly require working with the software instead of the hardware. Functions will thus increasingly shift to automated systems, changing human role requirements.

Competences

1. Situational Awareness
    - Awareness of the full operational environment: vehicles, traffic, pedestrians, system behaviour; essential for safety, incident management and correct decision-making.
    - Ability to interpret visual, sensor, and data feeds, being able to shift between levels of awareness: routine monitoring vs. incident response.
    - "Helicopter view" — understanding the overall system and anticipating risks; operators must fully grasp the AVs environment and traffic situation to act safely.

2. Technical and System Competences
    - Knowledge of AV electronics, vehicle behaviour, and software logic.
    - Understanding how systems respond to events — operational-level comprehension.
    - Ability to analyse AV usage data for optimisation and troubleshooting.
    - Awareness of how AV suppliers' tools affect what can be monitored or analysed.

3. Cybersecurity Awareness
    - Recognition of potential cybersecurity risks in daily operations. Cybersecurity awareness is vital to avoid disruptions, even if detailed IT expertise lies with specialists.
    - Knowing how to react to alerts, avoid phishing or data breaches, and handle system updates safely.
    - "Awareness" level for operators, but engineering expertise required at system level.

4. Incident & Risk Management
    - Ability to act quickly in abnormal situations.
    - Clear understanding of protocols and escalation procedures.
    - Decision-making under uncertainty.

5. Communication and Team Coordination
    - Collaboration across layers (onboard staff → teleoperator → technical engineers).
    - Clear reporting, status updates, and escalation.
    - Important for multilevel safety structures.

Educational and professional background

People working as remote operation specialists are

- Experienced drivers who possess some ICT or system literacy. For instance, drivers who as a hobby developed ICT skills.
- Transport control centre or dispatch operators, for instance in public transport or logistics. They already have situational awareness and experience handling multiple concurrent operations.
- Individuals with gaming experience tend to have strong reaction skills and environmental awareness, which are useful in remote operation.

Challenges

Participants point to a tension between supply and demand in terms of an acute skills need that cannot be met because of a shortage of applicants. For the remote operation operators with high-level situational awareness are scarce, and levels of cybersecurity awareness are uneven; engineers are in short supply.

Educational solutions

A point pressed in the use cases is that international (European) standards and quality and safety certification procedures /regulations are needed at process and competences/ incident management levels (ref. the Military, Airports and Airline companies). This means that training schemes, full courses as well as modularised programmes, need to be accredited in terms of learning outcomes, EQF levels and possibly learning format.

3.2.3 Fleet orchestrator

Job titles

AV Fleet orchestrator / Fleet data-analyst.

Content and dynamics

A Fleet Orchestrator supervises and coordinates autonomous vehicle fleets across multiple operators, zones, and mobility systems. The role of the occupation is to ensure safe, efficient, interoperable and scalable deployment of CCAM services. It acts as the central control function linking operations, technology, governance, customer service and emergency response. The role has logistical aspects, including coordinating routes across partially automated networks, optimising fleet deployment and adjusting schedules in response to demand or disruptions.

Competences

1. Technical & Analytical Skills
    - Ability to operate control room systems and interpret fleet KPIs.
    - Scenario-based reasoning and problem-solving in real time.
    - Ability to understand when remote intervention is needed and activate correct response teams.

2. Coordination & Orchestration Skills
    - Knowledge of logistic processes.
    - Cross operator orchestration across multiple territories and services.
    - Ability to align multiple stakeholders (operators, city authorities, technical providers).

3. Communication & Soft Skills
    - Clear, calm communication during unexpected events.
    - Multi-stakeholder facilitation and information sharing.

4. Decision Making & Judgment
    - Making rapid, high-stakes decisions, especially during safety-critical events.
    - Prioritizing interventions and coordinating support teams.

5. Adaptability & Continuous Learning
    - Ability to work in emerging, evolving operational contexts.
    - Openness to learning new technologies and operational models.

Educational and professional background

There is not a single predefined educational pathway for fleet orchestration, as the role is emerging. A Fleet Orchestrator typically needs a background in engineering, transport/mobility,

or ICT at Bachelor level for operational orchestration, while more strategic orchestration functions benefit from a Master-level profile, complemented by extensive on-the-job, cross-disciplinary training.

Challenges
The Fleet Orchestrators role faces several challenges as CCAM develops. Because fleets will operate across different operators, cities, and systems, orchestrators must work within fragmented responsibilities and unclear authority structures, making coordination complex. The technology itself is still immature—with gaps in connectivity, mapping, depot automation, and open IT standards—forcing orchestrators to manage vehicles in environments that are not yet stable or interoperable. At the same time, the occupation requires new skill sets (system supervision, data interpretation, incident response), but training guidelines do not yet exist, meaning learning happens "on the job". Finally, orchestrators must operate in contexts where regulations, business models, and procurement frameworks are still evolving, increasing operational uncertainty and complicating long-term planning.

Educational solutions
Formal education alone is insufficient because fleet orchestration related to AVs is new and evolving. Much of the competences need educational solutions concerning:

A. On-the-job training (Understanding AV behaviour, Remote supervision skills, Incident response, Using fleet dashboards and KPIs).'
B. Cross-disciplinary upskilling. Because CCAM requires both technical and mobility knowledge, training should cover cybersecurity basics, learn to understand automated depot and charging systems and risk assessment.
C. Soft-skill development (communication skills, adaptive decision-making, multi-stakeholder coordination, and crisis/incident escalation).

These are not tied to specific formal educational pathways.

3.2.4 AV mechanics and technicians

Job titles
AV systems technicians / vehicle mechanics / Maintenance & Support.

Content and dynamics
AV systems technicians and vehicle mechanics are responsible for maintaining and calibrating sensor suites (e.g. cameras, radar, LiDAR), onboard computing systems, and system interconnections. This requires a combination of traditional mechanical expertise with a deep understanding of digital diagnostics and AV electronics.

Competences
Predefined competences for this role include:

- The Combination of mechanical knowledge and digital diagnostics.
- Understanding AV electronics, such as sensors.
- Understanding of communication technology.

Educational and professional background

People working in this role have a background in automotive engineering and vehicle mechanics, EV mechatronics, robotics/mechatronics, or software/hardware analytics. Also mentioned: experience in data analytics and knowledge of traffic system.

Challenges

On the competence scale, participants rated this group much closer to the "lacking skills" end than to "fully competent", highlighting a skills shortage. The main difficulties included lack of AV electronics knowledge in the maintenance field, limited experience with sensor calibration, and challenges in adapting from mechanical systems to digital and software-driven systems.

Educational Solutions

Participants agreed that bridging this gap requires a combination of formal education and on-the-job training:

- Formal education is necessary to provide technicians with a strong base in AV electronics, sensors, and digital diagnostics. This helps to build the broad knowledge foundation, currently missing.
- On-the-job training to reskill technicians already in the workforce, supporting the transition from conventional automotive maintenance to AV/EV systems.

3.2.5 Safety driver

Job titles

Safety driver.

Content and dynamics

Safety drivers operate vehicles during early CCAM deployment phases, monitor automated system's behaviour, intervene when necessary and log anomalies. Safety drivers have a hybrid role in both securing safe operations as well as testing the system and system & hard- and software updates. This role is seen as transitional by some experts. Others points out that, although a business case may need driverless driving, safety drivers will remain necessary for testing new hard- and software, in case of adjustments in the ODD and when upscaling pilots to other places.

Competences

Driving autonomous vehicles is not necessarily easier: drivers need to anticipate on what the system is going to do and need to have an eye both on traffic and on a screen with system information. This leads to the following required competences.

- Stress resistance.
- Advanced situational awareness under AV supervision.
- Basic understanding of automated driving systems' (ADS) behaviour and limits.
- Manual intervention readiness.
- Communication and reporting skills for reporting system anomalies and communicating with engineering teams.
- Advanced driving skills.
- Operational validation skill: testing and validating software updates.
- Keeping track simultaneously of both traffic and information given via screens.

Educational and professional background
There is no fixed background for safety drivers. People being recruited for this job are for example people with professional driving experience (being responsible, having a quick reaction time) combined with basic IT skills, obtained through hobby or professional experiences, to perform the software testing tasks.

Challenges
Examples where bus drivers were re-educated appeared not fruitful, especially because of the software part. Age was considered a bottleneck, according to one of the experts. Another challenge for companies that work internationally are country specific requirements for drivers, for example in Norway basic health standards or not having criminal records.

Educational Solutions
A software provider certifies safety drivers after completing a one-month course on the software. Before that, the candidates had already completed an advanced driving course for several vehicles. Cooperation with trade schools is sought to upscale the education of safety drivers.

3.2.6 AV road infrastructure

Job titles
Road infrastructure design / infrastructure engineers and public infrastructure trainers.

Content and dynamics
This concerns a cluster of roles related to road infrastructure, that need to be further defined. Several professionals are engaged in making the infrastructure fit for CCAM deployment. This entails one the hand (civil) engineering parts, where physical infrastructure meets digital infrastructure (V2X, connectivity, etc.). On the other, aspects of urban planning are relevant for "public space design". In the development of these roles, "public infrastructure trainers" play a role in educating public authorities and other stakeholders.

For professionals working in road infrastructure design and public infrastructure training in the context of automated vehicles (AVs), the following tasks have been identified:

- Adapting infrastructure to AV deployment.
- Training public authorities and stakeholders in AV interaction and operational procedures.
- Developing both traffic management systems and AV-friendly urban designs.

Educational and professional background
The backgrounds and profiles typically recruited for this occupation, are traffic engineering and specialisation in urban mobility planning. People with backgrounds in engineering and urban/transport design are common, with knowledge of policy, system thinking and consultancy skills. Also relevant are management profiles and experience in Intelligent Transport Systems (ITS).

Educational Solutions
Participants stressed a distinction between technical and planning-oriented roles:

- Formal education (degrees or diplomas) is seen as necessary for technical functions, such as infrastructure design and engineering. These roles demand a strong academic and technical foundation before entering practice.
- (Extra) training on the job was highlighted as the most fitting solution for planning, organisational, and policy-related positions. Here, the AV-specific competences can be developed through targeted in-house programmes, mentoring, or professional courses once individuals are in the role.

