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D4.8 Final Report on Social Impact Assessment

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Deliverable No. 4.8 Final Report on Social Impact Assessment

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Abbreviations

Abbreviation	**Definition**
CCAM	Cooperative, Connected and Automated Mobility
WP	Work Package
CY	Cyprus
DE	Germany
NL	Netherlands
GDP	Gross Domestic Product
Km	Kilometers
PPS	Purchasing Power Standards

Executive summary

Deliverable D4.8 presents the final social impact assessment of Cooperative, Connected and Automated Mobility (CCAM) technologies and services developed within WP4C of the CCAM-ERAS project. It consolidates the forecasting and extrapolation results produced under Task 4.C.3 following their stakeholder validation and reports the resulting refinements and final conclusions. The deliverable builds directly on D4.6, which established the empirical evidence from stakeholder interviews and a population survey in five European countries, and D4.7, which documented the social impact assessment model and preliminary forecasts.

The validation took place during the CCAM-ERAS stakeholder workshop held in Brussels on 19 November 2025. The WP4C session consisted of a 30-minute presentation of the evidence and model outputs followed by a 30-minute breakout discussion. Stakeholders examined the plausibility, internal coherence, contextual relevance, interpretability and decision-making value of forecast trajectories covering 2025–2050. The core validation material addressed mobility patterns, renewable energy, household economic capacity, road safety, economic and infrastructure conditions, charging stations, self-driving taxis and automated last-mile delivery, using regional examples from Helmond, Düsseldorf and Limassol. The validation broadly confirmed the direction and coherence of the projected pathways. Stakeholders recognised CCAM as a potentially transformative development whose effects extend beyond transport operations to accessibility, safety, inclusion, economic activity, infrastructure and public acceptance. The results indicate gradual and cumulative change rather than immediate transformation, reflecting the time required for technological diffusion, infrastructure development, regulatory adaptation and behavioural acceptance.

The regional results demonstrate that CCAM will not follow a uniform pathway. Helmond presents favourable conditions for comparatively early proportional uptake of self-driving taxis and substantial charging-infrastructure development. Düsseldorf generates the largest absolute taxi-trip volumes and shows strong economic and infrastructure growth, alongside a gradual shift from private vehicles towards public transport. Limassol follows a more gradual adoption trajectory in which automated services may initially address specific mobility needs. These differences underline the importance of interpreting CCAM effects in relation to regional population, spatial structure, infrastructure, economic capacity and institutional readiness. The assessment identifies considerable potential for improvements in road safety, accessibility and mobility opportunities. However, these benefits are conditional. Automated services may also increase travel demand, empty vehicle movements, congestion or digital exclusion if deployment is not accompanied by appropriate policy and service design. Similarly, GDP, disposable income, renewable-energy use and infrastructure development are treated as contextual or enabling conditions rather than outcomes caused exclusively by CCAM.

Stakeholder feedback resulted in several refinements. The final assessment more clearly distinguishes contextual variables from direct CCAM adoption indicators, moderates causal language and emphasises that the results represent conditional pathways rather than precise predictions. Figures were recreated using consistent formats, terminology and units. More focused, explicitly disclosed non-zero vertical axes were applied to selected environmental, income, GDP and infrastructure figures to make gradual changes visible without modifying the underlying results. The principal conclusion is that CCAM can generate significant societal benefits, but these benefits are not inherent in automation. Their scale and distribution depend on governance, public trust, infrastructure readiness, affordability, inclusive design and integration with public and active transport. CCAM deployment should therefore be managed as a social and institutional transition, supported by region-specific planning, phased implementation, transparent monitoring and continued stakeholder participation.

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1 Introduction

1.1 Background

Cooperative, Connected and Automated Mobility (CCAM) technologies are expected to transform the organization and delivery of passenger and freight transport. Their effects are not limited to improvements in vehicle technology or transport operations. The deployment of automated mobility services can influence travel behavior, accessibility, affordability, road safety, employment, infrastructure requirements, environmental conditions and the distribution of mobility opportunities among different population groups. These effects may also vary considerably according to the type of CCAM service, its level and speed of market penetration, and the socioeconomic and spatial characteristics of the area in which it is deployed. The assessment of CCAM therefore requires a multidimensional perspective that considers both potential benefits and possible adverse or unintended consequences. Automated services may improve access to mobility for older people, people with disabilities and individuals who cannot drive. They may reduce travel-related stress, contribute to improvements in road safety and support more flexible passenger and freight services. At the same time, their introduction may generate additional travel demand, increase pressure on transport networks, create new forms of digital exclusion or affordability barriers, and affect existing occupations and organizational structures. The actual balance between these outcomes will depend on the technological, regulatory, behavioral and institutional conditions accompanying deployment.

WP4C of CCAM-ERAS addresses this challenge by examining the economic and societal effects of CCAM technologies and services. The work follows a progressive analytical process. It began with the identification and mapping of anticipated effects through stakeholder engagement and a large-scale population survey. This evidence was subsequently used to inform the development of a social impact assessment model capable of representing relationships between social, economic, mobility, safety, environmental and technological variables. The model was then applied to explore how selected indicators could develop over time under different regional conditions and CCAM adoption pathways. The evidence base developed in WP4C combines professional and public perspectives. Stakeholder interviews captured the expectations and concerns of higher and vocational education institutions, road transport operators, representative organizations and industry actors. These interviews provided insights into the likely implications of CCAM for organizational change, workforce readiness, inclusion, affordability, investment, governance and public acceptance. In parallel, the population survey collected responses from 1,083 adults in Belgium, Cyprus, Germany, the Netherlands and Norway. The survey examined current travel behavior, preferences regarding different automated mobility services and perceptions of the wider social and economic consequences of CCAM.

The resulting social impact assessment model was used to explore projected changes over the period from 2025 to 2050. The outputs cover several dimensions of the transition, including modal split, renewable-energy use, household economic conditions, road safety, economic and infrastructure development, charging infrastructure, self-driving taxi adoption and last-mile delivery services. Regional examples were developed to demonstrate how common CCAM-related mechanisms may produce different outcomes depending on local circumstances. These projections are intended to represent plausible and internally coherent development pathways rather than precise predictions of future conditions. Forecasting long-term social effects inevitably involves uncertainty. Future outcomes depend on assumptions concerning technology diffusion, public acceptance, infrastructure availability, regulation, investment, behavioral responses and broader socioeconomic development. Quantitative model outputs must therefore be examined alongside the experience and contextual knowledge of stakeholders. Validation is particularly important when modelled relationships involve emerging technologies for which extensive historical deployment data are not yet available.

For this reason, the preliminary findings of the social impact assessment were presented during the CCAM-ERAS stakeholder validation workshop held in Brussels on 19 November 2025. The WP4C session combined a presentation of the evidence and model outputs with a structured discussion intended to assess the plausibility, relevance and clarity of the results. Participants were invited to confirm the main directions of change, identify findings requiring qualification, provide additional contextual insights and recommend improvements to the presentation and interpretation of the results. The workshop represented the transition from the preliminary forecasting stage to the final social impact assessment. Its purpose was not to treat stakeholder agreement as proof that individual forecast values will materialize. Rather, it provided an opportunity to examine whether the projected trajectories were understandable, internally coherent and consistent with the experience and expectations of actors involved in the CCAM transition. It also helped identify the conditions under which the projected benefits may be realized and the risks that should be considered by policymakers, industry and other decision-makers.

