D4.1 Supply chain mapping report

Deliverable No. 4.1 Supply Chain Mapping Report

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Introduction

This report summarises the supply chain for Cooperative Connected Automated Mobility (CCAM), with a focus on freight, logistics and passenger land transport as a part of the work done in Work Package 4A of the CCAM-ERAS project. The material has been gathered and written in preparation of subsequent deliverables in this project.

Work Package 3C selected six use case families rather than NACE-specific use cases. The work under Work Package 4A requires mapping the use cases to supply chain NACE sectors of the economy. These include freight transportation use cases such as last-mile delivery, bus depot operations, and port/terminal logistics, as well as passenger transportation use cases covering public transport, private shared mobility, and targeted shared services for specific groups. The changes to the supply chain of current transport NACE sector from the integration of CCAM have been identified through a literature review.

To understand the future evolution of transport and changes in the supply chain of transport with increasing levels of automation, this report begins with a discussion of the supply chain of the traditional freight, logistics and land transport sector. Subsequent section discuss the changing shares in different sectors due to automation.

Supply chain of traditional logistics and warehousing

The technology currently used for the large-scale production and deployment of traditional logistics supply chains in the EU spans over multiple sectors: e.g., vehicle manufacturing, infrastructure development, operational services, and support functions that enable the movement of freight across long-haul transportation, transition hubs, warehouses and urban deliveries. A detailed breakdown of these components is provided in Table 1.

Table 1: Supply chain of traditional logistics and warehousing sector

Category	NACE Code	Description
Vehicle manufacturing	C29.10	Manufacture of motor vehicles (buses, coaches, minibuses)
	C29.20	Manufacture of bodies (coachwork) for motor vehicles
	C29.30	Manufacture of parts and accessories for motor vehicles (engines, transmissions, safety systems)
Maintenance	C33	Repair and installation of machinery and equipment
Infrastructure	M71	Architectural and engineering activities
	F42.1	Construction of roads and railways.
Transport operations	H49	Land transport and transport via pipelines
	H50	Water transport
	H53	Postal and courier activities
Employment	N78	Employment activities
Support and ancillary services	H52	Warehousing and support activities for transportation (maintenance, parking facilities, logistic hubs)
	K64	Financial service activities, except insurance and pension funding
	K65	Insurance, reinsurance and pension funding, except compulsory social security
	J61	Telecommunications (digital ticketing, GPS tracking, intelligent transport systems for real-time passenger information)
Energy supply	D35	Electricity, gas, steam, and air conditioning supply (renewable energy for electric buses, trains, charging infrastructure)
	C19	Manufacture of coke and refined petroleum products
Trade	N77.1	Rental and leasing of motor vehicles
	G47	Retail trade, except of motor vehicles and motorcycles
	G46	Wholesale trade, except of motor vehicles and motorcycles
	G45	Wholesale and retail trade and repair of motor vehicles and motorcycles

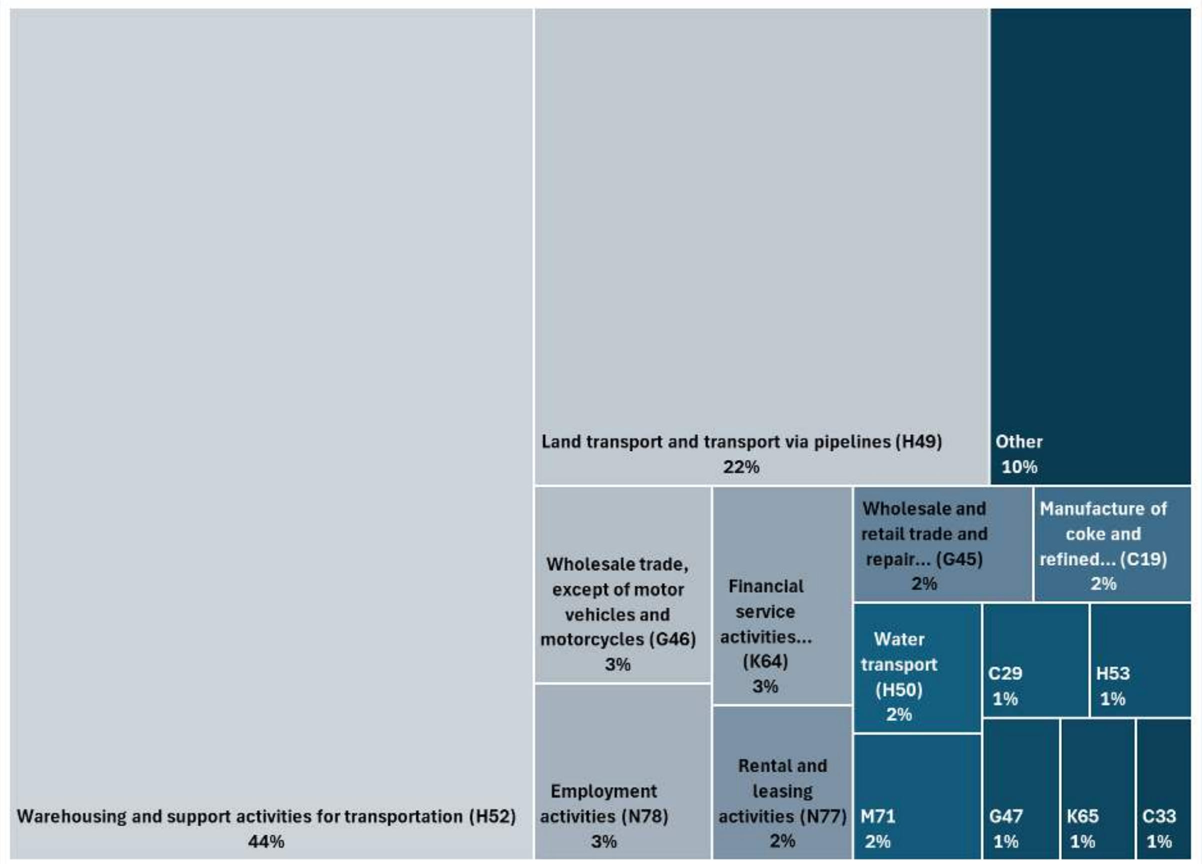
Source: Authors' elaboration based on Eurostat naio_10_cp1750 dataset.