3.2.7 Job titles: Policy and Regulations officer

Job titles

Policy and Regulations officer, policy developer (governments, authorities).

Content and dynamics

The role entails policy development and strategic planning for the integration of automated vehicles (AVs) within public transport and urban mobility systems. The occupation is positioned at the interface of technology, data, and governance, requiring the ability to translate technical insights into policy frameworks and operational strategies.

Participants described tasks such as:

- Developing and implementing policies.
- Coordinating crisis and remote management.

The Policy & Regulation Officer operates within a rapidly evolving CCAM ecosystem marked by fragmented legal frameworks, shifting responsibilities from human drivers to remote or automated oversight, and strong interdependencies between public authorities and private operators. Because national, regional, and municipal bodies each hold different responsibilities for regulation, policy, and authorization, the role requires navigating a multi-level governance landscape where implementation capacity—especially at local level—often lags behind regulatory ambition. The officer must bridge the worlds of law, technology, and mobility operations: translating complex technical developments into workable rules, supporting authorities and stakeholders in understanding CCAM systems, and ensuring deployments align with safety, data protection, accessibility, and public-value goals. In this context of fast-changing standards, emerging risks, and ongoing pilot-to-deployment transitions, the P&RO plays a crucial coordination and facilitation role that enables coherent, safe, and scalable automated mobility services.

Competences

The competences emphasised in the discussion included:

- Collaboration and communication skills to connect technical experts, policy makers, and stakeholders.
- Legal & regulatory literacy (mobility, data protection, liability, permitting).
- Technical & safety awareness (automated systems, ODD, safety vs. security).
- Policy & governance skills (multimodal mobility, stakeholder facilitation).
- Deployment & authorization competence (SOPs, risk assessment, site readiness).
- Data & communication skills (dashboard interpretation, cross-actor coordination).

Educational and professional background
Regarding backgrounds and profiles, participants mentioned software engineers, computer and data scientists, public policy and public administration specialists, and professionals in sociology or system design. Technical experts such as GIS data specialists, data analysts, and cybersecurity experts were also identified as common in these roles.

Challenges
Participants agreed that applicants generally meet many of the required competences, but some gaps remain. In particular, remote coordination skills, multimodal transport integration, and specific AV/ITS systems knowledge were identified as hard-to-find competences.

Educational Solutions
To address these gaps, participants suggested forms of training and learning on the job;

- (Extra) training on the job was considered the most effective solution, especially for developing AV-specific and coordination competences in planning and policy-related functions.
- Learning by doing was also mentioned as valuable, particularly for practical, real-time problem-solving and coordination challenges.

Solutions in formal education were not suggested.

3.2.8 Insurance underwriters

Job titles
Insurance underwriters

Content and dynamics
Insurance underwriters are confronted with a shift in risk assessment in the context of automated vehicles (AVs). Whereas risk traditionally resided with the driver, risks increasingly transfer to manufacturers, software providers, or operators. This requires applying data-driven risk models and new forms of supplier liability. Participants emphasised that underwriters need to handle real-time data and algorithmic pricing while accounting for complex liability structures.

Competences
The required competences identified include:

- Probabilistic and risk modelling, including algorithmic pricing.
- Strong data literacy.
- Real-time analysis skills.
- Understanding of supplier liability and regulatory frameworks.

Educational and professional background
Typical backgrounds and profiles hired into this occupation include data engineers, lawyers (particularly with expertise in liability and transport law) and system engineers. Expertise in risk modelling, AV-specific risk knowledge, and cybersecurity were also mentioned as valuable additions.

Challenges
While analytical and legal skills are in place, adapting them to AV system-level risks requires

further development. Participants noted that cybersecurity and AI knowledge are already relatively well embedded in existing training programmes. Challenges remain in legal frameworks, supplier liability, and contractual cybersecurity arrangements. Interface developers were considered relatively well-prepared compared to underwriters, where the gap is larger.

Another challenge for insurance underwriters is to gain access to software and operational data, for risk modelling. Another observation concerned the evolving liability framework, with responsibility shifting from OEMs/SDS providers towards operators, creating uncertainty about accountability. Another challenge lies in establishing legal and contractual arrangements around cybersecurity, especially when non-European software is used.

Educational Solutions
To bridge these gaps, a combination of approaches is suggested:

- Adaptations in formal education for building fundamental expertise in risk modelling, algorithmic pricing, and liability law.
- (Extra) training on the job recommended for adapting to the fast-changing AV context and for updating existing professionals on new liability regimes and data-driven practices.
- **Learning by doing**: Highlighted as relevant for dealing with the real-time, practical challenges of shifting from traditional to AV-based risk assessment.

3.2.9 Job titles: App developers & analysts

Job titles
App and interface developers & analysts.

Content and dynamics
App interface developers & analysts are central to CCAM-based mobility services. They are responsible for designing and managing the mobile platforms that enable users to book and coordinate rides, making these apps the primary access point to AV services. Their tasks include:

- App design.
- Platform management.
- Data analysis.

Competences
Predefined competences for this function include:

- Cybersecurity awareness.
- Programming.
- Data literacy.
- Problem-solving skills.
- Design based on user experience (UX/UI).

Educational and professional background
New entrants in these jobs often have backgrounds as software engineers, cybersecurity experts, or data analysts.

Other common profiles include lawyers (in cases involving data protection or contractual frameworks),

UX/UI designers, and professionals with training in computer science, traffic planning, or business/product management.

Challenges
On the Competence scale, participants rated these professionals close to the "completely skilled" end, but not without gaps. The most notable shortfall identified was in cybersecurity specific to AV and AI systems. While general app development and data analysis skills are widely available in the labour market and training programs, the specialised integration of cybersecurity in an AV context was considered more difficult to find.

Educational Solutions
To close these gaps, participants proposed a combination of approaches:

- On-the-job training was considered the most effective, enabling professionals to gain direct exposure to AV-specific cybersecurity and platform management challenges.
- Learning by doing was also recommended, particularly to strengthen problem-solving skills in real-world AV contexts.

3.2.10 AV system engineers

Job titles
AV systems engineers.

Content and dynamics
AV systems engineers are responsible for developing, testing, and refining automated vehicle (AV) systems. This includes integrating robotics, artificial intelligence (AI), and control systems into a coherent whole. They develop, test, and refine AV systems by integrating robotics, AI and control systems. Secure, monitor, and improve AV systems, are AI developers, AGVs optimizing AI-powered robotic systems

Their role requires a strong grasp of autonomous system architectures, as well as the ability to troubleshoot complex AV systems. Participants underlined the importance of cross-domain expertise. They pointed out that while AV engineers can transfer skills from related areas such as robotics, software engineering, and system integration, the field still demands specific knowledge of AV technologies.

Competences
Competences for this occupation include:

- Integration of robotics, AI, and control systems.
- Knowledge of autonomous systems.
- Deep understanding of AV-specific technologies (LiDAR, AI perception).
- Trouble shooting AV-systems effectively.

Educational and professional background
Typical backgrounds include people having been employed as software engineer, data engineer, cybersecurity expert or system architect, as well as a professional in information technology. Other relevant profiles are expertise in electronics, software, mechatronics, vehicle or computer science engineering, automotive standards, and system integration.

Challenges

On the competence scale, participants placed this occupation in the middle to upper range, indicating moderate competence gaps. Engineers are seen as partly able to transfer knowledge from other domains (e.g. robotics, IT, automotive engineering), but shortages remain in AV-specific areas. In particular, deep knowledge of AV cybersecurity standards and of AV system safety and integration is hard to find.

Educational Solutions

Participants suggested that bridging the gap requires a dual approach:

- Formal education is necessary to provide engineers with in-depth AV-specific knowledge, especially in AI perception, sensorics, LiDAR, and cybersecurity standards.
- On-the-job training is important for reskilling professionals from related fields and ensuring they can apply their knowledge to practical AV systems.

3.2.11 Compliance officer

Job titles

Compliance Officer (digital safety and regulatory oversight).

Content and dynamics

Compliance officers play a crucial role throughout the value chain. In addition to their supervisory duties, compliance officers also bear significant responsibility during incidents. Integrity and ethical conduct are essential qualities. Compliance officers must be confident they can act decisively and transparently under pressure.

They can be employed both by manufacturers (focusing on product safety, certification, and liability), transport companies (focusing on operational compliance and risk management) or public agencies (e.g. for type approval). The roles will differ in detail vis-a-vis the organisational contexts.

Competences

Competences for this occupation include:

- Cybersecurity awareness.
- Knowledge of laws and regulations.
- Risk assessment and management.
- Communication skills.
- Adaptability.
- Collaboration.

Educational and professional background

Typical backgrounds of compliance officers include law and regulatory affairs, AI risk management, and computer science with a focus on cybersecurity. Profiles from risk management, governance/compliance, and safety engineering are also mentioned. Beyond formal education, personal qualities such as uncompromising integrity, resilience under pressure, analytical skills, attention to detail, and discretion/confidentiality were highlighted.

Challenges

On the Competence scale, participants placed compliance officers around the middle, suggesting a moderate gap between current skills and requirements. Areas lacking included:

- Technical AV system literacy, as compliance officers often lack deep technical understanding to fully assess risks in AV systems.
- Legal skills and international standards knowledge, especially concerning emerging regulations and cross-border harmonisation.
- The ability to shift from conventional automotive risks to AV-specific risks, requires new frameworks and practices.

Educational Solutions
Participants emphasised that bridging the gap requires both formal education and targeted training:

- Formal education (law, compliance, or technical degrees with a regulatory focus) provides the foundation in legal and governance frameworks.
- On-the-job training was highlighted as necessary to build AV-specific expertise, enabling compliance officers to understand technical systems and emerging risks in practice.

3.2.12 AV Cybersecurity specialists

Job titles
AV Cybersecurity specialists.

