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D3.1 CCAM Scan and PESTLE analysis

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Carla de Oliveira Leite Nascimento

Lone-Eirin Lervåg

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AUTHORS

Carla de Oliveira Leite Nascimento	ITS Norway
Lone-Eirin Lervåg	ITS Norway

CONTRIBUTORS

Martin Clarke	Panteia
Nicola Hare	PAVE
Maruša Benkic	CORTE
Vladislav Sidorov	Rupprecht Consult
Hans-Georg Hermann	SwissRe

REVIEWERS

Robbin Bosch	
Maruša Benkic	
Maaike Koning	

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Acronyms and definitions

Acronyms	**Definitions**
CCAM	Cooperative, Connected, and Automated Mobility
PESTLE	Political, Economical, Social, Technological, Legal, Environmental
AV	Automated and connected vehicle
WP	Work Package
ERAS	Employment Realization through the Acquisition of Skills
VET	Vocational education training
ROI	Return on investments
SMEs	Small and medium-sized enterprises
ICT	Information and communication technology
AI	Artificial intelligence
GDPR	General Data Protection Regulation
IT	Information Technnology
STEM	Science, technology, engineering, and mathematics
HMI	Human-Machine Interfaces
EU	European Union
EU-CEM	European Common Evaluation Methodology
US	United States
R&D	Research and development
EV	Electric Vehicle

V2X	Vehicle-to-everything

Executive summary

The Connected, Cooperative, and Automated Mobility Employment Realisation through the Acquisition of Skills (CCAM-ERAS) project aims to address the socio-economic impact of the advancement of Connected, Cooperative, and Automated Mobility (CCAM) systems. Specifically, CCAM-ERAS will seek to increase knowledge of the necessary skills required for CCAM deployment while addressing real-world use cases to develop actionable schemes to tackle labour market challenges and support key innovators.

This deliverable provides a comprehensive **PESTLE analysis** (Political, Economic, Social, Technological, Legal, and Environmental) of the key external factors influencing the successful deployment of CCAM solutions across Europe. The aim is to build a shared evidence base that informs future work within the project, particularly the development of a CCAM innovation radar, labour-market use cases, and skills-development strategies. The analysis addresses explicitly how PESTLE dynamics interact with job transformation, skill gaps, institutional readiness, and governance mechanisms relevant to the CCAM transition.

The analysis is grounded in a multi-method qualitative research approach. First, a structured stakeholder database was developed to ensure broad coverage across sectors and geographies. Then, 28 semi-structured interviews were conducted with experts from industry, public bodies, research, and labour-market institutions using tailored questionnaires for different stakeholder groups. To validate and enrich these findings, three thematic stakeholder workshops were held in Brussels on 26 November 2024, focusing respectively on (1) the transport value chain, (2) societal and labour-market impacts, and (3) regulatory and policy considerations. Data from interviews and workshops were coded and synthesised into the six PESTLE dimensions.

The findings reveal that CCAM deployment is shaped by complex and interdependent external factors. Politically, regulatory fragmentation and a lack of harmonised EU-level policies limit scalability. Economically, uncertain return on investment and high upfront costs create hesitation, especially among SMEs, while targeted public investment and incentives are needed to support workforce reskilling. Socially, CCAM is expected to transform job roles rather than eliminate them, requiring major efforts in lifelong learning, micro-credentialing, and inclusive training. Technological challenges include infrastructure interoperability, digital security, and alignment with electrification. Legally, unresolved questions around liability, data governance, and certification remain significant barriers. Environmentally, CCAM has the potential to support sustainability goals—but only if deployed in coordination with broader decarbonisation and circular economy strategies. These insights form the basis for guiding the

next stages of CCAM-ERAS, including innovation monitoring, use-case development, and skills roadmap design.

Contents

1. Introduction

1.1. Project overview

CCAM-ERAS aims to prepare society for managing labour market impacts that arise from deploying connected, cooperative and automated mobility (CCAM) services within the transport sector. The main objective of WP3 is to deliver a full CCAM scan, providing understanding and awareness of CCAM implications in the transport sector, carried out in three steps:

Task 3.1 An in-depth scan of CCAM implications

Task 3.2 Innovation radar development and monitoring

Task 3.3 Development of relevant use cases

The knowledge of CCAM's state of play and future development trends emerging from this work will be used to analyse future skills requirements and related labour aspects in subsequent parts of the project, contributing to a broader goal of supporting an inclusive, sustainable, and future-ready mobility ecosystem.

1.2. Purpose of the document

This report documents the work conducted in Task 3.1 of the CCAM-ERAS project. The broader implications of CCAM technologies across the transport ecosystem have been analysed. This includes examining the potential effects on the transport value chain—covering infrastructure, vehicles, logistics operations, traffic and transport management, and mobility services—as well as societal impacts such as land use, traffic safety, and resource consumption. Furthermore, the task explores the regulatory and policy frameworks that shape CCAM implementation, including cross-sectoral and multi-level governance collaboration.

The main activities carried out include:

1. Mapping relevant CCAM initiatives and stakeholders
2. Conducting stakeholder interviews
3. Organising stakeholder workshops
4. Conducting a PESTLE analysis

The analytical approach is based on a PESTLE framework, investigating Political, Economic, Social, Technological, Legal, and Environmental factors that may influence CCAM deployment. This structured method supports a detailed exploration of the future requirements for skills and employment, offering insights into the potential transformations in the labour market triggered by CCAM technologies.

A combination of stakeholder engagement activities—including stakeholder interviews and thematic workshops—has been employed to ensure the robustness and relevance of findings. The workshops focused on three key perspectives: the transport value chain, societal implications, and regulatory and policy considerations.

The document is structured as follows: Chapter 2 outlines the development of the stakeholder database; Chapter 3 details the data-collection methodology; Chapter 4 presents the interview guide and accompanying questionnaires; Chapter 5 discusses the interview findings; Chapter 6 synthesises the workshop outcomes; Chapter 7 delivers the PESTLE analysis; and Chapter 8 provides the overall conclusions.

2. Stakeholder database development

The successful implementation of CCAM requires collaboration among a wide range of stakeholders. WP3 has actively contributed to WP2 by supporting the creation of the CCAM-ERAS Stakeholder Database[1], which is crucial in identifying and engaging key experts. This database was the foundation for selecting interview participants, providing valuable insights that informed the PESTLE analysis conducted in Task 3.1. The database enhanced the study's depth and credibility by ensuring a diverse and relevant pool of stakeholders, enabling a more comprehensive evaluation of the factors influencing CCAM deployment. An in-depth mapping of the CCAM-ERAS stakeholder community can be found in Deliverable 2.1.

2.1. Stakeholder categorisation

To ensure a balanced representation of perspectives, stakeholders were classified into the following categories, represented in Table 1:

Table 1: categories of stakeholders and description

Categories of stakeholders	Description of the stakeholder group.
Associations and networks	Organisations that bring together industry professionals, fostering collaboration and knowledge sharing.
Educational and training institutions	Institutions responsible for developing CCAM-related curricula and training programs.
Employers' organisations	Groups representing employer interests and workforce development needs.
Government and policy bodies	National and regional authorities are involved in the legislative and regulatory aspects of CCAM implementation.
Higher education/VET Institutions	Universities and vocational education training (VET) providers contribute to research and skills development.

[1] More on the criteria for the choice of stakeholders can be found in Deliverables 2.1 and 2.2

Innovative companies/SMEs	Small and medium-sized enterprises contributing to CCAM-related technologies and solutions.
Insurance providers	Companies involved in risk assessment and liability coverage for automated mobility.
Labour market experts	Specialists in workforce trends, employment shifts, and skills forecasting.
Media and public relations	Entities responsible for shaping public discourse and awareness around CCAM.
Professional and accreditation bodies	Organisations setting standards and certification requirements for CCAM professionals.
Representative organisations	Groups advocating for sector-specific interests within CCAM policy discussions.
Research institutions/Think tanks	Entities conducting studies and providing insights into CCAM adoption challenges and opportunities.
Sector skills alliances	Collaborative bodies addressing skill development and workforce readiness for CCAM.
Trade unions	Organisations representing workers in industries affected by CCAM advancements.
Transport companies	Businesses operating in passenger and freight transport integrating CCAM solutions.
Other stakeholders	Entities with indirect yet significant influence on CCAM policy, implementation, or public perception.

2.2. Importance of stakeholder engagement

A well-structured stakeholder database ensures that diverse perspectives are considered in CCAM implementation. Including various stakeholder groups allows for a more holistic understanding of the opportunities and challenges associated with CCAM deployment. This approach also fosters multi-sector collaboration, ensuring that regulatory frameworks, workforce development strategies, and technological advancements align with the needs of all relevant actors.

By incorporating a broad range of expertise, the stakeholder database has significantly contributed to the credibility and comprehensiveness of the research conducted under WP3. The continued engagement of these stakeholders will be essential in shaping future policy recommendations, industry standards, and educational programs supporting CCAM development.

2.3. Conclusion

The development of the CCAM-ERAS stakeholder database has been instrumental in structuring the research efforts within WP3. The database has enabled meaningful discussions and insights that have directly contributed to the PESTLE analysis and broader CCAM implementation strategies by systematically identifying and categorising experts from diverse sectors. Moving forward, this stakeholder network's continuous update and engagement will ensure the successful deployment of CCAM technologies across various sectors.

3. Data collection process

The data collection process for this study was conducted through semi-structured interviews with experts and key stakeholders from various sectors relevant to CCAM. These interviews provided crucial qualitative insights that informed the PESTLE analysis, ensuring a comprehensive understanding of the political, economic, social, technological, legal, and environmental factors influencing CCAM deployment.

3.1. Interview guide and setup for PESTLE Analysis

The initial set of questions for the interviews was developed based on prior research in projects that looked into CCAM initiatives[2]. This ensured the guide was rooted in existing knowledge and addressed relevant issues within the CCAM ecosystem. Following this initial draft, expert consultation was conducted within the project partners. Their insights helped refine the questionnaire, ensuring it captured all critical aspects necessary for the analysis.

No formal pilot interviews were conducted before the questionnaire was deployed. However, to enhance accuracy and relevance, the consortium reviewed the questions and provided feedback before distributing the final version to stakeholders.

A structured interview guide (questionnaire) was developed to ensure consistency and maximise the quality of stakeholder insights. The primary objective of this guide was to obtain comprehensive feedback across all six PESTLE dimensions. Each dimension was addressed through a minimum of three targeted questions, ensuring that responses provided relevant input for the subsequent analysis.

All project partners collaboratively designed the interview guide to ensure its relevance, accuracy, and consistency across stakeholder groups. The questions were carefully formulated to address key issues within each PESTLE category while allowing interviewees to provide detailed responses based on their expertise and experience.

3.2. Customisation for stakeholder categories

The interview guide was customised according to stakeholder categories, recognising stakeholders' diverse backgrounds and expertise. Specific questions were tailored to capture specialised insights, ensuring that responses were relevant and valuable to the research objectives. Nine stakeholder-specific questionnaires and a general questionnaire applicable to broader discussions were developed.

[2] https://skillfulproject.eu/; https://www.virtual-vehicle.at/projects/trustvehicle-eu/; http://brave-h2020.eu/; https://levitate-project.eu/.