Figure 1 shows that the supply chain associated with the logistics sub-sector are largely concentrated in the warehousing and support activities for transportation (H52) sector, which accounts for 44% of total inputs, and the land transport and transport via pipelines (H49) sector, which makes up 22% of the inputs. Together, these two sectors contribute approximately 66% of total inputs required by the freight and logistics sector in the EU.

Besides these two NACE sectors, there are several ancillary sectors related to activities around motor vehicles, which includes the wholesale trade, except for motor vehicles and motorcycles sector (3%), employment activities (3%), financial service activities (3%), and rental and leasing activities (2%). Additionally, wholesale and retail trade and repair of motor vehicles and motorcycles (2%), manufacture of coke and refined petroleum products (2%), and water transport (2%) could also be categorised under the sector grouping of ancillary activities surrounding the manufacture and sale of motor vehicles.

Several smaller input sectors contribute 1% or less to the supply chain for freight and warehousing services, including manufacture of machinery and equipment, manufacture of other transport equipment, postal and courier activities, insurance, reinsurance, and pension funding, and manufacture of motor vehicles, trailers, and semi-trailers.

Figure 1: Share of sectors in the supply chain of traditional logistics and warehousing



Note: Sectors abbreviations refer to the NACE Rev.2 classification and their description can be found in Table 1. *Other regroups all other NACE sectors not specified in the treemap. The top ten sectors in the "Other" grouping include manufacture of machinery and equipment n.e.c.; air transport; manufacture of fabricated metal products, except machinery and equipment; telecommunications; manufacture of electrical equipment; manufacture of basic metals; advertising and market research; manufacture of paper and paper products; activities of membership organisations; manufacture of chemicals and chemical products.*

Source: naio_10_cp1750, update of 30.01.2025.

Supply chain of traditional land passenger and freight transport sector

Current technology for the manufacture, and deployment of traditional land transport supply chain in the EU involves multiple sectors. It encompasses the production of vehicles, infrastructure development, operational services, and support functions that facilitate the movement of passengers and freight across urban, interurban, and rural networks. The supply chain is summarised in **Error! Reference source not found.**. It shows that warehousing and s upport activities for transportation, land transport and transport via pipelines sectors make up approximately 50% of total inputs of the land transport sector in the EU. Vehicle production forms a critical part of the supply chain (4%), with key segments including the manufacture of motor vehicles, trailers, and semi-trailers. Specific sub-sectors focus on the production of buses, coaches, and minibuses, as well as manufacturing and the production of essential parts and accessories, such as engines, transmissions, and safety systems. Vehicle manufacturing relies on a broad network of suppliers providing raw materials, components, and technology, which are also present in the supply-chain of land transport.

The energy supply sector, particularly the manufacture of coke and refined petroleum products, represents 11% of the supply chain share, illustrating the continued reliance on fossil fuels. However, with the increasing share of electrical vehicles in the existing fleet of passenger vehicles, the supply chain dynamics of traditional passenger vehicles is expected to change. There is now a greater emphasis on mineral sourcing for battery production (e.g., lithium-ion batteries), charging infrastructure, and the electrification of roads, which are not yet fully captured in the conventional supply chain categorisations (European Commission, 2024a).

Table 2 Supply chain of traditional land transport sector

Category	NACE Code	Description
Vehicle manufacturing	C29	Manufacture of motor vehicles, trailers, and semi-trailers
Infrastructure	F42.1	Construction of roads and railways.
Transport operations	H49	Land transport and transport via pipelines
	H53	Postal and courier activities
	G45	Wholesale and retail trade and repair of motor vehicles and motorcycles
	G46	Wholesale trade, except of motor vehicles and motorcycles
Support and ancillary services	H52	Warehousing and support activities for transportation (maintenance, parking facilities, logistic hubs)
	J61	Telecommunications (digital ticketing, GPS tracking, intelligent transport systems for real-time passenger information)
Energy supply	D35	Electricity, gas, steam, and air conditioning supply (renewable energy for electric buses, trains, charging infrastructure)
	C19	Manufacture of coke and refined petroleum products
Trade	G47	Retail trade, except of motor vehicles and motorcycles
	G46	Wholesale trade, except of motor vehicles and motorcycles
	G45	Wholesale and retail trade and repair of motor vehicles and motorcycles
Administrative and support services	N77	Rental and leasing activities
Financial and insurance activities	L64.9	Financial service activities, except insurance and pension funding
	L65	Insurance, reinsurance and pension funding, except compulsory social security