Content and dynamics
Cybersecurity analysts and specialists in the AV sector ensure the security of vehicle software and infrastructure. Their tasks include conducting threat modelling, applying and implementing AV system hardening and monitoring for vulnerabilities in complex connected environments.
Participants underline that this role is technical, but also tied to responsibility in case of incidents, highlighting integrity, confidentiality, and ethical conduct. Cybersecurity specialists must be able to act transparently and decisively when responding to attacks or breaches, given the potentially severe safety and reputational consequences. The occupation will likely emerge in both manufacturers (focused on vehicle software, hardware integration, and supply chain security) and transport companies (focused on operational IT/OT security, fleet-level vulnerabilities, and data protection). The required profiles are similar but will differ in emphasis, depending on the organisational context. Stakeholders report a critical shortage of cybersecurity engineers, especially those trained in mobility applications.

Competences
Competences for this occupation include:

- Cybersecurity awareness.
- Programming.
- Automation implementation.
- Adaptability.
- Logical reasoning and troubleshooting.
- Communication skills.

Key personal qualities include resilience under pressure, attention to detail, confidentiality, and uncompromising integrity.

Educational and professional background

Relevant profiles are information security specialists, computer scientists, cybersecurity experts. Backgrounds in software /vehicle/mechatronics engineering, risk assessment and management, and in applying security standards are also mentioned.

On the Competence scale, participants placed this occupation in the moderate gap range, recognising that while general cybersecurity expertise is mature and widely available, gaps emerge when applied specifically to AVs. The most pressing shortage is in AV-specific cybersecurity knowledge and standards, many of which are still under development or not yet regulated, according to a participant.

Challenges
Cybersecurity specialists with technical/engineering backgrounds often lack knowledge of legal and regulatory frameworks, and those with legal/governance profiles lack in-depth understanding of AV systems.

Educational Solutions
Participants agreed that closing the Competence gap requires on-the-job training as the primary solution, to build AV-specific expertise and adapt general cybersecurity knowledge to the AV environment.

3.3 Educational backgrounds and solutions: the need to formulate learning outcomes

Professionals working in the aforementioned occupations come from a wide variety of **educational and professional backgrounds**. In the operational occupations though, their precious work experiences come close to the role in CCAM deployment. For example, in customers service roles, general experience with customers service in non-CCAM areas is an asset. The same goes for driving and transport-related roles. Safety drivers are recruited among people with professional driving experience and evident affinity with the application of software. Recruiting safety drivers and remote operators among former drivers is not always a successful experience as they might lack affinity with applying software. The general shortage of drivers could also be a factor in this.

For occupations ‘preparing and enabling CCAM’ and ‘developing CCAM’, (e.g. policy and regulation officers, insurance underwriters and compliance officers) references are made mostly to higher education qualifications. For example, a background in legal studies, data analysis or software design. Both in the operational occupations as well as in the occupations directed at preparing and enabling CCAM, CCAM related competences need to be added to the core competences the professionals already have.

It is different in technical occupations, here the core lies in specialised technical CCAM competences. Both mechanics and technicians being active in CCAM deployment as well as engineers that work in the development of CCAM systems, need mechanical and engineering backgrounds combining hardware (vehicle) and software competences.

We see that **educational solutions** proposed for the technical occupations have a basis in formal, initial education, whereas for non-technical occupations solutions in lifelong learning

and informal and non-formal pathways are mentioned. Distinguishing between formal, non-formal and informal learning[4] is helpful. Formal learning takes place in a structured environment, leading to officially recognised qualifications. In non-formal (or semi-structured) learning some form of learning support is present, for example in case of training-on-the-job settings. Learning outcomes may be validated or certified, but not necessarily. Most learning for occupations happens in an informal manner. This means that without designated learning activities acquisition of competences happens via work experience. Informal learning may lead to validation or certification, though.

From this perspective, we see that experts propose non-formal learning options in particular. Adaptations in formal education are most relevant for technical occupations.

- Opportunities to master AV technology in a formal education setting is in particular relevant for technical and engineering occupations, including AV mechanics and technicians, road infrastructure engineers, and AV system engineers. Formal education should provide them with both a broad and in-depth understanding of AV technology.
- Training remains necessary for the professionals in technical occupations, due to the fast development of technologies. Experts state that suppliers of technology often take responsibility for this role.
- (Short) professional courses are relevant for professionals lacking a mechanical or engineering background. Certification of learning outcomes is important for safety and compliance issues, due to accountability regulations. Training can be provided by accredited institutes in the public and private sector.
  An important target group is the professionals working in operational occupations, recruited for their competences obtained in work experiences in adjacent occupations or sectors.
  Secondly, professionals in occupations having a strong basis in formal higher education can benefit from this type of training. These professionals, like insurance underwriters, policy and regulation officers, compliance officers, have obtained important competences in non-CCAM topics (e.g. data analysis, legal knowledge, governance), but need to supplement their expertise with specialist CCAM subjects.
- Making certain certification mandatory, for example for quality purposes, has the disadvantage of reducing access to the professions, which could be a hinderance to CCAM deployment. In contrast to formal education, non-formal training can be organised close to the shopfloor; in-house, by training-on-the-job.

Apart from training schemes, learning by doing is essential for all occupations. This can be characterised as informal learning. Organisations can stimulate informal learning in the way they organise work, for example by rotating staff across various workplaces.

The CCAM competences that professionals need to acquire not only depend on the occupation, but also on the background of individuals. Competences can be obtained in various ways. The diversity in the backgrounds of potential professionals in CCAM occupations means that single, predefined educational pathways to these occupations are not expected to be effective. The formulation of clear **learning outcomes** as a start enables the design of learning pathways for a variety of target groups. Defining the learning outcomes that professionals should obtain is a logical next step towards preparing the workforce for working with and further developing CCAM.

[4] https://www.cedefop.europa.eu/en/tools/vet-glossary/glossary

Within the boundaries of CCAM-ERAS, we develop learning outcomes for the occupations where development of educational provision is most urgent.

3.4 Short list of occupations

The next step in developing educational schemes and activities, is to formulate learning outcomes to serve as a basis for the development of education and training programmes. Learning outcomes describe the competences (knowledge, skills, professional attitudes) learners should acquire in their learning trajectory. Learning trajectories to reach learning outcomes can vary, both in response to types of competences to be mastered and learning styles; especially in case of adult learners with different educational backgrounds and work experiences.

Participants indicated which occupations should be prioritised for the development of education and training provisions. In both co-creation sessions, as well as in additional interviews and roundtable discussions, participants presented arguments why some occupations should be prioritised over others when it comes to education and training development.

The criteria used for this selection can be summarised as:

- The extent to which the occupation holds a pivotal **position** in developing and upscaling CCAM deployments;
- The degree of similarity or difference to **existing roles**;
- **Competence gaps** with respect to existing provisions of education and training;
- The **feasibility** of the development of sets of learning outcomes within the boundaries of this research project, regarding the complexity of the task or Competence.

Developing learning outcomes for the following occupations was seen as most urgent and feasible:

- For upscaling pilot projects aiming to integrate CCAM as a permanent component of the transport system, **Policy makers** and **regulation specialists** have key role here.
- In running CCAM pilots **Remote Monitoring Operators** are crucial for daily operations of pilots and regular CCAM services.
- Occupations within the social cluster including **customer services** and **CCAM ambassadors**, were not prioritised in first instance (in co-creation sessions), but their importance was stressed by other stakeholders in additional interviews. These occupations have a crucial role in preparing the public for the acceptance of CCAM.

In both co-creation sessions participants also gave arguments why other occupations should not be prioritised over the three above mentioned occupations:

- Finding candidates with both driving skills and skills and knowledge about software, required for **safety drivers** is a challenge. A part of the experts and stakeholders interviewed sees safety driving as transitional activity. Other state that it remains necessary to test new or adapted vehicles, software and ODDs.
- Although professionals in technical occupations (mechanics, technicians) are crucial and in high demand, the development of new training provisions is not considered as most urgent. Suppliers of technologies (hard- and software) are seen as important actors for training mechanics to work with their products.

- The conditional services cluster (**insurance underwriters** and **App interface developers & analysts**) was dropped because companies working in this field are responding to CCAM developments by anticipating potential markets for innovative services. Competences to develop these new products emerge in a process by learning and doing (RDD) within their company.
- The same is true for occupations in the automotive cluster; **systems engineers** are at the forefront of the CCAM-wave.
- **Compliance** issues are highly complex with shared responsibilities throughout the value chain, from manufacturer to authority and operator. Within the limits of this project, it is not feasible to further elaborate on this occupation.

3.5 Conclusions

The development within occupations and the emergence of new occupations due to CCAM can, in very general terms be described a development in which to existing occupations a layer of CCAM competencies need to be added. What this CCAM layer entails, differs per occupations. It fits with a trend in which elements of various profiles are combined with integrated in other profiles (for instance IT-knowledge for non-ICT-specialists).

In general, professionals in technical CCAM occupations find the core of their competences in formal technical schooling. These occupations could benefit from more attention for CCAM in technical, formal education. Apart from a thorough initial training, these occupations require constant learning because of technological developments.

Non-technical CCAM professionals need to add thorough CCAM related knowledge and skills to the competences they acquired through work experience (customer services, professional driving) and formal (higher) education (legal, governance, data analysis). For the acquisition of CCAM competences, especially solutions in non-formal learning are suggested (training-on-the-job, short courses).

The formulation of learning outcomes for the occupations where educational provision is most urgent, is an important first step. The results of this chapter show that the two occupations with the most urgent needs are remote operators and policy and regulation officers. Professionals in customer-related roles were suggested in a later stage.

4 Learning outcomes

4.1 Introduction

To translate occupational profiles into courses involves translating the competences required for a profession into learning outcomes and then a curriculum. This process ensures that graduates possess the necessary knowledge and skills to meet the (new) demands of the occupation or profession. In other words, the activities to be performed in a specific occupation have to be translated into learning outcomes; statements of what an individual should know, understand, and/or be able to do at the end of a learning process. A learning outcomes approach is an enabler for drafting qualifications frameworks and standards, curriculum development, assessment, validation and certification, etc.[5]

In this chapter, we present sets of learning outcomes for 2 profiles: Remote Operations Specialist and Policy and Regulations Officer.

4.2 Approach

4.2.1 Data collection

The selection of the two profiles is the result of a process that can be described as a funnel. The use cases led to a long list of 12 relevant CCAM occupations. Co-creation sessions in September and several additional validation interviews and expert consultation[6], 2 profiles were chosen as most relevant for the development of sets of learning outcomes.