Customising the questionnaires allowed for targeted data collection, ensuring that insights from each stakeholder category contributed effectively to the analysis. Table 2 below outlines the relationship between stakeholder groups identified in WP2 and the specific questionnaires used in the data collection process:

Table 2: relationship between stakeholder groups and questionnaires

Stakeholders from WP2	**Questionnaire used**
Associations and networks	Associations and networks/labour market experts
Educational and training institutions	Higher education/VET institutions/professional and accreditation bodies/educational and training institutions
Employers' organisations	Representative organisations/trade unions/employers' organisations/sector skills alliances
Government and policy	Government and policy
Higher education/VET institutions	Higher education/VET institutions/professional and accreditation bodies/educational and training institutions
Innovative companies/smes	Innovative companies/smes
Insurance providers	Use everyone questionnaire
Labour market experts	Government and Policy/Professional and Accreditation Bodies/Labour Market Experts
Media and Public Relations	Use Everyone Questionnaire
Professional and accreditation bodies	Government and policy/professional and accreditation bodies/labour market experts
Representative organisations	Representative organisations/trade unions/employers' organisations/sector skills alliances
Research institutions/think tanks	Research institutions/think tanks/media and public relations

Sector skills alliances	Representative organisations/trade unions/employers' organisations/sector skills alliances
Trade unions	Representative organisations/trade unions/employers' organisations/sector skills alliances
Transport companies	Transport companies
Other	Use everyone questionnaire

The decision to create nine different stakeholder-specific questionnaires was driven by the need to capture insights unique to each stakeholder group. Given that other organisations and experts have distinct expertise, a generalised questionnaire would have resulted in limited or less meaningful responses.

By designing tailored questionnaires, the study was able to extract more relevant insights, leading to a robust and well-informed PESTLE analysis. While the core structure of the questionnaires remained the same (following a standard template), additional questions were included based on the expertise of the stakeholders being interviewed. This ensured that each respondent could contribute detailed, valuable information aligned with their field.

To illustrate how different questionnaires were designed, the following examples highlight key adaptations made for various stakeholder groups:

- Higher education institutions and training providers: Additional questions focused on educational and training needs for CCAM-related professions, ensuring that future workforce requirements are aligned with technological advancements.
- Innovative companies/SMEs: This category of stakeholders received more technology-focused questions related to automation, artificial intelligence, and digital infrastructure required for CCAM.
- Government and policy makers: These stakeholders were asked specific legal and regulatory questions to understand potential legislative barriers and necessary frameworks for CCAM implementation.
- Transport companies: Questions were tailored to operational concerns, covering how CCAM could improve efficiency, reduce costs, and enhance safety in logistics and mobility services.

These tailored questions ensured that the study gathered a more in-depth understanding of sector-specific concerns, enabling a more precise and actionable analysis.

3.2.1. Ensuring data accuracy and consistency

To enhance the credibility of the data collected, multiple measures were taken:

- Collaborative questionnaire development: All project partners designed and reviewed the questionnaire to ensure alignment with research objectives.
- Structured interview process: A semi-structured format was used to balance consistency with flexibility, allowing interviewees to elaborate on their perspectives.
- Stakeholder matching: Participants were matched with the most relevant questionnaire based on their expertise, ensuring that responses were meaningful and informed.
- Data validation: Interviews were recorded, transcribed, and analysed to ensure accuracy and consistency in interpreting responses.

3.3. Conclusion

The data collection process was crucial in obtaining in-depth insights into the challenges and opportunities surrounding CCAM implementation. The study gathered diverse perspectives by structuring the interviews around a comprehensive PESTLE framework and tailoring questions to different stakeholder groups. The findings from these interviews formed the basis of the PESTLE analysis, guiding the overall assessment of CCAM deployment factors and their implications for future policy and industry developments.

4. Interview guide and questionnaires

A core group was established to contact experts, schedule interviews, and discuss with selected stakeholders to ensure an effective and structured interview process. The interview process was a crucial component of data collection, providing direct insights from experts across different sectors involved in CCAM implementation.

4.1. Stakeholder engagement and interview coordination

Stakeholders were initially identified and approached as part of the stakeholder database compilation. Once identified, potential participants were invited to participate in the study. Upon their agreement, the core team coordinated with them to finalise availability and conduct interviews.

All interviews followed a semi-structured approach to maintain consistency and capture diverse perspectives. Depending on feasibility, the sessions were scheduled based on stakeholder availability and conducted online or in person.

All interviews were recorded to ensure reporting accuracy. This allowed researchers to transcribe and analyse responses in detail, minimising the risk of misinterpretation. After each interview, the responsible project partner prepared an anonymous summary of key insights, capturing the most relevant points for the subsequent PESTLE analysis.

4.2. Number of interviews conducted

Between October and December 2024, 28 expert interviews were conducted. These interviews covered a diverse range of stakeholder groups, ensuring comprehensive representation in the study. The breakdown of completed interviews per stakeholder category is shown in Table 3 below:

Table 3: Breakdown of conducted interviews per stakeholder category

Questionnaire	Completed
Associations and networks/labour market experts	4
Government and policy/professional and accreditation bodies/labour market experts	1
Higher education/VET institutions/professional and accreditation bodies/educational and training institutions	7

Innovative companies	1
Representative organisations/trade unions/employers' organisations/sector skills alliances	4
Research institutions/think tanks/media and public relations	6
Transport companies	3
General Questionnaire	2
Grand Total	**28**

This distribution reflects the broad engagement of different stakeholder groups, particularly emphasising higher education institutions, research organisations, and professional bodies.

4.3. Role of interview summaries

The interview summaries serve as critical input for the PESTLE analysis. Each summary captures the key insights from stakeholders and is structured around the political, economic, social, technological, legal, and environmental factors influencing CCAM implementation. These structured summaries provide a foundation for analysing the broader challenges and opportunities associated with CCAM solutions.

The interview process has helped ensure that the PESTLE analysis is grounded in real-world perspectives by systematically categorising expert opinions. This evidence-based approach enhances the credibility and relevance of the study's findings, contributing to informed policy recommendations and industry strategies.

4.3.1. Challenges and mitigation strategies in the interview process

While the interview process was successfully executed, several challenges emerged:

- Stakeholder availability constraints: Some stakeholders had limited availability due to their professional commitments. To address this, flexible scheduling options were offered, including after-hours interviews and asynchronous responses when necessary.
- Reluctance to participate: Some organisations hesitated to participate due to concerns over confidentiality or the perceived burden of participation. The research team provided explicit assurances regarding data privacy and streamlined the interview process to minimise inconvenience.

- Sectoral imbalances: Certain stakeholder groups, such as government and policy representatives, had lower participation rates. Future efforts should focus on targeted engagement strategies to ensure a more balanced representation across all sectors.

4.3.2. Data analysis approach

To ensure rigorous data analysis, the following approach was adopted:

- Qualitative coding: Responses were categorised based on recurring themes within each PESTLE dimension. This helped identify key concerns, priorities, and potential policy implications.
- Thematic analysis: Insights were grouped to highlight cross-sectoral trends, such as the widespread emphasis on workforce upskilling and regulatory standardisation.

4.4. Conclusion

The structured approach to expert interviews has been instrumental in gathering diverse insights into the CCAM-ERAS project. Through careful coordination, targeted stakeholder engagement, and detailed data collection, the study has ensured that a wide array of perspectives is represented in the analysis. Moving forward, these insights will play a central role in shaping the evaluation of CCAM deployment and its associated challenges and opportunities.

5. Overview of CCAM implications according to stakeholders' interviews

The implementation of CCAM presents opportunities and challenges that span political, economic, social, technological, legal, and environmental dimensions. This chapter integrates insights from expert interviews obtained via the structured questionnaires to analyse the factors shaping CCAM deployment. By examining these dimensions holistically, we can better understand the drivers and barriers to adoption and the necessary strategies to facilitate a smooth transition toward cooperative and automated mobility.

5.1. Political considerations and regulatory challenges

One of the most pressing political challenges in CCAM implementation is the lack of regulatory standardisation across Europe. Experts highlighted how fragmented policies across different jurisdictions hinder seamless cross-border operations, necessitating the development of harmonised frameworks at the EU level. Without such alignment, manufacturers and service providers face challenges in compliance, making widespread deployment difficult. Additionally, it is a common statement that Europe lags behind the US and China in CCAM testing and deployment due to strict regulatory frameworks that delay innovation.

Governments should lead the creation of policies that facilitate CCAM adoption and ensure compliance with data protection laws and cybersecurity protocols. With cybersecurity threats rising globally, governments must integrate strong digital security measures into CCAM policies to protect user data and ensure the safety and security of automated systems. International cooperation is essential, particularly for cross-border transport operations that require seamless regulatory alignment. Stakeholders emphasise that policies should encourage industry participation, rather than imposing restrictive regulations that hinder progress.

A critical factor in this political landscape is the role of public-private partnerships. Industry stakeholders emphasise the importance of collaboration between governments, automotive manufacturers, and technology providers to create viable regulatory policies. Certain nations have initiated controlled test environments or regulatory sandboxes to allow companies to trial CCAM applications within safe, designated areas. Such approaches should be expanded to foster innovation while ensuring safety and accountability. Policies should also support small transport businesses transitioning to CCAM, preventing monopolisation by large logistics companies. To ensure a fair and inclusive transition to CCAM, public policies should provide targeted support for small and medium-sized transport companies—such as grants for upgrading fleets or subsidised access to digital platforms—so they can participate in the

emerging market. Without such measures, there is a risk that only large logistics firms with significant capital and technological resources will dominate the CCAM landscape, marginalising smaller operators. For instance, a local bus cooperative could be supported to adopt autonomous shuttles in rural areas, instead of being pushed out by national or global transport providers.

Political stability and long-term policy commitments are essential for ensuring sustained investment and innovation in CCAM technologies. Given the rapid pace of technological advancements, governments must remain adaptive and proactive, ensuring that regulations evolve with new developments. Countries must also take a strategic approach to integrating CCAM within public transport systems, ensuring that public operators are included in deployment projects.

5.2. Economic implications of CCAM deployment

The economic feasibility of CCAM remains a pivotal concern, as stakeholders consistently emphasise the high costs associated with infrastructure development and technological integration. Public investment in smart roads, digital communication networks, and vehicle connectivity is essential for enabling large-scale deployment. However, the financial burden cannot rest solely on governments. Public-private partnerships must be established to distribute investment risks and encourage the involvement of private entities in the commercialisation of CCAM services. Government subsidies should focus on mitigating early adoption risks and should be allocated strategically to balance investments between urban and rural deployments, thus impacting society directly.

The long-term financial viability of CCAM remains uncertain. While automation can potentially reduce operational costs in the long run, through reduced driver costs, fuel efficiency, reduced congestion, and optimised logistics, the initial expenses for developing and integrating the necessary infrastructure are significant. Financial incentives such as tax breaks, direct subsidies, and investment grants have been proposed to mitigate these barriers. Business models for CCAM are still evolving, and large logistics companies are generally more optimistic about automation, while small and medium-sized enterprises (SMEs) may struggle due to cost barriers. Return on investment (ROI) uncertainty further complicates adoption, necessitating financial frameworks encouraging private sector participation.

The transition also poses challenges for businesses operating in rural areas, where lower population densities may make CCAM deployment less financially viable. Strategic planning is required to balance investments between urban centres, where the business case is stronger, and underserved regions may need government support to ensure equitable access

to automated transport solutions. Furthermore, the impact on traditional transport businesses must be considered, as automation could disrupt existing economic structures.

