Ref. Ares(2026)6513099 - 29/06/2026

RESKILLING

Deliverable D3.3

Short, medium and long-term employment effects of CCAM

Grant Agreement no.: 101147328

Project acronym: RESKILLING

Project title: Research initiative for Enhancing and Adapting Workforce SKILLs for Implementing TraNsport Automation with Employment Growth

Project coordinator name and organisation:

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Funded by the European Union

This project has received funding from the European Commission under the European Union's Horizon Europe research and innovation programme under grant agreement No. 101147328

This work has received funding from the Swiss State Secretariat for Education, Research and Innovation (SERI) for the Swiss partners

Document Details	
Document identifier	Short, medium and long-term employment effects of CCAM
Due Date of Delivery	June 2026
Actual Date of Delivery to EC	30 June 2026
Task Number	Task 3.2: Employment effects of CCAM Task 3.3: Effects of CCAM on special workforce groups
Dissemination level	Public

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Control Sheet			
Version	**Date**	**Editor**	**Summary**
1	10/03/2026	Karoline Führer (Ecorys, the Netherlands)	ToC creation
2	13/05/2026	Karoline Führer (Ecorys, the Netherlands) Matina Loukea (CERTH, Greece)	First draft for WP3-internal review
3	02/06/26	Karoline Führer (Ecorys, the Netherlands) Matina Loukea (CERTH, Greece)	Revised draft for peer review
4	25/06/26	Karoline Führer (Ecorys, the Netherlands) Matina Loukea (CERTH, Greece)	Final draft

List of Abbreviations	
ADAS	Advanced Driver Assistance Systems
AI	Artificial Intelligence
AV	Automated Vehicle
AWS	Amazon Web Services
CAD	Connected Automated Driving
CCAM	Connected, Cooperative, and Automated Mobility
EC	European Commission
ETF	European Transport Workers' Federation
EU27	European Union (27 Member States)
GDP	Gross Domestic Product
GVA	Gross Value Added
HF	Human Factors
HMI	Human–Machine Interface
ICT	Information and Communication Technology
ILO	International Labour Organization
ISCO	International Standard Classification of Occupations
ITF	International Transport Forum
ITS	Intelligent Transport Systems
LLM	Large Language Model
ML	Machine Learning
OECD	Organisation for Economic Co-operation and Development
NACE	Statistical Classification of Economic Activities in the European Community
NGO	Non-Governmental Organization
PKM	Passenger-kilometres
R&D	Research and Development
SAE	Society of Automotive Engineers
SME	Small and Medium-sized Enterprise
STEM	Science, Technology, Engineering, and Mathematics
T	Task
TKM	Tonne-kilometres
UX	User Experience
VAR	Vector Autoregression
V2X	Vehicle-to-Everything
WEC	World Employment Confederation

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Executive Summary

This deliverable presents the short-, medium- and long-term employment and skills impact of Connected, Cooperative and Automated Mobility (CCAM) within the RESKILLING project. It supports the project's objective to anticipate labour market transformations driven by automation, digitalisation, and connectivity in transport, and to inform evidence-based policy, training, and reskilling responses at European and national levels. In line with RESKILLING's social innovation approach, particular attention is given to workforce groups that may experience differentiated impacts due to their socio-demographic characteristics, employment conditions, digital readiness, physical abilities, or access to training and career progression opportunities.

The analysis combines literature review and research gap analysis, quantitative employment forecasting, and stakeholders' consultation through interviews and two co-creation workshops. This mixed-methods approach allows the assessment of how CCAM affects job content, skill requirements, and labour demand along the CCAM value chain, across different automation levels and over time. The deliverable builds on the occupational baseline developed in earlier RESKILLING work (see D3.1 - Professions & jobs related to the entire CCAM services value chain) and provides key inputs to subsequent socioeconomic analysis and reskilling activities.

Overall, the findings show that, while CCAM could lead to job losses or gains across different sectors, the primary result is rather a structural transformation of employment. Increasing vehicle automation primarily reshapes tasks, responsibilities, and skill compositions, with many professions undergoing significant change rather than disappearing. While demand for certain routine or manual tasks may decline, particularly in manufacturing, operations, and maintenance, CCAM simultaneously generates new and expanded roles in software engineering, systems integration, data management, cybersecurity, safety assurance, remote operations, and regulatory compliance. Targeted upskilling and reskilling of the existing workforce emerges as a more prominent challenge than large-scale workforce displacement. At the same time, findings indicate that the pace and distribution of these changes are unlikely to be uniform across the workforce, with certain occupational and socio-demographic groups potentially facing higher adaptation pressures or exclusion risks.

A central output of the deliverable is the CCAM skills matrix, mapping functional job families against three levels of CCAM deployment (current, transitional, and full deployment). The matrix is detailed, workshop-validated, and directly usable in WP 4 and 5 of the RESKILLING project. Four overarching skills trends are identified:

1. increasing technical depth and system-level competence;
2. an expansion of assurance, governance, and compliance-related skills;
3. a re-centring of human roles around supervision, judgement, and interaction; and
4. growing importance of coordination across organisational and sectoral boundaries.

Across nearly all roles, transversal skills (e.g. digital literacy, systems thinking, problem-solving, adaptability, and continuous learning) become increasingly critical. In parallel, the analysis highlights that inclusion-related competences, such as human-centred design, communication across diverse user and workforce groups, and organisational change management, are becoming increasingly relevant for successful CCAM deployment.

The quantitative analysis provides indicative employment projections for CCAM-related employment sectors, building on and updating earlier modelling work. Results suggest that aggregate employment

effects remain moderate in the short term due to slow and uneven CCAM uptake, while more pronounced restructuring is expected in the medium to long term. These net projections mask substantial internal shifts between occupations and skill levels, highlighting the need to interpret employment impacts beyond headline job numbers (typically employment and unemployment rates) alone.

Qualitative insights from interviews underline that CCAM is often perceived as a response to structural labour shortages, particularly in driving and operational roles, rather than solely as a cost-cutting enabler. Extended transition phases with parallel operation of manual and automated systems may temporarily increase organisational complexity and staffing needs. Risks include labour market polarisation, reduced entry-level pathways, and challenges for specific workforce groups if skill requirements evolve faster than training systems. At the same time, CCAM offers opportunities for improved job quality, extended careers, and sectoral mobility, provided that inclusive reskilling strategies and supportive institutional frameworks are in place.

Overall, the findings further suggest that organisational readiness, workforce transition planning, and early stakeholder engagement may be as critical as technological deployment itself. The employment and skills effects of CCAM are highly dependent on policy choices, governance arrangements, and investments in training and reskilling. Proactive and inclusive transition strategies, supported by continuous monitoring, are essential to ensure that CCAM deployment contributes to quality employment and socially sustainable mobility transitions across Europe.

1. Introduction

The deployment of Connected, Cooperative and Automated Mobility (CCAM) is expected to profoundly reshape employment patterns across the European transport and mobility value chain. In Europe, as well as elsewhere, while CCAM technologies enable solutions that promise gains in efficiency, safety and sustainability, their diffusion also raises important questions regarding job creation, job transformation, and potential displacement across different professional groups. Beyond technological deployment, CCAM represents a broader socio-technical transition, requiring changes not only in vehicles, infrastructure, and digital systems, but also in organisational models, workforce capabilities, and institutional arrangements across the mobility ecosystem.

In line with the objectives of the RESKILLING project, this deliverable provides an evidence-based analysis of the short-, medium- and long-term employment effects of CCAM. For this deliverable, CCAM uptake is more important than the temporal horizon. The link between CCAM uptake and time horizon is very uncertain. Therefore, we refer to low CCAM uptake, representing the current and near time horizon, mid CCAM uptake, representing a transitional phase, in which various technologies coexist, and high CCAM uptake.

The analysis combines quantitative modelling with qualitative insights to support a nuanced understanding of how CCAM deployment may affect employment dynamics across passenger and freight transport. Special attention is given to workforce groups that may experience differentiated impacts due to socio-demographic characteristics, employment conditions, digital readiness, accessibility constraints, or unequal access to reskilling opportunities.

The analysis systematically relies on findings derived from (i) literature review, (ii) stakeholder evidence (interviews and workshops), and (iii) quantitative modelling and expert interpretation. Throughout the report, these sources are combined through triangulation, with qualitative findings primarily reflecting stakeholder perspectives, quantitative results reflecting model-based projections, and overarching conclusions informed by the convergence of multiple evidence streams.

1.1. Purpose of the Document

This deliverable provides a comprehensive analysis of both the direct and indirect impacts of CCAM deployment on various professions across the entire CCAM value chain. The deliverable also addresses the specific effects on special workforce groups, including workforce categories that may face increased adaptation pressures or, alternatively, new inclusion opportunities during the transition, such as older workers, women in underrepresented technical roles, workers with low digital confidence, migrant workers, persons with disabilities, workers in precarious employment, and workers in rural or underserved areas.

We analysed two types of impacts: on skills specific to a job and on the labour market. For the skills, we developed a skills matrix illustrating the required skills for various types of jobs, grouped into job families, at three levels of CCAM deployment. The wider labour market effects show the development of the number of jobs in various sectors. In parallel, the analysis explores how these changes may be unevenly distributed across occupational profiles, sectors, and workforce groups, highlighting where targeted intervention may be required.

This analysis provides a robust analytical basis for subsequent policy, training, and roadmap activities within the RESKILLING project, while also contributing to the project’s broader objective of ensuring that the transition to CCAM is not only technologically successful, but also socially inclusive and workforce-centred.

1.2. Intended Audience

The intended audience includes the following:

- European, national, and local policymakers responsible for transport, employment, skills, and education policies.
- Public authorities and regulatory bodies involved in CCAM deployment, labour market planning, and workforce transitions.
- Industry stakeholders along the CCAM value chain, including transport operators, mobility service providers, OEMs, and technology suppliers.
- Social partners, labour unions, and employer organisations concerned with employment quality and workforce adaptation.
- Research organisations, educators, and training providers working on future skills, reskilling strategies, and labour market forecasting.
- Civil society organisations, equality bodies, and representatives of workforce groups potentially more exposed to labour market exclusion or transition barriers.
- The RESKILLING Consortium and the wider CCAM stakeholder community as a reference document for employment impact evidence.

1.3. Interrelations

This deliverable mainly builds on D 3.1 Professions & jobs related to the entire CCAM value chain, which identifies affected and emerging jobs, clusters them into job families, and provides the occupational baseline.

The results of D3.3 provide key inputs to D3.4 - Short, medium, and long-term socio-economic effects of CCAM, which expands the analysis beyond employment into broader economic and social impacts.

The overall work and analysis implemented and described in this deliverable has also informed the RESKILLING Use Cases (described in D3.2), which capture workforce implications across different operational environments, including public transport, logistics, traffic management, infrastructure operations, micromobility, and emerging digital mobility services. This allows employment impacts to be examined not only at the occupational level, but also within realistic service and deployment contexts.

Moreover, the employment effects quantified and discussed in this deliverable inform WP4 activities on reskilling journeys, training curricula, and business model innovation. In addition, WP5 activities on impact assessment, policy guidelines, and the roadmap for socio-economic transition to CCAM build on the work in this deliverable.

Together with the CCAM skills matrix and taxonomy, D3.3 supports the development of the CCAM Employment & Skills Observatory, enabling continuous monitoring and evidence-based decision-making.

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2. Approach and Methodology

This deliverable is based on a multi-disciplinary approach to cover qualitative and quantitative employment effects of CCAM related to skills requirements and wider labour market effects, with specific emphasis on special workforce groups.

2.1. Research gap analysis

As the basis of our work, we performed a literature review to define the scope and objectives of our research. Given the extensive body of R&I projects and policy studies that have already assessed CCAM-related employment effects, the research carried out in this project aimed to identify knowledge gaps, which would then guide the selection of areas requiring further investigation. The literature review was performed in three phases: First, we collected evidence across many sectors and jobs; second, we organised the information in a matrix connecting the CCAM-related jobs with CCAM deployment levels; third, an additional specific search was conducted to fill as many gaps as possible.

The first phase was a targeted literature review to examine CCAM's impact on jobs and skills, identifying knowledge gaps to guide further research. Evidence was collected and categorised based on the following fields:

- Type of material (book, industry publication, project deliverable, research paper, study, other).
- Publication year.
- Topic.
- Geographical scope.
- Sectors covered.
- Jobs covered.
- Technology covered.
- Methodology.
- Data output.

We prioritised material from the last 5 years but included material from the last 10 years if particularly relevant, with European scope, and, in in-depth studies, global scope. We collected 40 relevant studies, from which we moved on to the following two phases.

The second phase was the creation of the skills matrix. This matrix links jobs to CCAM uptake and presents the skills required for each job at each level. We distinguish three CCAM uptake scenarios corresponding to the SAE automation levels (SAE International, 2021): low (Level 0-1), mid (Level 2-3), high (Level 4-5). The jobs are based on the mapping of CCAM-related professions. The jobs were clustered into job families (as defined in D3.1) to keep the matrix manageable and useful for providing an overview. For each job family, the skill level according to ISCO was also noted. The information gathered from the research material was used to populate the cells of the skills matrix. Subsequently, key takeaways from the co-creation workshops and the stakeholder interviews were added to form a more robust and targeted version of the skills matrix.

The third phase encompassed a second round of literature search, targeting knowledge gaps remaining after the first round. For this, we searched directly for the impact of CCAM on specific professions (“legal experts transportation automation”, “transportation designers’ automation”), and during the transition period (“transportation workforce transition to automation”, “employment and automation in transportation”). In this phase, an additional six publications were identified.

2.2. Interviews

The deliverable draws on two complementary interview streams: interviews with transport-sector organisations addressing skills, employment impacts and workforce implications, and targeted interviews focusing more specifically on the identified special workforce groups.

2.2.1. Interviews on the impact on skills

The primary objective of the interviews on the impact on skills was to further populate and validate the skills matrix. In addition, broader effects of CCAM were also inquired about. The interviews were designed to capture how CCAM affects:

- Required skills and competences (current, evolving, and new)
- The emergence of new job profiles
- Impacts of the coexistence of conventional and automated systems during the transitional period
- Implications for special workforce groups

The interviews were semi-structured to allow for comparability across interviews and flexibility to explore job-specific or sector-specific developments. All interviews followed a common interview guide developed within the RESKILLING project (see Annex I). Each interview lasted about 45-60 minutes and was transcribed to support systematic analysis.

The interview guide was structured around the following core blocks:

1. Current content and skills needed for the job family discussed
2. Organisational and operational context
3. Expected impacts of CCAM on the job family discussed
4. Skills evolution and new skills needs for the job family discussed
5. Transitional period: challenges due to varying levels of technology deployment
6. Emerging jobs in the sector
7. Special workforce groups: suitability of the job family and expected impacts of CCAM

In total, 50 experts were consulted in 48 interviews. Stakeholders covered various sectors and job profiles. In each interview, one or more job families were discussed in depth, depending on the interviewee's role and expertise. The interview sample was chosen to ensure coverage across the CCAM value chain and different job families. Interviewees were selected based on their expertise, role, and relevance to specific job families, ensuring a balance across sectors (e.g. transport operators, technology providers, public authorities, and research organisations) and types of professions. This approach supports analytical depth and a diversity of perspectives, which is better suited to exploratory and forward-looking analysis.

For each interview, we prepared a structured interview summary, documenting the interviewee's role, job families that were discussed, and the answers to the questions.

The interview results were then used to populate the skills matrix with the required skills for each job family at each level of CCAM deployment. The resulting skills matrix represents a qualitative synthesis of expert expectations and lived professional experience, rather than a deterministic forecast.

The methodology is subject to several limitations. First, findings are based on expert judgement and expectations regarding CCAM, which remains an evolving field. Second, interview coverage reflects the availability and profiles of stakeholders and may underrepresent some niche roles. Third, the pace and direction of CCAM deployment may differ across regions and sectors, affecting the generalisability of results.

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2.2.2. Interviews on special workforce groups

Methodologically, the interview component combined evidence gathered through the broader T3.2 consultation process, described in section 2.2.1 above, with additional targeted interviews carried out under Task 3.3, focusing on the needs of the different groups examined, following a semi-structured process. The interviews followed a flexible structure, allowing common themes to be explored across respondents while also enabling interviewees to elaborate on issues linked to their specific expertise. The material was reviewed thematically, focusing on expected CCAM impacts, time horizons, affected groups, reskilling barriers, organisational readiness and enabling conditions for an inclusive transition.

Although the consultation faced limitations, particularly where contacted organisations had limited familiarity with CCAM and therefore could not provide detailed input, the interviews provided valuable evidence on dimensions that go beyond technological or occupational change, including job quality, work organisation, access to training, social dialogue, qualification recognition, mentoring, discrimination, gendered participation in technical roles and the distinction between flexible work and insecure employment.

2.3. Forecasting

A projection of future employment trends was performed to complement the qualitative analysis results and enhance the robustness of the analysis. The forecasting analysis is based on the "Study on exploring the possible employment implications of connected and automated driving" carried out in 2020 by Ecorys, TRT, M-Five, VTT, SEURECO, ERTICO-ITS, IRU, and UITP (Ecorys et al., 2020), and it updates the assumptions behind the study and compares projected labour trends. The employment model we used, which is described below, provides a more precise estimation of the employment trends and patterns followed by sectors related to CCAM. This helps to identify major changes and job market evolutions that could occur due to CCAM adoption. Whereas the mentioned study considers employment in professions related to autonomous vehicles, our forecasting analysis is focused on manufacturing sectors connected to CCAM, which highlights the changes brought about in the CCAM manufacturing value chain and in professions related to the development of CCAM technologies and services. Employment implications for service-related jobs are discussed in greater detail in the qualitative analysis chapter, Section 5.2, based on the job families identified and described in Deliverable 3.1.

The 2020 CAD study defines and estimates potential future scenarios of CCAM adoption, and forecasts the evolution of employment for key manufacturing sectors in the short-, medium-, and long-term (2030, 2040, and 2050, respectively). Our analysis builds upon these two tracks, which are explained further below. The sectors considered relate closely to Connected Automated Driving (CAD). The present work focuses more widely on CCAM, which extends the concept of CAD beyond strict technological applications to services and related industries. For the purpose of the present analysis, and limited by the availability of reliable data, CAD has been treated as a subset of CCAM (specifically related to driving technologies), and data for CAD has been included in the analysis of CCAM-related professions.

2.3.1. Scenario comparison

As the first step in our quantitative analysis, we compare the scenarios defined in the 2020 CAD study to recent real-world data, and we highlight the most realistic of the scenarios based on how well the data used to define them match the recorded data.

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The four scenarios of the Ecorys 2020 study (referenced from here onwards as "modelling scenarios", to avoid confusion with the workshop scenarios in Section 2.4.1) deal with the technological development paths and regulatory burden placed on CAD. The modelling scenarios for the uptake of CAD are comprised of two boundary conditions analysing maximum and minimum uptakes and two intermediate cases. They are briefly described as follows, and are further summarised in Table 1 below:

- Scenario 1: Fast, private, unrestricted and partial geographic distribution (Maximum uptake);
- Scenario 2: Fast, private, restricted and partial geographic distribution (Intermediate uptake);
- Scenario 3: Moderate, shared, restricted and with limited geographic distribution (Moderate uptake);
- Scenario 4: Slow, shared, restricted and with limited geographic distribution (Low uptake).

These modelling scenarios are defined, in the CAD study, through a scenario model that returns values for the following data series:

- Car fleet SAE level composition
- Bus fleet SAE level composition
- Freight vehicles SAE level composition
- Passenger transport activity (in terms of passenger-kilometres travelled by all modes)
- Passenger transport activity (in terms of vehicle-kilometres travelled by road modes)
- Freight transport activity (in terms of tonne-kilometres of road modes)

The modelling scenarios are also defined through additional macroeconomic data: the GDP of all EU27 Member States and the total EU27 employment level.

We have used these data series for comparison, with the exception of passenger transport activity in terms of vehicle-kilometres, which was excluded from the analysis as no reliable data could be found for comparison. Thus, we compare the four modelling scenarios on a total of seven data series and determine the scenario which most closely reflects recorded data in 2025, which indicates the most likely path that is taking place, as of 5 years after the initial study. We comment on the characteristics of this scenario and the expected outlook for CCAM deployment.