Deliverable D4.8 presents the outcome of this process. It consolidates the social impact assessment results following stakeholder validation, documents the feedback received and explains how the final presentation and interpretation of the results were refined. In this way, the deliverable completes the analytical sequence from evidence collection and impact mapping to forecasting, stakeholder scrutiny and final reporting.

1.2 Objectives of Deliverable 4.8

The principal objective of D4.8 is to present the final social impact assessment of CCAM technologies and services after consideration of the findings from the stakeholder validation workshop. The deliverable focuses on the validated results and the conclusions that can reasonably be drawn from them. It does not reproduce the complete empirical analysis or model development process already documented in previous CCAM-ERAS deliverables.

More specifically, D4.8 aims to:

- Document the approach used to validate the social impact assessment results, including the material presented, the workshop procedure and the criteria used to interpret stakeholder feedback.
- Present the final forecast trajectories for the selected mobility, environmental, equity, safety, economic, infrastructure and service-adoption indicators.
- Record the aspects of the assessment that stakeholders confirmed as plausible and relevant, as well as the findings that required qualification or further contextual explanation.
- Identify the enabling conditions and constraints affecting the realization of the projected social effects, including governance, infrastructure readiness, inclusive design, affordability, public trust and regional capacity.
- Explain the refinements introduced following validation, including changes to figure design, axis ranges, terminology, units and the distinction between contextual developments and effects more directly associated with CCAM.
- Provide a transparent link between the evidence presented at the workshop, the feedback received and the final interpretation adopted in the deliverable.
- Draw cross-cutting conclusions regarding the potential distribution of CCAM benefits and risks across regions, population groups and transport applications.

- Provide decision-makers with concise and evidence-informed messages concerning the conditions required for an inclusive, safe and socially beneficial transition towards CCAM.

A further objective is to communicate the forecasting results more clearly. The validation process demonstrated that the presentation of results can affect their interpretation. Figures showing gradual changes over a long forecasting period may conceal meaningful variation when the vertical axis covers a substantially broader range than the modelled values. The final figures are therefore recreated using a common visual approach and, where appropriate, more focused vertical-axis ranges. Where a non-zero axis is used, this is clearly disclosed, and line charts are preferred to avoid the potentially misleading visual effect of truncated bar charts.

The deliverable also distinguishes between three types of conclusion. First, some outputs describe contextual trends that can support or constrain CCAM deployment, such as household income, GDP, renewable-energy use and infrastructure availability. Second, other outputs describe CCAM adoption more directly, including the uptake and use of self-driving taxis and automated last-mile delivery services. Third, the assessment considers potential social outcomes associated with the interaction of CCAM deployment and its wider context, such as changes in mobility patterns and road safety. Maintaining this distinction supports a more cautious interpretation of causal relationships. D4.8 consequently provides a final, validated account of the social effects considered in WP4C while retaining the conditional nature of long-term forecasting. The results should be understood as structured pathways illustrating how effects could evolve under the assumptions applied, rather than deterministic predictions or fixed regional targets.

1.3 Relationship with Previous CCAM-ERAS Deliverables

D4.8 builds directly on the evidence and modelling work documented in D4.6 and D4.7. The three deliverables form a connected analytical sequence, but each has a distinct purpose. D4.6, Stakeholders' and Population Groups Impact Analysis and Mapping, established the empirical basis for the social impact assessment. It presented the findings from stakeholder interviews and the population survey and mapped the anticipated positive and negative effects of CCAM technologies and services. The deliverable identified stakeholder and population expectations concerning accessibility, affordability, safety, well-being, travel demand, employment, skills, economic development, inclusion and public acceptance.

The findings of D4.6 informed the selection and interpretation of variables included in the social impact assessment. Stakeholder evidence helped identify relevant causal relationships and implementation conditions, while the population survey provided information about public expectations and preferences relating to different automated passenger and delivery services. D4.8 does not repeat the detailed interview and survey results. Instead, it refers to D4.6 where this evidence is needed to explain the empirical basis of a modelled relationship or a validated conclusion. D4.7, Social Impact Assessment, documented the development and application of the social impact assessment model. It described the analytical scope, model structure, forecasting approach, indicator selection and the preliminary results generated for different regional and service contexts. It also explained how the assessment combined quantitative evidence, contextual projections and relationships identified through stakeholder and population engagement.

D4.8 uses the D4.7 results as the starting point for validation. It does not reconstruct the model architecture, equations or full methodological framework. These elements remain documented in D4.7 and are referenced where necessary. The additional contribution of D4.8 lies in examining how the preliminary results were received by stakeholders, identifying the qualifications introduced through the validation process and presenting the resulting final interpretations and revised figures.

This relationship is also reflected in the organisation of the WP4C tasks. The stakeholder and population analyses supplied the foundation for forecasting and extrapolating social effects under T4.C.3. The results of this forecasting work were subsequently examined through the stakeholder-validation activities undertaken in T4.C.4. D4.8 therefore reports the final outputs of the T4.C.3 assessment after consideration of the validation evidence generated during the subsequent WP4C validation stage. The deliverable should consequently be read together with D4.6 and D4.7. D4.6 provides the detailed empirical findings, while D4.7 provides the complete description of the model and forecasting approach. D4.8 concentrates on what was validated, what was qualified or revised, and what conclusions remain after this process. This division limits unnecessary duplication and maintains a traceable progression from evidence to modelling and from modelling to validated findings.

1.4 Structure of the Deliverable 4.8

Following this introductory section, the remainder of D4.8 is organized into five main sections.

Section 2 describes the stakeholder validation approach. It presents the context and objectives of the Brussels workshop, the material submitted for validation, the structure of the WP4C session, the stakeholder groups represented and the criteria used to assess the results. It also discusses the scope and limitations of stakeholder-based validation. Section 3 reports the results of the validation process. It distinguishes between findings confirmed by stakeholders, findings accepted subject to specific qualifications and recommendations that led to changes in the presentation or interpretation of the results. A validation-and-revision matrix provides a transparent record connecting the feedback received with the corresponding response in the final assessment.

Section 4 presents the final validated social impact assessment results. The findings are organized by impact domain and CCAM application, covering mobility patterns, environmental conditions, equity and household economic capacity, safety, economic and infrastructure conditions, self-driving taxi adoption and automated last-mile delivery. Revised figures are presented using consistent terminology, units and visual conventions. The section concludes with a cross-regional synthesis highlighting common trends and context-dependent differences. Section 5 discusses the refinements and wider implications of the validated assessment. It summarizes the changes introduced following the workshop and identifies the principal conditions affecting the distribution of CCAM benefits and risks. It also translates the validated findings into implications for public authorities, industry, transport operators and other decision-makers.

Finally, Section 6 presents the overall conclusions of D4.8. It summarizes the principal findings confirmed through the validation process, the qualifications that should accompany their interpretation and the main messages for socially inclusive and context-sensitive CCAM deployment. Supporting information, including the workshop material, participant profile, validation matrix and underlying figure specifications, is provided in the annexes.

2 Stakeholder Validation Approach

2.1 Context and Purpose of the Validation Activity

The validation of the social impact assessment constituted the final stage of the WP4C analytical process. Following the collection and analysis of stakeholder and population-group evidence and the subsequent development of the forecasting model, the preliminary results were presented to external stakeholders for examination. The validation activity was organised as part of the CCAM-ERAS stakeholder workshop (approximately 30 stakeholders participated) held in Brussels on 19 November 2025.