CCAM deployment should initially focus on long-distance freight transport, where predictable routes, high asset utilisation, and controlled highway conditions offer clearer revenue models and fewer technical challenges. In contrast, local shuttle services face fragmented demand and complex, stop-and-go environments. This highlights a key dilemma: while long-haul applications are more immediately viable, the business case and technical solutions for last-mile CCAM still require further development.

5.3. Social impacts and workforce transformation

The deployment of CCAM technologies is expected to bring significant shifts in employment patterns, with traditional driving roles gradually being replaced by positions in fleet monitoring, system management, and AI-driven logistics. The perception of job losses due to automation has been a common concern among stakeholders and the general population. However, experts generally agree that CCAM will not eliminate jobs outright but will lead to their transformation within and across sectors. On the other hand, automation is also seen as a solution to mitigate the already prevailing challenge of driver shortage, especially in Europe.

There is a high demand for Information and communication technology (ICT) and artificial intelligence (AI) expertise, as workers must develop new skills to manage digital transport networks. Thus, reskilling and upskilling initiatives will prepare the workforce for emerging roles. These may include technicians specialising in autonomous vehicle maintenance, AI system operators, and logistics managers trained in automated fleet oversight. Governments, educational institutions, and businesses must collaborate to develop targeted training initiatives that support workforce transitions within and across sectors. International apprenticeship programs and knowledge-sharing networks could be beneficial in addressing workforce gaps.

Additionally, public perception remains a crucial factor in CCAM adoption. Misinformation and scepticism about safety, job security, and the reliability of automated systems could hinder public acceptance. Transparent communication, public education campaigns, and real-world pilot projects will be key strategies in fostering trust in CCAM technologies. Additionally, the involvement and possible collaboration with trade unions can bring many benefits. Automated transport should prioritise inclusivity, ensuring mobility solutions for elderly individuals, low-income communities, and people with disabilities.

5.4. Technological advancements and infrastructure readiness

Technological progress is at the heart of CCAM implementation, but integrating these innovations into existing transport networks presents considerable challenges. Experts emphasise the need for interoperable digital systems to facilitate seamless communication between vehicles, infrastructure, and urban mobility platforms. The rollout of 5G and, eventually, 6G networks will be instrumental in ensuring the low-latency connectivity required for real-time data transmission. Investment in smart infrastructure can significantly reduce overall automation costs, making deployment more feasible for businesses and public operators.

Cybersecurity risks remain significant, as automated transport systems are vulnerable to cyber threats that could compromise vehicle safety and user data. Addressing these risks requires stringent cybersecurity protocols, advanced encryption methods, and continuous monitoring of network vulnerabilities. Additionally, digital twins and simulation environments are becoming increasingly relevant for testing and optimising CCAM technologies before large-scale deployment. As innovative city initiatives expand, integrating CCAM into urban planning will be essential for maximising the efficiency and sustainability of automated mobility solutions.

Moreover, the successful deployment of CCAM is increasingly dependent on its alignment with the ongoing energy transition. The convergence of automation and electrification presents a strategic pathway to achieving operational efficiency and environmental sustainability. Automated electric vehicles, supported by renewable energy and innovative grid systems, can reduce greenhouse gas emissions and lower long-term transport costs. This dual shift necessitates coordinated investments in digital infrastructure, clean energy capacity, and the redesign of vehicles to accommodate native drive-by-wire systems. By synchronising technological innovation with energy and climate goals, CCAM can be pivotal in shaping a more resilient and low-carbon mobility future.

5.5. Legal frameworks and policy development

Policymakers must establish clear legal frameworks that define responsibility in autonomous vehicle incidents and ensure compliance with data protection laws such as the General Data Protection Regulation (GDPR). Cross-border regulatory alignment is another critical challenge, as differing national laws create barriers to CCAM deployment on an international scale. Standardising liability laws and streamlining regulatory approval processes for automated transport solutions will be key to facilitating adoption. Legal frameworks must also provide appropriate protections and support for workers shifting from traditional driving roles to new responsibilities such as remote vehicle supervision and system monitoring, ensuring

fair working conditions and job security during the transition. Similarly, insurance frameworks should also be incentivised through legal interventions, to create new insurance products that foster CCAM deployment.

5.6. Environmental sustainability and CCAM's role

CCAM has the potential to contribute to environmental sustainability by optimising transport efficiency and reducing traffic congestion. Automated route planning and fleet coordination can minimise unnecessary mileage and fuel consumption, indirectly lowering emissions. However, CCAM must integrate with electrification efforts to maximise its sustainability potential (as mentioned in chapter 5.4). Recycling and circular economy principles should be incorporated into CCAM infrastructure to promote resource efficiency. Even though plenty of studies and evidence show the potential of CCAM initiatives in promoting environmental sustainability, real-life experiments and results are yet to be documented to support this claim.

5.7. Conclusion

A multi-stakeholder approach that aligns political, economic, social, technological, legal, and environmental considerations will be essential to achieving large-scale CCAM deployment. Equally crucial is a forward-looking workforce strategy that anticipates new skill requirements, reskills and upskills existing employees, and secures a steady talent pipeline across the CCAM value chain. Harmonised regulatory policies, strategic investments, and active public engagement will determine the long-term success of CCAM technologies.

6. Stakeholders' workshop on CCAM implications

The following chapter presents the consolidated outputs from three thematic stakeholder workshops held on 26 November 2024, in Brussels. While the earlier one-to-one interviews provided deep, individual insights for the project's PESTLE analysis, the workshops added a collective dimension. Each workshop focused on a specific lens that is critical to the CCAM transition: (1) the transport value-chain perspective, (2) the societal perspective, and (3) the regulation-and-policy perspective. Together, these sessions complement the interview results by exposing cross-sector interdependencies, surfacing converging and diverging views among stakeholder groups, and generating jointly validated priorities that feed directly into the CCAM-ERAS roadmap.

Workshop 1 - Transport value chain perspective

The first workshop focused on the impacts of CCAM on the transport value chain. The workshop covered both freight and passenger transport providers and users. Discussions highlighted key challenges and opportunities, including technological advancements, regulatory considerations, and business model transformations. Participants explored the potential for automation to reduce traditional driving roles while creating new positions in remote vehicle operation, fleet management, and AV maintenance.

6.1.1. Industry and technology: Business models and barriers

The discussion highlighted the challenges of implementing a single business model for urban and rural areas, acknowledging differences in population density and transportation needs. Both areas require tailored approaches for effective deployment, particularly in investment and technological development. Participants pointed out that current pilots are insufficient, and more investment is needed to make significant progress. This includes ensuring clear regulations supporting European deployment and addressing regional needs.

The industry's future workforce will require specialised skills, particularly in managing and maintaining advanced technologies like automated vehicles. As these technologies evolve, educational institutions must collaborate with industry players to develop curriculums that address the needs of CCAM deployment.

6.1.2. Road and infrastructure: Data management and digitalisation

Substantial changes to road infrastructure are necessary for CCAM to be effective, particularly with digital infrastructure investments and data management systems. Standardisation of road markings and addressing geographic disparities were critical points raised during the

discussions. The deployment of automated vehicles will require workforce training in new technologies and data management systems.

6.1.3. Public transport and workforce transition

The potential for automating public transport was discussed, including the necessity of adapting fleets and maintenance systems. Operators will face challenges related to the maintenance of automated vehicles, requiring new skill sets. Maintenance personnel will need training to understand and manage AV systems, which differ significantly from traditional vehicles. The shift towards remote public transport operation will necessitate new roles for workers. Remote operators will be required to monitor multiple vehicles. A transition of current drivers into these new roles would require retraining in computer skills and vehicle monitoring systems.

6.1.4. Public authority and regulatory challenges

Regulatory frameworks were a significant topic of discussion. The lack of uniformity in traffic laws and regulations across countries poses a significant challenge for the European deployment of CCAM. Public authorities must establish clear guidelines for using automated vehicles, especially concerning safety, data privacy, and integrating AVs into public transport services. They must also play a key role in facilitating data sharing and the development of data platforms that allow for more efficient traffic management and safety protocols.

Regarding the workforce, local authorities need to ensure that their administrative and technical staff are adequately trained to handle the deployment of CCAM. They will also need to invest in infrastructure, including flexible pick-up and drop-off points for automated vehicles.

6.1.5. User interaction and safety: Trust and accessibility

The user experience is critical for the successful deployment of CCAM. Participants highlighted the need for clear communication between automated vehicles and other road users, including pedestrians and cyclists, to ensure safety. Developing user-friendly interfaces and systems accessible to all, including people with disabilities, is paramount.

Safety is another significant concern. While automation is expected to reduce road accidents, particularly involving freight vehicles, passenger safety in autonomous vehicles must be a priority. Remote operators or stewards may be required to ensure passenger safety, particularly in public transport settings. From a workforce perspective, new roles will emerge for individuals trained to manage user interactions and automated systems. These roles will involve ensuring that automated vehicles are not only safe but also trusted by the public.

6.1.6. Freight and logistics: Workforce impact and efficiency

The automation of freight transport is expected to reduce operational costs and improve frequency by helping to address the current shortage of drivers, enabling longer operating hours and by reducing traffic congestion. However, the automation of logistics systems will have significant labour implications. As more tasks are automated, existing logistics workers must retrain to maintain and operate automated systems. Logistics companies must invest in new digital systems to optimise vehicle usage and manage data flow between vehicles and service providers.

6.1.7. Educational institutions and collaboration with industry

Educational institutions will need to adapt quickly to meet the emerging needs of the CCAM industry. Collaboration between industry players and educational bodies will be essential in creating training programs that equip workers with the necessary skills. For instance, remote operators will need specific training in managing autonomous fleets, and maintenance personnel will require specialised skills in AV technologies.

Curriculum development must focus on new areas such as vehicle automation, data management, and remote monitoring. Knowledge transfer partnerships between universities and industries, are vital in bridging the skills gap and preparing the workforce for the future of transportation.

6.1.8. Societal and economic impacts

CCAM deployment could bring significant societal benefits, including improvements in road safety and accessibility. However, it could also lead to job displacement, particularly for freight and public transport drivers. As traditional driving roles decrease, retraining programs will be necessary to help workers transition into new roles, such as remote operators or maintenance staff for automated systems.

6.2. Workshop 2 - Societal perspective.

The second workshop on CCAM's societal perspectives explored the impact of automation on jobs, workforce development, public trust, and regulatory frameworks. The discussions focused on how automation will reshape employment in key transport sectors, the need for targeted skills development, strategies for improving public perception, and the role of policy in ensuring an equitable transition. This summary outlines the key insights and recommendations from the workshop.

6.2.1. Job displacement and job creation

Automation in CCAM presents both challenges and opportunities for various sectors. The taxi and public transport industries are among the most affected. Autonomous vehicles threaten traditional taxi roles but simultaneously create new opportunities, such as positions for safety and remote operators. Transitioning these workers will require extensive retraining. Public transport also faces workforce shortages, and automation could help bridge these gaps, particularly in urban transit systems and bus depots. However, the impact will differ between urban and rural areas, with rural regions potentially struggling more due to limited infrastructure. This difference is primarily because urban areas are more likely to see the early implementation of autonomous services due to their higher population density, more developed infrastructure, and greater investment in technology. In contrast, rural areas may face challenges due to lower service demand, less investment, and fewer supporting technologies such as smart roads or communication networks.