Table 1 Modelling scenario as defined in the 2020 CAD study

Modelling scenario	Technology develop-ment	Circulation restrictions	User accep-tance	Purchase cost	Operation cost	Mobility	Forerunner countries
Scenario 1	Fast	None	Positive	Low	Low	Private	NL, SE, NO, FI, DE, UK, FR, ES, BE, DK, AT
Scenario 2	Fast	Urban	Positive	Low	Low	Private	NL, SE, NO, FI, DE, UK, FR, ES, BE, DK, AT
Scenario 3	Medium	Urban	Neutral	High	Low	Shared	NL, SE, NO, FI, DE, AT
Scenario 4	Slow	Urban	Low	High	Low	Shared	NL, SE, NO, FI, DE, AT

Source: elaboration of the authors, from (Ecorys et al., 2020).

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2.3.2. Employment forecasting

In addition to comparing scenarios, mirroring the work of the 2020 CAD study, we also provide a more updated forecast of employment trends. That study calculated, among other outputs, the employment trends, up to 2050, of five manufacturing sectors related to autonomous mobility. The purpose of this forecasting analysis is to update the outcomes of (Ecorys et al., 2020) with data from the past 5 years, and compare the projections in the short-, medium-, and long-term (2030, 2040, and 2050, respectively). The sectors covered in our analysis are: Electronics, Vehicles, Construction, Communication, and Computers. Although these sectors are defined more strictly in the CAD study, we have mapped them to their corresponding NACE sectors in order to facilitate data collection and comparison, and we have connected them to the job families across the CCAM value chain, as defined in Deliverable 3.1, as follows:

Table 2 Mapping of sectors

Manufacturing sector (Ecorys et al., 2020)	NACE sector	Job family
Electronics	**NACE C26**: Manufacture of computer, electronic and optical products	**Manufacturing and assembly technician**
Vehicles	**NACE C29-C30**: Manufacture of motor vehicles, trailers, semi-trailers and of other transport equipment	**Manufacturing and assembly technicians**
Construction	**NACE F**: Construction	**Construction workers**
Communication	**NACE J61**: Telecommunications	**Software & Systems Developers**
Computers	**NACE J62-J63**: Computer programming, consultancy, and information service activities	**Data Science & Analytics experts**

Source: elaboration of the authors.

In the present modelling of employment in these sectors, we have used a different methodology than the Ecorys 2020 study. This is due to different scopes and objectives of the two projects. The CAD study used a multi-layer model approach, consisting of the following components:

- Scenarios model: a System Dynamics model specifically designed to analyse alternative uptakes of CAD in an integrated manner as a result of different dynamics of both the supply and the demand sides, which feeds into the following two;
- ASTRA model: an integrated assessment model applied for strategic policy assessment in the transport and energy field;
- NEMESIS model: a detailed macro sectoral simulation model for the EU economy. It includes all EU Member States, which can be simulated altogether or individually (Ecorys et al., 2020).

The outcome of the interaction of these three models is the projection, up to 2050, of employment in the considered sectors, by job category, by Member State, and disaggregated at a regional level.

Taking stock of this, we applied a simpler and more direct methodology. In our current analysis we built a model which takes as input several data series (see Table 3), maps the relationships between them, and outputs a projection of those data series to a specified future timeframe. By feeding the model with macroeconomic data, CCAM-related employment data, innovation and research data, and transportation

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related data (as detailed in Figure 1), we aimed to produce an indicative forecast of targeted employment sectors in the long term. Specifically, to do this, we built a Vector Autoregression (VAR) model. A VAR model is a stochastic process model, which can capture dynamic, linear relationships between the multiple time series it is applied to. It functions as an extension of univariate autoregressive (AR) models, in that it treats each variable as a function of its own past values, as well as the past values of all other variables considered.

Our VAR model was built and trained on the five target employment data series mentioned in Table 3, and additional explanatory time series reflecting macroeconomic data, population data, transportation data, and innovation potential data. To improve the stability of the model, the data were log-transformed before training, and an inverse transformation was done at the end of the modelling to visualise the real modelled values. The full data series used in the model is described in the table below.

Table 3 Overview of data series

Data series	Reason for inclusion	Time period	Geographical coverage	Source
Employment (C26): Manufacture of computer, electronic and optical products	Electronics manufacturing	1995-2023	EU27	https://ec.europa.eu/eurostat/databrowser/product/page/nama_10_a64_e__custom_20878527
Employment (C29-C30): Manufacture of motor vehicles, trailers, semi-trailers and of other transport equipment	Vehicles manufacturing	1995-2023	EU27	https://ec.europa.eu/eurostat/databrowser/product/page/nama_10_a64_e__custom_20878527
Employment (F): Construction	Construction	1995-2024	EU27	https://ec.europa.eu/eurostat/databrowser/product/page/nama_10_a64_e__custom_20878527
Employment (J61): Telecommunications	Communication	1995-2023	EU27	https://ec.europa.eu/eurostat/databrowser/product/page/nama_10_a64_e__custom_20878527
Employment (J62-J63): Computer programming, consultancy, and information service activities	Computers manufacturing	1995-2023	EU27	https://ec.europa.eu/eurostat/databrowser/product/page/nama_10_a64_e__custom_20878527
Gross domestic product (GDP)	Macroeconomic	1995-2024	EU27	https://ec.europa.eu/eurostat/databrowser/product/page/nama_10_gdp__custom_20812017
Total population	Population	1995-2025	EU27	https://ec.europa.eu/eurostat/databrowser/product/page/nama_10_pe__custom_20821982

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Data series	Reason for inclusion	Time period	Geographical coverage	Source
Gross Value Added (GVA) and income by detailed industry	Macroeconomic	1995-2023	EU27	https://ec.europa.eu/eurostat/databrowser/product/page/nama_10_a64__custom_21145451
Unemployment rates: Less than primary to post-secondary non-tertiary education	Societal	1995-2024	EU27	https://ec.europa.eu/eurostat/databrowser/product/page/lfsa_urgaed__custom_20875567
Labour Productivity: Index, 2020=100	Macroeconomic	1995-2025	EU27	https://ec.europa.eu/eurostat/databrowser/product/page/nama_10_lp_a21__custom_21158135
R&D personnel by sector of performance, professional position and sex	Innovation potential	1995-2024	EU27	https://ec.europa.eu/eurostat/databrowser/product/page/rd_p_persocc__custom_20875638
Road expenditure: Expenditure on infrastructure	Transportation data	1995-2024	EU27 except BE and EL	https://ec.europa.eu/eurostat/databrowser/product/page/road_ec_invest__custom_20876427

Source: elaboration of the authors.

A visual representation of the data series is given in Figure 1. The VAR model passes all the relevant statistical tests (Granger's Causality Test, Cointegration, Serial Correlation of Residuals) and can thus be reliably used in our analysis.

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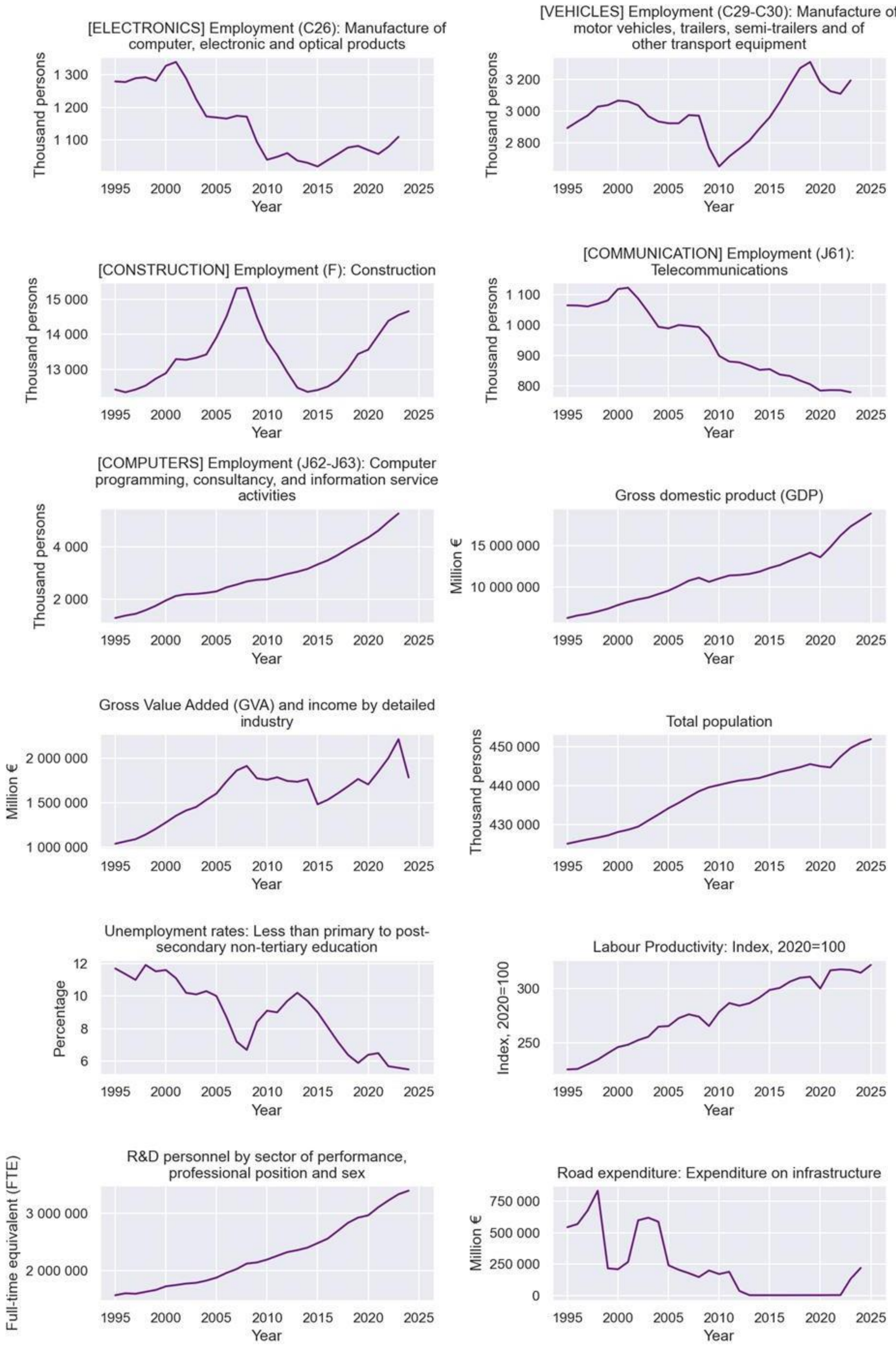
Figure 1 Overview of the data series



Source: Eurostat (elaboration of the authors).

The forecasting results should be interpreted as indicative trends rather than precise predictions. The job families defined in Deliverable 3.1 are represented in the modelling through proxy employment categories. The VAR model assumes that historical relationships between macroeconomic indicators, employment, and CCAM-related sectors provide a meaningful basis for projection. As such, it captures structural dynamics but does not explicitly model disruptive technological shifts or policy changes beyond those reflected in historical data. This implies that CCAM-specific effects are only partially captured and should be interpreted in combination with qualitative insights.

2.4. Co-creation workshops

Two workshops were held to enrich and validate the findings of the literature review, interviews, and forecasting.

2.4.1. Workshop 1

The first workshop was held on 8 October 2025 at the premises of the VUB in Brussels with 38 participants. The objectives of the workshop were to present and validate research findings, get direct input from involved stakeholders, fill research gaps, and connect CCAM skills to Business Models. The workshop was designed as an interactive, facilitated process combining structured group work and plenary discussions.

Part 1: Presentation of research findings

The first part of the workshop focused on the presentation and discussion of research findings. First, the work on mapping jobs along the CCAM value chain and the resulting job families was presented. The results of the job mapping can be found in D3.1.

Following this, preliminary results on the employment effects of CCAM based on the literature review were presented. To add to the preliminary findings, the participants were divided into three groups to discuss the following questions:

- What are the most important employment effects of CCAM deployment?
- What will the transitional phase be like?
- What are the most essential skills?

Each group discussed one question and recorded their ideas with sticky notes on a canvas. After 5 mins, the groups rotated to discuss the next question until all groups had discussed all the questions. This session concluded with a plenary to share insights and discuss the main points raised within the groups, common trends, and unexpected results.

Next, the discussion focused on the special workforce groups. The preliminary list of identified groups was presented to participants, who were invited to provide feedback on the list itself and to reflect on how these groups may be affected by the deployment of CCAM technologies. In particular, participants were asked whether these groups are likely to gain new opportunities or face additional challenges, and whether impacts are expected to differ significantly across groups, for example, between women and older workers, or between low-skilled and highly skilled workers. The discussion was conducted as a moderated plenary session.

Part 2: Scenario exploration

The second part of the workshop led participants to explore scenarios to gather additional information to enhance the skills matrix. We presented four scenarios along two axes: government power and corporate power. Figure 2.1 presents short descriptions of the four scenarios. The main goal of these scenarios was to stimulate the participants to think outside the box and generate additional employment effects.

Table 4 Workshop scenarios

	Low government power	High government power
High corporate power	Corporations dominate CCAM innovation with minimal oversight, resulting in rapid disruption, inequality, and privatised reskilling.	Governments and corporations collaborate to drive inclusive, well-regulated CCAM innovation with strong social protections and benefits.
Low corporate power	CCAM development is fragmented and unsupported, leading to informal work, community reliance, and widespread uncertainty.	Governments lead CCAM deployment with a focus on equity and sustainability, while corporations play a limited, regulated role.

Source: elaboration of the authors.

The participants were divided into four groups, one group per scenario. Each group received a written description and visualisation of their scenario, and was asked to reflect on the following questions:

- What is the impact of your scenario?
- How may the employment effects change?
- What are the challenges and opportunities of workers in this scenario?
- How can negative developments be mitigated?

Each group was supported by a facilitator, ensuring balanced participation and time management. Facilitators guided the discussion, clustered inputs, and documented key discussion points. The participants documented their main points with sticky notes on a canvas.

Part 3: Business models

The third part linked the job families to emerging business models and asked participants to discuss operational changes, stakeholders, and effects of new business models. The results of this part of the workshop belong to WP4 and are outside the scope of this deliverable.

2.4.2. Workshop 2

The second workshop was held online on 26 May 2026, with the participation of around 40 people throughout its duration. The goal of this workshop was to validate the findings from the interviews and forecasting and connect the results to subsequent tasks of the RESKILLING project.

Part 1: Presentation and validation of the analysis of employment effects

The workshop applied a structured validation and reflection approach to assess and refine findings on the employment and skills impacts of CCAM. It combined short presentations of key analytical outputs with moderated discussion and feedback from participants, drawing on their professional experience and sectoral expertise. This part of the workshop started with a presentation of key findings on skills, including an overview of the CCAM skills matrix. Participants were then invited to validate the matrix through guided discussion, focusing on whether the identified skills reflect current labour market realities and stakeholder experience, and whether any critical skills gaps or blind spots remain.

This was followed by a presentation of labour market forecasting results, combining modelling outcomes with complementary insights from stakeholder interviews. Participants discussed and validated the direction and plausibility of the observed labour market developments, reflecting on how well the results align with real-world trends and expectations.

The workshop concluded with a plenary reflection session, linking the findings on skills and labour market developments to practical implications for training, reskilling, and workforce planning. Participants were encouraged to identify the most actionable insights and consider how the results can inform policy, education, and industry decision-making in the context of CCAM deployment.

Part 2: Presentation of the research on special workforce groups

Within Workshop 2, a dedicated stakeholder session was also organised under Task 3.3 (Effects of CCAM on special workforce groups), focusing on the effects of CCAM on special workforce groups. The session aimed to validate the pre-final findings of the task and to complement the evidence already gathered through the literature review, stakeholder interviews and previous workshop activities. Its purpose was not only to present the emerging results, but also to test their relevance with stakeholders and identify possible gaps, refinements or additional considerations before finalising the analysis.

The session brought together around 40 participants representing different perspectives within the CCAM and transport ecosystem, including research and academia, transport operators, social partners, civil society organisations, public authorities, training providers and other relevant stakeholders. This diversity of participants supported the validation of the findings from both sectoral and social perspectives, particularly in relation to workforce groups that may face differentiated risks or opportunities during the CCAM transition.

Methodologically, the workshop followed an interactive and participatory format. A short presentation of the findings was followed by a structured discussion and real-time digital polling through Mentimeter. The polling questions were designed to gather feedback on the relevance of the identified workforce groups, the expected nature of CCAM-related employment impacts, the factors shaping differentiated outcomes, such as organisational preparedness, barriers to reskilling and priorities for future workforce transition measures. Mentimeter was used to collect anonymous input from participants and support discussion on points of agreement and disagreement. This enabled the task team to capture both quantitative and qualitative reflections emerging from the discussion. The outcomes of the session were used to cross-check the analytical framework, update, where needed, the interpretation of differentiated impact pathways, and ensure that the final findings reflect stakeholder perspectives on inclusive reskilling and workforce transition in the CCAM context.

Part 3: Development of reskilling journeys

The third part built on the results of the first two parts of the workshop. The results on skills needs and effects on special workforce groups were used to develop personas and reflect on their reskilling journeys. The results of this part will be presented in a later project deliverable (D4.3).

3. Research gap analysis

During the research gap analysis, we identified missing evidence in the literature. This served as a central analytical step guiding the design of the skills matrix and the stakeholder consultation process. While an extensive body of research exists on the employment implications of CCAM and automation more broadly, the available evidence remains uneven in scope, level of detail, and methodological approach. Therefore, this analysis aimed to identify not only where evidence is lacking, but also how existing approaches fall short in capturing the complexity of CCAM-related workforce transformation.

In terms of evidence coverage, a clear imbalance was observed across job families. Well-researched domains include technical and operational roles such as engineers, cybersecurity specialists, remote operators, maintenance workers, trainers, and drivers. In contrast, significantly less evidence is available for roles such as UX designers, policymakers, ethics experts, and decommissioning and recycling operators. This uneven coverage limits the ability of existing studies to provide a comprehensive view of skills needs along the CCAM value chain.

In addition, the literature shows important gaps across different levels of CCAM deployment. While current (low automation) and fully automated scenarios are relatively well documented, the transitional phase, characterised by the coexistence of conventional and automated systems, is substantially underexplored. This phase is likely to be the most complex from an organisational and workforce perspective, involving hybrid roles, evolving responsibilities, and continuous reskilling needs.

Beyond coverage gaps, the analysis also revealed important methodological limitations in the existing literature. First, many studies focus on aggregate employment effects, often expressed in terms of job creation or job loss, while providing limited insight into changes in tasks, skill requirements, or job content. Second, analyses are frequently concentrated on specific sectors (e.g. automotive manufacturing or driving occupations), without adopting a holistic perspective across the CCAM value chain. Third, the level of detail regarding skills is often insufficient to inform training design or workforce transition strategies, as skills are typically discussed at a high level (e.g. “digital skills” or “ICT skills”) without specification across roles or deployment stages.

Despite these limitations, several recurring themes emerge consistently across the literature. These include the increasing importance of ICT-related competences, as well as emerging demand for skills in AI, machine learning, and cybersecurity. Soft and transversal skills, such as communication, problem-solving, and adaptability, are also highlighted, particularly for roles involving interaction with users or complex systems. However, these themes are rarely systematically mapped across job families, nor are they explicitly linked to different stages of CCAM deployment.

These identified gaps directly informed the methodological approach adopted in this deliverable. The development of the CCAM skills matrix addressed the need for a more granular and structured mapping of skills across job families and deployment levels. In parallel, the stakeholder interviews were specifically designed to fill evidence gaps identified in the literature, with a particular focus on underrepresented roles, transitional dynamics, and emerging skill needs. The workshops further helped validate and refine these insights, ensuring that the analysis reflects both existing evidence and stakeholder expectations.

Overall, the research gap analysis highlights that the main challenge is not the absence of evidence on CCAM-related employment effects, but the fragmentation and partial nature of existing knowledge. Therefore, the approach adopted in this deliverable moves beyond isolated findings by combining literature review, structured skills mapping, and stakeholder input into an integrated framework.