The purpose of the exercise was to assess whether the projected social effects were plausible, understandable and relevant to the circumstances in which CCAM technologies and services may be deployed. Since many of the CCAM applications examined remain at an early stage of deployment, sufficient historical data are not yet available to perform conventional ex-post validation across all modelled variables and regions. The validation therefore focused on the credibility and internal coherence of the projected pathways rather than on a direct comparison between forecasts and observed future outcomes. Stakeholder validation was considered necessary for three main reasons. First, the social impact assessment incorporates relationships involving behaviour, public acceptance, institutional capacity and infrastructure readiness. These factors cannot be assessed exclusively through technical or statistical criteria. Experience from transport operators, public authorities, industry, researchers, representative organisations and other actors can help determine whether the modelled relationships reflect plausible real-world processes.

Second, the results cover a long forecasting period from 2025 to 2050. Over such a period, the development of CCAM is likely to be affected by changes in regulation, investment, technological maturity, service availability and social acceptance. Stakeholder input is therefore important for identifying assumptions that may require qualification and conditions that could accelerate or delay the projected effects. Third, the validation examined whether the results were communicated clearly enough to support decision-making. A technically consistent forecast may still be of limited practical value if its indicators, scales, units or underlying assumptions are difficult to interpret. The workshop consequently addressed both the substance of the assessment and the way in which its findings were presented.

Within this context, validation was understood as a structured assessment of:

- The plausibility of the direction of change projected for each indicator.
- The credibility of the pace and scale of the projected developments.
- The consistency of the relationships between social, economic, mobility, environmental and technological variables.
- The relevance of the regional differences represented in the results.
- The clarity of the figures and their accompanying interpretations.
- The usefulness of the findings for CCAM planning and policy development.

The validation exercise did not ask participants to confirm that each annual numerical value would occur exactly as projected. The results are conditional on the assumptions and relationships incorporated into the model and should not be interpreted as deterministic predictions. Stakeholders were instead asked to consider whether the trajectories provided reasonable representations of how the relevant effects could develop under the modelled conditions. The workshop also provided an opportunity to identify the broader conditions under which positive social outcomes may be realised. These include supportive governance, infrastructure investment, inclusive service design, affordability, public trust, digital accessibility and appropriate transition measures for affected workers and communities. The validation therefore, contributed not only to checking the model outputs but also to strengthening their interpretation.

2.2 Material Submitted for Validation

The WP4C presentation covered the complete analytical progression from evidence collection to forecasting. The first part briefly summarized the stakeholder interviews and population survey that had informed the assessment. This contextual material was included to demonstrate that the model was grounded in the expectations, concerns and requirements identified through the preceding engagement activities.

The stakeholder-interview evidence covered four main categories of organizations: higher and vocational education institutions, road transport operators, representative organizations and industry actors. The presentation summarized the different perspectives of these groups concerning socioeconomic transformation, inclusiveness, employment, skills, investment, health, well-being and institutional preparedness. The population-group evidence summarized the survey of 1,083 respondents in Belgium, Cyprus, Germany, the Netherlands and Norway. It presented public expectations relating to travel demand, travel costs, accessibility, safety, employment, economic development and the use of self-driving mobility services. These findings provided the social and behavioral context within which the model outputs were interpreted.

The presentation subsequently introduced the social impact assessment model and illustrated selected relationships between its components. This part of the workshop was intentionally concise because the main objective was to validate the results rather than to repeat the full methodological description provided in D4.7. The core validation material consisted of the results presented. The selected outputs represented different dimensions of the social impact assessment and included representative regional examples for Helmond (NL), Düsseldorf (DE) and Limassol (CY). The modelled period extended from 2025 to 2050, as shown in the table below.

Table 1: Social impact assessment material presented during the validation workshop

Assessment dimension	Indicators presented	Purpose within the validation
Mobility	Modal split between private vehicles, public transport, walking and cycling	Examine the plausibility of changes in travel behaviour and the balance between motorised and active modes
Environment	Renewable-energy sources as a share of the energy mix	Examine the development of environmental and energy conditions supporting future mobility systems
Equity and economic capacity	Disposable household income	Assess the development of household economic capacity and its relevance to the affordability and uptake of CCAM
Safety	Road-traffic fatalities	Examine the potential direction and scale of long-term safety improvements
Economy	Regional GDP	Provide socioeconomic context for CCAM development and investment capacity
Transport infrastructure	Development of infrastructure length or	Assess regional preparedness for the deployment and operation of CCAM services

	investment-related network capacity	
Electrification infrastructure	Number of charging stations	Examine the alignment between CCAM development, electrification and infrastructure provision
Passenger CCAM adoption	Adoption rate and number of trips made by self-driving taxis	Compare the timing and scale of automated passenger-service adoption
Freight and last-mile services	Adoption rate of automated last-mile delivery	Examine the diffusion of automated freight and delivery applications

The results were selected to provide a multidimensional view rather than a complete presentation of every variable included in the model. The objective was to show how the assessment represents interactions between broader enabling conditions and outcomes more directly associated with CCAM deployment. Some indicators, including GDP, disposable income, renewable-energy use and infrastructure development, represent contextual conditions. They can influence the speed, affordability and scale of CCAM adoption but should not be interpreted as outcomes generated exclusively by CCAM. Other indicators, including self-driving taxi adoption and automated last-mile delivery uptake, are more directly connected to the diffusion of CCAM technologies and services. Mobility and safety indicators represent outcomes that may result from the interaction between CCAM deployment, user behavior, policy measures and wider transport-system developments.

This distinction was important for the validation because it prevented the presentation of all forecast changes as direct causal effects of CCAM. Instead, the model was presented as a system of interdependent developments in which social effects emerge through the interaction of technology, infrastructure, behavior, socioeconomic conditions and governance.

2.3 Workshop Format and Validation Procedure

The WP4C validation session consisted of two main stages. The first was a 30-minute presentation of the evidence and model outputs. The second was a 30-minute breakout discussion (stakeholders were split into 3 breakout groups where the discussions were led by a moderator) during which participants were invited to validate the findings, provide additional insights and suggest actions or improvements. During the presentation stage, participants were first reminded of the WP4C evidence base and the progression from stakeholder and population analysis to forecasting. The social impact assessment model was then introduced at a conceptual level, followed by the regional forecast examples. Each result was accompanied by a short interpretation explaining the direction of change, the potential factors underlying the trajectory and its relevance to CCAM deployment.

The presentation stage was intended to establish a common basis for discussion. Particular attention was given to:

- The meaning of the indicator.
- The geographical area represented.
- The direction and approximate magnitude of change.
- The period is covered by the forecast.
- The relationship between the indicator and CCAM deployment.

- The main contextual conditions that could affect the projected trajectory.

The breakout stage provided participants with an opportunity to examine the findings critically. Discussion focused on whether the results reflected reasonable development pathways, whether important conditions or risks had been omitted and whether the figures communicated the model outputs clearly. For reporting purposes, the validation procedure can be represented through the sequence shown below.