In the process of drafting learning outcomes, we followed again iterative, design-oriented research approach, consisting of the following elements:

- Drafting a preliminary, rough design, based on CCAM-ERAS deliverables D3.2 Innovation radar and D5.1. Analysing the impact on each use case.
- Stakeholder consultation by in-depth interviews on the preliminary design.
- Based on feedback, refining the design into a detailed design.
- Validate and receive feedback via written consultation.
- Finalise the sets of learning outcomes.

4.2.2 Drafting learning outcomes

For education and training institutions, learning outcomes provide an important instrument for developing as well as reviewing programmes and qualifications. The approach provides the basis for systematic dialogue with labour market and society stakeholders regarding evolving skills needs. The perspective helps to determine the purpose and orientation of a course, a programme or qualification. Learning outcomes provide an important reference point for quality assurance and close dialogue with end-users (Defining, writing and applying learning outcomes | CEDEFOP).

[5] Learning outcomes | CEDEFOP

[6] Including a survey among 18 experts during the CCAM-ERAS validation meeting in Brussels (19 November 2025)

National qualifications frameworks (NQFs) based on learning outcomes and linked to the European qualifications framework (EQF) at EU level, have improved transparency and comparability of qualifications across Europe. The CEDEFOP guidelines for short learning outcomes descriptions of NQF/EQF qualifications suggest the following principles to be considered when developing and writing short descriptions:

A. Formal aspects (context) and EQF level

A.1 Length of the description (750 to 1 500 characters without space);

A.2 Format of the description (narrative and bullet points).

B. Content aspects

B.1 Overall objectives and orientation of the qualification (in the form of narrative text);

B.2 Main learning outcomes (in bullet points) to capture orientation, content and complexity of the qualification by covering the following aspects:

B.2.1 Breadth/scope of learning acquired;

B.2.2 Depth/complexity of learning acquired;

B.2.3 Context information (European guidelines for the development and writing of short, learning-outcomes-based descriptions of qualifications | CEDEFOP)

The remainder of this chapter consists of the profiles of the Remote Operations Specialist (section 4.3) and the Policy and Regulation Officer (section 4.4).

4.3 Remote Operations Specialist

Competence framework
This Competence framework defines the skills, knowledge and professional behaviours required of a Remote Operations Specialist.

Context of the CCAM Remote Operations Specialist profile

Connected, Cooperative and Automated Mobility (CCAM) is transforming the transport workforce. As vehicles progress toward higher automation levels, human oversight shifts from on-board drivers to Remote Operation Centres (ROCs). The setup and staffing of ROCs are often part of the operational permit of a CCAM service and therefore subject to regulatory approval. The Remote Operations Specialist (ROS) has emerged as a critical new role ensuring safety, continuity, and public trust during this transition phase.

The Remote Operations Specialist supervises and monitors multiple autonomous vehicles in real time, through remote assistance and mission-level supervision rather than continuous remote driving, intervenes when automation reaches its limits or when unexpected conditions arise, ensures safety and service reliability for passengers, road users, and cargo, and supports the scalable deployment of automated mobility through human–machine collaboration.

The Remote Operations Specialist has three core tasks (responsibilities) which can be broken down into a number of subtasks (working processes). Note that the work of a Remote Operations Specialist may include all or a selection of the subtasks. Core task 1 and core task 3 may be done by different persons, who are ideally able to alternate between these tasks and do both.

The three core tasks are:

1. **Ensuring service continuity by keeping autonomous fleets running smoothly and safely**
2. **Ensuring quality of work and compliance with current regulations**
3. **Contributing to operational optimisation and innovation**

Core task 1

Ensures service continuity by keeping autonomous fleets running smoothly and safely

Subtasks:

- **A.** Performs pre-departure system validation (brief checklist verifying AV readiness before service).
- **B.** Observes live dashboards and interprets sensor data, camera feeds, and telemetry from multiple AVs, following staffing and backup rules (e.g., # of vehicles per operator), using alert-driven monitoring and AI-assisted detection where available.
- **C.** Provides live passenger assistance before, during, and after the ride, including handling early stop requests, in-vehicle issues, and passenger reassurance procedures, and applies inclusive communication practices for passengers with disabilities.
- **D.** Identifies anomalies, anticipates risks, detects incidents, and prioritises attention with ROC (Remote Operations Centre) tools.
- **E.** Intervenes and resolves operational disruptions, supporting navigation, routing, or decision-making in complex or ambiguous traffic situations ("edge case") by confirming manoeuvres proposed by the AV, actively proposing manoeuvres, sending commands and applying request-based assistance, rather than continuous remote driving, and adapting interventions to open traffic systems vs. closed/controlled environments.
- **F.** Maintains safety by monitoring autonomous vehicles in real time, intervening remotely when a vehicle encounters an unexpected situation and preventing accidents and ensuring passenger, cargo, and road-user safety, applies emergency protocols and fallback procedures when connectivity is degraded.
- **G.** Handles pedestrian/bystander interaction using approved procedures and tools (e.g., external displays on Avs).
- **H.** Human–machine teaming aspects.
- **I.** Communicates effectively with technicians, engineers, and emergency services, and coordinates with police and multi-agency control centres during incidents.

Skill requirements for core task 1

- Situational awareness by data interpretation and risk anticipation, interpreting multiple feeds.
- Cross modal understanding (integration with public transport operations when AVs are part of a multimodal network).
- Working under time pressure by event-driven spikes.
- Adaptive problem-solving.

- Incident management and emergency procedure execution.
- Human–machine interaction competence, especially in interpreting automation uncertainty.
- Professional communication across multidisciplinary teams, with occupants, and with police/emergency services.
- Ability to stay focused, stress tolerance, emotional stability.
- Customer interaction skills during rides.
- Driving skills (and appropriate driving licence for the vehicle category).
- Adaptability for tiered operations and rotation (in first-line and second-line roles).

Knowledge requirements for core task 1

- Knowledge of AV systems (sensors, connectivity (V2X, 5G), software logic), dependent on (limits of) Operational Design Domain, e.g. knowledge of awareness of open versus closed system operational distances, (baseline functional understanding)
- Knowledge of remote operation interfaces (full working knowledge of interface functions and workflows)
- Knowledge of fail-safe and fallback strategies automated driving
- Knowledge of connectivity quality assessment (latency, bandwidth, redundancy)
- Knowledge of Safety Regulations and standards
- Knowledge of Fleet Operations
- Knowledge of Risk Management
- Knowledge of traffic, familiarity with local traffic rules and signage
- Knowledge of emergency procedures
- Knowledge of customer interaction protocols

Knowledge Area	Knowledge Types
AV systems (sensors, connectivity, software logic, ODD)	Factual, Conceptual, Implicit
Remote operation interfaces	Factual, Procedural, Conceptual
Safety regulations & standards	Factual, Procedural, Implicit
Fleet operations	Conceptual, Factual
Risk management	Procedural, Conceptual
Emergency procedures	Procedural, Factual
Customer interaction protocols	Procedural, Implicit
Environment-specific (open vs. closed)	Conceptual, Factual

Autonomy & Responsibility level for core task 1

- High autonomy for routine decisions
- Shared/moderated autonomy during incidents with backup/escalation
- High responsibility for operator-side safety & continuity
- Low responsibility for system-level compliance/certification

EQF clarification core task 1

EQF 3 would fit to this task. It is dominated by operational execution of standard methods: pre-departure validation, monitoring dashboards/feeds, identifying anomalies, applying

emergency/fallback protocols, and handling interactions using approved tools and procedures. Autonomy is mainly routine decision-making with shared/moderated autonomy during incidents via escalation/backup, and responsibility is mainly operator-side safety and continuity rather than system-level compliance or certification.

Communication is a strong component (passengers, engineers, emergency services). EQF 3 still fits when communication is executed within defined structures and roles; the EQF level trends upward when it requires systematic tailoring to target groups and higher-stakes coordination responsibilities.

Core task 2

Ensures quality of work and compliance with current regulations

Subtasks:

A. Monitors operational performance according to service level requirements.
B. Accurately logging of operations, system behaviour and incidents for traceability and accountability. Justifying and substantiating decisions made, for accountability and audits (to regulators and authorisation bodies).
C. Complies with current (employer-set) regulations (incl. local, national, EU-regulations, internal safety standards and cybersecurity protocols), limited to operator-level compliance (following strictly predefined SOPs (Standard Operating Procedures), safety protocols and legal boundaries).

Skill requirements for core task 2

- Quality awareness and accuracy
- High-quality reporting, producing clear, structured, and traceable documentation
- Communication skills to work with internal and external stakeholders
- Attention to detail in documentation and compliance checks
- Digital security awareness specific to remote operation environments

Knowledge requirements for core task 2

- Knowledge of internal quality assurance and safety procedures (following SOPs, with ethical considerations included)
- Knowledge of cybersecurity basics
- Knowledge of current local, national and EU-regulations (liability, data protection, etc.), mostly for legal boundaries for actions

Knowledge Area	Knowledge Types
Internal QA & safety procedures	Procedural, Factual
Cybersecurity basics	Factual, Procedural, Conceptual
Regulations (local/national/EU)	Factual, Procedural, Implicit

Autonomy & Responsibility level for core task 2

- High autonomy for executing Quality Assurance/logging/cyber hygiene
- Limited autonomy for interpreting regulations/ethics beyond SOPs

- High responsibility for traceability and SOP adherence
- Low responsibility for certification/compliance strategy

EQF clarification core task 2

This task aligns with EQF 3 because it focuses on accurate execution and documentation: logging for traceability, producing structured reports, and complying with regulations and cybersecurity protocols within predefined SOP boundaries. Autonomy is high for executing QA/logging and cyber hygiene, but limited for interpreting regulations/ethics beyond SOPs; responsibility is high for traceability and adherence, low for certification/compliance strategy.

A potential lift toward EQF 4 occurs when "attention to detail" becomes specialist information handling (obtaining, processing, combining specialist information) and when the role requires interpretation and judgement instead of strict execution.