4. Impact of CCAM on skills

The outcomes of the literature review, complemented with the key takeaways of the stakeholder discussions of the first co-creation workshop and the stakeholder consultation process, give shape to the final version of the skills matrix. The skills matrix presents on one axis the functional job families from D3.1 and on the other axis three levels of CCAM deployment, representing the current situation, a transitional period, and full CCAM deployment. The full matrix can be found in Annex II. For some job families, no information could be obtained to robustly specify skills developments. This reflects a combination of factors, including limited coverage in the literature, absence of explicit reference in stakeholder interviews, and the emerging or niche nature of certain roles within the CCAM value chain. These cases are therefore explicitly marked as “no information available” in the skills matrix to ensure transparency. They should not be interpreted as the absence of impact, but rather as an indication of current evidence gaps and priorities for further research.

We identify four overarching trends: technical depth increases, safety assurance and governance expand, human roles recentre on interaction and judgement, and ecosystem coordination becomes core work. These trends have been validated and ranked based on their importance during the second workshop. Below, we present them in the order resulting from the ranking. Figure 2 provides an overview of the main insights from the skills matrix.

First, ecosystem coordination becomes core work. CCAM deployment increasingly requires professionals who can operate across organisational, contractual, and sectoral boundaries, rather than within single firms or value-chain segments. Skills related to coordination, partnership management, contracting, and negotiation become more prominent as systems rely on collaboration between OEMs, software providers, infrastructure operators, public authorities, and service providers. Operational success depends not only on technology, but on the ability to integrate automated systems into existing routines, workflows, and institutional arrangements. Many roles require a system-level perspective, linking fleet operations, urban systems, regulation, and societal outcomes rather than optimising individual components. Change management and internal communication skills appear repeatedly, highlighting that organisational adaptation is a major determinant of whether CCAM capabilities can be effectively deployed.

Second, technical depth increases for many technical roles. Across many technical roles, CCAM deployment is associated with a shift from component-focused or discipline-specific skills to end-to-end system competence, covering vehicle, infrastructure, software, data, and cloud layers. Higher CCAM levels place stronger emphasis on software engineering, AI/ML, data management, and systems architecture, even in traditionally hardware- or mechanics-oriented roles. Skills related to sensing, perception, localisation, and system integration become more central as automation increases, particularly where vehicles must operate reliably in complex, mixed environments. As systems mature, there is a visible move from exploratory or iterative development towards formalised testing, validation, and verification, with lower tolerance for trial-and-error approaches. Interdisciplinary proficiency becomes increasingly valuable, combining vehicle dynamics knowledge with software, data, and safety expertise, rather than deep specialisation in a single technical domain. Conversely, a risk remains that certain roles (e.g. ancillary jobs like on-call maintenance, cleaning, and recovery; remote customer support and security) lose technical depth by being platformised, with technical knowledge and skills centralised within algorithmic management systems.

Third, assurance and governance expand. With higher levels of CCAM uptake, skills related to safety assurance, standards compliance, and risk management become core requirements rather than supporting activities. There is a clear expansion of roles and competences linked to regulatory compliance,

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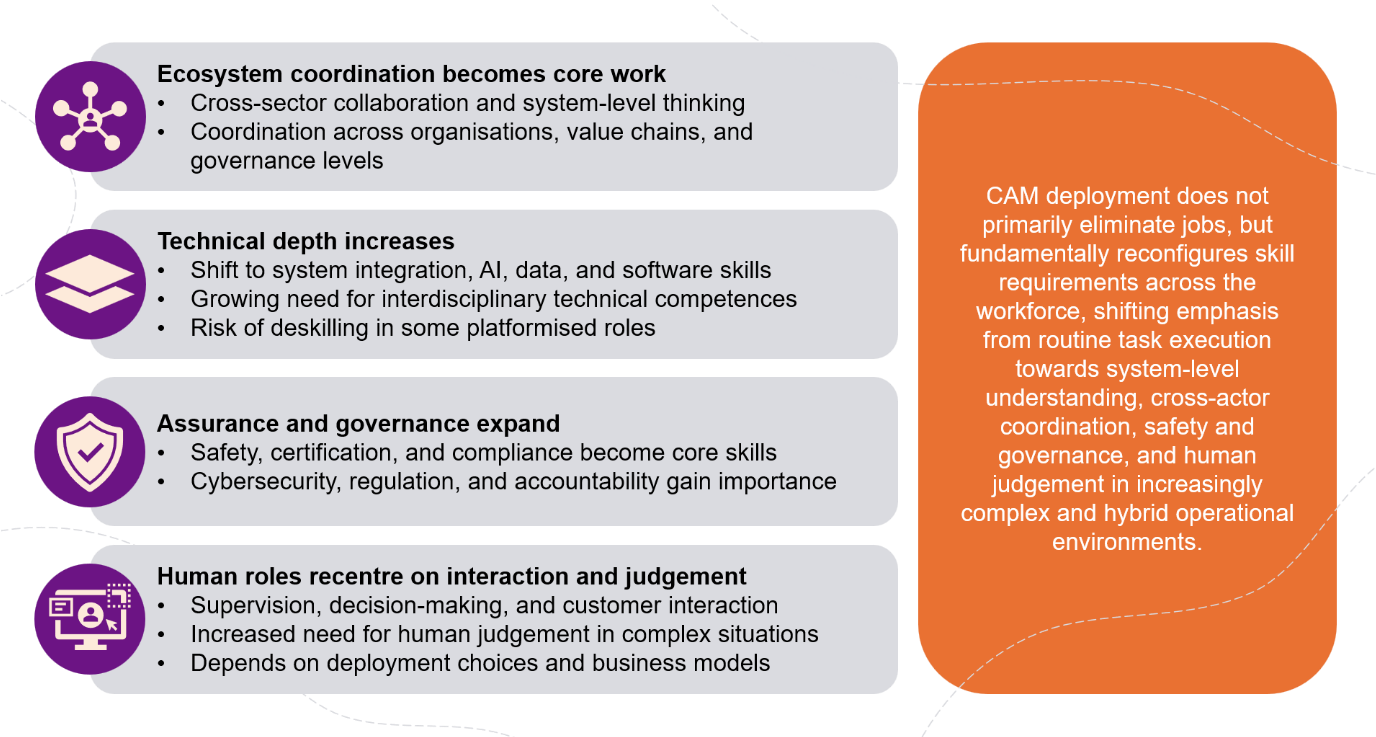
certification, and liability management, reflecting the increased societal and legal stakes of automated systems. Cybersecurity and data protection evolve from specialised niches into cross-cutting concerns, affecting engineering, operations, platform management, insurance, and legal professions alike. Governance skills increasingly span technical and institutional boundaries, requiring an understanding of how technical system behaviour translates into legal responsibility and accountability. Decision-making shifts toward evidence-based justification, increasing the importance of skills related to documentation, auditability, transparency of systems, and safety cases.

Fourth, human-centric and service roles recentre on interaction and judgment. Rather than disappearing, these roles evolve toward supervision, oversight, and intervention in non-routine or safety-critical situations. Operational roles increasingly require the ability to interpret system outputs, assess data reliability, and make informed judgments under uncertainty rather than continuously perform manual tasks. In passenger-facing services, higher CCAM coincides with a stronger emphasis on customer interaction, empathy, accessibility support, and communication, alongside sufficient digital literacy to guide users through automated systems. Driving and control functions partially shift toward remote operation, monitoring, and escalation handling, blending technical understanding with situational awareness and stress management. Human-factors expertise grows in importance, particularly skills linked to attention, workload management, trust calibration, and rapid re-engagement in unexpected scenarios. This development is dependent on how CCAM is deployed, by whom, and for what reasons. The risk of this trend is a reduction of staff as a cost-cutting measure, rather than upskilling workers to provide a more inclusive customer experience.

Overall, the matrix shows that higher CCAM deployment is less about replacing roles and more about reconfiguring skills toward system integration, assurance, human judgment, and cross-actor coordination.

Figure 2 Main insights from the skills matrix



Source: elaboration of the authors.

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5. Impact of CCAM on the labour market

The results from the quantitative analysis on the employment trends and future scenarios, enriched with insights from the interviews, are discussed in this section. The interpretation of labour market impacts builds on the combined reading of quantitative projections and qualitative insights from stakeholder interviews. While the quantitative model provides indicative trends at the sector level, the qualitative evidence allows these trends to be interpreted in terms of job transformation, task reallocation, and organisational change dynamics.

5.1. Quantitative analysis

The results of the scenario comparison and employment forecasting are shown in the subsections below.

5.1.1. Scenario comparison

We compared recent Eurostat data to the forecasted data used to define the four modelling scenarios. The scenarios in the CAD study are modelled for the years 2020, 2025, 2035, and 2050. For the purpose of the present comparison, Eurostat data from 2025 was used, where available. Alternatively, Eurostat data from 2024 was used, and a 2024 scenario data point was extrapolated. We assumed a linear progression of modelled trends between the modelled years, and calculated the 2024 data point according to the linear formula:

$$Model_{2024} = Model_{2020} + \frac{4}{5} \times (Model_{2025} - Model_{2020})$$

The results from the analysis are reported below for each data category, followed by a final overview of which scenario best reflects the measured data and what the implications are for CCAM deployment.

It is important to note that the study could not account for the effects of the COVID-19 pandemic. This is visible in the scenario predictions, often being skewed by a similar difference from the recorded Eurostat data. This can explain why the differences between the scenarios themselves are often smaller than the differences between the recorded data and any of the scenarios. An additional reason for the scenario values being very close to each other is that the modelling horizon of 2025 is only 5 years after the start of the modelling timeframe, in 2020. The scenario model runs until 2050, where the values diverge more, and the scenarios become more different to each other. We can, however, compare the first 5 years of modelling and draw conclusions based on these intermediate results.

GDP data

Data for GDP is taken from Eurostat (Eurostat, GDP, 2026), for each EU Member State. For coherence with the Ecorys CAD study, GDP data is kept in 2005 Euro values. Data for 2025 was not yet available at the time of this analysis, so we used 2024 GDP values and calculated the 2024 data points for the four modelled scenarios, as explained above. A visual comparison of the four scenarios is given in Figure 3 GDP comparison. As can be seen, all modelled GDP values are higher than Eurostat data, and they are skewed by a similar amount. Scenario 3 shows the best approximation of the recorded data, but only by a marginal amount.

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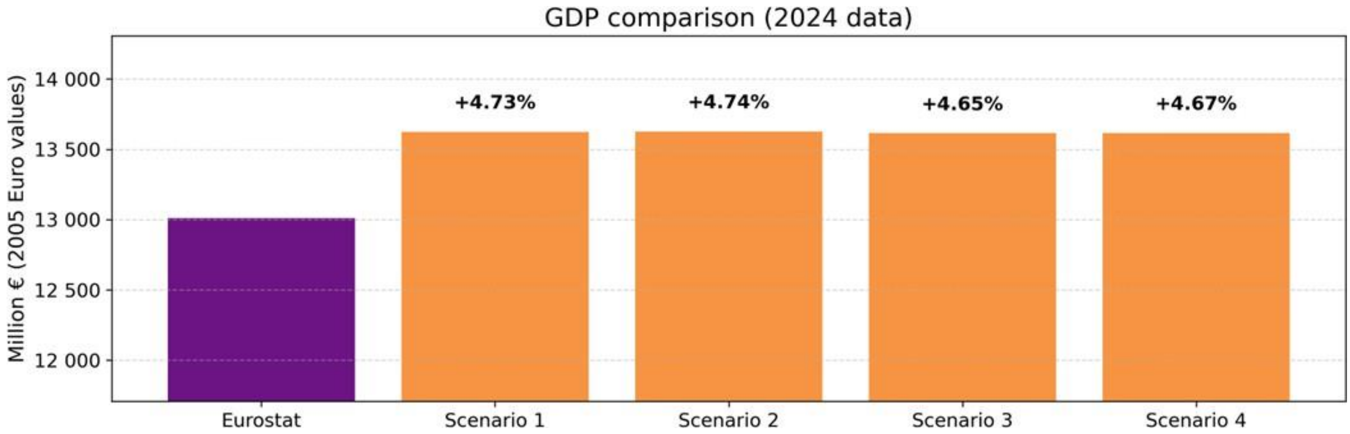
Figure 3 GDP comparison

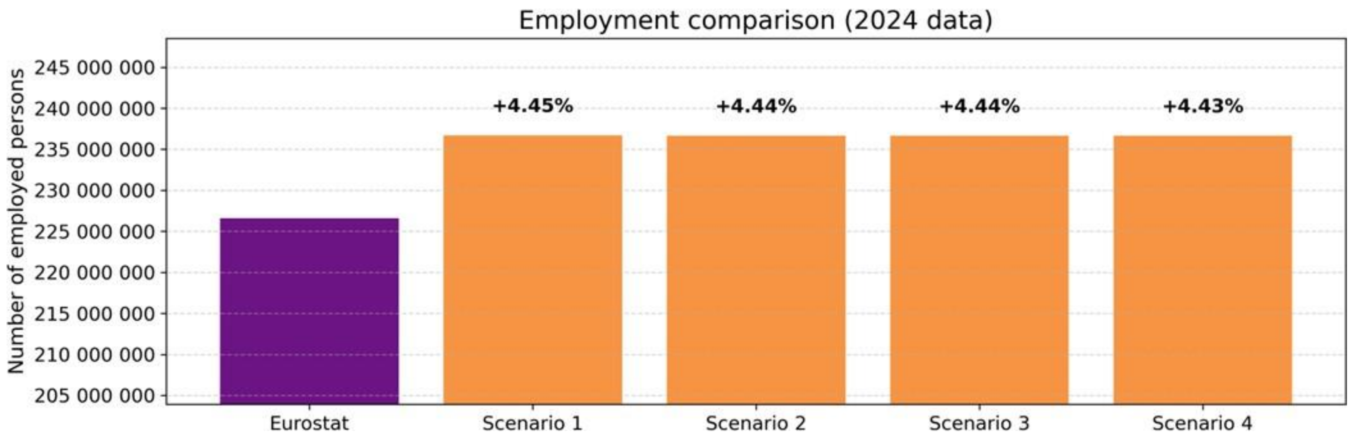


Source: elaboration of the authors.

Employment data

Employment data is taken from Eurostat (Eurostat, Employment, 2026). Data from 2024 was used, as data for the year 2025 was not yet available. The results in Figure 4 show a similar deviation from Eurostat data as seen in the GDP data case. The difference between scenarios is negligible for this comparison.

Figure 4 Employment comparison



Source: elaboration of the authors.

Car fleet automation level data

When comparing the car fleet composition, based on the SAE autonomous driving level, we used data taken from the following study (Duboz et al., 2025). It is clear from Figure 5 that all of the scenarios overestimated the prevalence of Level 1 and underestimated that of Level 2. The scenario which most closely resembles the recorded data is Scenario 2, where Level 0 corresponds exactly, and Levels 1 and 2 show less deviation (22% difference each) than the other scenarios. Level 3 is correctly modelled at 1%.

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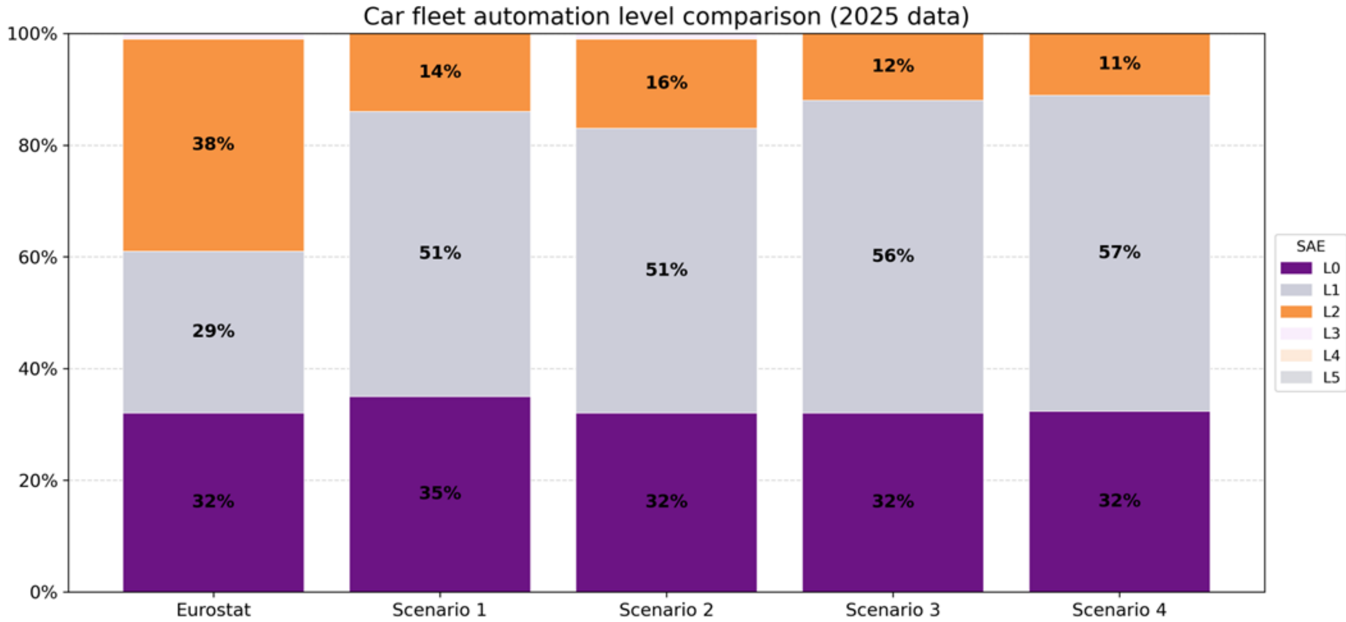
Figure 5 Car fleet automation level comparison

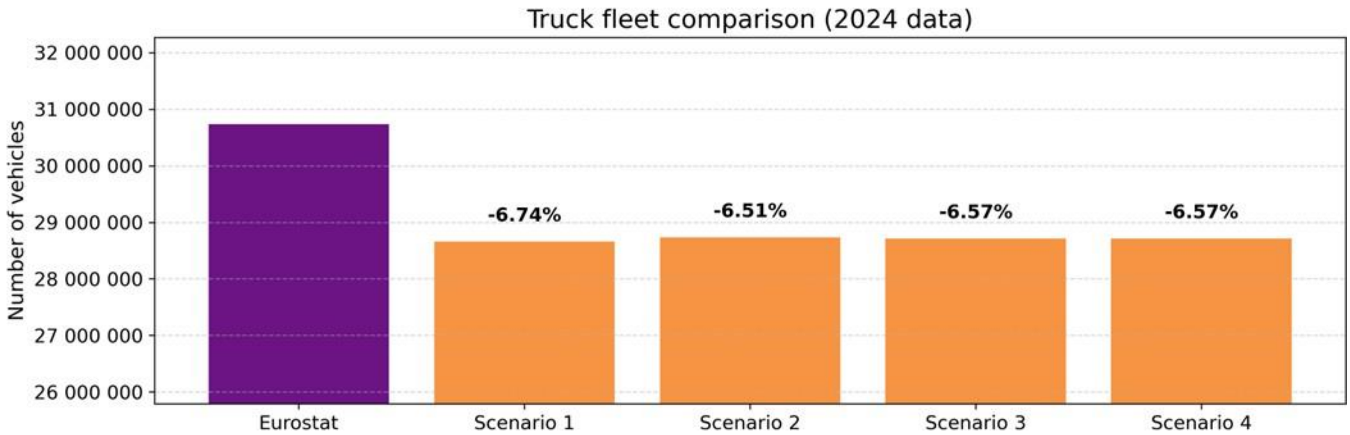


Source: elaboration of the authors.

Truck fleet data

Truck fleet data is taken from Eurostat (Eurostat, Truck fleet, 2026). Trucks are defined as goods vehicles below 3.5 tonnes and road tractors. The scenarios model gives detailed information on the truck fleet composition by driving automation level, just as for the car fleet above. However, the data was not available for comparison at this level of detail. Instead, our comparison takes into account the aggregate truck fleet size, not accounting for the SAE level. The results in Figure 6 show a similar underestimation of fleet size across all four scenarios, with Scenario 2 scoring slightly better than the other three scenarios.

Figure 6 Truck fleet comparison



Source: elaboration of the authors.

Bus fleet data

Similarly to truck fleet data, we used the total bus fleet size data from Eurostat (Eurostat, Bus fleet, 2026) to compare with the model results, without considering fleet SAE composition for lack of data. The bus category includes mini-buses and mini-coaches, buses, trolley buses, and motor coaches. In this case, the scenarios all closely match the recorded data (see Figure 7), and the difference is negligible.