Table 2: Validation procedure applied during and after the workshop

Stage	Activity	Intended Outcome
Contextualisation	Brief presentation of the stakeholder and population evidence	Establish the empirical foundation of the assessment
Model orientation	Explanation of the main model dimensions and relationships	Ensure that participants could interpret the results within the wider assessment framework
Presentation of outputs	Presentation of regional forecasts for 2025–2050	Expose the selected trajectories to stakeholder examination
Stakeholder discussion	Breakout discussion on plausibility, relevance, risks and missing conditions	Collect confirmations, qualifications and recommendations
Feedback consolidation	Organisation of comments by indicator and cross-cutting theme	Identify common findings and issues requiring action
Revision	Adjustment of figures, terminology and interpretation	Improve the clarity and robustness of the final assessment
Final reporting	Presentation of validated findings in D4.8	Provide a transparent record of the validation outcome

The validation process distinguished among three possible outcomes. A result was treated as confirmed when the direction of change and its interpretation were considered plausible without requiring a substantive modification. A result was treated as confirmed with qualification when its general trajectory was accepted but its realisation was considered dependent on specific policy, regulatory, social or regional conditions. A result was identified for revision when the figure, terminology, unit or accompanying explanation required modification to avoid ambiguity or overinterpretation. This approach allowed the validation to recognise that a result may be useful and plausible without implying certainty. For example, stakeholders could accept that automated mobility is likely to contribute to improved road safety while also noting that the scale of the improvement depends on penetration rates, infrastructure quality, interactions with conventional vehicles and regulatory oversight.

2.4 Stakeholder Participation and Treatment of Feedback

The validation session was addressed to participants attending the CCAM-ERAS stakeholder conference. The event brought together actors with professional or institutional interests in CCAM development, transport planning, technological innovation, research, skills, employment and wider societal effects. The participation of stakeholders from different backgrounds was important because the results addressed multiple dimensions of CCAM deployment. Technical and industry participants could assess technological and operational feasibility. Transport and public-sector actors could consider infrastructure, regulation and implementation capacity. Researchers and representatives of education and training could contribute perspectives on behavioral change, workforce readiness and longer-term socioeconomic implications. Representatives with knowledge of users and communities could examine accessibility, inclusion, affordability and public acceptance.

The validation was qualitative and deliberative. It was not designed as a statistically representative survey of stakeholder opinion. The value of the exercise lay in the contextual knowledge of participants and in their ability to identify assumptions, conditions and consequences that may not be fully visible through quantitative modelling alone. For the purposes of D4.8, the feedback was organized into four categories:

- Confirmation of the direction and overall coherence of the projected effects.
- Qualification of results according to regional, institutional, behavioral or policy conditions.
- Identification of cross-cutting risks and enabling factors.
- Recommendations concerning presentation, terminology and interpretation.

The contributions were reported in aggregated form. The analysis focused on the substance of the comments rather than attributing individual statements to named participants. This approach supported open discussion while allowing the deliverable to provide a transparent account of the issues raised.

2.5 Validation Criteria and Analytical Treatment

Five criteria were applied when interpreting the workshop feedback, as shown in the table below.

Table 3: Criteria used to assess the social impact assessment results

Criterion	Definition	Evidence considered
Plausibility	The direction and approximate scale of change are credible under the modelled conditions	Stakeholder assessment of whether the trajectory represents a reasonable future pathway
Internal coherence	The projected relationships between indicators are logically consistent	Consistency between adoption, mobility, safety, infrastructure and socioeconomic developments
Contextual relevance	The outputs reflect meaningful differences between regional settings	Feedback concerning local infrastructure, population, institutional capacity and travel behaviour
Interpretability	The figure and accompanying explanation can be understood without misleading emphasis	Comments on axes, units, terminology, captions and graphical representation

Decision relevance	The output supports the identification of policy or implementation priorities	Stakeholder assessment of the result's usefulness for planning and action

Feedback was not treated as a numerical adjustment factor unless it identified a specific issue requiring modification of a model assumption. In most cases, stakeholder input was used to improve the interpretation of the trajectories and to make their conditional nature more explicit. This is appropriate because the workshop was primarily a plausibility and relevance assessment rather than a recalibration exercise. Where feedback related to graphical presentation, the relevant figures were redesigned without changing the underlying data. This included the use of more focused vertical-axis ranges for selected indicators where a zero-baseline concealed meaningful changes over time. Because truncated axes can visually exaggerate changes when used with bar charts, the revised presentation uses line charts for the affected time-series indicators and explicitly reports the axis range.

2.6 Scope and Limitations of the Validation

The validation strengthens the assessment but does not remove the uncertainty associated with long-term forecasting. The following limitations should therefore be considered. First, the workshop provided qualitative validation. It captured the informed judgement of participants but did not generate a statistically representative measure of stakeholder agreement. The results should be interpreted as evidence of professional and contextual plausibility rather than as a population-wide consensus.

Second, the regional examples illustrate different development pathways but do not represent every CCAM-ERAS country or every possible deployment environment. The trajectories are sensitive to regional scale, population, existing infrastructure, economic conditions and technological readiness. Third, some indicators represent wider socioeconomic trends that both influence and interact with CCAM deployment. Changes in GDP, household income, renewable-energy use or infrastructure cannot be attributed to CCAM alone. The final assessment consequently avoids presenting these contextual projections as isolated causal effects of automation.

Fourth, the results depend on assumptions about technological diffusion and market penetration. Regulatory changes, technological disruptions, major economic events or unexpected changes in public behaviour could produce different trajectories. Finally, validation focused on the selected results presented during the workshop. It did not constitute a full independent audit of all equations, parameters or data sources used in the social impact assessment. The detailed methodological basis remains documented in D4.7.

Within these limitations, the validation provided a valuable assessment of the coherence, relevance and usability of the model outputs. It also identified the qualifications and presentation improvements required for the final reporting of the social effects.

3 Results of Stakeholder Validation

3.1 Overall Validation Outcome

The overall outcome of the workshop was broadly confirmatory. Stakeholders recognized CCAM as a potentially transformative development with implications extending beyond transport operations to mobility behavior, accessibility, safety, economic activity, skills, employment, organizational structures and long-term societal readiness. The model outputs were considered capable of illustrating realistic and coherent future pathways. In particular, the gradual nature of most trajectories was regarded as more plausible than an assumption of immediate or uniform change. This reflects the expectation that CCAM deployment will proceed progressively as technologies mature, regulatory frameworks develop, infrastructure becomes available and users gain experience and confidence.

The validation also supported the representation of regional differentiation. The results did not assume that all regions would follow the same pathway or reach comparable levels of adoption at the same time. Differences among Helmond, Düsseldorf and Limassol demonstrated how population scale, transport demand, infrastructure, economic conditions and technology readiness can affect both the speed and absolute scale of CCAM uptake. Stakeholders nevertheless emphasized that positive outcomes are not automatic. The projected benefits depend on appropriate governance, inclusive design, public trust, long-term planning, infrastructure investment and measures addressing the distributional effects of the transition. The validation therefore supported the general direction of the assessment while strengthening the conditions and qualifications attached to its interpretation.

The workshop did not identify a need to replace the overall assessment logic or discard the principal forecast trajectories. The most significant resulting changes concerned the clarity of the figures, the explanation of contextual indicators and the need to avoid interpreting all projected socioeconomic developments as effects caused exclusively by CCAM.

3.2 Validation of the Principal Forecast Patterns

3.2.1 Gradual and Cumulative Change

A central result confirmed through the workshop was that CCAM-related effects are more likely to accumulate gradually than emerge as abrupt changes. The forecast trajectories generally show progressive development over the 2025–2050 period, reflecting the time required for technology diffusion, infrastructure expansion, regulatory adaptation and behavioral acceptance.

This pattern is visible across service adoption, safety, charging infrastructure and broader socioeconomic indicators. The implication is that the social effects of CCAM should be assessed over a sufficiently long-time horizon. Short-term evaluation alone may underestimate both potential benefits and emerging risks.