Core task 3

Contributes to operational optimisation and innovation

Subtasks:

A. Reads data, executes data-driven analysis focused on basic operational insights (e.g., recurring interventions), no deep engineering analysis
B. Optimises routing, performance, and fleet operations within operational procedures and standardised digital mission orders.
C. Logs and reports incidents during AV operations and provides feedback to engineers and supervisors on risks and improvements on AV software, perception models, and remote operation tools and procedures through structured digital channels (replacing informal communication)
D. Supports knowledge transfer to new colleagues or operators
E. Learns continuously by participating in training and staying updated on AV behaviour, software features, policies, and AI-assisted ROC tools

Skill requirements for core task 3

- Critical professional attitude, including questioning assumptions, validating data before acting, and providing constructive feedback
- Practical data literacy
- Basic operational data analysis
- Pattern recognition, spotting recurring issues and trends
- Communication skills, including structured feedback to engineers and supervisors, and collaboration across teams
- Willingness to learn, adapting to evolving systems, tools and procedures

Knowledge requirements for core task 3

- Knowledge of internal procedures, including understanding workflows for routing optimisation and reporting
- Knowledge of applicable local, national and EU-regulations (basic awareness only)
- Knowledge of traffic and mobility systems

- Knowledge of incident classification frameworks (tiering severity and response strategy)

Knowledge Area	Knowledge Types
Internal procedures	Procedural, Factual
Applicable regulations	Factual, Implicit
Traffic and mobility systems	Conceptual, Factual

Autonomy & Responsibility level for core task 3

- High autonomy for routine feedback/basic analysis/knowledge transfer
- Limited autonomy for deep analytics/system changes
- Moderate responsibility for actionable feedback
- Shared responsibility for continuous learning and knowledge transfer

EQF clarification core task 3

This task fits EQF 3 as written because it primarily involves bounded optimisation and feedback: reading data for basic operational insights (without deep engineering analysis), optimising within standardised mission orders and procedures, and providing structured feedback through defined channels. Responsibility is moderate for actionable feedback and shared for learning/knowledge transfer; autonomy is limited for deep analytics or system changes.

Elements that raise EQF level include: taking initiative to drive improvements, conducting deeper analysis, and adapting communication to varied target groups (especially when feedback has higher consequence or requires negotiation/coordination beyond routine collaboration).

EQF – Remote Operations Specialist

The profile of Remote Operations Specialist is indicated as EQF level 3. Across the core tasks, the ROS primarily executes clearly defined operational work using standardised procedures (SOPs), tools, and predefined protocols. Decision-making is mainly routine and procedure-based (identify a situation, select the appropriate procedure, execute and document), with escalation/backup for non-routine or high-impact situations. Responsibility is largely for own work output (safe and correct execution, traceability, accurate logging, compliance with boundaries), rather than for designing policies, determining compliance strategy, or taking system-level accountability.

Communication is operationally critical (passengers, engineers/technicians, emergency services), but in the profile as written it is mostly framed as executing communication within approved formats and channels, aligned with operational procedures and incident coordination.

Elements that can raise the level toward EQF 4-5

Factors that would move the profile upward are shifts in complexity, autonomy, and accountability, for example:

- Initiative and ownership beyond SOPs: independently choosing and justifying non-standard approaches when procedures are insufficient; proactively improving operations rather than only reporting.

- Analytical problem handling: not only identifying anomalies/incidents, but analysing causes, weighing alternatives, and proposing validated solutions (beyond basic pattern recognition).
- Responsibility for the work of others: coaching, allocating tasks, quality control for colleagues, acting as shift lead, or being accountable for team outcomes.
- Audience-adaptive, goal-driven communication: tailoring communication strategies to different target groups (public authorities, diverse passenger groups, multi-agency settings), including persuasion/negotiation and managing reputational/public-trust risk.
- Specialised tasks/knowledge: deeper domain expertise (e.g., advanced cybersecurity, regulatory interpretation, safety assurance methods) with consequential judgement and decision latitude.
- Higher consequence: decisions where incorrect judgement directly creates major safety/legal/service impact without immediate escalation pathways.

4.4 Policy and Regulation officer

Competence framework
This Competence framework defines the skills, knowledge and professional behaviours required of a Policy & Regulation Officer.

Context of the CCAM Policy and Regulation Officer profile

Connected, Cooperative and Automated Mobility (CCAM) is transforming the transport workforce. As vehicles progress toward higher automation levels, human oversight shifts from on-board drivers to remote control centres. Harmonisation across countries and ports is limited, resulting in a patchwork of rules, fragmented certification procedures, and varying local interpretations.

Developers must navigate different approval processes, temporary test licences and locally defined operational constraints. This situation requires CCAM developers and authorities to have stronger regulatory literacy to ensure compliance and avoid deployment delays. Apart from their role in creating coherent regulations, authorities also act as key organisers and funders of CCAM-based on-demand transport. As a result, deployments depend heavily on the priorities and decisions of cities, municipalities and public institutions.

Within the Policy & Regulation Officer profile, three distinct roles within public authority bodies can be distinguished. The extent to which the three roles are fulfilled by a single person or several people generally depends on the size of the organisation. Larger organisations tend to have more specialised roles, whereas in smaller organisations, for example, in smaller and medium-sized cities, several roles can be fulfilled by one officer.

1. Regulator. The primary function is to draft and harmonise regulations, interpret higher-level laws, and ensure alignment with international standards. The focus is on legal and technical literacy for shaping frameworks; compliance with safety and data protection. The regulator has an important role concerning processing permit applications, providing oversight of compliance with already granted permits and using data and feedback from operations to improve regulations

and procedures at the public level to continuously improve safety. Regulators rarely act alone - they rely on expert groups and public consultations.

Governance level: Mostly European/national/federal (e.g., ministries, transport agencies)

2. Policy Maker. The primary function is to develop strategic mobility visions and long-term policy frameworks. The focus is on multimodal integration, accessibility, socio-economic impacts, and funding strategies. Policy makers emphasise facilitation and public affairs rather than technical depth; they synthesise knowledge from experts rather than hold it all themselves. The policymaker has a key role in understanding the technical and service landscape, in order to recognise the public´s role in an efficient transport system and an effective market for autonomous solutions.

Governance level: national/federal/regional (upper-level strategic units)

3. Integration and authorisation officer. The primary function is to assist with implementing projects and locally approved deployments; check compliance with safety, cybersecurity, standards, type approval and operational conditions and use for continuous risk assessment. Also, this function includes applying regulations and granting licenses. This role will have to work closely with strictly operational staff to ensure continued safety and compliance with permits and operating instructions. Integration and authorisation officers work more on a technical level rather than on a strategic level.

Governance level: Regional/local for site-specific integration, and implementing pilots; and national for local approval of deployments (e.g., local mobility department, transport authorities).

The Policy & Regulation Officer has three core tasks (responsibilities), which are broken down into several subtasks (working processes). The three core tasks are:

1. **Draft, harmonise and update regulations related to CCAM.**
2. **Develop policy and arrange institutional support for CCAM deployment.**
3. **Integrate CCAM systems into municipal or regional mobility services.**

Core task 1

Develops regulations: Draft, harmonise, and update regulations related to CCAM

Subtasks:

A. Interpret existing regulations issued by higher authorities and integrate experience from pilots and live operations (e.g. incidents, ROC data, user feedback) and feed into policy updates and regulatory decisions.
B. Ensure compliance with transport, accessibility, safety, data-protection and CCAM-specific regulatory requirements.
C. Manage licensing and permitting processes (safety, liability, data access).
D. Adapt regulatory frameworks for new vehicle types and remote supervision mechanisms
E. Consultation and public review processes.
F. Optimizing administrative pathways to avoid delays.

G. Track evolutions in standards and regulations (UNECE (EU/national), ISO) continuously.

Skills requirements for core task 1

Interpreting and processing evolving regulatory frameworks

- Ability to stay informed about and interpret evolving EU/UNECE/national frameworks and apply them to local contexts.
- Translate complex legal and technical requirements into actionable conditions.
- Continuous learning: stay updated on fast-changing regulations and technology.

Drafting regulatory conditions, permits, and safety requirements

- Draft local regulatory conditions, permits, and safety requirements (The safety requirements should be drafted only on the highest level (UNECE, EU). All levels below should then be tasked with assessing compliance with these safety requirements).
- Produce clear, implementable texts and ensure administrative feasibility.

Ensuring compliance

- Process permit applications and provide guidance to applicants (The main task for local regulators is to ensure compliance between ODD (theoretical and scenario-based) with actual local road network, traffic rules and conditions).
- Ensure regulatory conditions to align with standards (UNECE, ISO) and safety requirements.
- Integrate cybersecurity and data governance considerations into compliance frameworks.

Awareness and understanding of cybersecurity, data flows, data-governance considerations

Technical Translation

- Translate technical safety concepts and system limitations into regulatory language.
- Communicate technical constraints to non-technical decision-makers.

Consultation & Coordination

- Orchestrate multi-stakeholder consultations (industry, authorities, academia).
- Stakeholder communication: Clear, persuasive writing and public speaking.
- Negotiation & facilitation: Build consensus among actors coming from diverse backgrounds.

Risk Assessment & Scenario Thinking

- Evaluate regulatory impacts under uncertain conditions
- Balance innovation with safety principles (e.g., Vision Zero).
- Evaluate risk of specific local deployments of Avs

International Benchmarking

- Identify the similarities and differences between various legal frameworks , integrate best practices.

Knowledge requirements for core task 1

Legal Knowledge

- Knowledge of local, national, and EU frameworks for mobility, CCAM, data protection, critical infrastructure protection and public transport.
- Knowledge concerning liability principles (for example manufacturer, operator, remote driver), safety, and operation-related rules.
- Knowledge of vehicle approval pathways.
- Knowledge of public transport law and accessibility rules.
- Knowledge of comparative law and process literacy across jurisdictions. (regional/national/EU/UNECE).
- Standards Literacy, understanding how standards underpin type approval and compliance.
- Process & Administrative Knowledge (process literacy).
- Knowledge of local traffic laws, road networks and conditions.

Technical knowledge

- Knowledge of characteristics, limitations, and safety concepts of autonomous mobility systems.
- Knowledge of the interaction between vehicles, software, and infrastructure.
- Knowledge of potential cybersecurity risks, data flows, and data sovereignty.
- Knowledge of ISO standards relevant to CCAM (i.e. ISO 26262 (functional safety) and ISO 21448/SOTIF (Safety of the Intended Functionality).