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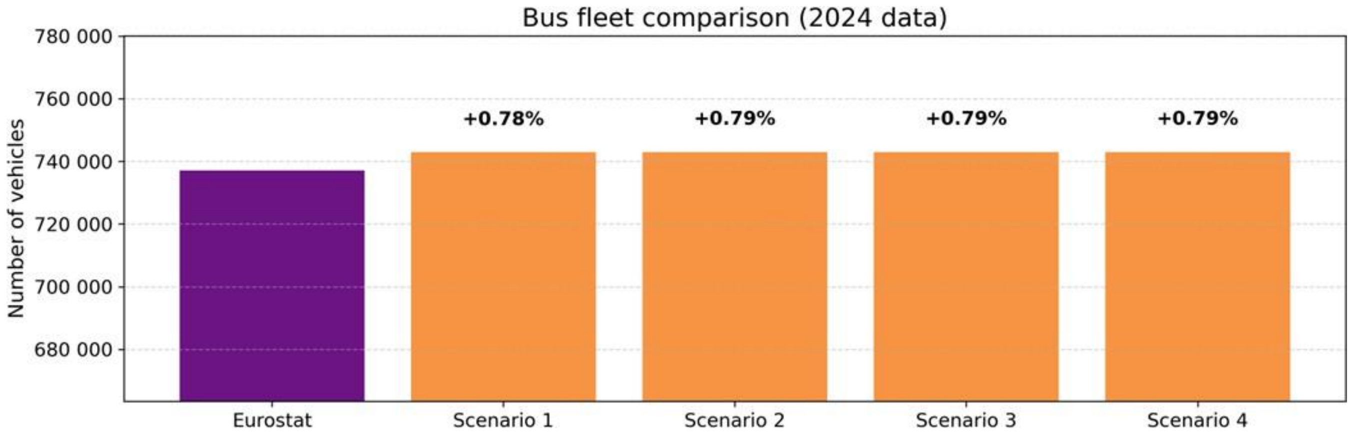
Figure 7 Bus fleet comparison

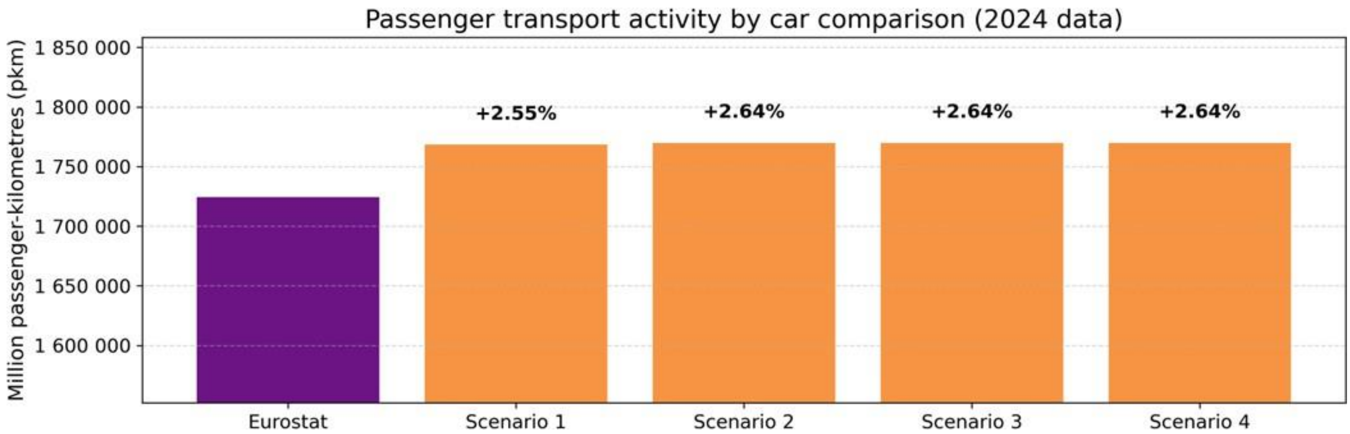


Source: elaboration of the authors.

Passenger transport activity by car (pkm)

The scenarios model also gives transport activity data. Passenger transport activity by car, in the form of passenger-kilometres, is compared with Eurostat data (Eurostat, Passenger activity, 2026) for the year 2024 (it is compared for the Member States whose data is available). A slight overestimation is common across all scenarios, as shown in Figure 8. Scenario 1 returns the best estimate, even if by a small amount.

Figure 8 Passenger transport activity by car comparison



Source: elaboration of the authors.

Road freight transport activity (tkm)

Road freight transport activity data, expressed in tonne-kilometre (tkm), is taken from Eurostat (Eurostat, Freight activity, 2026). The scenarios show a small underestimation of the Eurostat value, as seen in Figure 9. Again, Scenario 1 returns the best estimate.

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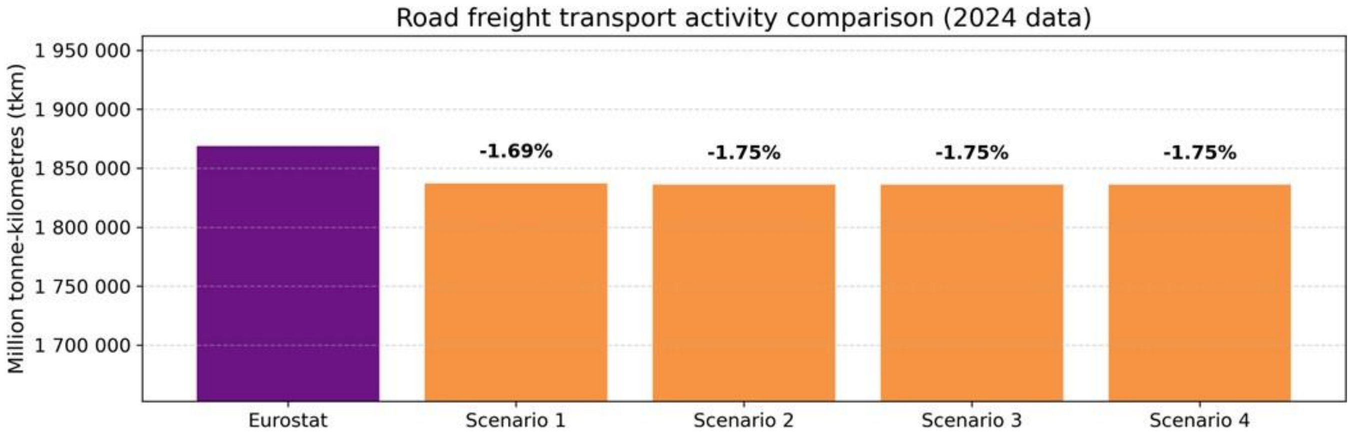
Figure 9 Road freight transport activity comparison



Source: elaboration of the authors.

Scenario comparison summary

Table 5 shows a summary of the scenarios' deviation from the recorded data, for each of the data categories analysed. The scenario closest to the data is highlighted with a checkmark. Overall, Scenario 1 most closely matches the recorded data up to 2025. It is the best performing in three of the seven data categories, while also showing minor differences in one of the other categories. This indicates that current socio-economic and transport trends are broadly aligned with the assumptions underlying Scenario 1, especially regarding passenger and freight demand growth. However, the limited divergence between scenarios reflects both the short time span between the base year and 2025 and common structural biases affecting all model runs.

Table 5 Scenario comparison summary

Data category	Scenario 1	Scenario 2	Scenario 3	Scenario 4
GDP	-4.73%	-4.74%	-4.65% ✔	-4.67%
Employment	4.45%	4.44%	4.44%	4.43% ✔
Car fleet automation level		✔		
Truck fleet	-6.74%	-6.51% ✔	-6.57%	-6.57%
Bus fleet	0.78% ✔	0.79%	0.79%	0.79%
Passenger transport activity by car	2.55% ✔	2.64%	2.64%	2.64%
Road freight transport activity	-1.69% ✔	-1.75%	-1.75%	-1.75%
Total number of best-scoring categories	**3**	**2**	**1**	**1**

Source: elaboration of the authors.

Scenario 1, as defined in the 2020 CAD study, is marked by a relatively early arrival of CAD on the market and quick deployment in the EU. It assumes SAE Level 4 readiness in 2030, and Level 5 readiness in 2035. Employment in manufacturing sectors is expected to increase, benefiting from the development of and investment in CAD. However, due to low prices and low regulation, Scenario 1 expects the use private cars to substitute, at least partly, the use of public transport services. The negative employment impact on employment in transport services is therefore quite high.

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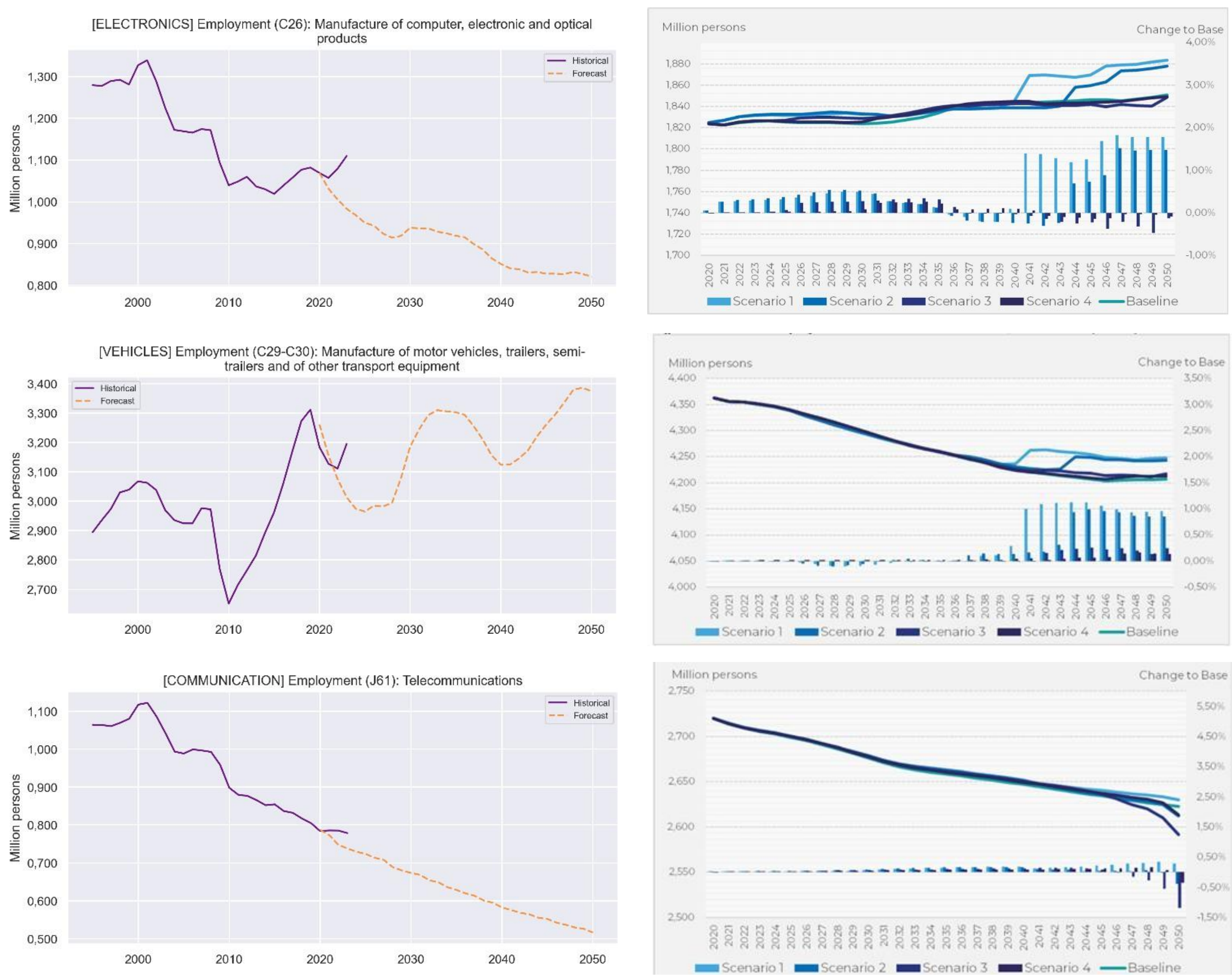
It should be underlined that the modelling scenarios present very similar values between each other for the year 2025, thus Scenario 1 is only marginally more representative of the recorded data than the other scenarios. As stated at the beginning of this section, this can be due to the short modelling timeframe, with greater divergence happing in the following years until 2050. Additionally, scenarios often are skewed by a similar value from the recorded data. This can be due to the effects of the Covid-19 pandemic, which could not be accounted for during the time of the study (2018-2020), and to structural imprecisions of the model, which perpetrate similarly across all of the modelled scenarios.

5.1.2. Employment modelling

The outcomes of the VAR model for the five modelled employment sectors are reported in Figure 10, where they are shown side-by-side, the modelling results of the 2020 CAD study. A comparison of the employment trends in each sector between the 2020 CAD study and the current analysis is made. As explained above, in our current analysis, NACE-sectors have been used as proxies for the manufacturing sectors considered in the 2020 study, thus the numerical values of the present forecast are not always aligned with the values of the 2020 study. The employment projections generated by the VAR model show points of alignment, as well as divergence when compared to the sectoral employment trends described in the CAD study.

Figure 10 Employment modelling results



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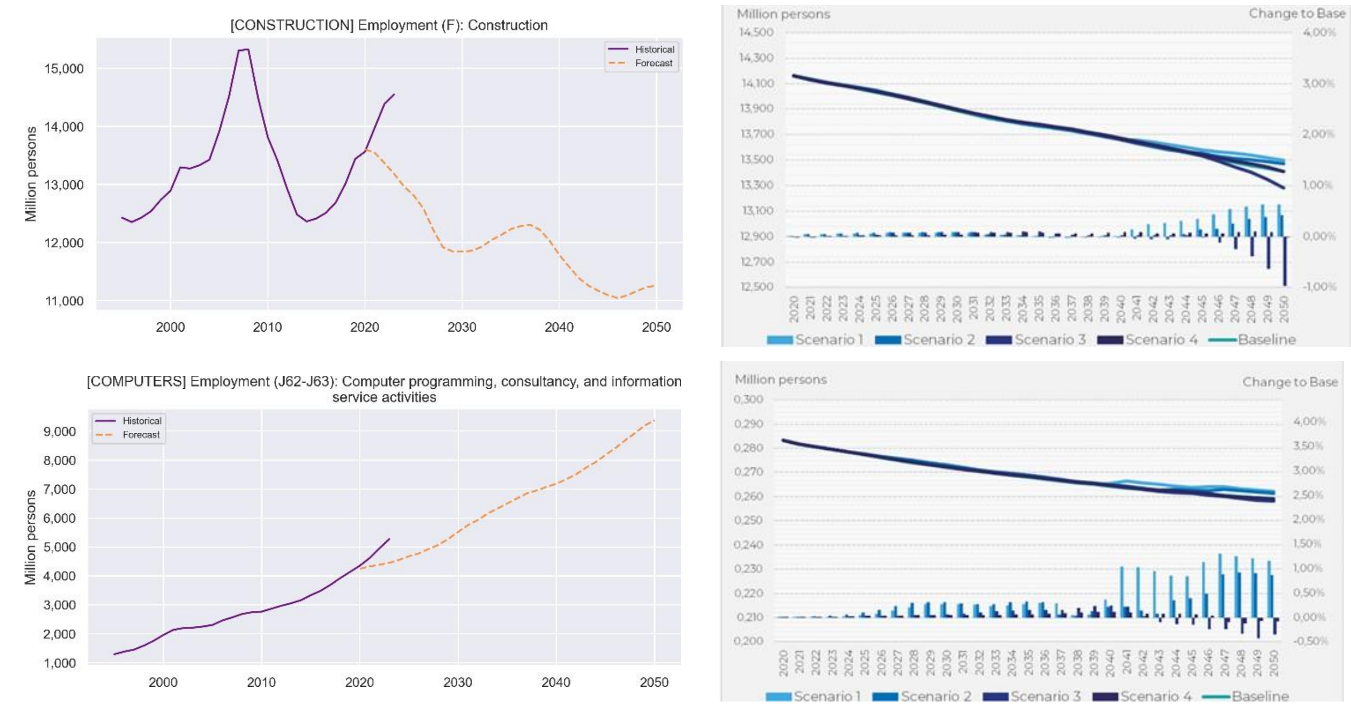

Source: elaboration of the authors, and (Ecorys et al., 2020).

For manufacturing of computer, electronic and optical products (C26), the VAR model projects a declining employment trend over the forecast horizon, whereas the CAD study reports a slight increase in employment linked to growing demand for CCAM-related electronic components. This divergence likely reflects differences in modelling focus: while the CAD study explicitly captures CAD-driven demand effects within the electronics production chain, the VAR model places greater weight on historical productivity gains and automation trends, which continue to drive employment to lower values in this sector at aggregate level.

In the manufacture of motor vehicles, trailers and other transport equipment (C29–C30), the VAR results indicate oscillating but increasing employment, in contrast to the declining trend identified in the CAD study. The CAD study attributes this decline to efficiency gains, automation within production processes, and task substitution, even under scenarios with growing CAD deployment. By comparison, the VAR model appears to capture the effects of a growing market more strongly, reflecting the historical association between transport demand, production volumes and employment, without explicitly modelling within-sector task automation.

For construction (F), both the VAR model and the CAD study point to a declining long-term employment trend. This convergence suggests that, regardless of CCAM deployment pathways, employment in construction is primarily shaped by broader structural and cyclical factors, with CCAM-related infrastructure effects insufficient to offset longer-term productivity improvements and labour-saving technologies.

A similar alignment is observed in telecommunications (J61), where both approaches project declining employment. This is consistent with the CAD study's assumption that efficiency gains and technological consolidation outweigh any CCAM-induced demand effects in traditional telecommunications activities.

By contrast, employment in computer programming, consultancy and information service activities (J62–J63) shows a steady increase in the VAR projections, whereas the CAD study reports a decline. This difference reflects a key methodological distinction: the CAD study highlights strong occupational reallocation within the ICT sector, with job creation in high-skill CCAM-related roles offset by job losses in other ICT occupations, leading to net declines at sector level. The VAR model, operating at a higher level of aggregation, is not able to capture this internal restructuring and instead reflects the historically positive relationship between digitalisation and overall employment in knowledge-intensive services.

When connected to the job families used for the skills matrix, our forecasting analysis suggests oscillating or declining employment in the manufacturing and assembly technicians job family, due to productivity gains and increasing automation. Construction workers face a declining employment trend, as is the case for software and systems developers, where increasing efficiency gains are not enough to offset the increased demand from CCAM technologies. Finally, employment for data science and analytics experts is expected to increase, driven by increasing digitalisation.

Our results are in part consistent with results from the CCAM-ERAS project, which ended in June 2026 and had a similar focus to ReSKILLING. Through econometric modelling, CCAM-ERAS also forecasted future employment prospects for key professions (CCAM-ERAS, 2026). They found increasing employment roles for occupations related to information, communication and technology (ICT). Decreasing employment outlook is also found for mobile plant technicians. The strongest job losses are forecasted in the warehousing sector, which was not central in our analysis. The modelling approaches differ, as in CCAM-ERAS, a more developed econometric model was used, though the findings are partially in agreement.

Overall, the VAR-based modelling analysis provides an updated and indicative forecast of employment trends in CCAM-related manufacturing sectors, building upon the projections of the CAD study. The results show that, while some trends broadly align with the earlier study, important differences emerge, largely reflecting the VAR model's reliance on historical relationships rather than explicit modelling of CCAM uptake and technological change. The results confirm general directional developments driven by macroeconomic and structural factors, but offer less insights in sector-specific transformation dynamics such as automation or task reallocation.

5.2. Qualitative analysis

In addition to the quantitative analysis above, the interviews provided additional insights into the labour market effects of CCAM. While the quantitative analysis focuses on manufacturing-related sectors, such as vehicle assembly and production of electronics, due to data availability, the broader employment impacts of CCAM are expected to also be significant in service-oriented activities. These include passenger services, logistics operations, mobility platforms, maintenance services, and customer support functions. In these sectors, CCAM is likely to drive significant changes in job content, with a shift towards supervision, coordination, customer interaction, and digitally supported service provision. Interview and workshop findings indicate that service-sector roles may experience less direct substitution and more gradual transformation, often involving hybrid functions that combine technical understanding with interpersonal and problem-solving skills.