At the same time, gradual trajectories should not be interpreted as evidence that progress will be uninterrupted. The model presents smooth pathways intended to illustrate long-term direction. Actual implementation may involve delays, pilot phases, regulatory interruptions or periods of more rapid development. The final interpretation therefore focuses on the overall direction and cumulative effect rather than on minor annual variations.

3.2.2 Regional Differentiation

The validation supported the use of region-specific trajectories. The three regional examples differ substantially in population, economic scale, existing transport conditions and infrastructure. Their forecast output consequently shows differences in both adoption rates and absolute activity levels.

Helmond presents comparatively favorable conditions for early CCAM adoption in several model outputs, including self-driving taxi uptake and charging-infrastructure development. Düsseldorf shows substantial absolute demand and infrastructure growth, reflecting its larger urban and economic scale. Limassol exhibits more gradual adoption and lower absolute trip volumes, consistent with a smaller regional market and different spatial and infrastructure conditions. These differences reinforce the conclusion that a uniform European CCAM trajectory would be inappropriate. Similar technologies may produce different social outcomes depending on where and how they are deployed. Regional forecasting should therefore be interpreted in relation to local baseline conditions rather than through simple comparison of absolute values.

3.2.3 Mobility Effects

The modal-split results indicate that CCAM deployment may be associated with gradual changes in the relative use of private vehicles, public transport and active modes. In Düsseldorf, the model suggests a gradual reduction in the share of private-vehicle trips accompanied by an increase in public-transport use. Walking and cycling remain relatively stable.

The Limassol results show a comparatively stronger role for active modes while private vehicles continue to represent an important part of the mobility mix. The forecast does not indicate an abrupt restructuring of travel behavior, suggesting that established spatial and behavioral patterns are likely to persist even as new services become available.

The validation supported the conclusion that the mobility effects of CCAM will depend on how automated services are integrated into the transport system. Shared and public-transport-oriented deployment may support a shift away from private vehicles. Conversely, highly individualized automated travel could increase the number of trips and vehicles on the road. This qualification is consistent with the population survey, in which respondents anticipated improvements in travel time and accessibility but also expressed concern about increasing travel activity and network pressure. The final assessment therefore avoids treating automation as inherently supportive of sustainable modal change. The outcome depends on service design, pricing, regulation and the relationship between automated mobility and existing public and active-transport networks.

3.2.4 Environmental and Energy Conditions

The environmental examples show increasing renewable-energy shares in both Helmond and Düsseldorf, although with different initial conditions and rates of growth. These trends were considered relevant to the wider sustainability context in which CCAM services may develop, particularly where automated vehicles are also electric. The validation highlighted the importance of distinguishing between an enabling trend and a direct CCAM effect. Growth in renewable-energy use may reduce the lifecycle emissions associated with electric and automated mobility, but this growth is also influenced by energy policy, investment and technological development outside the transport sector. It should not therefore be described as an environmental benefit produced by CCAM alone.

The final interpretation presents renewable-energy development as a contextual condition that can improve the environmental performance of CCAM deployment. The actual environmental effect will also depend on vehicle occupancy, changes in travel demand, fleet composition, vehicle production and the extent to which automated mobility complements or substitutes public and active transport.

3.2.5 Equity and Household Economic Capacity

The disposable-income trajectories for Helmond and Limassol indicate gradual growth in household economic capacity over the forecasting period. Increasing household income may improve the ability of users to access new mobility services, particularly during the early stages of deployment when costs may remain relatively high. The validation supported the relevance of affordability to CCAM uptake but also required a more cautious equity interpretation. Growth in aggregate disposable income does not demonstrate that mobility services will be affordable for every household or that benefits will be evenly distributed. Aggregate indicators may conceal inequalities between income groups, neighborhoods and population categories.

The final assessment therefore treats disposable income as an indicator of general economic capacity rather than a direct measure of equitable access. Realizing inclusive outcomes will require pricing structures, accessible service design, non-digital alternatives, geographic coverage and appropriate support for people who may otherwise be excluded.

3.2.6 Safety Effects

The road-safety trajectories show declining fatalities in both Helmond and Düsseldorf. The results support the expectation that increasing automation may contribute to safety improvements by reducing some forms of human error and supporting more consistent vehicle operation. Stakeholders broadly recognized road safety as one of the principal potential benefits of CCAM. However, the scale and timing of the improvement were considered dependent on the rate of deployment, the performance of automated systems, the quality of supporting infrastructure and the management of interactions between automated and conventional road users.

The differing regional trajectories demonstrate that automation alone does not determine the safety outcome. Effective regulation, infrastructure maintenance, enforcement, system monitoring and public understanding remain necessary. During mixed-traffic phases, new risks may also emerge from interactions among automated vehicles, conventional vehicles, cyclists and pedestrians. The final presentation retains the declining safety trajectories but makes their conditional nature explicit. It also requires consistent definition of the fatality indicator and its unit to avoid interpreting a rate, index or percentage as an absolute number.

3.2.7 Economic and Infrastructure Conditions

The GDP trajectories show continuing economic growth in Helmond and Düsseldorf, with substantial differences in absolute scale. These results provide context for the capacity of each area to support investment, innovation and the deployment of new mobility technologies. The validation supported the relevance of economic conditions but did not justify presenting all projected GDP growth as attributable to CCAM. Regional GDP is shaped by numerous sectors and wider macroeconomic conditions. CCAM may contribute through productivity, new services, logistics efficiency and investment, but its effect represents only one element of broader economic development.

A similar qualification applies to the infrastructure indicators. Growth in network length, investment-related capacity and charging stations can improve regional readiness for automated and electric mobility. However, infrastructure development also responds to population growth, land-use planning, conventional transport requirements and energy policy. The final interpretation therefore describes economic and infrastructure trajectories as enabling and interacting conditions. Strong economic and infrastructure capacity may accelerate CCAM deployment, while CCAM expectations may also stimulate further investment. The relationship should be understood as mutually reinforcing rather than unidirectional.

3.2.8 Self-driving Taxi Adoption

The self-driving taxi results were considered useful for illustrating how adoption may vary between regions. Helmond shows the highest proportional adoption rate; Düsseldorf reaches the greatest number of trips and Limassol follows a more gradual trajectory. The difference between adoption rate and trip volume was an important element of the interpretation. A smaller region may reach a high adoption percentage while still generating fewer trips than a larger metropolitan area. Absolute activity and proportional uptake should therefore be reported separately.

The S-shaped adoption curves for Helmond, Düsseldorf and Limassol are consistent with a diffusion process in which early uptake is limited, growth accelerates as technology and public familiarity develop, and the rate subsequently slows as the market approaches a more mature level. The timing differs according to infrastructure readiness, regulation, market size and social acceptance. The trip trajectories also demonstrate that service demand is influenced by population and urban scale. Düsseldorf generates much larger trip volumes than the other examples, while Limassol maintains a smaller but increasing market. The validation supported the use of these differences to demonstrate that CCAM services may assume distinct roles in different regional mobility systems.

The final interpretation avoids labelling one pathway as universally preferable. A high adoption rate or large number of trips is not automatically equivalent to a positive social effect. The outcome depends on whether automated taxis complement public transport, replace private-car ownership, improve accessibility or instead generate additional low-occupancy travel.

3.2.9 Automated Last-mile Delivery

The last-mile delivery trajectories indicate increasing adoption in both Helmond and Düsseldorf, with faster growth in Helmond under the applied assumptions. Stakeholders accepted gradual diffusion as a plausible representation of how automated delivery services may enter the market.