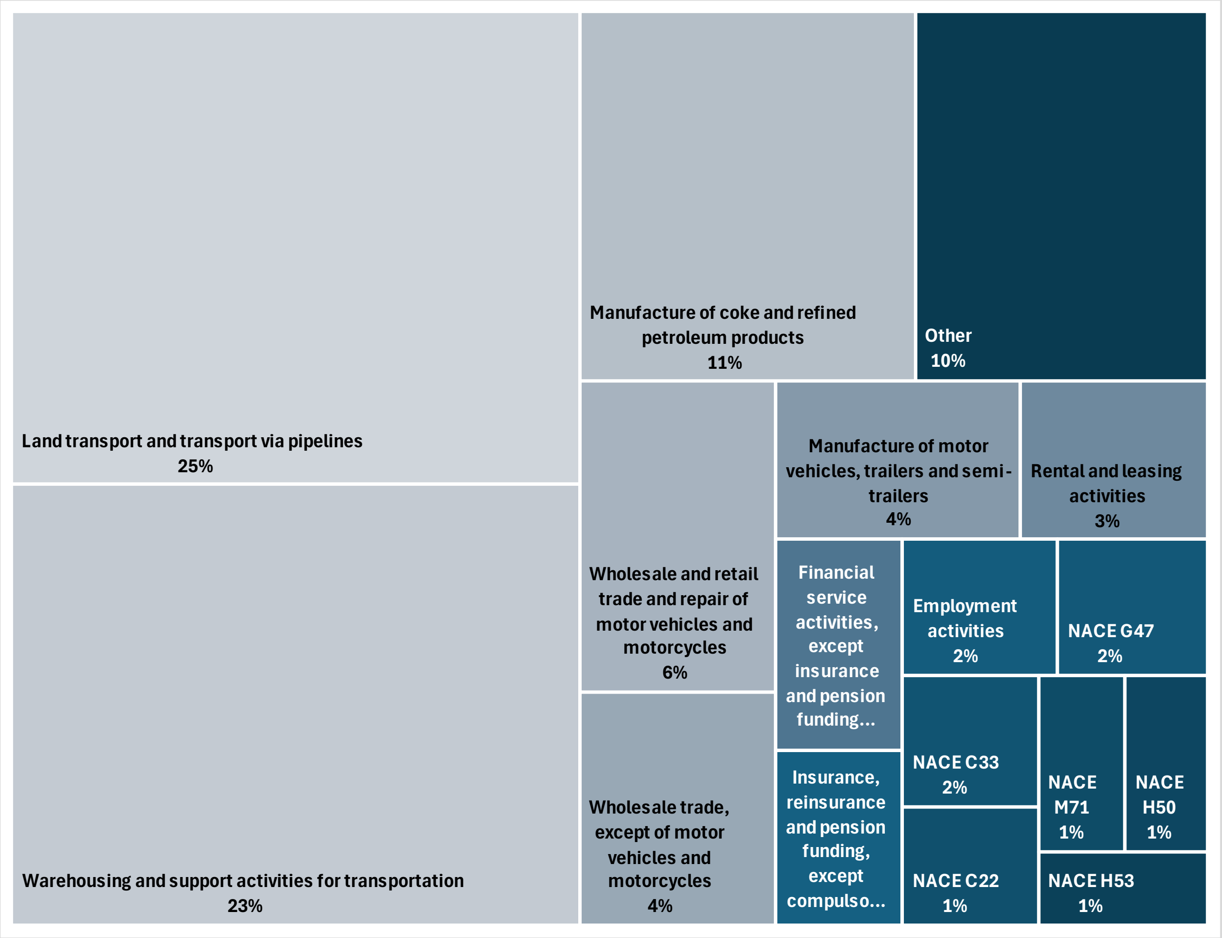
Source: Authors' elaboration based on Eurostat naio_10_cp1750

Wholesale trade accounts for 4% of the supply chain, emphasising its role in providing necessary materials, vehicle parts, and transport-related goods. Similarly, retail trade contributes 2%, further supporting sectoral activities by ensuring accessibility to essential transport-related products and services.

Financial and insurance activities together contribute 4%, supporting investment in transport infrastructure, vehicle procurement, and operational expansions. Additionally, rental and leasing activities account for 3%, facilitating access to vehicles and equipment, particularly for commercial transport operators. The employment activities sector accounts for 2%, highlighting the workforce dependency within the transport supply chain, with recruitment services ensuring a steady labour supply for driving, logistics, and maintenance functions.

Approximately 6% of the supply chain for land transport includes *postal and courier activities, water transport, architectural and engineering activities; technical testing and analysis, manufacture of rubber and plastic products, repair and installation of machinery and equipment as well as retail trade, except of motor vehicles and motorcycles* (details of the breakdown are indicated in Figure 2 with corresponding NACE codes).

Figure 2 Share of sectors in the supply chain of traditional land transport (H49)



Note: The description of sectors using NACE codes ca be found in Table 2*Sectors categorised as "other" in this figure include activities of membership organisations, travel agency, tour operator reservation service and related activities, manufacture of electrical equipment, manufacture of basic metals, activities auxiliary to financial services and insurance activities, telecommunications, manufacture of machinery and equipment n.e.c., manufacture of fabricated metal products, except machinery and equipment, manufacture of chemicals and chemical products, manufacture of other transport equipment*

Source: Eurostat naio_10_cp1750, update of 30.01.2025

Current fleets of passenger vehicles have digital elements (which call be called level 2 autonomous), but their share within the fleet is expected to increase (Mckinsey, 2023). As of 2024, there are approximately 54 million vehicles with some level of automation (Placek, 2023) globally. Key trends impacting the supply chain include:

- Electrification: increased demand for batteries, charging stations, and renewable energy sources.
- Integration of digital services: expansion of smart transport solutions, digital ticketing, and data analytics for mobility planning.

Similarly, freight vehicle fleets already integrate important digital elements (J61). However, with the ongoing advancement of automation, the scope of these digital components are expected to grow significantly within the supply chain.

Demand for CCAM

The demand for autonomous vehicles is driven by several key economic factors. Demand for automated logistics and warehousing has been driven by labour shortages and cost concerns (Das & Verma, 2025). This, combined with the rapid growth in sectors such as e-commerce, which rely heavily on efficient and rapid logistical operations and the rapid technological progress such as the creation of the Internet of Things (IoT), has stimulated demand for automated warehousing and logistics operations in recent years (LogisticsIQ, 2019; Research and Markets, 2024).

Automation can help mitigate labour shortages in the transportation industry, particularly the shortage of truck divers (Kelly, 2022). Additionally, automated vehicles can alleviate congestion and improve traffic flow, resulting in shorter travel times, lower fuel consumption, and reduced emissions (Uniyal, 2025). In freight transportation, autonomous trucks can operate continuously without the need for rest breaks, thereby increasing delivery speed and efficiency, making them an attractive option for carriers. Furthermore, automated vehicles have the potential to substantially reduce accidents caused by human error, which constitutes the majority of traffic incidents. Advanced Driver Assistance Systems (ADAS) and other autonomous driving technologies can detect and respond to hazards more swiftly and accurately than human drivers, thereby enhancing traffic safety (Thales, 2017).

The introduction of CCAM technologies in the transport sector is expected to have mixed repercussions on the labour force. On the positive side, the demand for IT professionals will rise as the need for support, maintenance, and development of digital infrastructure grows (European Commission, 2018). This could include roles such as software developers, data analysts, cybersecurity experts, and IT support specialists.