CCAM is widely seen as a response to structural labour shortages, particularly among drivers, linked to ageing workforces and recruitment difficulties, rather than primarily as a cost-cutting technology. Interviewees consistently expect partial workforce reductions in operational roles once systems are fully stabilised, but not one-to-one job losses, as new roles emerge in supervision, IT, maintenance, and coordination. During long transition phases with parallel manual and automated systems, overall staffing needs may temporarily increase or stagnate, creating operational inefficiencies rather than immediate job reductions.

The dominant effect of CCAM is job transformation rather than job disappearance, with most existing roles evolving in tasks, skill mix, and responsibilities. New roles are expected to emerge around remote

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operations, system supervision, data monitoring, cybersecurity, safety assurance, and regulatory compliance, while some narrow or routine roles become less prominent. Certain functions may shrink or disappear due to automation or data-driven maintenance, but displaced workers are often expected to be reassigned within organisations where possible. Re- or upskilling will likely be required. Technical and analytical roles linked to CCAM may command higher wages and face recruitment challenges due to competition with other sectors (e.g. IT, telecommunications).

Interviews point to a risk of labour market polarisation, with growing demand for highly skilled technical and coordination roles alongside simplified or automated routine tasks. Entry-level pathways may become more difficult in some professions as AI replaces parts of traditional junior tasks, creating risks for long-term talent pipelines. There is concern about raising skill requirements too quickly, which could reduce accessibility to jobs (e.g. “over-engineering” traditionally vocational roles). More broadly, evidence on AI-driven labour market change suggests that automation not only replaces routine tasks but also introduces additional layers of system oversight, coordination, and human–machine interaction, thereby increasing the complexity of many roles. At the same time, given the rapid evolution of AI, these dynamics should be understood within a wider and still-developing evidence base.

The interviewees expect CCAM deployment to be slow and incremental, driven as much by regulation, infrastructure lifecycles, and investment cycles as by technology development. Many years of coexistence between vehicles with different SAE-levels are expected, with spatial differentiation (e.g. depots vs public streets, specific corridors or zones). This prolonged transition places sustained demands on workforce adaptability, continuous updating of roles, and hybrid operational models. Moreover, CCAM deployment has important implications for organisational structures and leadership practices. The transition requires organisations to move from functionally siloed models towards more integrated, system-oriented modes of operation, where coordination across technical, operational, and regulatory domains becomes central. Leadership roles are increasingly expected to manage hybrid human-machine systems, support continuous reskilling of staff, and navigate organisational change in conditions of uncertainty. Interview insights highlight that successful implementation depends not only on technical readiness, but also on leadership capacity to align workforce strategies with technological deployment, foster employee acceptance, and promote a culture of continuous learning and adaptation.

Reskilling existing employees within the organisation is generally seen as more feasible and cost-effective than large-scale external recruitment, particularly given labour shortages. Interviewees stress the importance of continuous learning and modular training pathways, as initial formal education quickly becomes outdated in a rapidly evolving technological context. Older or highly experienced workers are often seen as well-suited for supervisory, advisory, or analytical roles, transferring operational knowledge rather than exiting the labour market. CCAM may facilitate job mobility within and across sectors (e.g. logistics, warehousing, retail), provided training and certification systems support transitions. This finding applies more strongly to bigger companies rather than SMEs.

Acceptance of CCAM by employees is repeatedly identified as a critical success factor, requiring clear communication that CCAM and other automation is intended to assist rather than replace workers. Interviewees highlight risks of cultural resistance, organisational silos, and misalignment between fast technological progress and slower organisational adaptation. For some occupational groups, digitalisation may alter job identity and perceived autonomy, potentially affecting job satisfaction and retention. Effective social dialogue is essential because it enables employers, workers, and public authorities to jointly shape how technological change is implemented, helping to ensure fair transitions, better job quality, and more inclusive labour market outcomes.

Despite increased automation and self-service (e.g. ticket machines rather than a ticket vendor), demand for human assistance is expected to grow for certain user groups, including elderly passengers, people with disabilities, and those with low digital literacy. Labour market effects are therefore closely linked to service design choices, with personalised support, accessibility services, and hybrid human-digital models generating continued employment.

Quantitative employment impacts should be interpreted as net effects emerging over long time horizons, shaped by slow adoption, transition phases, and job creation offsetting losses. Aggregate employment numbers may mask significant occupational restructuring, shifting skill distributions, and changing job content rather than large absolute employment shocks. The interviews underline that institutional choices (regulation, training systems, social dialogue) will strongly influence whether CCAM leads to inclusive transitions or widening labour market divides. Recruitment practices will need to adapt to these shifts, with greater emphasis on identifying cross-disciplinary skill sets and potential for continuous learning, rather than relying on traditional role-specific entry pathways.

6. Impact on special workforce groups

The analysis conducted in RESKILLING so far indicates that the employment effects of CCAM are unlikely to be distributed uniformly across the transport workforce. The key issue is not only whether the respective technology will create or remove jobs, but whether different groups of workers will have equal access to the opportunities created by the transition. Professional drivers, traffic operators, control room staff, maintenance technicians, customer service personnel, logistics coordinators and other operational workers may not experience immediate job loss, but they are likely to face changing tasks, responsibilities and skill requirements.

For this reason, the project specifically examines the impacts of CCAM on some special workforce groups (T3.3), understood as categories of workers who, due to socio-demographic characteristics, physical abilities, employment conditions, location, access to training, or labour market status, may be more strongly or differently affected by automation and digitalisation than the general transport workforce. The objective is not to label these groups as inherently vulnerable, but to identify where existing inequalities may become transition risks, and where targeted actions are needed to turn technological change into an inclusion opportunity.

The emerging evidence suggests that CCAM can create new roles and safer or more flexible forms of work, for example, in remote operations, system supervision, fleet coordination, digital maintenance, data-enabled mobility services, customer support, and safety monitoring. At the same time, the transition may reinforce existing inequalities if workers with limited access to training, low digital confidence, precarious employment, limited qualification recognition, care responsibilities, disabilities, or geographic constraints cannot access the new opportunities. The main risk is therefore not CCAM itself, but unequal preparedness for automation.

6.1. Insights from the multi-method approach

The work implemented in this specific RESKILLING task is also based on a multi-method qualitative approach combining evidence review, stakeholder consultation and participatory validation, which was designed to capture both general labour-market trends linked to automation and the specific ways in which CCAM may affect different workforce groups in the transport sector.

6.1.1. Literature review

The literature review was expanded to provide a stronger evidence base for assessing differentiated CCAM-related impacts on special workforce groups. The review covered approximately 70 scientific, policy and project-based sources addressing automation, digitalisation, labour-market transitions, transport employment, skills needs, reskilling, and inclusion. The purpose was not to produce a full systematic review, but to build a structured analytical foundation for interpreting how CCAM may transform tasks, occupations, skills requirements, employment conditions and transition opportunities for different workforce groups.

Sources were selected purposively from four complementary streams. First, scientific literature was reviewed on technological change, automation exposure, task transformation, job polarisation, human-automation interaction and the socio-economic implications of automated mobility. Second, transport- and CCAM-specific sources were examined, including studies on automated driving, driverless freight, autonomous public transport, shared mobility, human supervision, safety, operational change and governance. Third, policy and institutional sources were reviewed from organisations such as Cedefop, the Organisation for Economic Co-operation and Development (OECD), the International Transport Forum

(ITF), the European Commission, the European Parliament, Eurofound, the International Labour Organisation (ILO), the AGE Platform, the European Youth Forum and the World Bank, with emphasis on skills intelligence, upskilling and reskilling pathways, lifelong learning, labour-market inclusion, platform work, migration, gender equality, disability inclusion and the territorial dimension of labour-market transitions. Fourth, findings from previous and ongoing EU projects and initiatives were considered, including SKILLFUL, WE-TRANSFORM, CCAM-ERAS, FAME / the Connected Automated Driving Knowledge Base and related CCAM Partnership outputs.

The reviewed evidence confirms that CCAM impacts should be analysed primarily as task and skills transformation rather than as a simple job-loss forecast. Existing studies on automation show that technologies tend to substitute or reorganise specific tasks, especially routine or predictable tasks, while increasing the importance of complementary human competences such as monitoring, decision-making, problem-solving, communication, system oversight and adaptation to complex situations. The literature also highlights that the distribution of impacts will depend on mediating factors beyond the technology itself and this is why the review explicitly connected general future-of-work literature with sources on special workforce groups, including women, older workers, young entrants, migrant workers, persons with disabilities, low-skilled or digitally excluded workers, platform and temporary workers, rural workers, caregivers and people facing multiple or intersecting vulnerabilities. The literature review therefore concerned various analytical categories, including: (i) expected employment impacts; (ii) short-, medium- and long-term time horizons; (iii) transformation of skills; (iv) barriers and enabling conditions for reskilling; (v) differentiated impacts by workforce group; and (vi) policy, organisational and social-dialogue measures needed to support an inclusive CCAM transition.

The reviewed sources were also used to design the interview guide, workshop discussion points and survey questions, ensuring that the consultation activities were based on both transport-specific and broader labour-market evidence.

6.1.2. Stakeholder consultation

Semi-structured interviews were used to collect additional and more focused evidence from organisations and experts representing labour-market actors, social partners, and specific workforce groups. A significant number of interviews (48) were conducted within the work carried out under T3.2, where questions related to the impacts of CCAM on specific workforce groups were also included. Additional targeted interviews were conducted with social partners, including the European Transport Workers' Federation (ETF) and the World Employment Confederation (WEC), as well as with individuals and organisations representing the workforce groups examined. Despite these efforts, important limitations were encountered in engaging representatives across all the groups under analysis. In several cases, the individuals or organisations contacted had limited familiarity with the topic of CCAM and its potential impacts on employment and skills, and therefore felt that they were not in a position to provide substantial input. This affected the level of participation and the depth of evidence collected for some groups.

However, the interviews were useful for strengthening the analysis beyond purely technological or occupational aspects and provided additional and more targeted insight into expected CCAM impacts, time horizons, affected groups, reskilling barriers, organisational readiness, and enabling conditions towards an inclusive CCAM-related workforce transition. They highlighted issues such as job quality, work organisation, access to training, social dialogue, qualification recognition, mentoring, discrimination, gendered participation in technical roles, and the distinction between flexible work opportunities and insecure employment.

In addition to the interviews conducted, two stakeholder workshops were organised to present, discuss and validate the preliminary findings of this work, as already mentioned in Section 2.4. In the first workshop, held on 8 October 2025 at the premises of VUB in Brussels, the discussion focused in particular on the

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preliminary list of special workforce groups identified in the analysis and on how these groups may be affected by the deployment of CCAM technologies. Participants were invited to reflect on whether the identified groups are more likely to gain new opportunities or face additional challenges, and whether impacts are expected to differ significantly across groups, for example between women and older workers, or between low-skilled and highly skilled workers. The discussion was conducted as a moderated plenary session. While no major additions were proposed to the overall list of special workforce groups, a substantial discussion emerged around whether women should continue to be considered as a distinct group in the context of CCAM-related workforce impacts. This exchange helped clarify that the differentiated impacts of CCAM are not shaped only by formal access to employment or training, but also by broader social and cultural factors, presented below in Section 6.2. Participants highlighted the role of persistent gender stereotypes affecting girls' and women's educational choices, career pathways, participation in technical and transport-related professions, and access to future CCAM-related opportunities. The discussion therefore reinforced the need to consider the different groups' features, such as gender, not as an isolated vulnerability, but as a factor shaped by wider structural, organisational and cultural conditions.

The second workshop, held online on 26 May 2026, aimed to validate the findings emerging also from the interviews and the pre-final results of the task. Interactive methods, including structured discussion and Mentimeter-based polls, were used to collect feedback on the workforce groups considered, the factors shaping differentiated impacts, and priority actions for the coming years. The Mentimeter responses showed a diverse stakeholder base, with strong participation from research and academia, transport operators, NGOs and civil society organisations, as well as public authorities, training providers, industry and other stakeholders. This second workshop confirmed the relevance of the workforce groups already identified in the task. Participants most frequently referred to older workers, low-skilled workers, workers with low digital skills, drivers including taxi and public transport drivers, gig and temporary workers, migrants facing language or legal-status barriers, and women. Additional groups mentioned as potentially overlooked included mechanics, traffic planners, city planners, emergency services, administrative staff, management and regulatory actors, adult education institutions, neurodivergent people, car-related service providers, traffic wardens and other support occupations. This input suggests that CCAM-related impacts may extend beyond frontline operational workers and affect a wider ecosystem of occupations and organisations connected to transport services, planning, enforcement, training and support functions.

The Mentimeter results also helped validate the mediating factors shaping whether CCAM leads to inclusion or exclusion. Participants ranked policy and regulation as the most influential factor, followed by organisational support, access to skills and training, labour market and employment conditions, social norms and stereotypes, care and personal responsibilities, and geographic context. This confirms that CCAM impacts cannot be understood as a direct consequence of technology alone. Instead, they are shaped by the interaction between technological change, employment conditions, organisational readiness, policy frameworks and the social circumstances of different workforce groups.

A further important finding from the second workshop concerns organisational preparedness. Participants generally considered organisations to be insufficiently prepared to support workforce transition towards CCAM. Several responses referred to a lack of concrete planning, a "wait and see" attitude, limited awareness of future skills and job changes, and uncertainty about whether organisations are willing or able to invest in reskilling. SMEs were identified as particularly exposed, due to limited resources and strategic capacity, while some participants also noted that organisations may be more prepared to lay off workers than to redeploy or reskill them. This reinforces the importance of early workforce transition planning and not only technological deployment planning.

Both workshops also confirmed that CCAM impacts should not be assessed only through job creation or job loss. Stakeholders emphasised that the transition will also affect job quality, work organisation, career pathways, training access, worker confidence, and the capacity of organisations to anticipate and handle change. The barriers identified through Mentimeter included lack of funding, low awareness, resistance to

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change, limited organisational support, weak policy coordination, skills mismatch, lack of time, and limited access to training. When asked about priorities for the next five years (short term), participants highlighted the need to identify jobs at risk, define emerging skills and reskilling needs, design inclusive training programmes, raise awareness of expected impacts, implement large-scale skills-based reskilling linked to clear job transition pathways, support vulnerable groups, update current education curricula, and involve affected occupations (e.g., taxi drivers) in the discussion.

Overall, the two workshops provided important validation of the task findings, confirming the relevance of the identified special workforce groups, strengthening the analysis of the mediating factors shaping differentiated outcomes, and highlighting the need for early, inclusive and well-funded workforce transition strategies. They also reinforced the central point of the RESKILLING project that the success of the CCAM transition will depend not only on technological readiness, but also on whether workers, organisations and policy systems are prepared to manage the transition in an inclusive and socially sustainable way.

6.2. Mediating factors shaping differentiated impacts

Across the literature review, interviews, workshops and survey design, a consistent conclusion emerges: CCAM impacts are not technologically pre-determined. Two workers exposed to similar technological change may experience very different outcomes depending on factors like their employment status, access to training, organisational support and social circumstances. Seven groups of mediating factors can be considered particularly relevant, as also confirmed by the stakeholders' consultation activities of the task.

Table 6 Mediating factors affecting CCAM workforce impacts

Mediating factor	Description
Access to skills and training	Includes the availability, affordability, flexibility and relevance of training opportunities; levels of digital literacy; recognition of prior learning and qualifications; and access to workplace-based learning.
Organisational support and practices	Refers to management commitment, learning culture, career transition planning, job design, time allocated for training, mentoring schemes and internal mobility pathways.
Social norms, stereotypes and discrimination	Covers gender stereotypes, ageism, digital bias, and discrimination linked to migration background, disability, ethnicity or other personal characteristics.
Labour-market and employment conditions	Includes contract stability, income security, working time, access to social protection, subcontracting arrangements, platform work and the quality of newly emerging jobs.
Care and personal responsibilities	Refers to childcare, eldercare, domestic responsibilities and other time constraints that may affect participation in training or career mobility.
Geographic and infrastructural context	Covers urban–rural differences, access to digital infrastructure, availability of training opportunities, transport connectivity and regional labour-market opportunities.
Policy and regulatory environment	Includes public funding, vocational education and training systems, labour-market policies, equality legislation, qualification recognition, data and AI governance, and social dialogue frameworks.

Source: elaboration of the authors.

6.3. Findings by workforce group

The findings per workforce group are summarised in Table 7 below. The grouping follows the analytical categorisation used in the RESKILLING Task 3.3 work, distinguishing between age-related, gender-related, migration-related, skills/education-related, disability-related, employment status-related, geographic/place-related and intersectional vulnerability dimensions. The groups are not mutually exclusive. Several workers may experience overlapping vulnerabilities, for example migrant women in platform jobs, older workers with low digital confidence, or rural workers with limited access to training infrastructure.

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Table 7 Differentiated CCAM employment impacts by special workforce group: key risks, opportunities, mediating factors and implications for inclusive reskilling and workforce transition support

Grouping	Who is included?	Key risks / challenges	Key opportunities / positive impacts	Key mediating factors	Implications for reskilling and transition support
Age-related groups	Older workers, particularly workers aged 55+ or approaching retirement; young workers and new labour-market entrants.	Older workers may face stronger adaptation pressures as operational roles become more digitally supported and require monitoring, remote supervision, safety oversight or interaction with automated systems. Lower digital confidence, limited experience with continuous learning, and shorter retirement horizons may reduce willingness or capacity to participate in extensive reskilling. Young entrants may face risks if traditional entry-level jobs are automated or reorganised, or if new CCAM-related occupations require advanced qualifications, experience or access to professional networks.	Older workers often possess valuable operational knowledge, situational judgement, safety experience and mentoring capacity, which remain highly relevant in hybrid human-machine environments. Young workers may benefit from emerging digital, technical and service-oriented roles linked to CCAM, particularly in areas such as fleet coordination, customer-facing mobility services, system monitoring and automation support.	Digital confidence; retirement horizon; motivation for lifelong learning; recognition of practical experience; organisational attitudes towards ageing and younger workers; education alignment; access to apprenticeships, career guidance and professional networks.	Reskilling should be age-sensitive and modular. For older workers, training should build on existing experience and focus on practical digital confidence, system supervision and safety-related competences. For young entrants, stronger links are needed between education providers, apprenticeships, work-based learning and emerging CCAM occupations.
Gender-related groups	Women and girls, including those in STEM, transport, operational, technical and leadership pathways.	Women may remain underrepresented in emerging CCAM-related technical, digital and leadership roles if existing barriers persist. These include gender stereotypes, limited access to STEM pathways, lack of	CCAM may create new opportunities for women if it leads to safer, more flexible, more digital and less physically demanding roles. Potential opportunities include remote operations, digital	STEM access; gender stereotypes; educational and career choices; occupational segregation; workplace safety; harassment; predictable working conditions; care responsibilities;	CCAM-related reskilling should be linked to broader gender equality measures. These include targeted training, mentoring, women-in-transport networks, visible female role models, inclusive recruitment, employer

Grouping	Who is included?	Key risks / challenges	Key opportunities / positive impacts	Key mediating factors	Implications for reskilling and transition support
		professional networks, weaker access to technical training, occupational segregation, gender pay and opportunity gaps, care responsibilities, safety concerns, harassment and lack of predictable working conditions.	monitoring, system supervision, safety, coordination, training, customer support, mobility services and management roles. Inclusive policies can increase women's participation and leadership in the future transport workforce.	mentoring; women-in-transport networks; employer investment; inclusive recruitment and promotion practices.	investment in qualifications, safer workplaces, predictable working conditions and career progression pathways into technical and leadership roles.
Migration-related groups	Migrant workers, refugees and workers with migration background.	Migrant workers may face a double transition risk: exposure to routine, operational, logistics or service-related roles affected by automation, combined with barriers to accessing emerging digital, supervisory or technical CCAM-related roles. Challenges include language barriers, limited access to information, weak professional networks, discrimination, complex recognition of qualifications, legal or residence-status constraints, and concentration in lower-protection employment segments.	Labour shortages in transport and the emergence of new CCAM-related roles may create opportunities for migrant workers, especially where previous skills and international experience are recognised. CCAM could open pathways into logistics coordination, maintenance support, digital mobility services, supervision, customer support and other roles if appropriate support is available.	Language proficiency; recognition of foreign qualifications and prior experience; legal and residence status; employment status; discrimination; access to information; professional networks; job-specific training; mentoring; socioeconomic pressures; employer engagement.	Transition measures should include qualification recognition, competence assessment, job-specific language training, mentoring, career guidance, information on rights and training opportunities, and direct links with employers. Migrant workers should not be treated as a homogeneous group; gender, age, legal status, education level, care responsibilities and socioeconomic pressures should also be considered.
Skills / education-related groups	Low-skilled or low-qualified workers; workers with low digital confidence; workers with limited	These groups are among the most exposed to CCAM-related transition risks. CCAM is expected to increase demand for digital, technical, data-	Accessible reskilling can enable upward mobility and support transition into new or transformed roles. Modular and practical training can	Basic digital confidence; access to affordable and flexible training; recognition of practical experience; employer support; funding; paid	Training should be demand-driven and linked to real job transition pathways. It should be modular, affordable, practical and accessible in

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Grouping	Who is included?	Key risks / challenges	Key opportunities / positive impacts	Key mediating factors	Implications for reskilling and transition support
	digital, technical or STEM backgrounds.	related, cybersecurity, system-oriented and human-machine interaction competences. Routine-based and low-skilled operational tasks may be more easily automated or re-organised, while new jobs may require skills that these workers do not yet possess. Risks include displacement, skills mismatch, downward mobility, labour-market polarisation and exclusion from higher-quality emerging roles.	help workers develop job-relevant digital confidence, technical awareness, safety-related competences and transversal skills such as communication, adaptability and problem-solving. Human skills are expected to remain important in customer service, supervision, incident management and support functions.	training time; training format and location; motivation; clarity of job-transition pathways; demand for emerging CCAM-related roles.	terms of time, cost, location and format. Recognition of practical experience, basic digital confidence-building, workplace-based training and clear progression routes are essential.
Disability-related groups	Workers with physical, sensory, intellectual or psychosocial disabilities.	Persons with disabilities may face exclusion if CCAM technologies, workplaces, training platforms, recruitment processes and digital interfaces are not accessible. Additional support needs and reasonable accommodations may not always be recognised by employers. Limited access to tailored training, assistive technologies or inclusive job design could deepen existing labour-market exclusion.	CCAM may create important inclusion opportunities if it enables remote work, digitally supported tasks, reduced dependence on physically demanding activities, and more accessible work environments. Potential roles include monitoring, customer support, remote operations, data-enabled mobility services, system supervision and safety-related support. Inclusive design can improve working conditions for all workers.	Accessibility by design; reasonable accommodations; assistive technologies; accessible digital interfaces; inclusive recruitment; employer awareness; workplace adaptations; tailored learning pathways; accessibility of training platforms and materials.	Accessibility should be embedded by design from the earliest stages of CCAM deployment. Training platforms, digital tools, workplaces and recruitment processes must be accessible. Employers should provide reasonable accommodations, assistive technologies, tailored learning pathways and inclusive job design. Disability inclusion should not be treated as a corrective measure after deployment.