Knowledge Area	**Knowledge Types**
Core legal instruments, standards texts, system specifications.	Factual
Understanding interactions between law, technology, and safety; risk boundaries.	Conceptual
Safety regulations & standards.	Factual, Procedural, Implicit
Knowing how to navigate approval processes and orchestrate consultations.	Procedural
Political intelligence, cultural communication patterns, and practical insights from pilots.	Implicit

Autonomy & Responsibility level for core task 1

- High autonomy in interpretation and shaping proposals for regulations and their translations to actionable conditions.
- High level of responsibility concerning reporting to and advising heads of agencies or ministries.
- High level of responsibility operating a bridge function between law, technology, and operations. They mediate between technical constraints and political priorities, ensuring that regulations are both legally sound and operationally realistic.

EQF clarification core task 1

This task fits EQF 6 because it requires independent interpretation of evolving EU/UNECE/national frameworks, translation into implementable regulatory conditions, and continuous alignment with standards, safety, data protection, and cybersecurity considerations. It combines conceptual understanding (law–technology–safety interactions) with procedural competence (consultations, permitting pathways, administrative optimisation) and substantial responsibility in advising and bridging across domains.

Core task 2

Develops policy and arrange institutional support for CCAM deployment

Subtasks:

A. Secure funding (local, regional/federal, national, EU programs).
B. Provide political, administrative, and departmental continuity for deployments.
C. Support procurement and PPP structures for CCAM services.
D. Stakeholder Coordination: facilitate cooperation between developers, operators, infrastructure providers, municipalities and national regulators. Align interests and support common governance structures.
E. Produce briefs and scenarios.

Skills requirements for core task 2

Interpreting technical data for policy decisions

- Use processed KPIs/dashboards to allow a data-driven decision-making approach to inform policy decision-making (not raw technical logs).
- Basic data literacy to understand mobility and safety metrics for evidence-based policy.

Designing deployment frameworks, operational zones, and safety concepts

Stakeholder and citizen engagement and communication across public and private actors

- Ability to facilitate governance processes and multi-stakeholder decision-making.
- Ability to navigate institutional dynamics and stakeholder interests effectively (Strong communication skills for engaging politicians, civil servants, enterprises and citizens).
- Ability to translate technical outputs into policy language for non-technical decision-makers.
- Negotiation and lobbying skills to secure institutional support and funding.
- Public speaking, negotiation, and clear writing for diverse audiences.
- Adaptability and continuous learning to keep up with evolving regulations and technology.

Ability to produce policy briefs, scenario analyses, and recommendations

- Competence in writing clear policy briefs, recommendations, and scenario analyses.
- Ability to synthesise complex inputs into coherent reports for decision-making bodies.

Procedural navigation

- Skills in mapping institutional responsibilities and accelerating administrative processes.

- Competence in procurement and PPP design.
- Ability to embed data governance and cybersecurity clauses.

Systems thinking & risk assessment

- Ability to balance innovation with safety principles (e.g. Vision Zero).
- Scenario-based reasoning under uncertainty and understanding socio-technical impacts.
- Creativity and the ability to be a change agent.

Knowledge requirements for core task 2

- Knowledge and understanding of principles of multimodal transport integration, accessibility, and public transport systems.
- Knowledge and understanding of urban mobility governance and infrastructure planning.
- Knowledge of policy cycles, administrative decision-making, procurement, PPPs. Policy is typically led by upper-level strategic units; the role needs literacy in that process.
- Knowledge of evaluation frameworks, monitoring, and impact assessment.
- Data literacy & digital regulation so policy can leverage mobility/safety data in decision making.
- Knowledge of socioeconomic context & business models.
- Functional knowledge of integration technology.
- Knowledge of governance tiers & role boundaries: knowledge of the split between regulator, policy maker, and authorisation body, and how EU/national/(federal/regional)/local contexts shape who leads which policy levers.
- Political & Institutional Knowledge: implicit knowledge of political agendas, party priorities, and cultural communication patterns.
- Knowledge of and application of international and national support schemes for CCAM development

Knowledge Area	**Knowledge Types**
City plans, legal instruments, and multimodal frameworks.	Factual
Systems thinking across modes, understanding CCAM's societal impacts.	Conceptual
Administrative pathways, procurement steps, stakeholder orchestration.	Procedural
Political intelligence, stakeholder negotiation experience.	Implicit

Autonomy & Responsibility level for core task 2

- Moderate to high autonomy in facilitating governance, producing briefs, and coordinating stakeholders.
- Shared responsibility for shaping policy proposals; final decisions sit with final decision-makers (elected representative, management board).
- High level of complexity (political, multimodal, multi-stakeholder governance).

EQF clarification core task 2

This task aligns with EQF 6 because it requires synthesising processed evidence (KPIs/dashboards) into policy, navigating governance tiers and institutional dynamics, securing funding and continuity, and coordinating multi-stakeholder decision-making. The core is policy judgement + stakeholder orchestration, with shared responsibility for proposals but high complexity and autonomy in preparation, facilitation, and advisory output.

EQF 7 becomes relevant when uncertainty is structurally higher (unpredictable outcomes), when strategy is fully owned, and when the officer's role becomes decisional rather than mainly advisory/facilitative.

Core task 3

Integrates CCAM systems into municipal or regional mobility services

Subtasks:

A. Conduct scenario development, risk assessment, and socio-technical analysis.
B. Assess infrastructure suitability: Evaluate how autonomous services fit in existing infrastructure and multi-modal networks.
C. Structure pilots.
D. Ensure accessibility, safety, and equity for all user groups.
E. Authorisation of pilots and deployment of AV systems. Includes defining and deciding on the match between ODD and operational area/domain and reviewing and adjusting ODDs over time, as in practice ODDs change due to weather, road works, incidents or software updates and are not only defined once at the start.
F. Distinguish between system/type approval (e.g. UNECE, vehicle and ADS level) and operational permit within a defined ODD, as these are handled by different authorities in practice.
G. Monitor service quality i.e. how well the deployed CCAM service performs from both an operational and user perspective.

Skills requirements for core task 3

- Assess **risks and operational conditions**
- Asses **regulatory impacts**
- Ability to **reconcile ODDs**, conditions under which vehicles can operate with local conditions in targeted service area
- **Develop monitoring frameworks**
- **Project and programme management** skills (ability to structure pilot deployments, plan evaluation cycles, and upscale considerations)
- Understanding **user accessibility,** inclusion needs, social/societal impacts of CCAM

- **Technical & data literacy** (Understand technical constraints to guide integration decisions)
- **Operational coordination skills** (Coordinate across operations, legal, and compliance teams)
- **Stakeholder engagement** (Facilitate collaboration between municipalities, operators, and infrastructure providers)
- **Continuous learning & adaptability** (stay updated on evolving regulations, standards, and technology, and perception of CCAM systems by citizens)

Knowledge requirements for core task 3

Legal Knowledge

- Knowledge of local, federal/national, and EU frameworks for (public) transport, mobility, CCAM.
- Standards literacy (familiarity with UNECE regulations and international standards for type approval and compliance).
- Knowledge of data protection and critical infrastructure protection rules.
- Knowledge of liability, vehicle approval, safety, and operation-related rules.
- Knowledge of administrative organisation: Who authorises pilots of type-approved vehicles; knowledge of institutional responsibilities to avoid delays.

Technical knowledge

- Knowledge of characteristics, limitations, and safety concepts of autonomous mobility systems.
- Knowledge of requirements for Operational Design Domains (ODDs): conditions under which vehicles can operate, including geography, weather, and infrastructure compatibility.
- Knowledge of remote operation and telecom aspects: latency, connectivity, and resilience for remote supervision.
- Knowledge of operational procedures: awareness of risks when operational rules are poorly designed and their impact on scaling deployments.
- Knowledge of mobility and integration context (understanding multimodal integration and how CCAM services fit into existing networks to ensure a seamless multimodal travel from a user perspective.)
- Knowledge that ensuring authorisation frameworks and SOPs include robust cybersecurity measures is crucial, even if technical implementation is handled by specialists.

Knowledge Area	**Knowledge Types**
Regulations, standards, SOPs.	Factual
Understanding interactions between law, technology, and infrastructure.	Conceptual
Licensing, permitting, and deployment processes.	Procedural

Insights from pilots and operational realities.	Implicit

Autonomy & Responsibility level for core task 3

- Substantial autonomy locally for implementing pilots, ODD decisions, monitoring frameworks; bounded by national rules.
- Shared responsibility for risk assessment, accessibility, and integration; no liability for vehicle failures.
- High level of complexity (operational + legal + socio-technical).

EQF clarification core task 3

This task fits EQF 6 because it combines legal/standards literacy with socio-technical integration: scenario development, risk assessment, ODD-to-local-conditions reconciliation, authorisation logic (type approval vs operational permit), monitoring frameworks, and accessibility/equity considerations. The work is locally autonomous but bounded by national rules; complexity is high because operational, legal, and societal constraints interact.

Movement toward EQF 7 is driven by higher uncertainty, original analytical framing, and system-level accountability for integration strategy and governance outcomes.

EQF Policy and Regulation Officer

The profile of Policy and Regulation Officer is best indicated as EQF level 6. Across the three core tasks, the PRO operates with high autonomy in interpreting and translating higher-level regulation into actionable conditions, drafting and harmonising regulatory frameworks, and advising senior public bodies. The profile requires integrated legal–technical understanding, the ability to interpret and synthesise complex information, and to mediate between operational realities, technological constraints, and political priorities.

Communication is not routine "stakeholder contact", but multi-audience, persuasive and bridging communication (specialists and non-specialists), often in consultation, negotiation, and public/political contexts. This aligns with EQF 6 because it combines advanced knowledge with substantial responsibility and autonomy.

Elements that can raise the level toward EQF 7

The profile trends toward EQF 7 when the work shifts from shaping and implementing frameworks to creating new (policy/regulatory) knowledge and high-uncertainty strategic judgement, for example:

- Leading highly complex, uncertain policy and regulatory decisions with major public impact where outcomes are unpredictable and trade-offs must be justified at system level.
- Producing original research / scientific-policy knowledge (or commissioning and critically evaluating it at a level equivalent to advanced academic practice), rather than mainly using existing evidence and expert inputs.