In logistics, automation has already made significant progress in controlled environments such as ports and warehouses. However, road freight automation requires further infrastructure development and collaboration between stakeholders. The role of truck drivers is evolving, with administrative tasks like communication, paperwork, and trailer management becoming increasingly automated. CCAM must address current labour shortages while ensuring a viable business model for logistics companies.

New roles are emerging within CCAM, including safety drivers, autonomous system supervisors, and maintenance professionals specialising in mechanical and digital systems. The demand for Information technology (IT) savvy professionals is expected to rise significantly. Additionally, regulatory expertise and cross-border logistics roles are becoming crucial due to the complexities of automating transport systems across different jurisdictions.

Strong collaboration between governments, industry, and trade unions is necessary to mitigate the risks of job displacement. Stakeholders must work together to address potential job losses and ensure equitable workforce transitions. Reskilling programs enable workers to move from manual to technology-focused positions, with practical education and certification programs playing a key role.

6.2.2. Skills and training needs

The current education system is not fully aligned with CCAM’s technical requirements. This is especially evident in public transport, where IT professionals are deterred by the prospect of lower salaries compared to other sectors. Developing new curricula focusing on electric-mechanical engineering, artificial intelligence, and autonomous system maintenance is critical.

Training programs that help safety drivers transition into autonomous operations will also be crucial.

One example of an adaptive educational initiative mentioned by one of the participants is Croatia's collaboration between industry, academia, and government, which showcases the potential for tailored academic programs. Vocational training for technicians and engineers must be expanded to meet the growing demand for skilled CCAM professionals.

Efforts must also include vulnerable groups, including women and rural workers, in CCAM-related education and employment. Gender disparities in science, technology, engineering, and mathematics (STEM) fields must be addressed through early intervention and education programs. Additionally, certifications for autonomous vehicle operators and repair professionals must be standardised across the EU to ensure consistency and quality across borders.

Given the rapid evolution of CCAM technologies, continuous education and modular learning will be essential. Industry-driven initiatives must focus on upskilling existing workers to prevent redundancies and ensure a steady supply of qualified professionals.

6.2.3. Public perception and trust

Public attitudes towards CCAM remain mixed, with scepticism surrounding job security, safety, and data privacy. Trade unions and public transport stakeholders remain cautious about automation's potential implications. Public understanding of CCAM's benefits—such as reduced traffic congestion and environmental improvements—is also limited.

Building trust requires transparency in how autonomous systems operate, particularly regarding safety measures, liability, and incident management. Demonstration projects like the Aurrigo Automated Pod trials[3] are crucial in familiarising the public with CCAM technologies and reducing apprehensions.

Tools with user-friendly Human-Machine Interfaces (HMI) can enhance public acceptance by visually communicating vehicle intentions, making autonomous systems feel more relatable. Engagement strategies such as virtual reality-based education can also help demystify CCAM technologies and emphasise their practical benefits. Branding efforts should focus on CCAM's usefulness in daily life rather than just highlighting technological advancements.

[3] For more information, please see the following link: https://aurrigo.com/aurrigo-hits-the-fairway-with-completion-of-canadas-first-ever-public-autonomous-pod-trial/

6.2.4. Policy and regulatory frameworks

The regulatory landscape presents significant challenges for CCAM, particularly concerning cross-border automation. Streamlined regulations across the EU are essential to fostering widespread deployment. Furthermore, infrastructure gaps—such as the lack of necessary digital and physical support systems—must be addressed, with public authorities playing a proactive role in ensuring adequate resources are available.

To mitigate these challenges, urban and regional authorities must implement policies that ensure equitable access to CCAM benefits while protecting vulnerable populations from job displacement. Regulatory sandboxes, which allow for controlled piloting of CCAM projects, can help remove barriers to broader adoption. Establishing clear liability frameworks and robust cybersecurity measures will also be critical to gaining public and stakeholder trust.

Public and private sectors must collaborate to address infrastructure and workforce needs. Governments and industries should share funding responsibilities to support such partnerships. At the EU level, coordination is vital to ensure harmonised regulations and standardisation, reducing deployment delays and enhancing overall efficiency.

6.2.5. Long-term impacts and outlook

The transition to CCAM will redefine existing job roles while creating new opportunities. Rather than widespread job losses, the shift will necessitate new skills and qualifications. Continuous reskilling and training in emerging technologies will be vital to maintaining a competitive and adaptable workforce.

Aligning CCAM with broader urban planning efforts is crucial. For instance, automating depots in public transport could significantly improve efficiency and address workforce shortages. Additionally, combining automation with electrification presents a viable pathway for CCAM deployment, reducing costs by lowering operational expenses such as fuel, maintenance, and labour and enhancing environmental sustainability.

Ensuring inclusivity in CCAM deployment is another key consideration. To prevent transport inequities, efforts must be made to extend the benefits of automation to rural areas and low-income populations. Moreover, gender inclusion in the transport sector should be prioritised through targeted initiatives encouraging women to pursue careers in CCAM-related fields.

Finally, workshop participants emphasised the urgency of addressing CCAM challenges, from workforce development to infrastructure investment. Delaying these efforts could leave Europe lagging in the global transition to automated mobility, underscoring the need for proactive policies and strategic investments to secure the future of CCAM.

6.3. Workshop 3 - Regulation and policy perspective

The objectives of Workshop 3 were to regulate the policy perspective of CCAM (for example, legal aspects for test deployment and legal elements for real-life deployment; specific legal requirements for data protection; regulation vs. standardisation; liability; ethics). The key findings from the workshop are listed below by topic and represent the opinion of all the participants.

6.3.1. Policies that could support the deployment of CCAM:

Regulations for commercialisation: National regulations support testing but often fail to support the commercialisation of CCAM services. The regulatory framework lacks aspects crucial for commercialisation, creating uncertainty in rule implementation. Deploying CCAM services requires cooperation between national and local authorities at various levels, a challenge yet to be met. In the US, testing and deployment are generally permitted unless specifically restricted, whereas in the EU, the default is to require explicit authorisation before they can proceed. This US approach facilitates testing and deploying new services, suggesting that regulatory sandboxes should support testing and deployment. In Europe, large-scale deployment remains unrealised, limited to small-scale tests in confined spaces. For example, in vehicle electrification, a top-down regulatory approach set a deadline for stakeholders to meet requirements. It remains uncertain if a similar approach would succeed for CCAM.

Europe must look beyond testing and establish a clear path for commercialising CCAM services and products. CCAM's cross-border operations present additional challenges, underscoring the need for EU harmonisation to scale up CCAM solutions and incentivise company investments.

Real-life deployment in the transportation sector: There are two potential scenarios for the market dominance of automated vehicles: private ownership or shared usage, with the latter being preferred due to resource efficiency. Vehicle lifecycles must be considered, as new cars in a fleet may be used for up to 15 years, making immediate replacement with autonomous vehicles (AVs) impractical. Additionally, the transport industry must focus on replacing services rather than just vehicles, acknowledging the high costs of deploying AVs and retrofitting public transport fleets.

Liability: Legal frameworks must address liability issues, shifting from driver liability to product liability, as seen in the US. Insurance must adapt to cover damages caused by CCAM systems. There is a need to show a commercial need/opportunity for profit to change the risk-adverse logic of insurers concerning AVs. Currently, insurers are uncertain about pricing, which makes insurance costs high (due to a lack of data, risk models, etc). New insurance products are

necessary, and insurers must find profitable opportunities to support the widespread deployment of these technologies.

Social: Following the European Common Evaluation Methodology (EU-CEM) handbook, CCAM services should be designed around the methodology's societal-level impact areas—liveability, equity, employment, sustainability, land-use, etc. By applying EU-CEM's scenario-based evaluation logic and core indicator set *before* deployment, planners can quantify community needs and anticipate broader effects, providing a harmonised Europe-wide alternative.

Croatia as best practice example: Croatia utilised an EU grant to complete a regulatory framework enabling companies to commercialise their CCAM solutions, incorporating aspects like insurance and road passenger safety. Initially, AVs were deployed in geo-fenced areas, with the Ministry of Interior the Ministry of Transport involved. Public acceptance grew through political, academic support, and stakeholder consensus. Regulations at the national level required insurers to provide insurance for CCAM, supported by EU funding from 2020 to 2022, making Croatia an example for other EU countries without an automated industry.

Shared mobility vouchers could encourage people to give up private cars and use shared mobility services or robot taxis. By adapting the design of vehicles and apps to meet their needs, as seen in Croatia, these vouchers could particularly benefit marginalised groups and individuals with disabilities while facilitating the transition to CCAM.

6.3.2. Policies that could be adopted (by governments and universities) for upskilling and reskilling workers

A gap between education and industry needs has been observed. The conventional structure of education in Europe, which focuses on specialisation through university degrees, must be reassessed.

Determining the skills and qualifications needed for CCAM-related jobs will be necessary. The government should specify the skill requirements for a particular job, and universities and schools should ensure that these skills are part of the curriculum. It will also be essential to ensure mutual recognition of diplomas or certificates related to CCAM jobs between the Member States.

The key is to work with the whole ecosystem of relevant stakeholders, including trade unions, and include them in the transition, both at the company level and at the level of national governments.

6.3.3. Harmonisation of rules across the EU

The EU has established a regulatory framework for AV.[4] EU regulations require testing before deployment; however, different member states use different testing standards. While some countries may have rules for national-level transport, there are no regulations for international or cross-border cases.

The validation of AV testing on public roads in the EU today is often very complicated and limited in space/time in local environments. There are also differences between testing on public roads and 'controlled environments', such as airports. There is a need for guidelines/harmonisation of permits and test procedures. In some cases, it has been observed that there is no cooperation between local, national and regional authorities granting permits. Therefore, the national systems should become clearer to guide local entities. In addition, understanding the needs of local entities and making pilots relevant for cities has also been highlighted as very important.

6.3.4. Ethics on job displacement and corporate social responsibility

Companies need to balance responsibilities to investors and workers. Creating programs to help workers affected by automation is essential. Job losses in some companies are primarily due to economic factors rather than automation. For example, Belgium and Germany face job losses due to market changes and shifting work types. Cohesive language guidance around CCAM can prevent misuse of terms and ensure consumer protection. Building trust and marketing CCAM services ethically is a company's responsibility, while involving specific communities, like the blind community, in discussions is crucial for ethical deployment.

[4] https://single-market-economy.ec.europa.eu/sectors/automotive-industry/vehicle-safety-and-automatedconnected-vehicles_en

7. PESTLE Analysis

PESTLE (sometimes written “PESTEL”) is an evolution of the original PEST framework conceived by Francis Aguilar in 1967 for environmental scanning in strategic planning. It expands the scan from four to six categories—Political, Economic, Social, Technological, Legal and Environmental—capturing external factors that lie largely outside an organisation’s direct control yet strongly influence its ability to achieve objectives:

- **Political** examines governmental priorities, regulation and public-sector investment.
- **Economic** looks at growth trends, cost structures, funding and market forces.
- **Social** explores demographic shifts, skills, equity and public sentiment.
- **Technological** assessment assesses the maturity, interoperability and disruptive potential of innovations.
- **Legal** reviews liability, standards and compliance obligations.
- **Environmental** considerations include resource use, emissions and broader sustainability drivers

By integrating policy signals, market indicators and societal expectations, a PESTLE scan acts as a holistic risk radar, furnishing organisations with an “early-warning” view of weak signals before threats or opportunities fully emerge. This foresight is converted into strategic design inputs, ensuring that investments, skills programmes and technology roadmaps remain firmly anchored to real-world enablers and constraints. Because the resulting narrative is transparent and widely understood, it provides a common language for policymakers, industry, labour groups and citizens, fostering collaboration around shared evidence rather than isolated assumptions. Having outlined the rationale and mechanics of the PESTLE approach, the remainder of this chapter presents our detailed findings for each dimension. It discusses their combined implications for the project’s vision and roadmap.