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Grouping	Who is included?	Key risks / challenges	Key opportunities / positive impacts	Key mediating factors	Implications for reskilling and transition support
Employment status-related groups	Platform workers, gig workers, temporary workers, part-time workers, outsourced workers, self-employed workers and other workers in insecure or non-standard employment.	These workers may face transition risks due to weaker access to employer-sponsored training, social protection, bargaining power, stable income, career development and worker representation. Automation may increase job insecurity, income volatility and algorithmic management. Workers most exposed to automation-related risks may also be those least likely to receive adequate training.	Flexible forms of work can support participation for some workers, including caregivers, students, self-employed workers or workers seeking gradual labour-market entry. CCAM and digital platforms may create new roles in micro-mobility services, remote support, customer services, fleet-related tasks or local mobility provision. There may also be opportunities to formalise roles and improve employment conditions if properly regulated.	Contract type; income security; access to training rights; employer responsibility; social protection; worker representation; collective bargaining; platform regulation; algorithmic management; career progression; distinction between flexibility and precarity.	It is important to distinguish flexibility from insecurity. Reskilling strategies should extend beyond standard employees and include non-standard workers. Training rights, access to career guidance, social protection, representation, predictable income and quality standards should be considered in CCAM-related transition measures.
Geographic / place-related groups	Workers in rural, remote, peripheral or underserved areas; low-income workers affected by geographic or socioeconomic barriers.	Emerging CCAM-related occupations may initially be concentrated in urban mobility ecosystems, digital operations centres, technology clusters or large transport organisations. Workers in rural, remote or underserved areas may face limited access to training, digital infrastructure, employers, professional networks and new job opportunities. Low-income workers may face additional barriers linked to training costs, loss of income during	CCAM may create opportunities if digitalisation enables remote operations, remote supervision, distributed maintenance support, local innovation hubs or improved transport connectivity. Automated or digitally coordinated public transport services could improve access to workplaces, training and services in underserved areas.	Digital infrastructure; transport connectivity; regional training capacity; local labour-market diversification; availability of employers; affordability of training; access to equipment and connectivity; financial support; paid training time; place-based policy measures.	Regional training capacity, digital infrastructure, affordable connectivity and locally accessible reskilling programmes are critical. Policy measures should ensure that CCAM deployment does not reinforce urban-rural inequalities. Low-income workers may require financial support, paid training time, equipment support and flexible training formats.

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Grouping	Who is included?	Key risks / challenges	Key opportunities / positive impacts	Key mediating factors	Implications for reskilling and transition support
		reskilling, limited equipment or connectivity, and reduced capacity to take career risks.			
Intersectional vulnerabilities	Individuals facing multiple and overlapping disadvantages, for example migrant women in precarious employment, older workers with low digital confidence, rural workers with disabilities, low-income caregivers, or workers combining several barriers.	Multiple barriers can compound the risk of being left behind. Workers may face simultaneous constraints related to gender, age, migration status, disability, employment insecurity, low income, limited digital skills, care responsibilities, rural location or discrimination. These combined barriers can make it harder to access information, training, professional networks, stable employment and transition support.	Targeted and tailored support can break cycles of exclusion. Inclusive transition strategies can promote social cohesion, improve access to training and support, and ensure that CCAM-related opportunities are not limited to already advantaged workers. Strong social dialogue and stakeholder engagement can help identify groups that may otherwise remain invisible.	Combination of individual, organisational and structural factors; care responsibilities; income insecurity; language needs; accessibility requirements; location; discrimination; employment status; access to information; social support; policy and institutional coordination.	One-size-fits-all approaches should be avoided. Transition measures should be flexible, targeted and accessible, taking into account real-life constraints such as time, care responsibilities, income insecurity, language needs, accessibility requirements, location and employment status. Intersectionality should be used as a guiding principle in policy design, training provision and stakeholder engagement.

Source: elaboration of the authors.

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6.4. Cross-cutting findings

The findings from the literature review, interviews, workshops and survey design indicate that CCAM-related workforce impacts should be understood as a gradual and multidimensional transition, rather than only as a question of job creation or job loss. The nature and intensity of impacts are expected to evolve over time, as CCAM deployment moves from early digitalisation and partial automation towards more advanced, integrated and large-scale automated mobility systems.

In the short term, CCAM is expected to transform tasks and work processes, rather than eliminate entire occupations. Drivers may progressively take on supervisory, remote support or customer-facing functions; maintenance technicians may need to interpret diagnostics, software updates and sensor data; and traffic operators may increasingly interact with AI-supported decision-making systems. During this phase, the main challenge is therefore not full occupational replacement, but the reconfiguration of existing roles and the growing need for workers to adapt to new tools, procedures and responsibilities.

In the medium term, as CCAM applications become more widespread and operationally mature, skills mismatch and workforce transition pressures are expected to become more visible. The demand for digital, technical, data-related, safety, cybersecurity, monitoring and human-machine interaction competences is likely to increase. At the same time, workers in routine, operational, low-skilled, subcontracted or insecure roles may face greater transition risks if they do not have access to relevant training, guidance and career pathways. This period is therefore likely to be critical for determining whether workers can move into transformed or emerging CCAM-related occupations.

In the longer term, CCAM may contribute to broader labour-market restructuring across the transport ecosystem. New occupational profiles may emerge around remote operations, fleet supervision, infrastructure monitoring, automated-system support, data-enabled mobility services, maintenance, safety assurance and customer support. However, the long-term effects will depend strongly on whether technological deployment is accompanied by inclusive policy, accessible training, organisational planning, social dialogue and employment standards. Without such support, CCAM could reinforce existing inequalities; with adequate preparation, it could broaden participation in the future mobility workforce.

Table 8 Evolution of CCAM-related workforce impacts over time: expected changes, affected groups and transition priorities

Time horizon	Expected nature of CCAM impacts	Workforce groups likely to be particularly affected	Main risks/ challenges	Main opportunities	Transition and reskilling priorities
Short term (2030)	Task transformation and work reorganisation rather than large-scale job displacement. Digital tools, automated scheduling, monitoring systems and AI-supported decision-making begin to affect daily work	Professional drivers, public transport workers, traffic operators, maintenance workers, low-skilled workers, older workers, platform or temporary workers, and workers in operational roles.	Work intensification; uncertainty about future roles; early skills gaps; low digital confidence; limited awareness of CCAM-related changes; risk that digitalisation affects work organisation without adequate worker involvement.	Existing workers can build on operational knowledge and gradually move into supervisory, monitoring, customer-support, safety or human-in-the-loop roles. Early training can prepare workers before more disruptive changes occur.	Raise awareness of expected changes; map changing tasks; identify workers and occupations most exposed; provide basic digital confidence-building; involve workers and unions early; introduce modular and practical upskilling linked to current roles.

Time horizon	Expected nature of CCAM impacts	Workforce groups likely to be particularly affected	Main risks/ challenges	Main opportunities	Transition and reskilling priorities
	processes before higher levels of automation are widely deployed.				
Medium term (2040)	Wider diffusion of CCAM applications and stronger transformation of occupational profiles. Skills mismatch becomes more visible as new technical, digital, supervisory and service-oriented competences are required.	Workers with low digital or STEM backgrounds, low-skilled workers, migrant workers, women in underrepresented technical pathways, young entrants, SMEs and subcontracted workers.	Skills mismatch; unequal access to training; exclusion from emerging higher-value roles; concentration of vulnerable groups in lower-protection jobs; insufficient employer investment; weak transition pathways.	New employment opportunities may emerge in remote operations, system supervision, fleet coordination, digital mobility services, maintenance, infrastructure monitoring, safety support and user assistance.	Develop demand-driven reskilling pathways; link training to real job transitions; support SMEs through shared training funds or sectoral schemes; strengthen qualification recognition; provide job-specific language support; improve access for underrepresented groups.
Longer term (2050)	Structural labour-market change across the transport and mobility ecosystem. Some traditional roles may decline or be substantially redefined, while new roles emerge around automated mobility systems, data-enabled services and integrated operations.	Older workers, low-income workers, workers in rural or peripheral areas, persons with disabilities, workers in precarious employment, caregivers, migrants, women, and people facing multiple or overlapping barriers.	Labour-market polarisation; regional inequalities; exclusion from advanced CCAM roles; unclear career pathways; reinforcement of existing inequalities if inclusion is not embedded; possible decline of some traditional operational jobs.	CCAM may create safer, more flexible, less physically demanding and more accessible jobs. Remote, digital and supervisory roles may improve participation for some groups, including women, persons with disabilities, caregivers and rural workers, if infrastructure and support are available.	Embed inclusion in long-term workforce planning; ensure accessible training and digital infrastructure; support lifelong learning; strengthen social dialogue; create clear employment standards; use policy and regulation to prevent unequal outcomes and support fair transitions.

Source: elaboration of the authors.

Across all time horizons, job quality and work organisation are as important as employment numbers. Stakeholder input, particularly from the public transport sector, highlighted that digitalisation and automation can already affect workers through scheduling systems, shift planning, task allocation and organisational control, even before higher levels of vehicle automation are deployed. New roles such as stewards, recovery teams, remote supervisors or automated-system support staff may create employment opportunities, but they may also involve demanding working conditions, increased responsibility or unclear career pathways if not properly designed.

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The evidence also shows that access to training is unevenly distributed. Workers in lower-paid, operational, subcontracted, insecure or lower-protection roles may be more exposed to transition risks while also being less likely to benefit from employer-sponsored training. Smaller companies may also lack the resources, strategic capacity or funding to anticipate future skills needs and invest in structured reskilling programmes. This reinforces the need for demand-driven training aligned with real labour-market needs, supported by shared training funds, sectoral schemes, public funding mechanisms and employer engagement.

Organisational readiness emerges as another critical condition for an inclusive CCAM transition. The successful deployment of CCAM will depend not only on technological maturity, but also on whether organisations are able to map changing roles, anticipate skills gaps, communicate with workers, support managers, provide time and resources for learning, and create credible transition pathways. Without such organisational planning, even well-designed training programmes may have limited impact.

Social dialogue and worker involvement are also central. Stakeholder inputs highlighted the importance of involving trade unions and workers' representatives from the early stages of technology deployment, rather than only after technical decisions have already been made. Worker mentoring schemes, where trained workers or union delegates support colleagues in accessing training and professional development opportunities, were identified as promising practices for building trust, reducing resistance and encouraging participation among workers who may not otherwise seek reskilling.

Overall, the findings confirm that inclusion is not an automatic outcome of CCAM deployment. CCAM can create safer, more flexible and more accessible jobs, but these benefits depend on proactive policy measures, inclusive design, accessible training, anti-discrimination practices, recognition of qualifications, social dialogue and clear employment standards. The transition can either broaden participation in the future mobility workforce or reinforce existing inequalities. Its social impact will therefore depend on how effectively technological innovation is accompanied by workforce planning, organisational support and inclusive transition measures.

6.5. Preliminary implications for reskilling and workforce transition

The findings have several implications for the design of CCAM-related reskilling and workforce transition strategies. A first key implication is that training should begin early, before workers are already at risk of displacement or exclusion from emerging roles. Reskilling should therefore be anticipatory rather than reactive, helping workers and organisations prepare gradually for changing tasks, new responsibilities and future occupational pathways.

A second implication is that reskilling should be demand-driven and clearly linked to concrete roles within the evolving CCAM ecosystem. Training pathways should not remain generic, but should connect workers to identifiable opportunities in areas such as remote operations, fleet coordination, digital maintenance, safety monitoring, infrastructure management, customer support, data-enabled mobility services and AI-supported transport operations. This connection between training and real labour-market demand is particularly important for building trust and demonstrating the value of participation.

At the same time, reskilling should not be limited to advanced technical competences. Digital, data, cybersecurity, AI and system-management skills will become increasingly important, but workers will also need transversal skills such as adaptability, problem-solving, communication, safety awareness, collaboration with automated systems and confidence in using new technologies. For several workforce

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groups, especially those with limited digital experience, the first step may be building digital confidence and familiarity with technology, rather than moving directly to advanced technical training.

Transition measures should also be accessible and sensitive to the needs of different workforce groups. This requires flexible and modular training formats, financial support, paid training time, childcare or care-related support, accessible digital platforms, job-specific language training, recognition of qualifications and prior experience, mentoring, career guidance and outreach through trusted intermediaries. Such measures are particularly important for workers who may face practical, financial, organisational or social barriers to participation.

Finally, reskilling should be embedded within broader workforce transition planning. Training alone will not be sufficient unless it is accompanied by social dialogue, job-quality safeguards, organisational change management, inclusive recruitment practices and clear career progression pathways. In this sense, CCAM-related reskilling should be understood as part of a wider strategy for managing technological change in a fair, inclusive and sustainable way.

7. Conclusions

The analysis presented in this deliverable provides a comprehensive understanding of how CCAM deployment impacts skills needs and the wider labour market, including its differentiated effects on specific workforce groups. By combining literature review, stakeholder interviews, co-creation workshops, and quantitative employment modelling, the analysis provides a comprehensive and nuanced understanding of how CCAM deployment is expected to reshape work, skills, and labour markets across the European transport and mobility ecosystem.

The findings from the analysis of employment effects confirm that CCAM does not lead to straightforward employment decline or growth, but to structural transformation of work. Across the job families along the CCAM value chain, automation primarily affects task composition, skill requirements, and occupational profiles, rather than eliminating entire professions. Many roles are expected to persist in transformed forms, characterised by increased technical complexity, stronger emphasis on supervision and judgement, and closer interaction with digital systems. As a result, reskilling and upskilling of the existing workforce emerge as more relevant challenges than large-scale workforce displacement.

The skills analysis shows a clear shift towards system-level competencies, combining knowledge of vehicles, infrastructure, software, data, and digital services. At higher levels of CCAM uptake, skills related to assurance, safety, cybersecurity, regulatory compliance, and governance become increasingly central across a wide range of roles. At the same time, human-centred skills, such as communication, problem-solving, adaptability, and situational judgement, remain essential, particularly in operational, supervisory, managerial, and passenger-facing functions. The transitional phase, characterised by the coexistence of conventional and automated systems, stands out as a critical period with heightened skill demands and organisational complexity.

The quantitative employment analysis complements these findings by providing indicative projections for CCAM-related sectors. Aggregate employment effects remain relatively moderate in the short term due to gradual and uneven CCAM uptake. However, more pronounced restructuring is expected over longer time horizons. The analysis at this aggregate level masks significant internal shifts between occupations, skill levels, and job content, underlining that headline employment figures alone are insufficient to capture the true labour market effects of CCAM.

Insights from interviews highlight that CCAM is often understood as a response to structural labour shortages, particularly in driving and operational roles, rather than primarily as a cost-saving measure. Extended transition periods may temporarily increase staffing needs as organisations operate parallel systems, but over time employment effects are shaped by task reallocation, new role creation, and changing skill mixes. Risks identified include labour market polarisation, reduced accessibility to certain occupations, and challenges for specific workforce groups if training systems do not adapt fast enough. Organisations and leadership structures will need to proactively adapt to this evolving skills landscape, ensuring they are equipped to anticipate changing skill needs, support continuous learning, and manage workforce transitions effectively.

The analysis of special workforce groups further indicates that impacts may differ for older workers, women, workers with low digital confidence, migrant workers, persons with disabilities, workers in precarious employment, and those in rural or underserved areas, depending on access to training, organisational support, social conditions, and regulatory frameworks. Conversely, CCAM also offers opportunities for improved job quality, longer careers, more accessible or less physically demanding roles, and cross-sector mobility, provided appropriate institutional support is in place.

The analysis is subject to several limitations related to data availability, scope, and methodological constraints. While the quantitative assessment provides indicative projections at the sector level, it does not deliver detailed estimates of jobs created, transformed, or displaced across all job families. This can be attributed to both the early stage and uncertainty of CCAM deployment as well as limitations in harmonised employment data. Similarly, for some job families, particularly those less represented in the literature or stakeholder engagement (e.g. decommissioning and recycling, construction, or surveillance roles), insufficient evidence was available to robustly specify skills developments, and these are therefore flagged as information gaps rather than omitted from the analysis. Substantial efforts were made to identify interviewees, but not all job families could be covered. In addition, although the analysis addresses a broad range of workforce groups, not all categories defined in the Grant Agreement could be examined to the same extent. This was mainly due to the limited availability of disaggregated empirical evidence, as well as challenges in identifying and engaging representatives of some groups with sufficient awareness of, or familiarity with, the relevant CCAM-related employment and skills issues. These limitations primarily concern completeness rather than analytical quality, and highlight areas where further targeted data collection and research are required in future work.

Overall, the findings underline that the employment and skills outcomes related to CCAM are not technologically predetermined. Rather, they are shaped by the interaction between technology, organisations, labour-market conditions, individual circumstances, policy choices, regulatory frameworks and social dialogue. CAM can open new employment opportunities and contribute to making transport work safer, more flexible and more inclusive. However, for special workforce groups, these outcomes will depend strongly on whether the transition is supported by early reskilling, inclusive organisational practices, targeted support measures, and sustained investment in education and training. Without such measures, CCAM may reinforce existing inequalities, particularly for workers who already face barriers related to digital skills, age, gender, migration background, disability, employment status, income, geography or care responsibilities. Conversely, with proactive and inclusive workforce strategies, CCAM can create new pathways into emerging roles and support quality employment within socially sustainable mobility systems. Such strategies should focus on continuous learning, targeted reskilling, accessible training pathways, social dialogue, job-quality safeguards and support during the transition phase. The central challenge for RESKILLING is therefore to support a transition in which today's transport workers, including those most exposed to labour-market change, can realistically become part of the future CCAM workforce.