However, the automation of transport systems will likely reduce the demand for several labour-intensive roles. For instance, the need for drivers, ticket sellers, and controllers will decrease as automated systems take over these functions (European Commission, 2018). This shift necessitates proactive measures to mitigate the negative impacts, such as retraining programs and social safety nets to support displaced workers.

Other occupations that might be impacted include maintenance and repair workers, who will need to adapt to new technologies and possibly acquire new skills to manage automated systems, highlighting a need for up-skilling part of the workforce (Alonso Raposo et al., 2018; European Commission, 2018).

CCAM use cases in freight and logistics transportation

The following use cases have been identified in freight transportation and logistics:

- **Ground transportation for last-mile delivery**: Distributing parcels and/or groceries that can arrive at your doorstep.
- **Bus depot**: Service involving public transportation OEMs, public transportation operators, and logistics, where the buses can be driven by wires within the depot.

- **Port/terminal**: Functions such as access control, charging, loading/unloading, transfer between modes, and logistics planning.

CCAM supply chain elements

The CCAM freight vehicle and the warehousing and logistics sectors utilise a largely identical vehicle supply chain as its non-automated counterparts, with some notable additions. The sectors supporting the production of CCAM freight vehicles can be broadly categorised into three groups:

1. sectors involved in the manufacturing of autonomous vehicles/robotics;
2. sectors purchasing autonomous vehicles/robotics and providing support and ancillary services;
3. sectors offering cross-cutting infrastructure throughout all stages of CCAM production and deployment.

As seen in Figure 4, the vehicle manufacturing sector (C29) is at the centre of the production of CCAM freight transportation. In logistics, the production of CCAM is more likely to be centred around the manufacturing of autonomous robots and drones (C28). However, Litman (2024) and DHL (2024) point out, that the integration of sophisticated technological hardware and software is crucial for the safe deployment of CCAM solutions. Automated freight, logistics and warehousing would thus need important contributions from the computer, optical, and electronic sectors (C26), as well as the computer programming and information services sectors (J62). These contributions would range from hardware components such as cameras and RADAR and LIDAR sensors to software tools such as the implementation of an Internet of Things (IoT) in a warehouse.

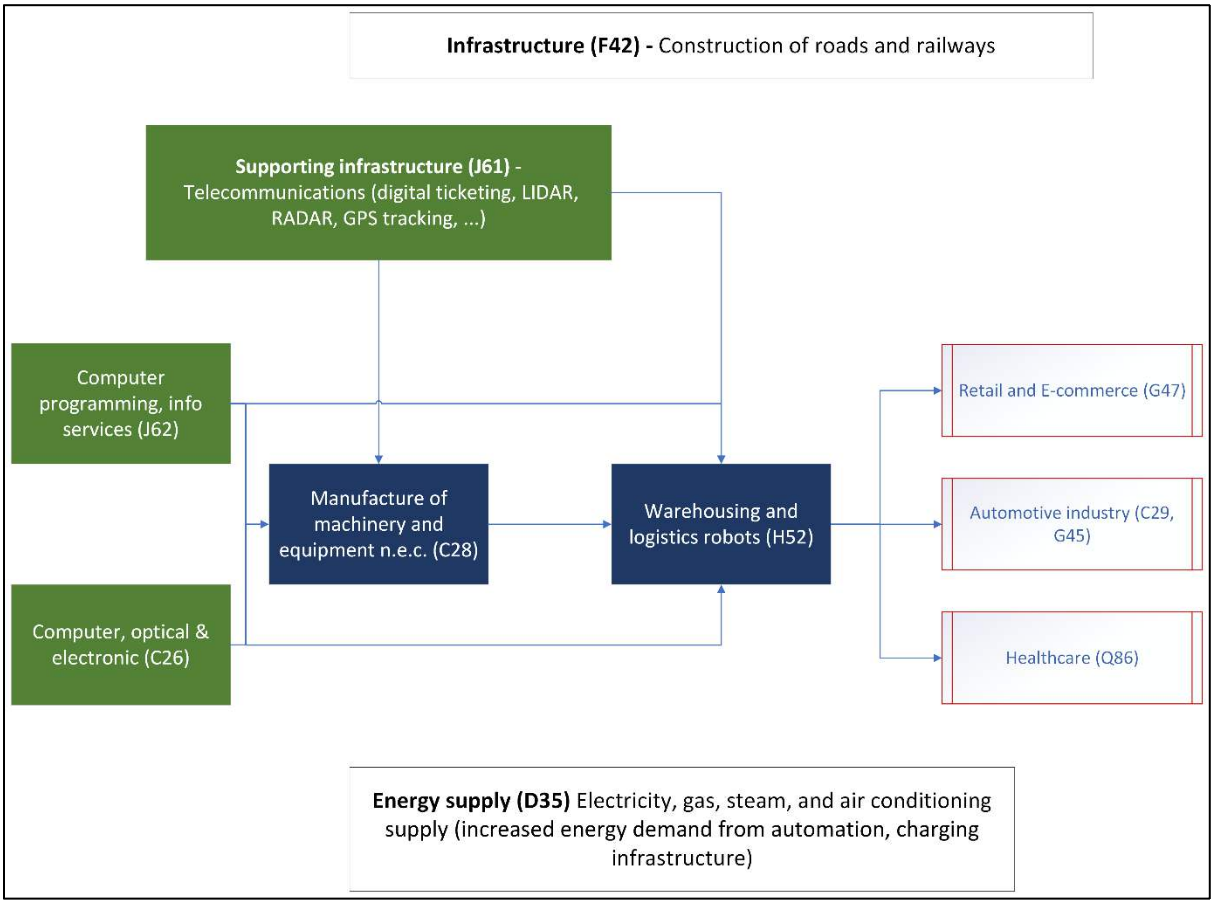
The demand for autonomous freight is anticipated to mirror current demand patterns for traditional freight services. Cognitive Market Research (2025) highlights the key sectors expected to drive this demand, which include:

1. Retail and e-commerce (G47)
2. Wholesale trade (G46)
3. Construction (F)
4. Mining (B)
5. Public administration and defence (O).