7.1. Political

- *Lack of regulatory standardisation across Europe*: Different regulatory frameworks create inconsistencies in CCAM adoption, requiring harmonisation efforts.
- *Harmonised European Union (EU):* wide regulations are essential for seamless cross-border transport and the deployment of automated vehicles.
- *International collaboration in CCAM strategy*: Cooperation among countries is essential for cross-border transport and global regulatory alignment (United States and China)

- *Government investment in digital and physical infrastructure*: To support CCAM, funding is needed for smart roads, digital networks, and intelligent transport systems.
- *Limited legal frameworks for Level 4 and beyond automated vehicle testing*: Restricts large-scale trials and implementation of higher-level automation.
- *Financial incentives, grants, and tax reductions*: These incentives encourage CCAM adoption by reducing the financial burdens on companies and stakeholders.
- *Public-private collaboration*: Policy formation must involve industry stakeholders to ensure realistic, applicable regulations and the investment in holistic systems.
- *Cybersecurity regulations*: Safeguards against cyber threats that can disrupt autonomous transport operations.
- *Unified EU regulatory policies for liability and insurance*: Clearly define responsibility for CCAM technology accidents. Current regulations in the EU are fragmented.
- *Political risks due to re-elections*: Leadership changes could alter policies, affecting long-term CCAM investments.

7.2. Economic

- *High initial and ongoing cost*: Implementation requires significant investments in technology, infrastructure, and fleet adaptation.
- *Low profit margins in logistics* make it difficult for companies to justify investing in expensive CCAM solutions.
- *Driver shortages*: Automation solves growing labour shortages in transportation industries.
- *Early adoption feasibility in controlled environments*: CCAM can be deployed in ports, warehouses, and dedicated lanes before broader rollout.
- *Government support for research and development (R&D), training, and innovation grants*: Encourages technological advancements while fostering a skilled workforce.
- *ROI uncertainty*: Investors hesitate due to unclear financial benefits and lengthy adoption timelines. The uncertainty is also due to regulations and the unpredictability of the future market
- *Urban Area Prioritisation*: Initial deployment should focus on high-traffic zones where infrastructure, population density, and existing transport networks support seamless integration. This approach leverages available resources, addresses immediate urban mobility challenges, and allows for incremental expansion to rural regions as technology matures. However, metropolitan areas may receive disproportionate investments, requiring strategies to ensure equitable expansion.
- *Rural and Low-Income Area Inclusion:* Ensuring CCAM benefits extend beyond urban

centres is critical for addressing transport inequities. Public transport struggles with workforce shortages, and automation may bridge gaps, particularly in bus depots and transit systems. However, rural areas face unique infrastructure challenges. A mixed approach, including subsidising ride-pooling services and investing in local digital infrastructure, is needed to facilitate CCAM adoption in these regions. The challenge lies in developing a sustainable business model that incentivises investment in urban and rural areas while balancing profitability with public service needs.

- *Public-private partnerships* help share the investment risks and ensure a more balanced approach to CCAM funding. Meaningful partnerships between the public and private sectors can address infrastructure and workforce needs. Funding for such collaborations should be shared between governments and industries.
- *Workforce transition funding*: Required to reskill displaced workers for emerging roles in automated transport operations (Ex, manual operations)
- *Procurement models aligned with Electric vehicle (EV) adoption strategies*: Lessons from electric vehicle deployment can inform CCAM adoption frameworks.

7.3. Social

- *Shift in job roles rather than elimination*: new fleet monitoring, maintenance, and AI-driven logistics opportunities.
- *Growing demand for Information and communication technology (ICT), artificial intelligence (AI), and mobility expertise*: Digital skills will be crucial for managing and operating CCAM technologies.
- *Public scepticism regarding job losses, safety, and data privacy:* Addressing concerns through education and transparency is key. Educating the public through immersive tools like virtual reality can demystify CCAM technologies and emphasise their practicality.
- *Improving accessibility for elderly and disabled populations*: CCAM has the potential to enhance mobility for individuals with limited transport options.
- *Lifelong learning and micro-credential programs*: Continuous training is needed to keep the workforce relevant in an automated transport ecosystem. Micro-credentials are a series of courses that culminate in a digital badge from an accredited university.
- *Diversity challenges in the automotive sector*: There is a pressing need to enhance inclusivity and equity by attracting underrepresented groups to technical roles in transport. Given the industry's traditionally male-dominated nature, fostering a more balanced male-to-female workforce is essential for driving innovation and ensuring equal opportunities.

- *Public perception and awareness campaigns:* critical to gaining social acceptance and trust in CCAM technologies. They create awareness for the transport sector's direct workers and society.
- *Trade unions' role in workforce transition*: Ensuring fair policies for workers affected by automation. Strong cooperation between governments, industry, and unions is critical to addressing potential job losses and ensuring equitable transitions.
- *Privacy and surveillance concerns*: Establish clear data collection and usage guidelines in automated transport systems.
- *Building community trust*: Transparency in how autonomous systems operate, including safety measures, liability, and incident management, is essential to gaining public trust.
- *Current education systems lack alignment with CCAM's technical needs*, especially in public transport, where IT professionals are not attracted due to higher salaries in other sectors.
- *University curriculum needs to be adapted to prepare the future workforce:* Focusing on electric-mechanical engineering, AI, and autonomous system maintenance is necessary. For example, training programs for safety drivers transitioning into autonomous operations will be crucial.

7.4. Technological

- *Interoperable digital systems:* Essential for seamless connectivity between vehicles, infrastructure, and logistics networks.
- *Monitoring enabling practicable and automated maintenance*: Monitoring done by vehicles and infrastructure sensors can reduce downtime using AI-driven diagnostics.
- *Updated road infrastructure*: including digital infrastructure investment, data management, and maintenance. It is essential to emphasise the importance of standardising road markings and addressing geographical differences.
- *Standardisation in information exchange:* Necessary to avoid fragmentation across different transport operators.
- *Deployment of 5G, 6G, and vehicle-to-everything (V2X) communication*: Improves real-time data sharing and vehicle coordination.
- *AI-driven route optimisation*: Enhances efficiency, reduces congestion, and cuts operational costs.
- *Cybersecurity and data protection*: Strong encryption and secure protocols are needed to safeguard transport networks.
- *Collaboration between tech developers and transport providers*: Ensures practical

implementation of cutting-edge solutions.

- *Digital twins for simulation and testing*: Virtual environments help optimise CCAM deployment before real-world application.
- *Integration of blockchain for secure transactions*: Enhances transparency and trust in autonomous freight logistics.
- *Road Safety and Automation:* Automated vehicles have the potential to improve road safety. Noting that 15% of fatalities in the EU involve heavy vehicles, new rules and regulations are needed to support automation and enhance safety.
- *Integrating CCAM technologies with urban planning*. Automated depots in public transport can improve efficiency and address labour shortages.
- *Electrification combined with automation* presents a more viable pathway for CCAM deployment, especially in reducing costs and improving environmental outcomes.

7.5. Legal

- *International policy coordination challenges:* Differing laws across nations slow down CCAM implementation.
- *Public-road testing legislation barriers*: Many EU regions lack the legal framework for CCAM testing.
- *Defining liability in autonomous vehicle incidents*: Key to establishing insurance policies and legal accountability.
- *Updating labour laws for remote fleet monitoring roles:* Automation changes job structures that require legal adjustments.
- *Data-sharing policies for transparency*: Secure data exchange must balance openness and privacy concerns.
- *Balancing safety regulations with innovation*: Overregulation may hinder technological progress.
- *Long-term and pro-active legal frameworks*: Policies must evolve alongside CCAM technology to ensure ongoing relevance.
- *Regulatory sandboxes* allow for piloting CCAM projects in controlled environments, removing barriers to broader adoption.

7.6. Environmental

- *CCAM's indirect role in emissions reduction:* Efficiency gains through automation contribute to sustainability efforts.
- *AI-driven route planning for reduced fuel consumption*: Minimises environmental impact by optimising transport operations.

- *Reducing urban congestion through fleet coordination*: Alleviates pollution and enhances city mobility.
- *High energy demands of CCAM technologies*: Increased power consumption necessitates clean energy solutions.
- *Renewable energy integration*: Essential for making CCAM a truly sustainable technology.
- *Surplus clean energy for sustainable deployment:* Ensuring a sufficient renewable energy supply to meet automation demands.
- *Circular economy practices in vehicle manufacturing*: Reducing waste through recycling and reusing materials.
- *Impact on urban planning and land use*: Autonomous mobility influences city development and transportation policies.
- *Encouraging green logistics frameworks*: Promoting sustainable freight and transport solutions
- *Electrification combined with automation:* presents a more viable pathway for CCAM deployment, especially in reducing costs and improving environmental outcomes.

8. Conclusions and recommendations

This deliverable has provided a structured scan of the external environment shaping the deployment of CCAM in Europe, focusing on its socio-economic and labour-market dimensions. Through a multi-method approach—combining stakeholder database construction, 28 expert interviews, and three targeted workshops—an in-depth PESTLE analysis has been developed to map out the political, economic, social, technological, legal, and environmental drivers influencing CCAM adoption.

Key findings show that harmonised regulation, strategic investment, and skills-oriented labour strategies will be central to unlocking CCAM's potential. Politically and legally, fragmented national rules remain a significant barrier, underscoring the need for EU-level harmonisation on liability, data sharing, and testing procedures. Economically, unclear business models and high capital costs persist, calling for public-private collaboration and incentives. Technologically, CCAM must be planned in synergy with digital and energy infrastructures, while ensuring cyber-resilience.

Crucially, the social and labour aspects are not peripheral—but foundational. Rather than causing widespread job losses, CCAM is expected to reshape occupational profiles, particularly in driving, maintenance, logistics, and mobility services. This shift necessitates a proactive approach to reskilling and upskilling, focused on ICT, AI, cybersecurity, and systems integration. Ensuring inclusion—for women, rural communities, and vulnerable groups—will also be essential for public trust and equitable deployment.

This evidence base is a cornerstone for the next steps in the CCAM-ERAS project, particularly for designing relevant use cases and skills frameworks. It also reinforces the importance of linking pilot evaluations to policy and training reform, using harmonised methods such as the EU-CEM. A workforce-ready transition to CCAM will only be possible if investment in technology matches investment in people.

CCAM-ERAS strengthens Europe's capacity to steer automated mobility towards economic resilience, social inclusion, and sustainable innovation by anchoring future work in the insights from this PESTLE analysis.