The results of this deliverable provide a key evidence base for subsequent RESKILLING activities on reskilling pathways, policy guidance, and the development of the CCAM Employment & Skills Observatory. They also support the identification of priority groups, including older workers, migrants, persons with disabilities, and workers with low digital confidence or in precarious employment, as well as key barriers such as limited access to training, low digital skills, organisational constraints, and qualification recognition challenges. At the same time, the analysis highlights enabling conditions, including modular and continuous learning pathways, employer-supported reskilling, inclusive workplace design, and supportive regulatory and institutional frameworks, which should be considered in future training, policy, and stakeholder engagement activities.

8. References

Anderson, J. M. (2018). Rethinking insurance and liability in the transformative age of autonomous vehicles. https://www.researchgate.net/profile/James-Anderson-38/publication/325664414_Rethinking_Insurance_and_Liability_in_the_Transformative_Age_of_Autonomous_Vehicles

Arup. (2019). Autonomous, connected, electric and shared vehicles. https://www.arup.com/insights/autonomous-connected-electric-and-shared-vehicles/

Bissell, D., Birtchnell, T., Elliott, A., & Hsu, E. L. (2020). Autonomous automobilities: The social impacts of driverless vehicles. Sociology, 54(1), 20–37. https://journals.sagepub.com/doi/full/10.1177/0011392118816743

CCAM-ERAS. (2026). D4.4 Analytical report on employment. Retrieved from https://ccam-eras.org/wp-content/uploads/2026/05/D4.4-CCAM_ERAS_Deliverable_D4.4_v06.pdf

Duboz et al. (2025). Scenarios for the deployment of automated vehicles in Europe. Transportation Research Interdisciplinary Perspectives, 101530.

Ecorys et al. (2020). Study on exploring the possible employment implications of connected and automated driving. Rotterdam: DG RTD. Retrieved from https://www.ecorys.com/app/uploads/files/2021-03/CAD_Employment_Impacts_Main_Report.pdf

European Commission. (2016). EU Reference Scenario. Retrieved from https://ec.europa.eu/energy/data-analysis/energy-modelling/eu-reference-scenario-2016_en

European Commission. (2014). Transport sector skills needs. https://trimis.ec.europa.eu/system/files/brochure/20140117_205136_81493_PB05_WEB.pdf

European Commission, Joint Research Centre. (2019). An analysis of possible socio-economic effects of a Cooperative, Connected and Automated Mobility (CCAM) in Europe. Publications Office. https://publications.jrc.ec.europa.eu/repository/handle/JRC111477

European Commission, Joint Research Centre. (2019a). The future of road transport: Implications of automated, connected, low-carbon and shared mobility. https://www.connectedautomateddriving.eu/wp-content/uploads/2023/06/The-future-of-road-Transport.pdf

European Youth Forum. (2026, May 8). *Ending precarity: Towards quality employment and strong protection for young people in Europe*. https://www.youthforum.org/policy-library/ending-precarity-towards-quality-employment-and-strong-protection-for-young-people-in-europe

European Youth Forum. (2026, May 8). *AI is already in schools. Now what? A necessary change in European education*. https://www.youthforum.org/policy-library/ai-is-already-in-schools-now-what-a-necessary-change-in-european-education

Eurostat. (2026, 5 4). Bus fleet. Retrieved from Motor coaches, buses and trolley buses, by type of vehicle: https://ec.europa.eu/eurostat/databrowser/view/road_eqs_busveh__custom_20635604/default/table

Eurostat. (2026, 13 5). Employment. Retrieved from Employment by detailed industry (NACE Rev.2) - national accounts: https://ec.europa.eu/eurostat/databrowser/view/nama_10_a64_e$defaultview/default/table

.

Eurostat. (2026, 2 17). Freight activity. Retrieved from Road freight transport by type of operation and type of transport (t, tkm, vehicle-km) - annual data: https://ec.europa.eu/eurostat/databrowser/view/road_go_ta_tott__custom_20667983/default/table

Eurostat. (2026, 15 5). GDP. Retrieved from Gross domestic product (GDP) and main components (output, expenditure and income): https://ec.europa.eu/eurostat/databrowser/view/nama_10_gdp$defaultview/default/table

Eurostat. (2026, 3 24). Passenger activity. Retrieved from National passenger road transport performance by type of vehicles registered in the reporting country: https://ec.europa.eu/eurostat/databrowser/view/road_pa_mov__custom_20668265/default/table

Eurostat. (2026, 5 4). Truck fleet. Retrieved from Lorries and road tractors by age and type of vehicle: https://ec.europa.eu/eurostat/databrowser/view/road_eqs_lorroa__custom_20635594/default/table

Infrastructure Australia & Swinburne University. (2023). Creating our future transport and mobility workforce: Understanding the workforce implications of transport digitalisation and automation in Australia. https://figshare.swinburne.edu.au/articles/report/26254238

Michigan State University & Texas A&M Transportation Institute. (2018). Preparing the workforce for AVs and truck platooning. https://comartsci.msu.edu/sites/default/files/documents/MSU-TTI-Preparing-Workforce-for-AVs-and-Truck-Platooning-Reports%20.pdf

Savy, M., et al. (2024). Automation and digitalisation on the transport workforce: How can the shock be prevented? Transportation Research Interdisciplinary Perspectives. https://www.sciencedirect.com/science/article/pii/S2352146524005313

SAE International. (2021). Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles. doi:https://doi.org/10.4271/J3016_202104

SHOW Project. (2024). D13.3: SHOW impact assessment on society. https://show-project.eu/wp-content/uploads/2024/11/D13.3-SHOW-impact-assessment-on-society.pdf

Upjohn Institute. (2018). Preparing U.S. workers and employers for an autonomous vehicle future. W.E. Upjohn Institute for Employment Research. https://research.upjohn.org/cgi/viewcontent.cgi?article=1039&context=up_technicalreports

Valtioneuvosto (Finnish Government). (2019). Work in the age of artificial intelligence: Four perspectives on the economy, employment, skills and ethics. https://julkaisut.valtioneuvosto.fi/handle/10024/160980

9. Annex I: Interview template

This document contains the questions for the RESKILLING interviews on employment effects, as well as some comments and additional guidance. Comments and guidance are in purple and italic, while questions and explanations for the interviewee are in black regular font. Please use this document to create the interview summary and fill out the table below with the interviewee's name, interview date, and job families that were discussed. After the interview, please return this filled out summary and a transcript to karoline.fuehrer@ecorys.com and davide.dolente@ecorys.com.

Name	
Role of interviewee	
Date	
Job Family/Families	

Do not forget to start the recording and transcript.

This interview is part of a broader study on the employment effects of Connected and Automated Mobility (CCAM). We're aiming to understand how CCAM technologies are influencing different job roles, skill requirements, and work environments across the sector. Your insights will help us build a clearer picture of how these changes are unfolding in practice.

Today, we will be talking about the following roles in your company: [introduce relevant job families].

We start by discussing the current situation before diving into CCAM and future developments.

Try to get an answer to all questions. Make sure to discuss all relevant job families per question. For emerging/new jobs, skip to the questions on emerging jobs.

1. **Which skills are currently required for this job?**

Within the RESKILLING project, we are putting an emphasis on "special" workforce groups[1]. These groups encompass people that might face barriers to employment, such as persons with disabilities, older workers, migrants, IT illiterate, workers from rural/remote areas, single-parents or caregivers, in some cases women.

We are interested in the special workforce categories they employ, or have employed, and what accommodations (if any) had to be made.

[1] *Special workforce groups* refer to categories of transport workers who, due to their socio-demographic characteristics, physical abilities, or labour market status, are expected to be more strongly or differently affected by the introduction of Connected, Cooperative, and Automated Mobility (CCAM) technologies than the general transport workforce.

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2. **Is this job suitable for workers from special groups or does it need to be adapted to meet their needs and possibilities?**

The following question relates to Business Models, and how the organisation was affected by operational changes.

3. **In the last five years, have there been any notable changes in day-to-day operations - for example, in processes, technologies, or management practices?**

Ask if the interviewee received and reviewed the factsheet. In any case, give a very short overview of CCAM.

Now we are moving on to discuss CCAM (Connected, Cooperative, and Automated mobility). CCAM refers to the integration of digital connectivity and automation technologies in transport systems, such as self-driving vehicles, smart infrastructure, and real-time data exchange. CCAM aims to improve safety, efficiency, and sustainability in mobility, and is expected to significantly reshape how transport services are delivered and how work is organized across the sector.

For this question, we are interested in specific impacts on the interviewee's own job, as well as wider impacts in the sector.

4. **How do you think CCAM will impact this job?**

5. **Given these impacts, how do you think this job will change? Will it develop into a different profession?**

If the job will evolve in a different profession, new skills will be needed. We are interested in those skills, which have not already been given under question 1.

6. **If yes, which skills do you think will be required for the changed or new job?**

CCAM will not be fully deployed from one day to the next. A transitional period with varying levels of technology deployment will bring its own challenges. This partial implementation can create uncertainty around roles, responsibilities, and required skills. Workers may need to adapt to hybrid systems, where manual and automated processes coexist, and organisations may face challenges in workforce planning, training, and maintaining operational consistency during this period.

We are especially interested in the transitional period of CCAM. Therefore, please take extra care to get an extensive answer on this. A transitional phase can be summarised as a system where present-day technologies coexist with future, more advanced technologies.

7. **What do you think the transitional period will look like?**

As a follow up to question 2, we are also interested in which effects will apply to special workforce groups.

8. **Do you think CCAM will affect workers from "special" groups differently in this job? If yes, how (e.g., more training needs, new safety risks, fewer job opportunities, better accessibility, new job roles, etc)?**

Now we are looking beyond the job families we discussed so far.

We are very interested in new types of professions, either related to current roles or entirely new.

9. **Which emerging jobs do you foresee in your sector?**

Also very important to find out which skills they think will be needed for emerging jobs in the sector. These can be very specific to the job, or more general. They can of course be based on speculation of how the CCAM evolution will unfold.

10. **Which skills do you think will be required for these emerging jobs?**

11. **Is there anything else you would like to share with us regarding future skills needs in the jobs we discussed, or your company or sector in general?**

Thank you so much for your time and your insights on this topic. We are conducting multiple interviews to gather information on a wide range of professions. We will be in touch regarding the outcomes. Please feel free to email me anytime if you have any further information to share.

10. Annex II: Skills Matrix

The skills matrix below shows the required skills for the job families identified in RESKILLING deliverable D3.1 at three levels of CCAM deployment. Each job family encompasses multiple jobs. Therefore, not all skills may be relevant, or additional specific skills may be required, depending on the specialisation within a job family.

The three CCAM deployment levels are not mutually exclusive. Skills from the lower CCAM levels may stay relevant for higher CCAM levels, with only a few skills becoming obsolete. In addition, the transition is expected to be gradual, with additional skills slowly being required.

The information from this matrix was obtained via a thorough literature review, stakeholder interviews, and a workshop. A second workshop was used to validate these findings. If a literature source contributed to an interview, it is referenced with a footnote.

Table 9 Skills matrix

Job family	Low CCAM uptake	Mid CCAM uptake	High CCAM uptake
Engineers[2]	• Traditional automotive engineering skills • Digital and systems engineering competences • Software development (automotive, embedded, data-driven systems) • Hardware development for sensing, communication, and data platforms • Data engineering and data analysis • AI / machine learning for automated driving • Robotics middleware and tools • Vehicle development and system integration • Sensor integration (including perception and sensing systems) • Understanding vehicle dynamics and control (braking, steering, acceleration logic) • V2X systems knowledge • Localization, perception fusion, and manoeuvre planning • Automated driving fundamentals • Understanding of standards and safety regulations • Safety and risk management • Testing and validation of automated driving systems • Systems-level understanding and holistic system oversight • Adaptability	• Vehicle concept design and rethinking vehicle architectures (e.g. driverless cab design) • Interdisciplinary engineering skills (integration of vehicle, software, data, and system safety expertise) • ADAS / automated driving system development experience • ADAS / automated driving system validation experience • Knowledge of new sensors and emerging automotive technologies • Fleet management for vehicles with different levels of automation	• Software development skills within automotive manufacturing • Data management and data handling for large-scale automotive data • Integration of connected vehicles into Intelligent Transport Systems (ITS) • Systems architecture design • Decision-making within complex technical systems • End-to-end systems engineering • Advanced testing, validation, and verification skills • Stakeholder collaboration and cross-organisational coordination

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[2] European Commission, Joint Research Centre (2019) and Infrastructure Australia / Swinburne University (2023).

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	• Flexibility • Teamwork/ collaboration		
Service & Business Design[3]	• Business and solution-oriented thinking • Translating technology into usable and valuable customer solutions • Human–Machine Interface (HMI) design skills • User experience (UX) design for automated systems • Operational understanding of user and operator interaction with automated systems • Strategic thinking • Systems thinking • Change management • Understanding of regulatory frameworks • Software engineering • AI programming and coding • Critical thinking and technical review skills • Validation and verification of AI outputs	• Operational and organisational skills to integrate automation into existing routines • Change management • Communication skills	• Contracting and partnership management • Solution selling and commercial skills • Knowledge of business and commercial law for digital / AI-enabled products and markets • Advanced digital competences • Systems integration skills • Data analysis skills • Change management capability • Understanding of advanced system functionality • Customer support for operational activities • End-to-end service delivery management • Service monitoring, follow-up, and performance management
Software & Systems Developers	• Proficiency in modern programming languages • Cloud technologies expertise (especially AWS) • System and software architecture design • Implementation of AI applications in cloud-based production environments • Integration of AI into end-to-end, scalable infrastructures (not stand-alone solutions) • Design and management of complex, cross-system architectures • Systems architecture across vehicle, infrastructure, cloud, and partner modules • System integration skills across heterogeneous platforms • Software engineering (embedded and off-board systems) • Use of modern development tools and tooling • Data management skills (data quality, structuring, governance) • Data science and analytics • Practical application of AI and ML	• Connectivity and infrastructure competences for reliable hardware/software communication • Communication systems integration across hardware and software components • Requirements definition and specification for product development processes • Development of user feedback and monitoring systems • Continuous improvement based on user feedback and system performance • Integration of AI into operational systems • Safety integration in automated and connected systems • Development of new digital services for end users • Management of coexistence between different automation levels	• Safety engineering and quality management under high safety and quality requirements • Vehicle and system integration skills • Operation within formalised development processes and regulated environments • Strategic digital literacy (understanding digital systems without hands-on coding) • Cybersecurity skills for connected and automated systems • Systems thinking on vehicle interaction with smart cities and cloud platforms • Understanding of vehicle-infrastructure-cloud ecosystems • Orchestration and coordination of AI agents

[3] Savy, M., et al. (2024).

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	• Understanding of vehicle systems and infrastructure constraints • Hardware and software engineering skills • Software development for automated driving systems • Understanding of sensing, perception, and vehicle behaviour		
Cyber-security & IT Protection[4]	• Cybersecurity skills	• Handling of privacy and antagonistic issues	• Technological knowledge • Stronger protection against cyberattacks for different domains (e.g. insurance) • Data science • Stakeholder management
Data Science & Analytics experts	• Solid statistical foundation (model understanding, significance testing, result interpretation) • Advanced statistical methods and inference • Mathematical analysis skills • Ability to work with large-scale / high-volume datasets • Programming skills for data analysis • Use of integrated data science toolchains (e.g. Python-based workflows) • Data science and AI tools proficiency • Information retrieval and data sourcing skills • Analytical interpretation of results in a broader contextual and systemic perspective • Critical analysis beyond model-internal results • Domain knowledge to contextualise data analysis • Identification of improvement areas based on data insights	• Data handling and integration across heterogeneous sources • Working with multiple data types and formats • Understanding and navigating different data models • Data interpretation beyond centrally generated datasets • Analytical flexibility in decentralized data environments • Coordination with external partners on analytical tasks • Adapting analytical workflows to organizational changes	• Validation and quality assurance of automated outputs •
HMI, UX & Human Factors	• Human Factors (HF) expertise • Knowledge of human psychology and cognition (e.g. attention, workload, decision-making, and situational awareness) • User research and evaluation skills • Task and workflow analysis • Survey design and interview techniques • Qualitative and quantitative data collection and analysis	• Knowledge of maintenance and monitoring • Identification of the ideal level of automation • Understanding of risks, critical points, and liability issues • CCAM domain knowledge (technicalities, organisational aspects, aim of CCAM) •	• Stronger user-centered design skills • Knowledge of regulation and safety aspects of CCAM • Collaboration with designers • Collaboration with AI disciplines • Collaboration with ethics experts • Cognitive systems engineering •

[4] SHOW Project (2024), European Commission, Joint Research Centre (2019), and Arup (2019).

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	• Human–Machine Interface (HMI) design • Design thinking, prototyping, and iterative design • Critical thinking • Empathy and user-centred perspective		
Manu-facturing and assembly technician[5]	• Installing cables and electrical components • Testing systems • Materials knowledge • Operation of machines • Quality assurance • Inspection • Procurement • Logistics • Production • Assembly	• Programming • Technical skills • Adapting to new technologies • Wider knowledge of different coexisting technologies	• Electrical knowledge (shift from mechanical to electrical knowledge) • Technical installation skills • Testing skills • Design capabilities • Data management capabilities • Cooperation with mobility technology developers • Interdisciplinary collaboration • Systems understanding
Decommis-sioning & Recycling technician	No information could be obtained on this job family.		
Recycling and waste manage-ment operators	No information could be obtained on this job family.		
Main-tenance & Repair operators[6]	• Low level of social tasks • Low level of ICT use • Basic mechanic skills (scheduled maintenance, wear and tear) • Technical skills • Willingness to learn and be trained on the job • Electromechanics • Painting and bodywork	• Electrical and digital skills • Maintenance of radar, lidar systems, and sensors • Skills and certifications in managing autonomous vehicles (AVs) • Skills and certifications in managing electric vehicles (EVs) • Body repair skills • Radar alignment and calibration • Use of specific diagnostic and repair tools • Electrical maintenance skills • Computer-based diagnostics • Software diagnostics • System validation • Mechanical maintenance tasks	• ICT skills for vehicle repair and manufacturing • Electrical knowledge (shift from mechanical to electrical knowledge) • Sensor calibration • Sensor repair
Con-struction workers	No information could be obtained on this job family.		

[5] European Commission, Joint Research Centre (2019).
[6] European Commission, Joint Research Centre (2019), European Commission, Joint Research Centre (2019a), and Infrastructure Australia / Swinburne University (2023),

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Emergency & Incident Manage-ment	No information could be obtained on this job family.		
Urban Planning & Digital infra-structure[7]	• Traditional urban planning skills	• Scenario planning • Data processing skills • Handling increased volumes of information • Identification of potential safety-critical situations	• Implementing big data and modelling for transportation systems management and operations
Remote mobility support roles	N/A		• Social skills • Customer service
On-site mobility assistance	• Customer service skills • Multilingual abilities • Understanding of passenger rights • Understanding of service procedures • Risk awareness • Basic security knowledge • Basic IT skills • Handling passenger service requests • Ticketing • Dispatching • Communication with transport operators • Customer service culture • Empathy • Ability to work with passengers with diverse needs • Logical thinking • Spatial orientation	• Acceptance of new technologies • Continuous learning • Adaptability to new digital tools • Advanced interpersonal service skills	• Higher digital literacy • Ability to support passengers in using digital systems • Knowledge of accessibility services • Empathy • Communication skills • Stress management • Risk management • Safety awareness • Interpersonal skills • Care-related skills
Sur-veillance Operators	No information could be obtained on this job family.		
Mobility and services platform managers[8]	• Operational understanding of digital platforms (fleet monitoring, vehicle status dashboards, map views) • Communication skills • Customer orientation • Human interaction with drivers and customers • Basic digital competencies • Operational planning • Procurement • Scheduling • Basic understanding of digital systems • Legal expertise • Risk analysis • Insurance knowledge	• Coordination skills • Systems overview skills • Legal and regulatory expertise • Insurance expertise • Liability expertise • Cybersecurity • Systems governance	• Data management expertise • Handling large volumes of collected data • Interaction with passengers • Managing autonomous fleets • Human interaction skills (changing nature) • System-level thinking (traffic systems, urban systems, societal impacts) • Governance skills • Coordination skills • Understanding authority, influence, and responsibility across levels • Negotiation skills

[7] Infrastructure Australia / Swinburne University (2023).
[8] Bissell, D., Birtchnell, T., Elliott, A., & Hsu, E. L. (2020).