Logistics and warehousing are crucial in the supply chain of many sectors, so the demand for autonomous solutions in these areas will likely be similar to the demand for traditional ones. DHL (2024) report identifies that the retail and e-commerce (G47), automotive (C29, G45) and healthcare (Q86) sectors are the most likely drivers of demand for automated logistics and warehousing. Retail and e-commerce both currently include large logistics operations in their business model. For example, since acquiring Kiva Systems in 2012, Amazon has deployed over 750,000 mobile devices and numerous robotic systems across its logistics network (Uddin, 2025). Similarly, the industries surrounding the retail and manufacture of motor vehicles require important logistics operations (e.g., warehousing, transport hubs) due to their decentralised nature (Assis, 2025).

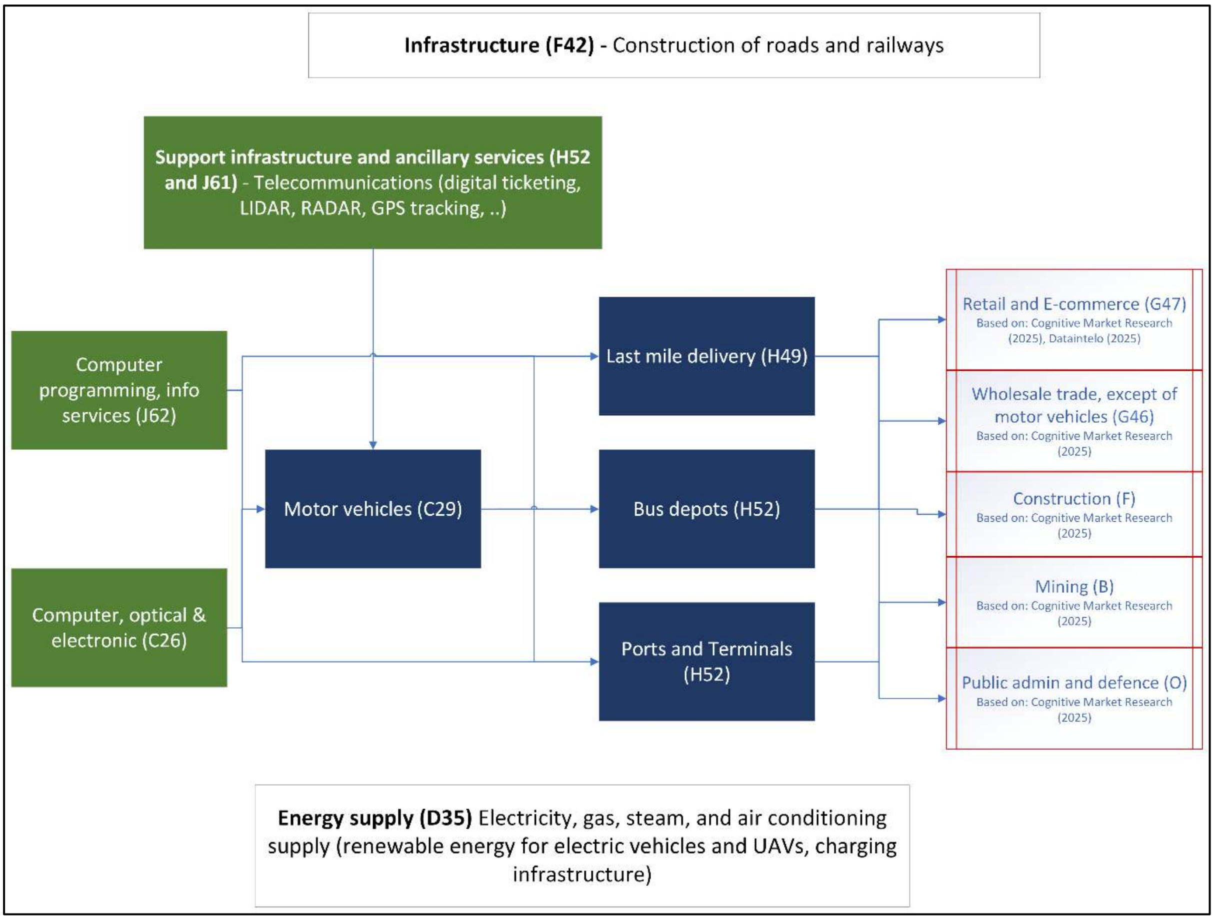
Channels of demand for freight include autonomous road freight transport (H49), both for last mile deliveries and long-haul transportation and the automation of warehouse operations (H52), particularly in transportation mode transit hubs such as ports, airports and terminals.

Figure 3: Supply chain of CCAM in warehousing and logistics



Source: Authors' elaboration based on DHL (2024); Global Market Insights (2023); Research and Markets (2024)

Figure 4: Supply chain of CCAM in freight transport



Source: Authors' elaboration based on Cognitive Market Research (2025)*; Litman* (2024)*; Roland Berger* (2016)

The deployment of CCAM freight vehicles necessitates additional investments in physical, energy, and software infrastructures. Upgrading existing roads and railways (F42) to allow for easier navigation of automated vehicles (e.g., dedicated lanes, clear road markers) is essential. Further, ensuring an increasing the availability and size of energy supply (D35) is crucial, given that automated vehicles are primarily electric (McCauley, 2017). For example, this would involve expanding the electricity grid to accommodate increasing numbers of charging stations. Finally, investments in the digital infrastructure will be required to integrate components from the telecommunications and digital services sectors (H52, J61) in the existing infrastructure for the use of technologies such as LIDAR and RADAR (Ferreira, 2019).