Annexe 1 – General Questionnaire

Political

CCAM Policies

1. What specific policies or government initiatives do you believe are necessary to support the successful implementation of CCAM?
2. How should government policies balance the promotion of CCAM technologies with the protection of jobs that might be made redundant by automation?
3. What role do you think government investment in infrastructure should play in facilitating the large-scale deployment of CCAM?
4. What kind of social policies do you think should be in place to support workers who might lose their jobs due to the automation associated with CCAM?
5. How important is international policy coordination for the successful deployment of CCAM, and what role should national governments play in this process?
6. How can government policies facilitate collaboration between different sectors (e.g., automotive, technology, infrastructure) to ensure the effective deployment of CCAM? More specifically impact on jobs/jobs creation, education, skills

Financial

7. Do you think subsidies or financial incentives from the government are essential for encouraging companies to adopt CCAM technologies? Why or why not?
8. How should public funds be allocated to support both the development of CCAM technologies and the necessary infrastructure, such as smart roads and communication networks?

Economic

Costs of CCAM

9. What do you think are the major (cost/ investment) drivers for implementing CCAM ?
10. What factors will influence the speed at which CCAM technologies are implemented?
11. Which will be the sectors that develop the CCAM technologies and how will their needs differ from the current automotive sector?

CCAM Jobs

12. Which job roles are most at risk of being automated?

13. What kind of upskilling programs will be essential to help the workforce transition? Can you rank the job roles as the most and least critical ones that will be affected?
14. How will the skillsets of engineers, technicians, and data analysts need to evolve for CCAM? Can you rank the skillsets as the most and least important ones?
15. What new roles might emerge as CCAM becomes more prevalent? Can you rank the roles as the most and least critical ones that will be emerge?

Social

Social impacts of CCAM

16. How can CCAM technologies be deployed in a way that ensures equitable access for all communities, including those in underserved or rural areas?
17. Do you think the adoption of CCAM technologies could widen social disparities, such as between different income groups or regions? If so, how can these disparities be addressed?
18. Which population groups (general population, people with special mobility needs, elderly, families with kids) are affected the most/least by the employment opportunities emerged from CCAM deployment)
19. In terms of social/equity impacts, what is the effect of employment distribution?

Education and training

20. What new curricula or training programs should be introduced to prepare future workers for the CCAM industry?

Public perception of CCAM

21. What are the key factors that influence public perception and trust in CCAM technologies, and how can stakeholders work to improve public acceptance?

Technological

22. How do you foresee CCAM technologies affecting employment in the transport and logistics sectors, and what measures should be taken to mitigate potential job losses?
23. What types of skills will workers need to develop in response to the rise of CCAM?
24. How can educational institutions and employers facilitate this transition?
25. What new technologies, materials, and data are necessary for the CCAM environment?

26. In what ways does CCAM enhance efficiency, safety, and environmental sustainability compared to current transport systems?

Legal

27. How do you see current government regulations impacting the deployment of CCAM technologies in your industry/field?
28. What are the most significant regulatory challenges you foresee in the implementation of CCAM, and how can they be addressed?
29. What changes do you believe are needed in the current legislative framework to better support the adoption of CCAM technologies? Which existing transport laws need to be modified to accommodate CCAM?

Environment

30. How can CCAM technologies be leveraged to promote environmental sustainability while also ensuring a smooth transition for workers moving from traditional roles to new opportunities in green industries?
31. In what ways can CCAM technologies help industries meet long-term environmental sustainability goals, and how might this shift influence the types of skills and expertise required in the workforce?
32. How do you anticipate CCAM technologies will affect the balance between traditional industries and emerging green sectors, and what strategies can be employed to support workers transitioning from one to the other?

Annexe 2 - Questionnaire for Associations and Networks/Labour Market Experts

Political

CCAM Policies

1. What specific policies or government initiatives do you believe are necessary to support the successful implementation of CCAM?
2. How should government policies balance the promotion of CCAM technologies with the protection of jobs that might be made redundant by automation?
3. What role do you think government investment in infrastructure should play in facilitating the large-scale deployment of CCAM?
4. How important is international policy coordination for the successful deployment of CCAM, and what role should national governments play in this process?

Financial

5. Do you think subsidies or financial incentives from the government are essential for encouraging companies to adopt CCAM technologies? Why or why not?
6. How should public funds be allocated to support both the development of CCAM technologies and the necessary infrastructure, such as smart roads and communication networks?
7. How can government policies facilitate collaboration between different sectors (e.g., automotive, technology, infrastructure) to ensure the effective deployment of CCAM? More specifically impact on jobs/jobs creation, education, skills

Economic

Costs of CCAM

8. What do you think are the major (cost/ investment) drivers for implementing CCAM?
9. What factors will influence the speed at which CCAM technologies are implemented?
10. How will the supply chain for CCAM be different from current transport sectors?

CCAM Jobs

11. How do you foresee CCAM technologies affecting employment in the transport and logistics sectors, and what measures should be taken to mitigate potential job losses?

12. Which job roles are most at risk of being automated and what new roles might emerge as CCAM becomes more prevalent? Can you rank the roles as the most and least critical ones that will be emerge?
13. What kind of upskilling programs will be essential to help the workforce transition? Can you rank the job roles as the most and least critical ones that will be affected?
14. How will the skillsets of engineers, technicians, and data analysts need to evolve for CCAM? Can you rank the skillsets as the most and least important ones?

Social

Societal impacts of CCAM

15. What are the main concerns within your community regarding the potential job losses or economic shifts caused by CCAM? What concerns do you have regarding potential disparities in access to CCAM technologies and related jobs?

a. How will CCAM affect the local economy, particularly in terms of income distribution?

b. Which population groups (general population, people with special mobility needs, elderly, families with kids) are affected the most/least by the employment opportunities emerged from CCAM deployment)

c. Do you think the adoption of CCAM technologies could widen social disparities, such as between different income groups or regions? If so, how can these disparities be addressed?

d. In terms of social/equity impacts, what is the effect of employment distribution?

16. What kind of social policies do you think should be in place to support workers who might lose their jobs due to the automation associated with CCAM?
17. How can CCAM technologies be deployed in a way that ensures equitable access for all communities, including those in underserved or rural areas?

Education and training

18. What types of skills will workers need to develop in response to the rise of CCAM, and how can educational institutions and employers facilitate this transition?
19. What new curricula or training programs should be introduced to prepare future workers for the CCAM industry?
20. What support do you think is necessary to help workers transition into new roles created by CCAM?

21. How can your organization contribute to addressing potential skill shortages in the labour market due to CCAM?

Public perception of CCAM

22. What are the key factors that influence public perception and trust in CCAM technologies, and how can stakeholders work to improve public acceptance?
23. How does your community view the adoption of CCAM? Are there significant levels of support or resistance?
24. What role do you see for your organization in educating the public about CCAM and its implications for the job market?

Technological

25. What new technologies, materials, and data are necessary for the CCAM ecosystem?
26. In what ways does CCAM enhance efficiency, safety, and environmental sustainability compared to current transport systems?

Legal

27. How do you see current government regulations impacting the deployment of CCAM technologies in your industry/field?
28. What are the most significant regulatory challenges you foresee in the implementation of CCAM, and how can they be addressed?
29. What changes do you believe are needed in the current legislative framework to better support the adoption of CCAM technologies? Which existing transport laws need to be modified to accommodate CCAM?

Environment

30. How can CCAM technologies be leveraged to promote environmental sustainability while also ensuring a smooth transition for workers moving from traditional roles to new opportunities in green industries?
31. In what ways can CCAM technologies help industries meet long-term environmental sustainability goals, and how might this shift influence the types of skills and expertise required in the workforce?
32. How do you anticipate CCAM technologies will affect the balance between traditional industries and emerging green sectors, and what strategies can be employed to support workers transitioning from one to the other?

Annexe 3 – Questionnaire for Governments and Policy makers

Political

CCAM Policies

1. What specific policies or government initiatives do you believe are necessary to support the successful implementation of CCAM?
2. How should government policies balance the promotion of CCAM technologies with the protection of jobs that might be made redundant by automation?
3. What role do you think government investment in infrastructure should play in facilitating the large-scale deployment of CCAM?
4. How important is international policy coordination for the successful deployment of CCAM, and what role should national governments play in this process?

Financial

5. Do you think subsidies or financial incentives from the government are essential for encouraging companies to adopt CCAM technologies? Why or why not?
6. How should public funds be allocated to support both the development of CCAM technologies and the necessary infrastructure, such as smart roads and communication networks?
7. Cross-sector Collaboration: How can government policies facilitate collaboration between different sectors (e.g., automotive, technology, infrastructure) to ensure the effective deployment of CCAM? More specifically impact on jobs/jobs creation, education, skills

Economic

Costs of CCAM

8. What do you think are the major (cost) drivers for implementing CCAM?
9. What other factors will influence the speed at which CCAM technologies are implemented?

CCAM Jobs

10. How do you foresee CCAM technologies affecting employment in the transport and logistics sectors, and what measures should be taken to mitigate potential job losses?

a. How do you anticipate CCAM adoption will impact overall employment levels in the transport sector?

b. What measures are being considered to mitigate potential job displacement caused by automation in the mobility sector?

c. What new job roles do you foresee emerging as a result of CCAM adoption?

d. How are you planning to support the creation of these new roles?

e. Which job roles are most at risk of being automated and what new roles might emerge as CCAM becomes more prevalent? Can you rank the roles as the most and least critical ones that will be emerge??

11. How is your organisation collaborating with educational institutions to ensure the workforce is equipped with the necessary skills for CCAM-related jobs?

a. What kind of upskilling programs will be essential to help the workforce transition? Can you rank the job roles as the most and least critical ones that will be affected?

b. Are there any initiatives in place to retrain workers who may be displaced by CCAM technologies?

c. What strategies are in place to transition affected employees to new roles?

12. How will the skillsets of engineers, technicians, and data analysts need to evolve for CCAM? Can you rank the skillsets as the most and least important ones?

13. How will CCAM integration into public transportation systems affect current job roles within your organization?

14. How will the maintenance of CCAM infrastructure create new job opportunities or alter existing ones?

Social

15. In terms of social/equity impacts, what is the effect of employment distribution?

Societal impacts of CCAM

16. What are the main concerns regarding the potential job losses or economic shifts caused by CCAM and how do you foresee CCAM adoption affecting job creation or loss in key sectors such as transportation, logistics, and manufacturing?

17. What concerns do you have regarding potential disparities in access to CCAM technologies and related jobs?

18. What policies are being considered to address potential unemployment due to job displacement by CCAM technologies?
19. How will CCAM affect the local economy, particularly in terms of income distribution? How do you plan to manage income distribution changes that may result from CCAM adoption?
20. Which population groups (general population, people with special mobility needs, elderly, families with kids) are affected the most/least by the employment opportunities emerged from CCAM deployment)
21. Do you think the adoption of CCAM technologies could widen social disparities, such as between different income groups or regions? If so, how can these disparities be addressed?
22. What measures are being considered to prevent potential disparities in access to CCAM technologies and services?
23. How can CCAM technologies be deployed in a way that ensures equitable access for all communities, including those in underserved or rural areas?
24. In terms of social/equity impacts, what is the effect of employment distribution?
25. How do you plan to ensure that access to CCAM-related jobs and education is equitable across different social groups?
26. What kind of social policies do you think should be in place to support workers who might lose their jobs due to the automation associated with CCAM?

Education and training

27. What new curricula or training programs should be introduced to prepare future workers for the CCAM industry?
28. Are there any current projections or studies on potential mismatches in the labour market (e.g., skill shortages) due to the introduction of CCAM?
29. What strategies are being discussed to retrain or upskill workers displaced by CCAM?
30. What support do you think is necessary to help workers transition into new roles created by CCAM?