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	• Data protection knowledge • Liability management • Economics and business understanding • Human factors and psychology • User-centred design • Knowledge of regulation		• Contract management skills • Scenario analysis • Optimisation logic • Understanding trade-offs between different optimisation goals (e.g. speed vs. climate impact)
Remote Operations[9]	• N/A	• Driving skills • Remote driving system skills (joystick operation, remote dashboards) • IT literacy • Ability to interpret system data • Ability to respond to anomalies	• Technological knowledge • Automated driving supervision skills • ICT expertise (for handling cyberattacks) • Problem-solving skills • Job-specific skills • Teamwork • Communication skills • Learning skills • Call-centre skills • Dispatcher skills • Technician skills • Maintenance skills • Strong language skills • Monitoring software and hardware used for automated driving • Familiarity with advanced safety systems • Understanding interaction between safety systems and the driving environment • Appropriate use of advanced safety systems to enhance operator safety • Data entry skills related to trip scheduling and route planning
Drivers[10]	• Low level of social tasks • Low levels of ICT use • Driving licence • Theoretical training • Practical training • Social skills (in case of passenger contact) • Managing stressful situations • Tram logistics • Shift work • Basic vehicle inspection • Carrying documentation for goods transport • Confirming goods condition • Securing merchandise • Route knowledge • Vehicle-handling skills	• Supervision skills • Selective intervention skills • Providing e-services on the road (e.g. ticketing) • Skills in other languages • Knowledge of international laws • Knowledge of international regulations • Knowledge of environmental requirements • Social skills for contact with the travelling public	• Rremote operation skills • Vehicle maintenance (non-driving tasks) • Cargo maintenance • Soft skills • Skills related to a service companion role • Skills related to a mobility facilitator role • Troubleshooting skills • Identifying dashboard warning lights • Identifying false breakdowns

[9] SHOW Project (2024), European Commission, Joint Research Centre (2019), Leonard, J., Mindell, D., & Stayton, E. (2020), and Michigan State University / Texas A&M Transportation Institute (2018).

[10] SHOW Project (2024), European Commission, Joint Research Centre (2019), WeTransform Project (2022), European Commission, Joint Research Centre (2019a), European Commission (2014), Michigan State University / Texas A&M Transportation Institute (2018), and Upjohn Institute (2018).

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	• Compliance with traffic rules • Resourcefulness • Carefulness • Adaptability • Respectfulness • Flexibility • Patience • Calmness • Creativity when loading the truck • Manoeuvring skills • Spatial awareness of the vehicle • Familiarity with road and safety regulations • Concentration • Punctuality • Politeness • Ability to work independently • Helpfulness • Collaborative skills • Motivation		
Freight, Warehouse & Port workers	• Availability • Adaptation • Safe driving skills	• Supervision • System control • Maintenance • Exception handling	• Technical skills • IT skills • System-monitoring skills • Data analysis • Compliance • System supervision • Decision-making skills
Logistics Managers	• Proficiency in working with computers • Proficiency in working with technical equipment • Proficiency in working with information systems • Logical thinking • Analytical abilities • Communication skills in several languages • Knowledge of industry-specific legislation • Planning work independently • Organizing work independently • Training new employees • Supervising fulfilment of duties • Defining logistics process policies • Preparing reports • Teamwork skills	No information on higher CCAM levels could be obtained for this job family.	
Traffic Control & Signalling[11]	• Adherence to occupational safety requirements • Technical skills in working with equipment • Technical skills in working with information systems	• Processing documentation electronically • Handling AI-planned routes • Data literacy for traffic management • Understanding reliability of different data sources	• Incorporating integrated corridor management techniques into traffic signal operations • Understanding CAV impacts on traffic signal operations • Using GIS tools

[11] Infrastructure Australia / Swinburne University (2023).

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	(route management information system) • Responsibility • Accuracy • Analytical thinking • Re-coordinating traffic operations • Monitoring compliance with schedules • Recording discrepancies • Communication skills with carrier representatives • Communication skills with drivers • Ability to work under pressure • Cooperation within a team • Preparation of reports • Collaboration with drivers • Route planning • Handling electronic documentation • Preparation of documents • Local decision-making • Physical infrastructure handling • Understanding of digital systems • Ability to navigate organisational boundaries • Knowledge of sensor systems • Data reliability assessment • Ability to analyse heterogeneous data sources • Ability to combine heterogeneous data sources • Understanding organisational constraints • Understanding of traffic signals • Understanding road quality • Understanding road safety • Maintenance planning • Analytical ability • Use of technical equipment • Assessment of durability • Traffic management • Equipment maintenance • Fleet supervision • Decision-making in operational incidents • Remote intervention in difficult situations	• Managing datasets • Working with data standards • Data analysis • Handling increased data delivery obligations	• Using analytical tools and models • Creating information to support operational decision-making • Using real-time data • Making real-time operational decisions • Implementing prediction software • Using prediction software for operational decisions
Human Resources & Orga-nisational Develop-ment	• Empathy • Awareness • Understanding of personal limitations • Finding solutions to adapt activities and jobs • Knowledge of the approach • Knowledge of accessibility issues in the job market	• Continuous research into skills needs • Updating training courses in response to changing technologies • Creating new vacancies based on emerging skill needs	• Same as for mid-CCAM deployment

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	• Methodologies to collect needs • Turning needs into requirements • Development of career paths • Designing training courses that include diverse groups		
Legal & Regulatory profes-sionals[12]	• Knowledge of anti-corruption legislation • Knowledge of international sanctions • Knowledge of personal data protection • Knowledge of corporate sustainability • Knowledge of business ethics • Formal writing skills • Drafting skills • Languages knowledge • Analytical skills • Responding to complex situations • Teaching skills • Communication skills • Pedagogical persuasion • Knowledge of legal frameworks • Knowledge of regulatory frameworks • Knowledge of insurance processes • Risk assessment • Digital literacy • Understanding of data protection regulations • Understanding of data privacy • Secure information handling	• Evaluating cyber safety issues related to AVs • Evaluating privacy issues related to AVs • Adaptation to new civil liability regimes • Adaptation to new criminal liability regimes • GDPR knowledge	• Knowledge of underlying regulations • Prompting skills • Literacy in new technologies • Use of automated analysis tools • Use of digital data systems • Decision-making in legal contexts • Legal interpretation • Governance expertise
Policy makers	• Data collection • Analysis of travel patterns • Cybersecurity awareness • Regulation • Supervision • Permitting	• Understanding proof and demonstrations of possible impacts • Rapid delivery of analytical material • Understanding AI • Using AI as a basis for decision-making • Requesting appropriate evidence and material for decisions	• Understanding of new technologies • Cybersecurity knowledge • Understanding of systemic risks • Continuous development of regulatory frameworks • Ongoing revision of definitions and regulation
Insurance & Risk Assess-ment[13]	• Traditional insurance and risk assessment skills	• Evaluation of cybersecurity and privacy risks	• Management of ICT experts and handling of cyberattacks • Intersection of legal and ethical knowledge

[12] Anderson, J. M. (2018).
[13] European Commission, Joint Research Centre (2019) and Anderson, J. M. (2018).

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Ethics & Philosophy experts	• Ethics and philosophy knowledge	• Policy advice • Human-machine interaction	• Intersection of legal and ethical knowledge • Regulation of liability and responsibility
Socio-economic & Impact Analyst	No information could be obtained on this job family.		
Health, Safety & Ergo-nomics	No information could be obtained on this job family.		
Sales workers[14]	• Knowledge of damage responsibility • Invoicing to customers • Customer service skills • Computer skills • Product knowledge • Problem-solving skills • Technical skills in working with equipment • Technical skills in working with information systems (ticketing software) • Responsibility in handling payments • Accuracy in handling cash and non-cash payments • Preparing precise reports • Communication skills in several languages • Resilience under pressure • Teamwork skills • Explaining vehicle functionality • Vehicle configuration skills • Basic vehicle operation • Vehicle troubleshooting	• Technical understanding of vehicles • Understanding problems and damages in vehicles • Computer skills • Software monitoring skills	• Understanding sector-specific vehicle knowledge • Communicating specific knowledge to customers
Sales & Marketing specialists	• Data analysis skills (structured data) • Customer behaviour analysis • Use of digital analytics tools • Translation of data into business decisions • Understanding of data privacy • Cybersecurity knowledge • Understanding of compliance requirements	• Communication • Collaboration • Engagement • Openness to change	• Strategic thinking • Creativity • Managing AI-supported processes • Adaptability • Openness to change • Curiosity • Collaboration • Teamwork
Trainers[15]	• Communication skills • Social skills • Cognitive skills requiring creativity • Maintenance of electric vehicles	• Use of large language models (LLMs) to prepare materials • Accessing a wider information base efficiently using LLMs	• New knowledge to teach • Teaching attention • Teaching decision-making • Teaching rapid re-engagement in unexpected situations

[14] European Commission, Joint Research Centre (2019) and Savy, M., et al. (2024).
[15] Valtioneuvosto (Finnish Government) (2019).

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	• Risk management • Public speaking • Teaching skills • Error analysis • Management (in a teaching context) • Improvisation • Subject-matter expertise • Soft skills related to the educator role • Teaching technical vehicle handling • Teaching driver behaviour • Teaching risk awareness	• Teaching monitoring of automated systems • Teaching understanding of automated systems • Teaching management of automated systems	• System understanding • Understanding limits of automation • Understanding risk of overtrust in technology • Teaching of handling rare but critical events
Educa-tional program Developers[16]	• Communication skills • Social skills • Cognitive skills requiring creativity • Digital literacy • Customer orientation • Feed management expertise • Understanding of connected car technologies • Data interpretation • Diagnostics • Ability to use digital platforms for vehicle management • Ability to use digital platforms for customer management	• Digital skills • Data skills • Customer experience design in a digital contact context • Soft skills	• New knowledge to teach • Teaching attention • Teaching decision-making • Teaching rapid re-engagement in unexpected situations • System understanding • Understanding limits of automation • Understanding risk of overtrust in technology Teaching of handling rare but critical events

[16] Valtioneuvosto (Finnish Government) (2019).

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11. Annex III: Literature reviewed for Task 3.3

1. Acemoglu, D., & Restrepo, P. (2020). Robots and jobs: Evidence from US labor markets.
2. Aisa, R., Cabeza, J., & Martin, J. (2023). Automation and aging: The impact on older workers in the workforce. *The Journal of the Economics of Ageing, 26*, 100476. https://doi.org/10.1016/j.jeoa.2023.100476
3. Ammann, A., & Hadj Abdou, L. (2026). *Sustainable labour market integration of migrants: Drivers of skills mismatch and skills matching policies and initiatives*. International Organization for Migration.
4. Anderson, J. M., Kalra, N., Stanley, K. D., Sorensen, P., Samaras, C., & Oluwatola, O. (2016). Autonomous vehicle technology: A guide for policymakers.
5. Arntz, M., Gregory, T., & Zierahn, U. (2016). The risk of automation for jobs in OECD countries: A comparative analysis.
6. Autor, D. H. (2015). Why are there still so many jobs? The history and future of workplace automation.
7. Autor, D. H., Levy, F., & Murnane, R. J. (2003). The skill content of recent technological change: An empirical exploration.
8. Brynjolfsson, E., & McAfee, A. (2014). The second machine age.
9. CCAM Partnership Strategic Research and Innovation Agenda and related Cluster 6 societal and people-needs outputs.
10. CCAM-ERAS project outputs and materials on the socio-economic foundations of automated mobility.
11. Cedefop and Eurofound. (2018). Skills forecast: Trends and challenges to 2030.
12. Cedefop. (2018). Insights into skill shortages and skill mismatch.
13. Cedefop. (2020). Empowering adults through upskilling and reskilling pathways.
14. Cedefop. (2020). *Empowering adults through upskilling and reskilling pathways*. Publications Office of the European Union.
15. Cedefop. (2023). Skills in transition: The way to 2035.
16. Cedefop. (n.d.). *Skills Forecast*. https://www.cedefop.europa.eu/en/projects/skills-forecast
17. Cedefop. (n.d.). *Skills intelligence*. https://www.cedefop.europa.eu/en/tools/skills-intelligence
18. Council of Economic Advisers. (2024). *Potential labor market impacts of artificial intelligence: An empirical analysis*. The White House. https://bidenwhitehouse.archives.gov/wp-content/uploads/2024/07/Potential-Labor-Market-Impacts-of-Artificial-Intelligence-An-Empirical-Analysis-July-2024.pdf
19. Đorđević, B., Milanović Zbiljić, S., & Radosavljević, M. (2025). Impact of the digital skills on employability: Cross-sectional analysis. *Economies, 13*(7), 196. https://doi.org/10.3390/economies13070196
20. Duboz, L., Alčiauskaitė, L., Mate, E., Mourtzouchou, A., Garus, A., Nahmias Biran, B. H., & Ciuffo, B. (2025). *Requirements for inclusive automated vehicle services: Insights for vehicle and smartphone application design*. Publications Office of the European Union. https://doi.org/10.2760/7655690
21. Endsley, M. R. (2017). From here to autonomy: Lessons learned from human-automation research.
22. Eurofound. (2020). New forms of employment: 2020 update.

23. Eurofound. (2021). Working conditions in platform work.
24. European Commission, Directorate-General for Employment, Social Affairs and Inclusion. (2023). *Employment and social developments in Europe 2023: Addressing labour shortages and skills gaps in the EU*. Publications Office of the European Union. https://doi.org/10.2767/089698
25. European Commission, Directorate-General for Employment, Social Affairs and Inclusion. (2025). *Employment and social developments in Europe 2025: Unlocking the potential of people: Promoting higher employment in the EU*. Publications Office of the European Union. https://doi.org/10.2767/9505984
26. European Commission, Directorate-General for Mobility and Transport. (2026). *Young people and transport jobs: Making transport careers more attractive: Brussels, 15 October 2025 conference report*. Publications Office of the European Union. https://doi.org/10.2832/8099180
27. European Commission, Joint Research Centre. (2019). *The changing nature of work and skills in the digital age*. Publications Office of the European Union.
28. European Commission, Joint Research Centre. (2020). The impact of automation on labour markets in EU regions.
29. European Commission. (2020). *A Union of Equality: Gender Equality Strategy 2020–2025*.
30. European Commission. (2020). Action Plan on Integration and Inclusion 2021-2027.
31. European Commission. (2020). European Skills Agenda for sustainable competitiveness, social fairness and resilience.
32. European Commission. (2020). Gender Equality Strategy 2020-2025.
33. European Commission. (2020). *Sustainable and Smart Mobility Strategy: Putting European transport on track for the future*.
34. European Commission. (2021). European Pillar of Social Rights Action Plan.
35. European Commission. (2021). Strategy for the Rights of Persons with Disabilities 2021-2030.
36. European Commission. (2021). *The European Pillar of Social Rights Action Plan*.
37. European Commission. (2021). *The New EU Urban Mobility Framework*.
38. European Commission. (n.d.). *Women participation in STEM*. https://education.ec.europa.eu/focus-topics/digital-education/action-plan/Women-participation-in-STEM
39. European Parliament / EPRS. (2019). Self-driving cars in the EU: From science fiction to reality.
40. European Parliament. (2021). Artificial intelligence in transport: Current and future developments, opportunities and challenges.
41. European Training Foundation. (n.d.). *Women and girls in STEM*. https://www.etf.europa.eu/
42. Fagnant, D. J., & Kockelman, K. (2015). Preparing a nation for autonomous vehicles: Opportunities, barriers and policy recommendations.
43. FAME / Connected Automated Driving Knowledge Base and EU Common Evaluation Methodology materials.
44. Filippi, E., Bannò, M., & Trento, S. (2023). Automation technologies and their impact on employment: A review, synthesis and future research agenda. *Technological Forecasting and Social Change, 191*, 122448. https://doi.org/10.1016/j.techfore.2023.122448

45. Frey, C. B., & Osborne, M. A. (2017). The future of employment: How susceptible are jobs to computerisation?
46. Goos, M., Manning, A., & Salomons, A. (2014). Explaining job polarization: Routine-biased technological change and offshoring.
47. Hadj Abdou, L., & Ebner, P. (2024). *Labour migration in times of labour shortages in Austria*. International Organization for Migration.
48. Hadj Abdou, L., & Ebner, P. (2025). *Labour migration in times of labour shortages in Austria*. International Organization for Migration.
49. International Labour Organization. (2019). *Work for a brighter future: Global Commission on the Future of Work*. International Labour Office.
50. International Labour Organization. (2021). World employment and social outlook 2021: The role of digital labour platforms in transforming the world of work.
51. International Labour Organization. (n.d.). *International Standard Classification of Occupations (ISCO)*. https://www.ilo.org/public/english/standards/isco/
52. International Transport Forum. (2017). Managing the transition to driverless road freight transport.
53. International Transport Forum. (2018). Safer roads with automated vehicles?
54. International Transport Forum. (2023). *Adapting (to) automation: Transport workforce in transition*. OECD Publishing. https://doi.org/10.1787/905fdc2c-en
55. International Transport Forum. (2025). *Skills move us forward: Transport workforce skills in the age of AI*. OECD Publishing.
56. International Transport Forum. (n.d.). *Gender analysis toolkit for transport policies*. https://gendertoolkit.itf-oecd.org/
57. Kyriakidis, M., Happee, R., & de Winter, J. C. F. (2015). Public opinion on automated driving: Results of an international questionnaire among 5,000 respondents.
58. Maronitis, K. (2019). Robots and immigrants: Employment, precarisation and the art of neoliberal governance. *Angles: New Perspectives on the Anglophone World, 8*. https://doi.org/10.4000/angles.570
59. Milakis, D., van Arem, B., & van Wee, B. (2017). Policy and society related implications of automated driving: A review of literature and directions for future research.
60. OECD. (2018). Working together for local integration of migrants and refugees.
61. OECD. (2018). *Working together for local integration of migrants and refugees*. OECD Publishing. https://doi.org/10.1787/9789264085350-en
62. OECD. (2019). OECD Employment Outlook 2019: The future of work.
63. OECD. (2019). OECD Skills Outlook 2019: Thriving in a digital world.
64. OECD. (2020). Job Creation and Local Economic Development 2020: Rebuilding better.
65. OECD. (2021). *Preventing deepening inequalities in the COVID-19 recovery*. OECD Publishing.
66. OECD. (2023). *Employment and skills policies for the green transition*. OECD Publishing.
67. OECD. (2023). OECD Skills Outlook 2023: Skills for a resilient green and digital transition.
68. O*NET Online. (n.d.). O*NET Online*. https://www.onetonline.org/

69. Pappas, M. A., Drigas, A. S., Papagerasimou, Y., Dimitriou, H., Katsanou, N., Papakonstantinou, S., & Karabatzaki, Z. (2018). Female entrepreneurship and employability in the digital era: The case of Greece. *Journal of Open Innovation: Technology, Market, and Complexity, 4*(2), 15. https://doi.org/10.3390/joitmc4020015
70. Parasuraman, R., Sheridan, T. B., & Wickens, C. D. (2000). A model for types and levels of human interaction with automation.
71. SAE International. (2021/2023). Taxonomy and definitions for terms related to driving automation systems for on-road motor vehicles (J3016).
72. SKILLFUL project outputs on future transport professionals, skills, competences and training needs.
73. Spencer, D., Cole, M., Joyce, S., Whittaker, X., & Stuart, M. (2021). *Digital automation and the future of work*. European Parliament, Panel for the Future of Science and Technology. https://doi.org/10.2861/826116
74. Susskind, D. (2020). A world without work: Technology, automation and how we should respond.
75. Taeihagh, A., & Lim, H. S. M. (2019). Governing autonomous vehicles: Emerging responses for safety, liability, privacy, cybersecurity and industry risks.
76. UNESCO Institute for Statistics. (n.d.). *Gender imbalances remain in digital skills and STEM careers*. https://uis.unesco.org/
77. WE-TRANSFORM project outputs on automation impacts, transport labour-force transition and stakeholder dialogue.
78. World Bank. (2019). World development report 2019: The changing nature of work.
79. World Economic Forum. (2023). *The Future of Jobs Report 2023*. World Economic Forum.
80. World Economic Forum. (2025). *The Future of Jobs Report 2025*. World Economic Forum.
81. World Economic Forum. (n.d.). *Global Skills Taxonomy*. https://initiatives.weforum.org/reskilling-revolution/gst