- Holding formal accountability for system-level governance outcomes and/or directing the work of others structurally (programme leadership, portfolio responsibility, institutional accountability).

5 Conclusions and recommendations

The development of CCAM can only succeed if human capital is developed to perform the new tasks and roles that come with CCAM deployment. These tasks and occupations require competences for a variety of professionals: both middle-level skilled professionals as well as professionals with higher education. And professionals varying from highly technical to professionals with social, legal or governance backgrounds. They all fulfil an important role in the realisation of CCAM deployment, from the development of systems to operating services.

Use cases that focussed on six different kinds of CCAM deployments, revealed that tasks and occupations to a large extent overlap between these use cases. Out of clusters based on the place in the value chain and on the type of tasks, a longlist of twelve occupations was identified. This longlist involves a variety of occupations, for middle level to higher educated professionals, and ranging from mechanical and engineering backgrounds to professionals with social, legal, data science or driving background.

For what it takes to develop CCAM competences, we can roughly distinguish between technical occupations (mechanics, engineers) and non- (or less-) technical occupations. The mechanics and engineers have a strong basis in formal, technical education and need to stay updated with rapidly developing technologies. These occupations could benefit from both adaptations in formal education as well as educational provision on new technologies via short courses. These could be provided for example by suppliers of technologies.

The competences of professionals in non-technical occupations are based on the one hand on work experience in adjacent sectors (professional driving, customer service) and education (legal, governance, data science, etc.). They need training to add a layer of CCAM competences to their core competences. Non-formal and informal ways of learning, like short courses, training-on-the-job and learning-by-doing could contribute to the development of the competences more than adaptations on formal training schemes.

Backgrounds of professionals working with new technologies and services are diverse, as no clear learning pathways towards CCAM occupations exist. This means that a variety of learning pathways is needed to serve the diverse group of potential CCAM professionals. The formulation of learning outcomes is an important basis for the development of educational provision for the occupations at key positions in CCAM deployment.

From this point forward actors in labour market and education can use the outcomes to prepare the human capital that is needed for CCAM deployment. The content offers possibilities for training development or labour market interventions like job-to-job mobility programmes. Follow-up research could be directed at identifying potential target for CCAM occupations, in order to tailor training schemes and mobility programmes.

Annex 1: Tasks, occupations and competences per use case

Use case 1: Ground transportation for last mile delivery

Tasks

For this use case the essential tasks can be grouped into five clusters.

- **Operational** tasks on CCAM-deployment. Oversee vehicle operations, supervise several AVs simultaneously; monitor surroundings; respond to anomalies via digital systems and make safety calls; parcel loading.
- **Safety driving** ensuring operational continuity and risk mitigation.
- **Coordination and management**. Coordinate routes and logistics across partially automated networks.
- **Technical tasks**. AV-specific diagnostics, sensor calibration, vehicle preparation, retro fitting existing vehicles.
- **Public domain**. Train public authorities in AV interaction.
- Direct customer interaction

Occupations

The above-mentioned tasks fit in several CCAM occupations.

- **Operational**: Remote Automated Vehicle Supervisors
- Safety / test drivers (in this use case seen as a transitional role)
- **Coordination**: AV fleet coordinator
- **Technical**: Maintenance mechanics
- **Public domain**: Public infrastructure trainers
- Scooter based parcel delivery

Competences

Some of the needed skills can be directly connected to specific roles, other skills are generic.

- **Technical tasks:** basic engineering knowledge,
- **Safety driving:** basic driving skills combined with the awareness of automated systems' behaviour.

Generic skills needs are.

- Digital communication skills and general digital readiness
- Technical proficiencies for the human - vehicle interface
- Situational awareness
- Data interpretation
- Computer science

Use case 2: Bus depot

Tasks

In the bus depot use case, we see tasks emerging in the following clusters.

- **Operational monitoring:** monitoring and analysing vehicle behaviour.
- **Technical** tasks: maintaining sensors, combining mechanics with systems and software, servicing.

Occupations

Although the tasks can be grouped in just two clusters, more occupations are involved.

- Depot teleoperator
- Fleet data analyst
- Automation technician
- Maintenance integrator

Competences

Several skill needs emerge in the bus depot use case.

- Shift from manual to digital: more software diagnosis instead of hardware maintenance
- Probabilistic modelling instead of rule-based decision making
- Data literacy and analytics
- Cybersecurity awareness
- Human-machine interaction

Use case 3: Port/terminal

Tasks

Core tasks in the ports and terminals are related to **operational, systems** and **security**.

- **Operational** tasks:
  - Remote operation of quay cranes requiring interaction with human-machine interfaces from secure control rooms
  - Overseeing autonomous navigation in varied weather and operational conditions.
- **Systems** development:
  - Optimizing AI-powered robotic systems
  - Integration of AR and VR
- **Cybersecurity** tasks

Occupations

In general, the deployment of CCAM in ports and terminals means an evolution into a tech-driven environment that necessitates hybrid roles blending logistics and system fluency. The following operational and technical roles are mentioned.

- Control room operators

- Warehouse IT specialists overseeing AGVs
- Robotics and automation technicians.

Competences

Important skills in this use are:

- understanding of robotics and automation
- human-machine interaction (HMI)
- basic digital skills
- cybersecurity
- logistics knowledge
- understanding of robotics and automation

Use case 4: Public (shared) transportation

Tasks

The emerging tasks in this use case are clustered as follows.

- (Remote) **operational** tasks
    - Monitoring and intervening in AV operations from a centralised control centre
    - Providing oversight of automated vehicle fleets and supporting them during exceptions
    - Handling app-based rider requests, real-time updates, and escalations across mobility services
    - Handling more advanced system supervision roles, often involving dashboards, incident response tools, and mobility analytics
- **Analytical** tasks: interpreting rider behaviour, vehicle performance, and system-level patterns to optimise fleet operations and service design
- **Technical** tasks are characterised by combining hands-on vehicle servicing with the ability to manage sensor systems, software updates, and diagnostics
- Tasks in the **social** domain consist of assisting vehicles and passengers on-site when needed. This is seen as a critical role during early deployment phases
- Tasks related to **policy** development are integrating CCAM systems into broader urban mobility strategies, addressing accessibility, equity, and user experience across communities

Occupations

Emerging occupations in this use case are clustered as follows.

- **Remote operations**: tele-assistants, remote supervisors, operations coordinators, remote operations specialists
- **Technical**: AV maintenance technicians
- **Analysis and planning:** mobility data analysts; socio-technical mobility planners
- **Social roles:** engagement & outreach coordinators, stewards / bus ambassadors, remote customer service staff, field support agents

Competences

Several skills can be related to specific tasks or roles; other skills are generally required.

- Skills for **drivers**: being able to work with automated systems, monitor vehicle sensors, and recognise system malfunctions, strong V2I and vehicle-to-vehicle (V2V) communication proficiency and a good understanding of wireless communication systems.
- Sensor calibration and diagnostics; software/hardware interfacing
- **Operational workers** with operating with semi-automated systems require basic knowledge of AV systems and the ability to switch between automated and manual control.
- Adaptation to the use of digital platforms (such as MaaS platforms) integrating multiple transport modes.
- Generic business management skills such as marketing, billing, and fleet organisation.

Use case 5: Private (shared) transportation

Tasks

In this use case the following tasks are identified

- **Safety driving**, including securing operational safety and software testing
- Continuous **software development**: providing real-time software performance input to engineering teams, vehicle training and software validation
- **Remote operations**: monitor and manage operations remotely, anticipate autonomous vehicle behaviour by monitoring both road traffic and live system feedback.
- **Intervening**: coordinating crisis response remotely across diverse data sources (vehicle telemetry, weather, bookings). Proactive customer intervention (incident management)
- **Coordinating**: fleet orchestration across operators
- **Technical tasks**: conducting sensor calibration, software diagnostics, and passenger interface verification.
- **Cybersecurity**: managing data governance and cybersecurity in cooperation with public transport authorities

Occupations

The roles and occupations relevant in this use case are clustered as follows.

- **Safety Driver,** having a hybrid role securing safe operations and testing the system and system updates. This role can be transitional to some extent, although new hard- and software will continue to need to be tested
- **Remote Operators**, monitoring safe operations
- **Coordinating** roles: fleet orchestration specialists
- **Technical** roles, including AV systems technicians and site crew technicians (focused on data and sensor systems)
- **IT and analysis**: data analyst / IT Translator Simulation and AI training engineers,
- **Interface development:** app interface developers & analysts

- **Public domain**: Program Manager Public Transport Authority (data and compliance), urban integration planners
- **Customer service and intervention** (mobility experience manager): customer service managers rapid-response intervention teams and hybrid customer service and technical support roles,
- **Safety and security**, including AV cybersecurity specialists and compliance officer (digital safety and regulatory oversight)

Competences

For the tasks and roles in this use case, the following competences are required.

- **Safety driver:** advanced situational awareness under AV supervision; understanding of automated driving systems' (ADS) behaviour and limits; manual intervention readiness; communication and reporting of system anomalies; communicating with engineering teams
- **Public domain**: Innovative procurement, infrastructure adaptation and road system analysis; multimodal planning with AV fleet integration;
- **IT and data analysis:** user data monitoring and being able to combine vehicle, user and environmental inputs.
- **Technical skills**: sensor calibration and diagnostics competences. sensor diagnostics (camera, radar, lidar); software/hardware interfacing; OTA (over the air) update execution; system calibration under TRL-level constraints.
- **Customer services and incident management:** communication skills for (remote) interaction with passengers; service empathy care skills for assisting passengers; crisis management and incident coordination; knowledge of protocols and procedures for safety, triage and escalation; behaviour coordination with FSAs.
- **Remote operations**: Real-time AV fleet supervision; edge case assessment and decision-making ; deep understanding of AV limitations and behaviour; coordination with FSAs.
- **Fleet and operations coordinator**: agile planning and scheduling, dispatch optimisation; system-level oversight of vehicle routing; fluency with platform interfaces
- **Interface development**: mobile UX/UI design for on-demand AV services; A/B testing.
- In general: crisis management and incident coordination; knowledge of protocols and procedures for safety, triage and escalation; behaviour coordination with FSAs.
- In general: English proficiency for cross-border operations, training, and systems.