Public perception of CCAM

31. How do you assess current public attitudes towards CCAM? Are there specific concerns or resistances that need to be addressed?

32. What are the key factors that influence public perception and trust in CCAM technologies, and how can stakeholders work to improve public acceptance?
33. What role do you see government playing in shaping public opinion and preparing educational institutions to align with future CCAM-related job markets?

Technological

34. What new technologies, materials, and data are necessary for the CCAM ecosystem?
35. In what ways does CCAM enhance efficiency, safety, and environmental sustainability compared to current transport systems?

Legal

36. How do you see current government regulations impacting the deployment of CCAM technologies in your industry/field?
37. What are the most significant regulatory challenges you foresee in the implementation of CCAM, and how can they be addressed?
38. What changes do you believe are needed in the current legislative framework to better support the adoption of CCAM technologies?
39. Which existing transport laws need to be modified to accommodate CCAM?

Environmental

40. How can CCAM technologies be leveraged to promote environmental sustainability while also ensuring a smooth transition for workers moving from traditional roles to new opportunities in green industries?
41. In what ways can CCAM technologies help industries meet long-term environmental sustainability goals, and how might this shift influence the types of skills and expertise required in the workforce?
42. How do you anticipate CCAM technologies will affect the balance between traditional industries and emerging green sectors, and what strategies can be employed to support workers transitioning from one to the other?

Annexe 4 – Questionnaire for Higher Education/VET Institutions/Professional and Accreditation Bodies/Educational and Training Institutions

Political

CCAM Policies

1. What specific policies or government initiatives do you believe are necessary to support the successful implementation of CCAM (such as those relating to educational/skills policies)?

Financial

2. Do you think subsidies or financial incentives from the government are essential for encouraging HEIs to address the move towards CCAM technologies? Why or why not?
3. How can government policies facilitate collaboration between different sectors (e.g., automotive, technology, infrastructure, education) to ensure the effective deployment of CCAM? More specifically impact on jobs/jobs creation, education, skills

Economic

4. How do you foresee CCAM technologies affecting employment in the transport and logistics sectors, and what measures should be taken to mitigate potential job losses?
5. What kind of upskilling programs will be essential to help the workforce transition? Can you rank the job roles as the most and least critical ones that will be affected?
6. How will the skillsets of engineers, technicians, and data analysts need to evolve for CCAM? Can you rank the skillsets as the most and least important ones?
7. What partnerships do you have with industry stakeholders to ensure your programs meet the evolving demands of the job market?
8. What skills gaps do you currently observe in students that need to be addressed to meet future CCAM industry needs?
9. How are you addressing the need for interdisciplinary skills combining engineering, IT, and data analysis?
10. How are you developing reskilling programs for workers displaced by CCAM technologies?

11. What role do you see for lifelong learning in preparing the workforce for the changes brought about by CCAM?
12. How are you encouraging current professionals to engage in ongoing education related to CCAM technologies?

Social

Education and training

13. What new curricula or training programs should be introduced to prepare future workers for the CCAM industry? What types of skills will workers need to develop in response to the rise of CCAM, and how can educational institutions and employers facilitate this transition?
14. How do you anticipate CCAM will influence the types of programs and courses you offer? What steps are you taking to align your curriculum with the needs of the emerging CCAM industry?
15. What partnerships do you have with industry to ensure that your graduates are prepared for CCAM-related roles?
16. How are you addressing potential mismatches in the labour market, such as skill shortages, due to CCAM?
17. How are you engaging with students and the public to raise awareness about the potential career opportunities in the CCAM industry?
18. What challenges do you foresee in adapting educational programs to keep pace with CCAM advancements?
19. How do you ensure that students from diverse backgrounds have equal access to CCAM-related education and training opportunities?
20. What initiatives are you undertaking to reduce barriers to education in fields related to CCAM, especially for underrepresented groups?

Public perception of CCAM

21. What are the key factors that influence public perception and trust in CCAM technologies, and how can stakeholders work to improve public acceptance?

Technological

22. What new technologies, materials, and data are necessary for the CCAM ecosystem?
23. In what ways does CCAM enhance efficiency, safety, and environmental sustainability compared to current transport systems?

Legal

24. What are the most significant regulatory challenges you foresee in the implementation of CCAM, and how can they be addressed?
25. What changes do you believe are needed in the current legislative framework to better support the adoption of CCAM technologies?

Environment

26. In what ways can CCAM technologies help industries meet long-term environmental sustainability goals, and how might this shift influence the types of skills and expertise required in the workforce?
27. How do you anticipate CCAM technologies will affect the balance between traditional industries and emerging green sectors, and what strategies can be employed to support workers transitioning from one to the other?

Annexe 5 – Questionnaire for Industry representatives

Political

CCAM Policies

1. What specific policies or government initiatives do you believe are necessary to support the successful implementation of CCAM?
2. How should government policies balance the promotion of CCAM technologies with the protection of jobs that might be made redundant by automation?
3. What role do you think government investment in infrastructure should play in facilitating the large-scale deployment of CCAM?
4. How important is international policy coordination for the successful deployment of CCAM, and what role should national governments play in this process?

Financial

5. Do you think subsidies or financial incentives from the government are essential for encouraging companies to adopt CCAM technologies? Why or why not?
6. How should public funds be allocated to support both the development of CCAM technologies and the necessary infrastructure, such as smart roads and communication networks?
7. How can government policies facilitate collaboration between different sectors (e.g., automotive, technology, infrastructure) to ensure the effective deployment of CCAM? More specifically impact on jobs/jobs creation, education, skills

Economic

Costs of CCAM

8. What do you think are the major (cost) drivers for implementing CCAM?
9. What factors will influence the speed at which CCAM technologies are implemented?

CCAM Jobs

10. How do you foresee CCAM technologies affecting employment in the transport and logistics sectors, and what measures should be taken to mitigate potential job losses?
11. Which job functions within your company are most likely to be automated due to CCAM, and how do you plan to address the resulting workforce changes?

12. How do you expect CCAM technologies to change the roles of workers in automotive manufacturing, particularly in areas like assembly, design, and quality control?
13. What new competencies will be required for these evolving roles?

Social

Societal impacts of CCAM

14. How do you anticipate CCAM will impact your workforce in the next 5-10 years? Do you expect more job creation or job loss?
15. What is your company's strategy to manage the transition for workers whose jobs may be at risk due to automation?
16. Which population groups (general population, people with special mobility needs, elderly, families with kids) are affected the most/least by the employment opportunities emerged from CCAM deployment)
17. Do you think the adoption of CCAM technologies could widen social disparities, such as between different income groups or regions? If so, how can these disparities be addressed?
18. How does your company address potential disparities in access to CCAM technologies and employment opportunities, particularly for marginalized groups?
19. How can CCAM technologies be deployed in a way that ensures equitable access for all communities, including those in underserved or rural areas?

Education and training

20. What types of new job roles do you anticipate emerging as a result of CCAM? What skills will be in high demand?
21. What types of skills will workers need to develop in response to the rise of CCAM, and how can educational institutions and employers facilitate this transition?
22. What new curricula or training programs should be introduced to prepare future workers for the CCAM industry? How is your organization working with educational institutions to develop curricula that address future skills needs in CCAM?
23. Are you facing any challenges in finding qualified candidates for new CCAM-related roles? How are you addressing these gaps?
24. What partnerships do you have with educational institutions to ensure that future graduates have the skills needed for CCAM-related roles?

25. Will full automation still require the presence of humans in the vehicles? If yes, what would be their role and skill requirement?

Public perception of CCAM

26. What are the key factors that influence public perception and trust in CCAM technologies, and how can stakeholders work to improve public acceptance?
27. What are your plans to ensure that the benefits of CCAM are shared broadly across different segments of society?
28. How is your company responding to public concerns about CCAM, such as fears of job loss or safety issues?

Technological

29. What new technologies, materials, and data are necessary for the CCAM ecosystem?
30. In what ways does CCAM enhance efficiency, safety, and environmental sustainability compared to current transport systems?
31. How important is interoperability between different CCAM systems and technologies, and what are the current challenges in achieving this?
32. How do you see the integration of CCAM technologies with existing transportation and communication infrastructure, and what are the key obstacles?
33. With CCAM generating large amounts of data, what are the key challenges in data management and analysis, and how can they be addressed?
34. What are the main cybersecurity risks associated with CCAM, and how can these be mitigated to ensure the safety and reliability of the systems?
35. What are the biggest challenges in scaling up CCAM technologies for widespread adoption, and how can they be overcome?
36. How important are industry-wide technological standards for CCAM, and what role should governments and industry bodies play in establishing these standards?

Legal

37. How do you see current government regulations impacting the deployment of CCAM technologies in your industry/field?
38. Are there regulations that govern introduction of automation in commercial road transport vehicles, if yes, please provide details (both national and EU)?

39. What are the most significant regulatory challenges you foresee in the implementation of CCAM, and how can they be addressed?

40. What changes do you believe are needed in the current legislative framework to better support the adoption of CCAM technologies? Which existing transport laws need to be modified to accommodate CCAM?

Environment

41. How can CCAM technologies be leveraged to promote environmental sustainability while also ensuring a smooth transition for workers moving from traditional roles to new opportunities in green industries?

42. In what ways can CCAM technologies help industries meet long-term environmental sustainability goals, and how might this shift influence the types of skills and expertise required in the workforce?

43. How do you anticipate CCAM technologies will affect the balance between traditional industries and emerging green sectors, and what strategies can be employed to support workers transitioning from one to the other?

Annexe 6 – Questionnaire for Representative Organisations/Trade Unions/Employers' Organisations/Sector Skills Alliances

Political

CCAM Policies

1. What specific policies or government initiatives do you believe are necessary to support the successful implementation of CCAM?
2. How should government policies balance the promotion of CCAM technologies with the protection of jobs that might be made redundant by automation?
3. What role do you think government investment in infrastructure should play in facilitating the large-scale deployment of CCAM?
4. What kind of social policies do you think should be in place to support workers who might lose their jobs due to the automation associated with CCAM?
5. How important is international policy coordination for the successful deployment of CCAM, and what role should national governments play in this process?
6. How can government policies facilitate collaboration between different sectors (e.g., automotive, technology, infrastructure) to ensure the effective deployment of CCAM? More specifically impact on jobs/jobs creation, education, skills

Financial

7. Do you think subsidies or financial incentives from the government are essential for encouraging companies to adopt CCAM technologies? Why or why not?
8. How should public funds be allocated to support both the development of CCAM technologies and the necessary infrastructure, such as smart roads and communication networks?

Economic

Costs of CCAM

9. What do you think are the major (cost) drivers for implementing CCAM ?
10. What factors will influence the speed at which CCAM technologies are implemented?

CCAM Jobs

11. Which job roles are most at risk of being automated and what are the main concerns of your members regarding job displacement due to CCAM adoption?
12. How are you advocating for policies or programs to protect workers in the transition to a more automated transportation sector?
13. What initiatives are you promoting to ensure that displaced workers receive adequate training and reskilling opportunities? What kind of upskilling programs will be essential to help the workforce transition?
14. How will the skillsets of engineers, technicians, and data analysts need to evolve for CCAM? Can you rank the skillsets as the most and least important ones?
15. What new roles might emerge as CCAM becomes more prevalent? Can you rank the roles as the most and least critical ones that will be emerge?
16. How are you collaborating with employers and government bodies to create a safety net for workers affected by CCAM technologies?
17. What strategies do you believe are necessary to ensure job security in the face of increasing automation in the mobility sector?
18. How are you addressing the need for collective bargaining to cover new and evolving roles in the CCAM ecosystem?