CCAM use cases in passenger transportation

The following use cases have been identified in the passenger transportation

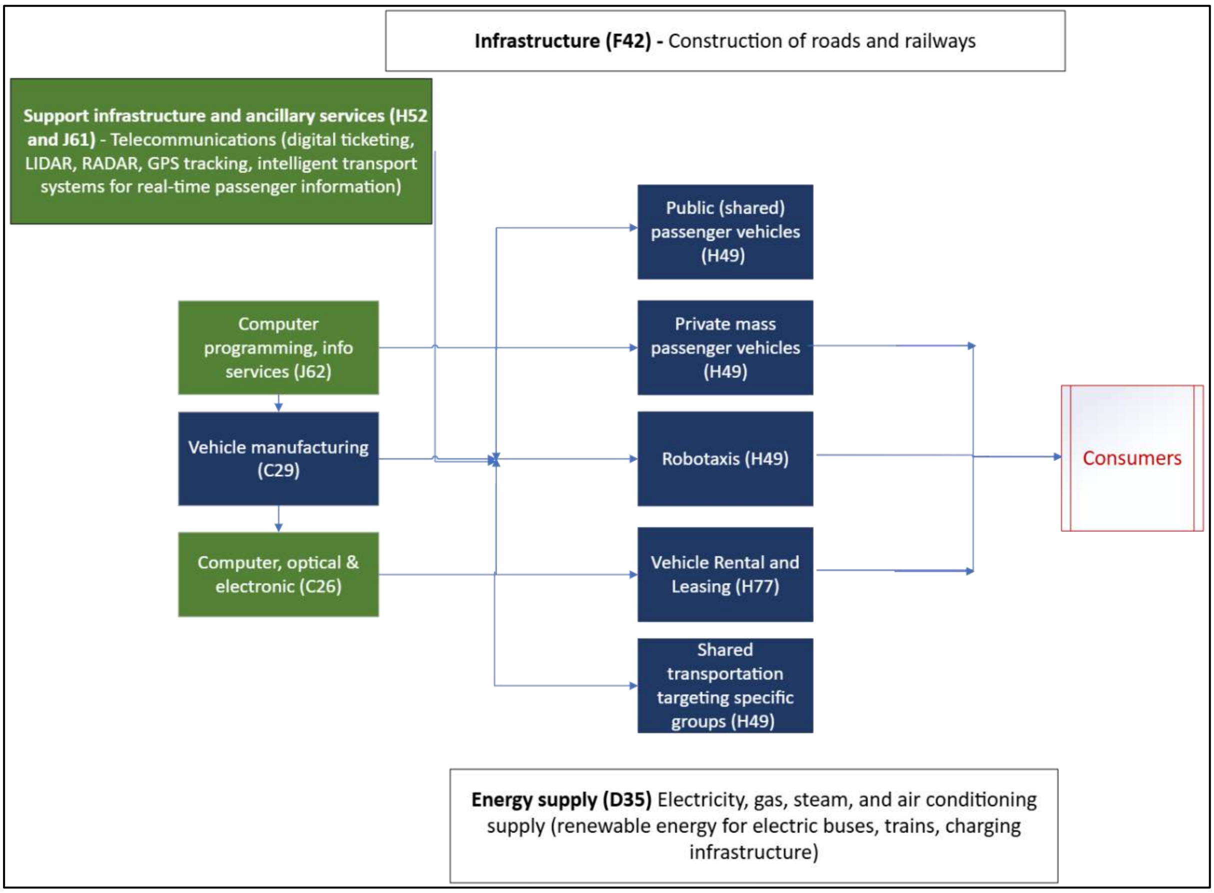
- Public (shared) transportation: Functions such as demand-responsive in urban areas, night transportation, and complementing rail transportation in rural areas.
- Private shared transportation: Robotaxi service, private hire, or taxi market.
- Shared transportation targeting specific groups: Services assisting people with disabilities, the elderly, and people located in rural or low accessibility areas.

CCAM supply chain elements for passenger transport

The core of CCAM's passenger vehicle supply chain consists of interlinked sectors largely the same as in the traditional land transport sector. These sectors can be broadly classified into three: firstly, sectors involved in the manufacturing of autonomous vehicles, secondly, sectors buying autonomous vehicles, sectors providing support and ancillary services and finally, sectors providing cross-cutting infrastructure at all stages of CCAM production and deployment. Figure 5 illustrates the supply chain of CCAM where on the right-hand side is - the vehicle manufacturing (C29) sector which produces vehicles with indirect inputs from increasing share relative to traditional land transport from the computer, optical, and electronic sectors (C26) and software from computer programming, and information services (J62).

Next, consumer demand is expected to drive the need for various CCAM private passenger transport solutions through an increase for mobility-as-a-service (expected to grow in value with an annual growth rate of 27% between 2024 and 2033, and reach a market size valuation $149 billion by 2033 (Global Newswire, 2025)). This is expected to lead to an increase in autonomous vehicle purchases and investments by private mass passenger vehicles (H49), robotaxis (H49), and vehicle rental and leasing services (H77). These CCAM sectors, in turn, will buy inputs from key sectors such as computer programming and information services (J62) with software installations both within the vehicle and for the broader infrastructure as well as internet subscription. This would then contribute to software development, data processing, deployment of 5G and AI integration (Schaller, 2021; Tirachini & Antoniou, 2020; Yu & Chen, 2021).

Figure 5 Supply chain of CCAM in passenger transport



Source: Authors' elaboration based on Tirachini & Antoniou (2020); Elander (2020); Yu & Chen (2021); Schaller (2021)

Cross-cutting infrastructure is expected to play a role in supporting CCAM by providing essential inputs across production, autonomous vehicle buyers, and consumers. The construction of roads and railways (F42) ensures that smart roads, highways, and railway networks can accommodate connected and automated vehicles through vehicle-to-infrastructure communication. Simultaneously, energy supply (D35) is important in powering the transition to automated and electric transport (this is particularly important given the legislation of having EV charging stations on every EU main roads as part of the Fit-for-55 package (European Parliament, 2022), supplying renewable electricity for the manufacture and deployment of electric buses, computation and charging stations (Tamas Gabor, 2025). Deployment of CCAM would also involve new infrastructure components, including telecommunications and digital services (H52, J61), enabling real-time automatic digital ticketing, LIDAR, RADAR, GPS tracking, and intelligent transport systems.

Similar to private passenger transport, the supply chain of publicly owned and operated passenger transport is anticipated to change. Public passenger transport will include bus, metro, and tram service providers and operators.