The validation nevertheless highlighted the influence of regulatory approval, infrastructure, operational suitability and public acceptance. Last-mile services operate in public or semi-public space and may affect pedestrians, cyclists, workers, local businesses and residents. Their adoption will depend not only on technological performance but also on whether they provide an acceptable and safe service within the local environment. A terminology issue was also identified. The workshop material referred both to “ground transportation for last-mile delivery” and to “delivery drones.” These terms may describe different technologies. The final report should use the terminology corresponding to the modelled service and apply it consistently across the figure, caption, legend and explanatory text.

3.3 Cross-cutting Qualifications Identified through Validation

The workshop demonstrated that the principal forecast trends must be interpreted in relation to several cross-cutting conditions.

- Governance and regulation: Clear regulation is necessary to define operational requirements, liability, data use, safety responsibilities and service-access conditions. Regulatory uncertainty may delay adoption even where the technology is available. Conversely, rapid deployment without appropriate oversight could weaken public confidence or generate unequal outcomes.
- Inclusive design and accessibility: CCAM has considerable potential to improve mobility for older people, people with disabilities and individuals unable to drive. These benefits depend on accessible vehicles, booking systems, payment methods and passenger-

support arrangements. Digital-only service models may create new barriers for people with limited connectivity, digital skills or access to financial services.

- Affordability and distribution: Improved regional economic conditions do not guarantee that CCAM will be affordable to all users. Pricing, ownership structures, public subsidies and service geography will influence who benefits. Particular attention is required where commercial operators may prioritize high-demand or higher-income areas.
- Public trust and acceptance: Adoption depends on confidence in safety, reliability, data protection and institutional oversight. Public acceptance may develop gradually through demonstrations and practical experience. A lack of transparency or highly visible incidents could slow uptake and alter the forecast pathways.
- Infrastructure readiness: Physical and digital infrastructure can either enable or constrain deployment. Charging facilities, road quality, communications coverage, mapping, maintenance and operational support must develop alongside CCAM services. Regional differences in these areas help explain the different modelled trajectories.
- Employment and fair transition: Although employment was not the central focus of the validated figures, stakeholders recognized the potential implications of CCAM for occupations, tasks and organizational structures. New technical and supervisory roles may emerge while some existing activities are reduced or transformed. Measures supporting skills development and fair workforce transitions remain important to the wider social outcome.
- Long-term planning: The benefits illustrated in the assessment accumulate over time and require continuity in investment, governance and monitoring. Short-term pilot activity without a longer implementation pathway may not generate the projected system-level effects. The results therefore support a staged approach in which deployment is accompanied by continuous evaluation and adjustment.

3.4 Feedback on the Presentation of Results

One of the clearest practical outcomes of the validation concerned the graphical presentation of the time-series results. For several indicators, the use of a vertical axis beginning at zero made the annual and cumulative changes difficult to distinguish..

The final figures are therefore revised according to the following principles:

- Refining the adoption curves for certain uses to reflect regional differences.
- A more focused vertical-axis range is used where it materially improves the visibility of change.
- Any vertical axis that does not begin at zero is clearly labelled.
- Line charts are used for time series with truncated axes, avoiding the misleading visual emphasis that may occur when bar charts begin above zero.
- Refining the household disposable income results to replicate regional contexts.
- Comparable panels use the same scale wherever this remains compatible with readability.
- Starting and ending values are reported in the figure or accompanying text.
- Units are stated in the axis label and caption.
- Regional abbreviations are replaced by full names where space permits.
- The distinction between percentages, proportions, rates, indices and absolute values is made explicit.
- Figure titles identify both the indicator and the region.
- Colors are applied consistently across impact dimensions.

The revised approach improves readability without changing the underlying forecast values. It also ensures that greater visual visibility does not imply greater forecasting certainty.

3.5 Validation and Revision Matrix

The table below summarizes the main outcomes of the validation and the corresponding treatment in D4.8.

Table 4: Summary of validation outcomes and resulting revisions

Assessment Area	Validation Outcome	Principal qualification or issue	Treatment in D4.8
Modal split	Confirmed with qualification	Outcomes depend on whether CCAM complements public transport or encourages additional individual travel	Retain trajectories and strengthen explanation of service design and demand effects
Renewable-energy share	Confirmed as contextual pathway	Not a direct effect of CCAM; changes were difficult to distinguish visually	Present as an enabling condition and use a focused non-zero axis
Disposable income	Confirmed as contextual indicator	Aggregate growth does not demonstrate equitable access or affordability for all groups	Reframe as household economic capacity and use a focused non-zero axis
Road safety	Confirmed with qualification	Benefits depend on deployment, infrastructure, regulation and mixed-traffic conditions	Retain declining trajectories, clarify assumptions and verify units
GDP	Confirmed as contextual trajectory	Economic growth cannot be attributed entirely to CCAM	Avoid direct causal language and revise chart scale
Transport infrastructure	Confirmed as enabling condition	Infrastructure development is affected by wider planning and investment	Present as regional readiness and revise chart scale
Charging stations	Confirmed as supporting condition	Electrification infrastructure supports but is not exclusive to CCAM	Retain trajectory and apply a more informative axis range
Self-driving taxi adoption	Confirmed with regional qualification	Adoption rates and trip volumes reflect different aspects of market development	Consolidate regional comparisons and report rates and volumes separately

Last-mile delivery	Confirmed with qualification	Adoption depends on regulation, operational context and public acceptance	Retain trajectories and standardise the service terminology
Cross-cutting assessment	Confirmed with conditions	Benefits depend on governance, inclusion, trust and long-term planning	Integrate enabling conditions throughout the final interpretations
Visual communication	Revision requested	Zero-based axes concealed meaningful changes in selected figures	Recreate affected figures as clearly labelled line charts with focused ranges

3.6 Final Validated Messages

The validation process resulted in six principal messages that guide the final presentation of the social impact assessment. First, CCAM is expected to generate multidimensional effects extending across mobility, accessibility, safety, infrastructure, economic activity and service provision. These dimensions interact and should not be assessed independently. Second, the transition is likely to be gradual. Significant system-level effects depend on sustained deployment, infrastructure development, institutional learning and public acceptance over an extended period. Third, regional context matters. Similar technologies can produce different adoption rates, trip volumes and social outcomes depending on population scale, spatial structure, economic capacity and infrastructure readiness.

Fourth, several forecast indicators represent enabling conditions rather than effects attributable exclusively to CCAM. The final assessment therefore uses cautious causal language and distinguishes contextual projections from more direct adoption variables. Fifth, positive outcomes are conditional. Safety, accessibility and economic opportunities will depend on governance, inclusive design, affordability, public trust and appropriate support for affected groups. Finally, the presentation of results is itself an important component of validation. Transparent units, consistent terminology and appropriate axis ranges are necessary to ensure that model outputs are visible and understandable without exaggerating their certainty or magnitude.

These conclusions provide the basis for the final validated results presented in Section 4.

4 Final Validated Social Impact Assessment Results

4.1 Interpretation and Reporting of the Final Results

This section presents the final social impact assessment results following their consideration during the stakeholder validation workshop. It concentrates on the substantive findings and their interpretation, while the model structure, equations, assumptions and analytical procedures are documented in D4.7. The results cover the period from 2025 to 2050 and include selected regional applications for Helmond, Düsseldorf and Limassol. These regional examples illustrate how common CCAM-related mechanisms may develop differently according to population, transport demand, infrastructure, economic conditions, institutional capacity and technological readiness. They should not be interpreted as a ranking of the three regions or as comprehensive forecasts of every aspect of their future transport systems.