Social

Social impacts of CCAM

19. What are your primary concerns regarding job loss or displacement due to CCAM adoption?
20. How are you preparing your members for the potential changes in the job market caused by CCAM?
21. How are you advocating for fair access to new jobs created by CCAM, particularly for workers from disadvantaged backgrounds?
22. What strategies are you considering to ensure that the adoption of CCAM does not widen income inequality?
23. Do you think the adoption of CCAM technologies could widen social disparities, such as between different income groups or regions? If so, how can these disparities be addressed?

24. Which population groups (general population, people with special mobility needs, elderly, families with kids) are affected the most/least by the employment opportunities emerged from CCAM deployment)

Education and training

25. Are you involved in any initiatives to upskill or retrain workers for new opportunities in the CCAM industry?
26. What are the biggest challenges you foresee in adapting the workforce to the demands of CCAM?
27. What new curricula or training programs should be introduced to prepare future workers for the CCAM industry?
28. What role do you see unions playing in shaping educational programs to align with CCAM's future job market?

Public perception of CCAM

29. How do you perceive public support or resistance to CCAM, and how do you think this will impact your members?
30. What are the key factors that influence public perception and trust in CCAM technologies, and how can stakeholders work to improve public acceptance?

Technological

31. How do you foresee CCAM technologies affecting employment in the transport and logistics sectors, and what measures should be taken to mitigate potential job losses?
32. What types of skills will workers need to develop in response to the rise of CCAM, and how can educational institutions and employers facilitate this transition?
33. What new technologies, materials, and data are necessary for the CCAM ecosystem?
34. In what ways does CCAM enhance efficiency, safety, and environmental sustainability compared to current transport systems?

Legal

35. How do you see current government regulations impacting the deployment of CCAM technologies in your industry/field?
36. What are the most significant regulatory challenges you foresee in the implementation of CCAM, and how can they be addressed?

37. What changes do you believe are needed in the current legislative framework to better support the adoption of CCAM technologies? Which existing transport laws need to be modified to accommodate CCAM?

Environment

38. How can CCAM technologies be leveraged to promote environmental sustainability while also ensuring a smooth transition for workers moving from traditional roles to new opportunities in green industries?

39. In what ways can CCAM technologies help industries meet long-term environmental sustainability goals, and how might this shift influence the types of skills and expertise required in the workforce?

40. How do you anticipate CCAM technologies will affect the balance between traditional industries and emerging green sectors, and what strategies can be employed to support workers transitioning from one to the other?

Annexe 7 – Questionnaire for Research Institutions/Think Tanks/Media and Public Relations

Political

CCAM Policies

1. What specific policies or government initiatives do you believe are necessary to support the successful implementation of CCAM?
2. How should government policies balance the promotion of CCAM technologies with the protection of jobs that might be made redundant by automation?
3. What role do you think government investment in infrastructure should play in facilitating the large-scale deployment of CCAM?
4. What kind of social policies do you think should be in place to support workers who might lose their jobs due to the automation associated with CCAM?
5. How important is international policy coordination for the successful deployment of CCAM, and what role should national governments play in this process?
6. How can government policies facilitate collaboration between different sectors (e.g., automotive, technology, infrastructure) to ensure the effective deployment of CCAM? More specifically impact on jobs/jobs creation, education, skills

Financial

7. Do you think subsidies or financial incentives from the government are essential for encouraging companies to adopt CCAM technologies? Why or why not?
8. How should public funds be allocated to support both the development of CCAM technologies and the necessary infrastructure, such as smart roads and communication networks?

Economic

Costs of CCAM

9. What do you think are the major (cost) drivers for implementing CCAM?
10. What factors will influence the speed at which CCAM technologies are implemented?

CCAM Jobs

11. What research are you conducting to understand the impact of CCAM on job markets?
12. How do you foresee the job market evolving in sectors most affected by CCAM?

13. Which job roles are most at risk of being automated?
14. What kind of upskilling programs will be essential to help the workforce transition? Can you rank the job roles as the most and least critical ones that will be affected?
15. How will the skillsets of engineers, technicians, and data analysts need to evolve for CCAM? Can you rank the skillsets as the most and least important ones?
16. What new roles might emerge as CCAM becomes more prevalent? Can you rank the roles as the most and least critical ones that will emerge?
17. What policy recommendations are you developing to address the potential negative impacts of CCAM on employment?

Social

Social impacts of CCAM

18. What are your findings on the potential societal consequences of CCAM adoption, particularly in terms of job creation, job loss, and income distribution?
19. What do your models suggest about the long-term economic impacts of CCAM on various sectors?
20. How can CCAM technologies be deployed in a way that ensures equitable access for all communities, including those in underserved or rural areas?
21. What research exists on the potential disparities in access to CCAM-related opportunities and services?
22. What policy recommendations would you suggest to ensure that the benefits of CCAM are equitably distributed across society?

Education and training

23. What evidence is there of potential mismatches in the labour market due to CCAM? How significant are these mismatches?
24. What research is being conducted on the types of skills that will be most needed in a CCAM-dominated economy?
25. How do you think educational institutions should respond to the changes brought about by CCAM in terms of curriculum development?
26. What new curricula or training programs should be introduced to prepare future workers for the CCAM industry?

Public perception of CCAM

27. What are the current trends in public attitudes towards CCAM, and how might these affect education and job trends?
28. What are the key factors that influence public perception and trust in CCAM technologies, and how can stakeholders work to improve public acceptance?

Technological

29. How do you foresee CCAM technologies affecting employment in the transport and logistics sectors, and what measures should be taken to mitigate potential job losses?
30. What types of skills will workers need to develop in response to the rise of CCAM, and how can educational institutions and employers facilitate this transition?
31. What new technologies, materials, and data are necessary for the CCAM ecosystem?
32. In what ways does CCAM enhance efficiency, safety, and environmental sustainability compared to current transport systems?

Legal

33. How do you see current government regulations impacting the deployment of CCAM technologies in your industry/field?
34. What are the most significant regulatory challenges you foresee in the implementation of CCAM, and how can they be addressed?
35. What changes do you believe are needed in the current legislative framework to better support the adoption of CCAM technologies? Which existing transport laws need to be modified to accommodate CCAM?

Environment

36. How can CCAM technologies be leveraged to promote environmental sustainability while also ensuring a smooth transition for workers moving from traditional roles to new opportunities in green industries?
37. In what ways can CCAM technologies help industries meet long-term environmental sustainability goals, and how might this shift influence the types of skills and expertise required in the workforce?
38. How do you anticipate CCAM technologies will affect the balance between traditional industries and emerging green sectors, and what strategies can be employed to support workers transitioning from one to the other?

Annexe 8 – Questionnaire for Transport companies

Political

CCAM Policies

1. What specific policies or government initiatives do you believe are necessary to support the successful implementation of CCAM?
2. How should government policies balance the promotion of CCAM technologies with the protection of jobs that might be made redundant by automation?
3. What role do you think government investment in infrastructure should play in facilitating the large-scale deployment of CCAM?
4. What kind of social policies do you think should be in place to support workers who might lose their jobs due to the automation associated with CCAM?
5. How important is international policy coordination for the successful deployment of CCAM, and what role should national governments play in this process?
6. How can government policies facilitate collaboration between different sectors (e.g., automotive, technology, infrastructure) to ensure the effective deployment of CCAM? More specifically impact on jobs/jobs creation, education, skills

Financial

7. Do you think subsidies or financial incentives from the government are essential for encouraging companies to adopt CCAM technologies? Why or why not?
8. How should public funds be allocated to support both the development of CCAM technologies and the necessary infrastructure, such as smart roads and communication networks?

Economic

Costs of CCAM

9. What do you think are the major (cost) drivers for implementing CCAM?
10. How economically feasible CCAM projects are? What is their potential impact on education and skill training funding?
11. What economic factors will influence the speed at which CCAM technologies are implemented?

CCAM Jobs

12. What aspects of your operations are most likely to be automated through CCAM, and how will this affect your current workforce? Which job roles are most at risk of being automated?
13. What new roles do you anticipate emerging in logistics (or your sector) due to CCAM adoption?
14. What plans do you have to retrain your workforce to meet the needs of a more automated and connected transportation network?
15. How will the skillsets of engineers, technicians, and data analysts need to evolve for CCAM? Can you rank the skillsets as the most and least important ones?
16. What new roles might emerge as CCAM becomes more prevalent? Can you rank the roles as the most and least critical ones that will emerge?

Social

Social impacts of CCAM

17. How can CCAM technologies be deployed in a way that ensures equitable access for all communities, including those in underserved or rural areas?
18. Do you think the adoption of CCAM technologies could widen social disparities, such as between different income groups or regions? If so, how can these disparities be addressed?
19. Which population groups (general population, people with special mobility needs, elderly, families with kids) are affected the most/least by the employment opportunities emerged from CCAM deployment)
20. In terms of social/equity impacts, what is the effect of employment distribution?
21. Are you aware of any existing funding opportunities / best practices to manage the transition in an inclusive manner for transport workers?

Education and training

22. What is the impact of automation on the skills required by people engaged in road transport sector (e.g., drivers, transport managers etc.)?
23. Are transport operators taking steps to upgrade the skills of workers due to automation and if so in which particular areas?
24. What new curricula or training programs should be introduced to prepare future workers for the CCAM industry?

25. Are there measures in place to incentivise companies to invest in adult learning in relation to use of automation?

Public perception of CCAM

26. What are the key factors that influence public perception and trust in CCAM technologies, and how can stakeholders work to improve public acceptance?

Technological

27. Which are the core functions that automation is supporting or expected to support in road transport sector? (e.g. Driving, fleet management, others etc.)
28. What is the extent of the support that automation is providing or expected to provide to various functions? (e.g. Driving, fleet management, others etc.)
29. How do you foresee CCAM technologies affecting employment in the transport and logistics sectors, and what measures should be taken to mitigate potential job losses?
30. What new technologies, materials, and data are necessary for the CCAM ecosystem?
31. In what ways does CCAM enhance efficiency, safety, and environmental sustainability compared to current transport systems?
32. How does the need for developing advanced physical and digital infrastructure, along with conducting predictive and automated maintenance, impact job opportunities and educational requirements?

Legal

33. Are there any rules (national or EU level) which regulate automation in the commercial road transport sector? If so, what aspects are regulated?
34. How do you see current government regulations impacting the deployment of CCAM technologies in your industry/field?
35. What are the most significant regulatory challenges you foresee in the implementation of CCAM, and how can they be addressed?
36. What changes do you believe are needed in the current legislative framework to better support the adoption of CCAM technologies? Which existing transport laws need to be modified to accommodate CCAM?

Environment

37. How can CCAM technologies be leveraged to promote environmental sustainability while also ensuring a smooth transition for workers moving from traditional roles to new opportunities in green industries?

38. In what ways can CCAM technologies help industries meet long-term environmental sustainability goals, and how might this shift influence the types of skills and expertise required in the workforce?
39. How do you anticipate CCAM technologies will affect the balance between traditional industries and emerging green sectors, and what strategies can be employed to support workers transitioning from one to the other?