Preliminary list of assumptions for the scenario development

Key assumptions gathered also extend to the broader economic and infrastructural adaptations required to support CCAM deployment. The following assumptions are required for the economic modelling of CCAM and its employment effects:

1. **Shares of different sectors in CCAM deployment**: Various sectors (automotive, ICT, logistics, public transport, infrastructure, and energy) will contribute to CCAM adoption, with different roles in development and integration.
2. **Year of CCAM deployment and fleet share**: The deployment timeline and the gradual increase in CCAM vehicles within the total transport fleet will depend on factors like consumer acceptance, infrastructure readiness, and regulatory approval.
3. **Investment required and sectors involved**: Substantial investments will be needed from automotive manufacturers, transport operators, infrastructure providers, energy suppliers, and governments for research, development, and deployment.
4. **Relative energy (including fossil fuels) consumption of CCAM**: CCAM vehicles, particularly electric ones, are expected to consume less energy than traditional vehicles, enhancing overall fuel efficiency and supporting sustainability goals.
5. **Fleet share by year**: The share of CCAM vehicles in the total fleet will grow gradually, with faster adoption in freight sectors compared to passenger transport, driven by technological maturity and cost-effectiveness (and relative cost savings) and this will subsequently impact the share of drivers and vehicle operators required and increase the need for ICT occupations.

The detailed assumptions gathered for modelling the employment effects of CCAM are detailed in the subsequent sections.

Freight and logistics

The availability of information on the key assumptions for the autonomous freight sector is limited, and it is severely lacking for the warehousing and logistics sector. Preliminary assumptions for both sectors are presented in

Table 3. Generally, the forecasts for the deployment of Level 5 CCAM solutions for freight transport extend over a long-time horizon. An optimistic forecast by Litman (2024) suggests that pilots of Level 5 autonomous vehicles could be introduced between 2020 and 2030, with 40-60% of the global fleet potentially being fully automated by 2060. Specifically for the freight sector, there are indications that Level 4 pilot programs for autonomous freight trucks might be successfully deployed by 2030 (Quijano et al., 2023). However, detailed timelines for this vehicle subgroup remain scarce. Roland Berger (2016) provides valuable insights into the relative cost savings from automating freight trucks, highlighting a 10% reduction in fuel consumption, a 90% decrease in crashes, and a 10% decline in labour demand. The paper also estimates the absolute costs of automation, projecting that the full automation process would cost approximately $23,000 per truck, with costs distributed between software (around 85%) and hardware (around 15%).

In contrast, the integration of CCAM technologies in logistics hubs, such as warehouses and distribution centres, is already underway, with companies like Amazon leading the charge. One of the main reasons why CCAM technology has already been implemented in this environment is that logistics hubs provide more controlled environments. Autonomous vehicles deployed in ports and warehouses operate in predictable environments which can be tightly controlled (OECD, 2015). For example, autonomous forklifts and trucks are commonly used in these settings. Amazon's investment of over EUR 400 million in advanced technologies, including autonomous vehicles, robotics, and AI-powered systems, has transformed its fulfilment centres into highly automated environments. These technologies, such as automated guided vehicles (AGVs), pallet movers, and tote retrievers, streamline operations, reduce manual labour, and enhance safety (Manufacturing & Logistics IT, 2022). For example, AGVs autonomously transport items within warehouses, minimising the need for employees to push or pull heavy carts, while robotic arms handle pallet movement, eliminating the need for forklifts.

Information to support the assumptions for the warehousing and logistics sector is minimal. The only forecast for large-scale deployment of CCAM technologies in this sector that could be accessed comes from Research and Markets (2024) , which predicts that by 2030, at least 51% of warehouses worldwide will have implemented some form of autonomous technology or process. Amazon's fulfilment centres, with their high levels of automation, provide a glimpse into the future of warehousing. It can reasonably be expected that technologies implemented by Amazon like the Universal Item Sorter (UIS) and the Bag Containerisation Matrix Sorter (BCMS) will spread through the freight and logistics industry (Amazon, 2024).

Table 3: Key assumptions for the scenario development of CCAM for freight and logistics

Type	**Timeframe**	**Automation Level**	**Share**	**Share Type**	**Vehicle Type**	**Investment Details**	**Infrastructure**	**Cost & Benefits**	**Geography**	**Reference**
Pilot	2020-2030	Level 5	1-2% of fleet composition by 2030	Market share	All Vehicles	Not available	Not available	Not available	Worldwide	Litman (2024)
Pilot	Up to 2030	Level 4	Not available	-	Autonomous freight trucks	Not available	Not available	Not available	Worldwide	Quijano et al. (2023)
Pilot	2022 onwards	Level 4	Not available	-	Autonomous freight trucks	Not available	Not available	Saved 917,000 kg of CO2e (2022-2024)	Sweden, U.S.	Einride (2023), Self Drive News (2024)
Pilot	2024	Level 4	Not available	-	Middle-mile delivery and mobile distribution hub logistics	Not available	Not available	Not available	Germany	LOXO (2024)

Type	**Timeframe**	**Automation Level**	**Share**	**Share Type**	**Vehicle Type**	**Investment Details**	**Infrastructure**	**Cost & Benefits**	**Geography**	**Reference**
Deployment	Not Available	Level 3	Not Available	-	All Vehicles	Not Available	Not Available	Fuel consumption reduction (30-90%)	N/A	Future Agenda (2020)
Deployment	2030-2060	Level 5	40-60% of fleet composition by 2060	Market share	All Vehicles	Not available	Not available	Not available	Worldwide	Litman (2024)
Deployment	Up to 2030	Not available	51% of all warehouses by 2030	Market share	Autonomous Mobile Robots	Not available	Not available	Not available	Worldwide	Warehouse Autonomous Mobile Robots Market(2024)
Deployment	Up to 2040	Level 5	Not available	-	Autonomous freight trucks	Not available	Not available	Automation cost $23k / truck, operating costs of $1.67/mile - 10% fuel consumption -90% crashes	U.S.	Roland Berger (2016)