The annual values represent conditional model trajectories. They describe how the selected indicators could develop under the assumptions incorporated into the social impact assessment. Stakeholder validation supports the plausibility and coherence of the overall trends but does not imply that each annual value will occur exactly as projected. The most relevant elements are therefore the direction of change, the approximate scale of development and the differences among regional pathways. The indicators presented in this section perform different functions within the assessment. Some represent broader contextual or enabling conditions, while others relate more directly to CCAM adoption or to transport-system outcomes. This distinction is summarised in the table below.

Table 5: Role of the indicators presented in the final assessment

Indicator group	**Indicators**	Function within the assessment
Contextual and enabling conditions	Renewable-energy share, disposable household income, GDP, transport infrastructure and charging stations	Describe wider conditions that may support, constrain or interact with CCAM deployment
CCAM adoption indicators	Adoption rates of self-driving taxis and automated last-mile delivery	Represent the diffusion of selected passenger and freight CCAM services
CCAM activity indicators	Number of trips made using self-driving taxis	Represent the scale of service use after accounting for regional population and market conditions
Transport and social outcome indicators	Modal split and road-traffic fatalities	Represent system-level effects that may result from the interaction of CCAM, user behaviour, policy and infrastructure

The classification is important for the interpretation of causality. For example, projected growth in GDP or disposable household income cannot be attributed exclusively to CCAM. These variables influence the capacity of a region or household to invest in and use new mobility services and may also be affected indirectly by improved transport performance. Their relationship with CCAM is therefore interactive rather than exclusively causal.

The figures have been redesigned using consistent colours, typography, terminology and time horizons. For the renewable-energy, disposable-income, GDP, infrastructure and charging-station results, more focused vertical-axis ranges are used to make gradual changes visible. These charts are presented as line charts, and non-zero axes are clearly indicated. Figures involving modal composition, adoption from a near-zero base, trip volumes or safety outcomes approaching zero retain a zero baseline where it is substantively meaningful.

4.2 Mobility Patterns

The modal-split results illustrate how the relative roles of private vehicles, public transport, walking and cycling may change over the forecasting period. Modal split is influenced not only by the availability of automated services but also by service pricing, land use, public-transport quality, infrastructure and established travel behavior. The results should therefore be interpreted as system-level pathways rather than direct effects of vehicle automation alone.

4.2.1 Düsseldorf

The Düsseldorf trajectory indicates a gradual reduction in the share of trips made using private vehicles and a corresponding increase in public-transport use. The change takes place progressively over the 2025–2050 period rather than through an abrupt restructuring of mobility behavior. Walking and cycling remain comparatively stable. This suggests that the projected shift occurs primarily between private vehicles and collective transport rather than through a substantial expansion of active travel. The result is consistent with a pathway in which public and shared mobility services become more competitive and convenient while active modes retain their established role.

The trajectory provides a potentially favorable outcome from the perspective of sustainable mobility, but it remains conditional on the way CCAM services are introduced. Automated public transport, shared shuttles and integration between self-driving services and mass transit could reduce dependence on individually owned vehicles. In contrast, widespread use of privately operated automated vehicles could weaken this effect or generate additional trips. The validated interpretation therefore emphasizes that automation is not, by itself, a modal-shift policy. The direction of change depends on pricing, service integration, parking policy, road-space allocation and the relative attractiveness of public and private travel.

4.2.2 Limassol

The Limassol trajectory indicates a comparatively strong role for walking and cycling while private vehicles continue to account for a substantial proportion of travel. The distribution among modes remains relatively stable, with gradual changes rather than a fundamental shift in the overall mobility structure. This stability may reflect persistent characteristics of the regional transport system, including urban form, travel distances, climate, infrastructure and existing behavioral patterns. Even where automated mobility services become available, these underlying conditions are likely to continue shaping travel choices.

The results suggest that CCAM deployment in Limassol may initially complement the existing mobility system rather than replace established modes. Automated services could address specific needs, such as first- and last-mile connections, mobility for people unable to drive, or travel during periods when conventional public transport is limited. However, if automated services primarily substitute walking, cycling or public transport, they could produce additional motorized travel. Measures supporting integration with active and collective modes will therefore be important to ensure that improved accessibility does not lead to an avoidable increase in traffic.

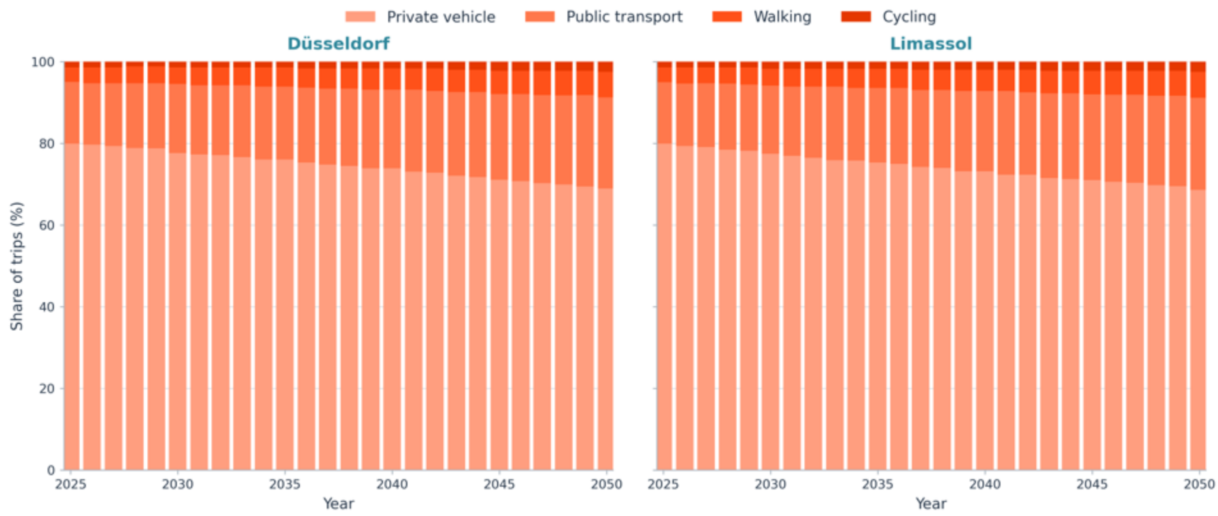

Figure 1: Projected modal split in Düsseldorf and Limassol, 2025–2050

4.2.3 Accessibility, Affordability and Distributional Effects

The comparison demonstrates that CCAM does not produce a single predetermined modal outcome. Regional transport structure and implementation choices determine whether automated mobility supports public transport, replaces private-car trips, or generates additional vehicle activity.

The final assessment identifies three implications:

- Shared and public-transport-oriented CCAM services offer greater potential to reduce reliance on private vehicles.
- Stable walking and cycling shares should not be interpreted as guaranteed protection of active mobility; appropriate street design and policy support remain necessary.
- Improvements in convenience and travel time may stimulate additional demand, potentially offsetting some network-efficiency benefits.

The mobility results should consequently be monitored alongside total trip generation, vehicle kilometers travelled, occupancy rates and the relationship between automated services and existing public transport.

4.3 Environmental and Energy Conditions

The environmental examples focus on the projected share of renewable-energy sources in the energy mix. This indicator is relevant because the environmental performance of electric and automated mobility depends partly on the energy used to charge and operate vehicles and supporting infrastructure.