Use case 6: Shared transportation targeting specific groups

Tasks

Emerging tasks mentioned by stakeholders in this use case focus on operations, coordination and contact with the target groups.

- Overseeing vehicle **operations**, monitoring surroundings and vehicle behaviour/
- Supervision of mobility, **coordinating** routes and logistics across partially automated networks.
- Offering in-vehicle or stop-based **support** for elderly, disabled, or anxious passengers, helping build public trust and ensure inclusive access

Occupations

New occupations in this use case require a mix of digital, operational and technical skills.

- Safety Drivers
- Remote Vehicle Supervisors
- Maintenance staff
- Driving engineering jobs
- Road infrastructure design
- Support Staff

Competences

For this use case skills are mentioned in general

- Stress resistance (for safety drivers and remote operators).
- Situational awareness with sensitivity to unprotected traffic participants and vulnerable road users (vru)
- Knowledge about legislation in case of incidents like collision with persons
- Communication and empathy for target groups are important in customer services.
- Supervision skills (supervision of technology instead of people)
- Basic engineering knowledge
- Basic HMI understanding
- Digital literacy

Annex 2: Questionnaires

This annex includes the interview questionnaires used in the study. For readability, only the question lists are provided.

The first questionnaire was used during the first interview round with stakeholders on the CCAM use cases. The interviewer selected the relevant use case at the start of the interview and used the same core question set across interviews, with use-case-specific follow-up questions where needed.

The second questionnaire was used during the validation round for both occupational profiles: Remote Operations Specialist (ROS) and Policy and Regulatory Officer (PRO). The question set was the same for both profiles; only the profile-specific context descriptions differed. These context descriptions have been omitted from the annex to keep the questionnaire concise.

In addition, input was gathered during design-thinking sessions. These were interactive focus groups in which participants worked in Miro to map, prioritise, and validate key elements (e.g., tasks, skills, challenges, and recommendations). For readability, the annex provides only a short overview of the guiding prompts used in these sessions, without reproducing the full background information and explanations shared during the workshops.

CCAM Interview Questionnaire use cases

Section 1: General Information

Name of interviewer	(Name and Org)
Name of interviewee	
Organisation and position	
Relevant use case	(indicate which use case)

1. Can you briefly introduce yourself and your organisation?
2. What is your role in relation to *[name of project]*?

Section 2: CCAM Impact on Use Cases (Task 5.1 – Policy, Regulation, Technology & Operations)

General Questions for All Use Cases

3. Could you shortly describe the current state of play of the project (in terms of life cycle of innovations: idea; business case; testing/prototyping; pilot; launch to market; growth).
4. What key factors are crucial to develop the use case into full deployment?
5. What are the main barriers your use case encounters?
6. How do the following factors impact CCAM deployment in your use case?
    a. current policies and regulations
    b. economic factors
    c. labour market, skills, education
    d. public acceptance
    e. technology / infrastructure
7. What are the key conditions which need to be met for the use case to enter into the next stage of development?
8. What actions should be prioritised to accelerate CCAM deployment in your use case?

Section 3: Skills and Workforce Needs (Task 5.2, 5.3)

Mapping Current and Future Skill Gaps

9. What are the key occupations and tasks (in CCAM) currently involved and affected in the use case? In terms of
    a. Occupations
    b. Underlying field of study & level of study by occupation
    c. Tasks
10. Are there currently any notable skill shortages or mismatches within the workforce relating to the use of CCAM within the use case?
    a. Please describe the shortage / mismatch: what competencies are currently needed?
    b. For which occupational roles
11. Can you describe the size of the workforce currently involved in the use case, according to the before mentioned occupational roles?
12. In case of successful implementation of CCAM deployment in your case, how do you anticipate increasing or decreasing human capital needs in the use case over the next 5-10 years?
    a. Qualitative:
        i. Competencies needed,
        ii. new occupations
        iii. Decreasing / disappearing occupation
    b. Quantitative: indication of employment size related to the use case
        i. Changing occupations (added or deducted tasks)
        ii. New occupations
        iii. Disappearing occupations
13. What types of training programs are currently available for CCAM-related roles within the use case, if any?
14. The current professionals working in new CCAM roles or performing new tasks, what is their educational and working experience background? Is it easy to employ these professionals for future CCAM-related activities?
15. What changes in the educational offer are needed to support CCAM workforce transitions? (e.g., short-term upskilling, full diploma-based training, which EQF-levels, company-based vs. general training).
    a. For further development of your use case
    b. To support people that might lose their job as a result of the use case/CCAM implementation
    c. In general
16. What key knowledge, skills, and competencies should be prioritised for CCAM workforce training?

Financing Reskilling and Workforce Adaptation

17. What are the biggest (financial) barriers to workforce reskilling for CCAM?
18. Who should take responsibility for funding workforce reskilling in CCAM? Private or public parties?
19. What incentives or funding mechanisms could create demand for CCAM-related training? (e.g., public/private funding, vouchers, individual learning accounts)

Certification and Validation of Skills

20. How should CCAM-related skills be formally validated and certified? (e.g., micro-credentials, industry certifications, EU-wide standards, full diplomas of School-based or dual VET programmes and/or Higher education programmes)
21. What challenges exist in developing standard certification structures for CCAM-related professions?

Social Programs and Workforce Mobility

22. What strategies should be in place to support workers transitioning to CCAM-related jobs? (e.g., retraining, job placement, mobility programs)
23. How could workers transitioning into CCAM job be supported in the future? (related to the occupations in het use cases).
24. What strategies can help prevent unemployment due to automation in CCAM?

Section 4: Future Perspectives & Recommendations & stakeholder suggestions

25. What other recommendations would you make for improving skills development and labour market alignment in CCAM?
26. What role should public and private stakeholders play in supporting CCAM?
27. Are there any additional insights or concerns you'd like to share regarding CCAM and its workforce impact?
28. We would like to involve experts and stakeholders from various perspectives into our project, by asking them for their reflections on our outcomes and recommendations. The main stakeholders we would like to get in contact with are employers who deploy CCAM, public authorities and educational institutions. Do you have any suggestions for us who we should contact considering your use case?
    a. Employers:
    b. Public authorities:
    c. Education:
    d. Other:

Interview guideline draft profiles validation round

1. *Could you briefly describe your role and expertise related to CCAM operations? In terms of operational experience, supervisory perspective, technical expertise.*
2. *How familiar are you with the responsibilities of a Remote Operations Specialist? In terms of firsthand observation, collaboration, general impression, daily tasks, critical moments, decision-making.*

A. Context of the CCAM Remote Operations Specialist profile

3. *What would you like to add to this description of this context?*

B. Core Tasks of a Remote Operations Specialist

Question

4. *We have subdivided the profile into a limited number of core tasks. Do they provide an accurate representation of a Remote Operations specialist's core tasks?*

a. *To what extent do these core tasks fit within a single profile?*
b. *Which core tasks or subtasks do not belong in this profile?*
c. *Are the subtasks assigned appropriately to the core tasks?*
d. *Which subtasks are missing?*

C. Core tasks in detail

5. *How would you describe the types of knowledge the Remote Operations Specialist needs to master?*

Questions for all core tasks

6. *Is this a complete list; what requirements would you like to add to or remove from this list?*
7. *Considering these skills, could you elaborate on the complexity of the roles, degree of responsibilities and level of autonomy of the Remote Operations Specialist?*
8. *How would you describe the types of knowledge the Remote Operations Specialist needs to master?*
9. Etc.

D. Overall assessment and closing questions

10. *In general, what kind of responsibility, autonomy and accountability does the Remote Operation Specialist have on the following subjects? (no, partial/shared, overall / final)*

a. *Managing complex professional activities across multiple organisations.*
b. *Independently interpreting evolving regulatory frameworks.*
c. *Taking responsibility for policy decisions affecting safety, mobility systems and public governance.*
d. *Coordinating stakeholders, designing governance structures*
e. *Ensuring compliance in unpredictable or emerging contexts.*

11. *What elements should be added to the Remote Operation Specialist profile?*
12. *Is there anything else we should include to ensure strong, assessable learning outcomes for training, assessment, and qualification design for this profile?*
13. *Would you be open to review the updated profile or to participate in a follow-up interview?*

Miro Design Thinking Sessions Questionnaire

1. CCAM operating career paths – write in post its below what of the shown career paths stand out or doesn't match your expectations.
2. Which of the skills, knowledge & professional behaviour do would you rate as most important ones for the correlating career path? Vote (maximum of 8) which ones you find most important.
3. Which competences (skills, knowledge, professional behaviour) per career path are hardest to find in candidates for operational CCAM occupations? Vote [max. 3 votes per person per career path] on the ones that form the biggest (hiring) challenge.
4. Potential educational and labour market interventions to address these possible competence gaps are presented. Could you indicate which of the suggested solutions are most appropriate to fill the current competence gaps?
5. What good practices of CCAM training do you know of that are worth following?
6. What needs to be said that not yet been said? Any last thoughts or additions to today's session?

Annex 3: Experts

This annex lists the experts who contributed to the CCAM report through interviews, sessions/workshops, and/or written feedback.

This annex names only participants who consented to attribution. Further contributions were received from additional respondents who did not consent to being listed or whose consent was not received. Total number of experts that contributed is 31.

#	Expert name	Organisation
1	Mihai Chirca	Transdev Group
2	Magdalena Szymańska	Gdansk University
3	Eetu Pilli-Sihvola	VTT technical Research Centre of Finland
4	Christian Willoch	Ruter
5	Gustavo Enrique Reyes Rodriguez	Municipality of Helmond
6	Jan Gramatyka	Autonomous Systems
7	Hans Fridberg	Holo
8	Oscar Nissin	Metropolia University of Applied Sciences
9	Oliver Nahon	SAAM
10	*Project Manager*	LOXO
11	Peter Smeds	Trafikverket
12	Matthieu Graindorge	Municipality of Helmond
13	Tobias Reich	Rich Autonomy GmbH
14	Stefanie Berliner	Holo