Type	Timeframe	Automation Level	Share	Share Type	Vehicle Type	Investment Details	Infrastructure	Cost & Benefits	Geography	Reference
								- 10% driver labour demand Software ~85% of total cost		

Passenger transportation

The investments for CCAM will be driven by a combination of public and private sector involvement. Public investments will primarily focus on R&D and pilot programmes, as seen in France in 2021, where under the "France Relance" government initiative, an investment of EUR7.5 million (Elander, 2020) for level 3 automation pilot of buses. This pilot, expected to conclude in 2026, is testing Level 3 automation, in which vehicles can handle driving tasks but require human intervention when necessary. Similarly, the German government has committed EUR13 million for public passenger vehicles under the BMDV programme. After a dip in financing for the development of autonomous vehicles, a Pitchbook (2024) report found that autonomous driving startups received $2.9 billion in funding from venture capitalists in the second quarter of 2024 globally with private actors like Toyota Ventures and Intel Capital leading these investments in CCAM in passenger transport. Local producers of autonomous vehicles in France like EasyMile have raised over $88.5 million in research and development financing through venture capital financing between 2017 and 2021 (Traxcn, 2025). Overall, the EU Commission has spent EUR159 million in research and innovation related to automated mobility since 2021 (European Commission, 2024b).

The first deployment of Level 4 automation, where vehicles operate autonomously under specific conditions, is anticipated to begin around 2030 and continue until 2050. However, starting September 2021, closed environment passenger transport service providers like EasyMile have begun operation of level 4 autonomous buses in Norway and Estonia (EasyMile, 2021) Information on the timeline for the introduction of Level 5 automation, which would enable fully autonomous vehicles in all conditions varies but is broadly expected to start by 2035 (Elander, 2020; Tirachini & Antoniou, 2020; Wadud, 2017). A recent analysis by Mckinsey (2023) produced three scenarios for the adoption of autonomous driving elements into passenger transport. The report's delayed scenario indicates that automakers further delay CCAM launch timelines, and consumer adoption remains low. This scenario projects that in 2030, only 4% of new passenger cars sold are installed with advanced level 3 autonomous driving functions, with that figure increasing to 17% in 2035.

In addition, by 2050, the total fleet size of automated vehicles is projected to range between 9 and 84 million, with an average estimate of approximately 46.5 million vehicles. Usage share projections for fully automated robotaxis and private autonomous vehicles suggest an adoption share between 85% and 95%, averaging at 90%, by 2067 (Tirachini & Antoniou, 2020). Additionally, the introduction of CCAM may result in a lower energy consumption per vehicle-kilometre, due to a more balanced vehicle driving and efficiency gains due to vehicle-to-vehicle and vehicle-to-individual communications. Tirachini and Antoniou (2020), find that automation may reduce energy consumption per kilometre by 25%. However, reduction in emissions is not a given with CCAM, with some studies indicating an increase in emissions with passenger vehicles automation due to an increase in ease of travelling leading to more vehicle miles travelled unless the CCAM fleet is in its entirety electricity operated and the energy consumption associated with computing is green as well (Tamas Gabor, 2025). Operational cost savings are also predicted from reduced driver-related operation costs of about 5-10% (Tirachini & Antoniou, 2020; Wadud, 2017).

Despite these projections, gaps remain in the literature regarding how shifts in CCAM adoption will alter the supply chain structure of the existing land transport sector. This includes changes in vehicle manufacturing processes, demand for specialised components (such as sensors and AI-driven control systems), and the adaptation of logistics and distribution networks to meet the unique requirements of automated mobility. Additional gaps in the literature also include the costs of updating software systems required for CCAM, whether these would be one-time fee or would require multiple subscription fees for automation software updates and maintenance and how that differs from traditional transport remains unexplored. Further information would be required to assess the extent to which traditional transport supply chains will be reconfigured, along with the potential for new market entrants and industry consolidation within the sector. Details of the assumptions gathered are in

Table 4. It is important to note that due to safety concerns, legislative scrutiny and regulatory challenges, there is a lack of consensus in the projected timelines for the deployment of passenger transport automation, as gathered through desk research and stakeholder consultations. As a result, the forecasts presented should be interpreted with caution, as regulatory changes, safety concerns, and public acceptance may influence the pace of deployment across different regions.

Table 4 Key assumptions for the forecast of CCAM for passenger transport

Type	Timeframe	Automation Level	Share	Share type	Vehicle Type	Investment Details	Infrastructure	Cost & Benefits	Geography	Citation
Pilot	2021 – 2026	Level 3	Not available	-	Public Passenger Vehicles	€7.5 million (France Relance)	Not Available	Not Available	France	Elander (2020)
Pilot	Not Available	Level 4	Not Available	-	All Vehicles	Not Available	5G	Not Available	U.S.	Tirachini & Antoniou (2020)
Pilot	2022 – Feb 2025	Level 3	Not Available	-	Public Passenger Vehicles	€13 million (BMDV, Germany)	Internet Infrastructure	50% reduction in operational costs, Energy cost (0.6-5.3 €/veh-h)	Germany	Tirachini & Antoniou (2020)
Pilot	2017-ongoing	Level 4	Not Available	-	Airports, logistics, mass passenger transport	$88 million	Internet Infrastructure/ LIDAR/AI	Fully electric	France	Traxcn (2025)
Deployment	2067 – N/A	Level 4	85-95%	Usage Share	Private Passenger Vehicle (Robotaxis)	Not Available	5G, Maintenance Hubs	Not Available	U.S.	Schaller, 2021; Yu & Chen, 2021

Deployment	2035 – 2050	Level 5	9-84 million	Fleet Size	Private Passenger Vehicle	Not Available	5G	Not Available	U.S.	Lavasani et al. (2016)
Deployment	2030 – 2050	Level 4	18.5-50%	Fleet Size	All Vehicles	Not Available	5G	Not Available	U.S.	Concas et al. (2021)
Deployment	2030 – N/A	Level 3	*Significant Numbers*	Fleet size	Public Passenger Vehicles	GBP 13,000 per vehicle (Public Administration)	5G	Estimated driver cost savings of 60%	UK	Wadud (2017)

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