4.3.1 Helmond

The Helmond trajectory shows a sustained increase in the renewable-energy share over the forecasting period. The value rises from approximately 12–13% in 2025 to around 27% by 2050. The steady increase indicates a supportive transition towards lower-carbon energy. If CCAM deployment is accompanied by fleet electrification, this development can reduce the emissions associated with vehicle operation and charging. The environmental benefit would become progressively stronger as the energy mix improves. The trajectory should not be interpreted as growth caused exclusively by CCAM. Renewable-energy development is influenced by national and regional energy policy, investment, energy prices, generation capacity and broader decarbonization strategies. The relevance to CCAM lies in the interaction between energy-system development and automated mobility.

4.3.2 Dusseldorf

The Düsseldorf trajectory also shows continuous growth, from approximately 6% in 2025 to almost 16% in 2050. Although the projected increase is substantial relative to the starting value, the final share remains below that of the Helmond example. This difference illustrates how regional baseline conditions and energy-transition pathways affect the environmental context of CCAM. A slower increase does not necessarily indicate weak CCAM readiness, but it may limit the rate at which electrified automated mobility generates operational emission reductions.

The validated assessment therefore treats the renewable-energy share as one component of environmental readiness. A complete assessment would also require consideration of vehicle production, battery manufacture, induced travel demand, occupancy, modal substitution and infrastructure construction.

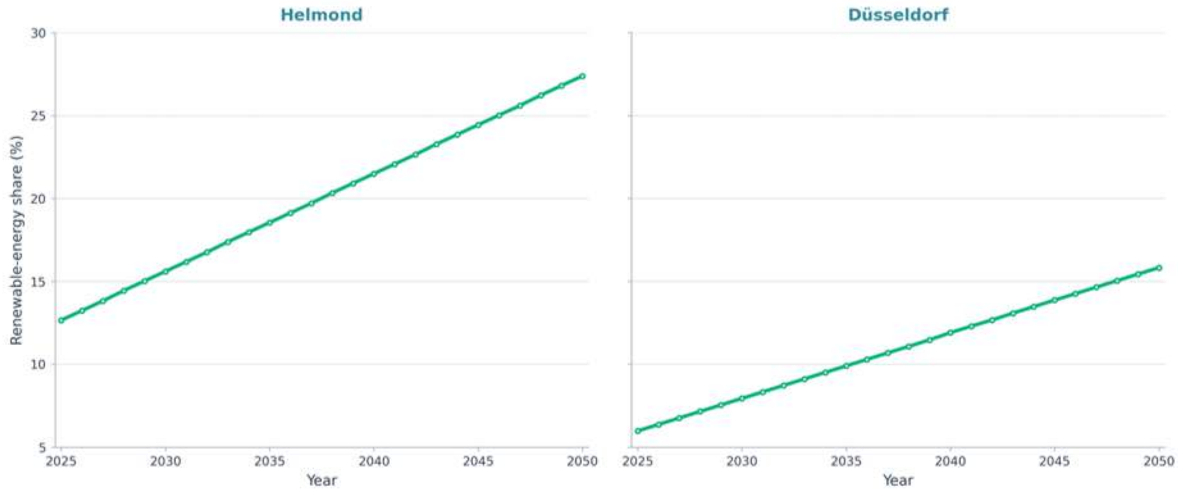

Figure 2: Projected share of renewable-energy sources in Helmond and Düsseldorf, 2025–2050

4.3.3 Validated Interpretation of Environmental Effects

The environmental result supports the conclusion that CCAM sustainability depends on the wider transition of the transport and energy systems. Automated mobility may improve operational efficiency, but automation does not guarantee lower environmental impact. Benefits are more likely where:

- Automated fleets are progressively electrified.
- Electricity generation becomes less carbon intensive.
- Shared use and higher occupancy reduce unnecessary vehicle activity.
- CCAM complements public and active transport.
- Empty vehicle movements and induced demand are controlled.

Renewable-energy growth therefore represents an enabling condition rather than an independent CCAM effect.

4.4 Equity, Affordability and Household Economic Capacity

Disposable household income was included as an indicator of the economic capacity of households to access and benefit from emerging mobility services. The results provide contextual information concerning affordability but do not directly measure the distribution of income or access among different population groups.

4.4.1 Helmond

Disposable household income in Helmond increases from slightly below €2,000 million in purchasing power standards in 2025 to approximately €3,000 million by 2050. The trajectory is gradual and approximately linear. The increase suggests strengthening household economic capacity over the forecasting period. Higher disposable income may improve the ability of households to adopt new mobility services and technologies, particularly if these involve subscription costs, digital access, specialized equipment or higher prices during early deployment.

Nevertheless, an increase in aggregate income does not demonstrate that CCAM will be affordable to all users. The indicator does not show how income is distributed among households or whether the price of CCAM services changes at the same rate. Affordability must therefore be assessed together with service prices, public support and the circumstances of lower-income users.

4.4.2 Limassol

The corresponding Limassol trajectory rises from approximately €2,450 million in 2025 to around €3,100–€3,150 million by 2050. The projected increase is steady and less steep than the Helmond trajectory in relative terms. The result indicates a gradual improvement in the aggregate economic capacity of households. This could support the uptake of automated passenger and delivery services, particularly once technologies mature and services become more widely available.

As with Helmond, the result should not be interpreted as proof of equitable adoption. Geographic coverage, access to digital services, payment options, age, disability and household income distribution will continue to influence whether individuals can use CCAM.

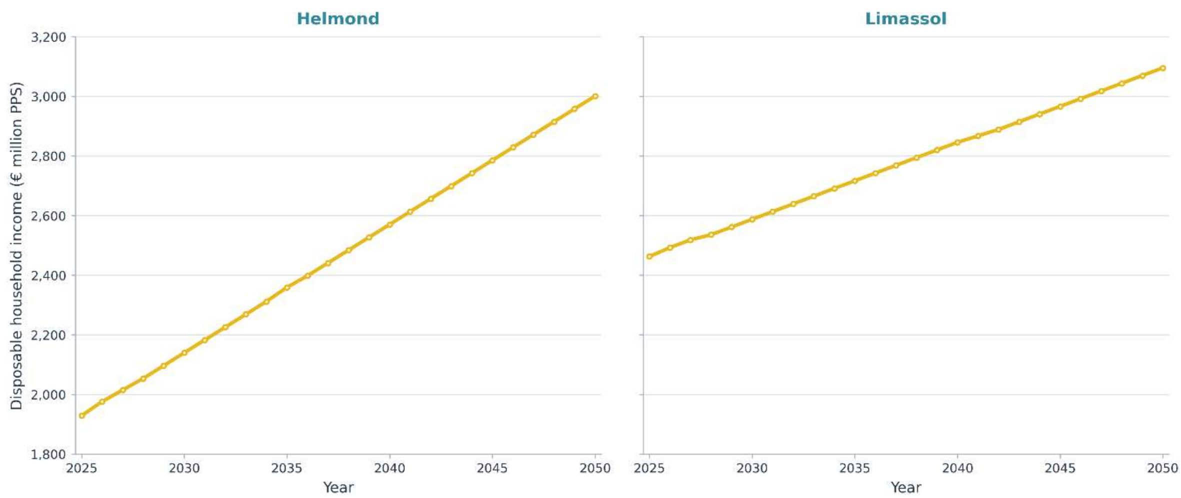

Figure 3: Projected disposable household income in Helmond and Limassol, 2025–2050

4.4.3 Validated Interpretation of Equity Effects

The validation reinforced the need to separate economic capacity from equity. Rising household income may support market uptake, but equitable mobility outcomes depend on service design and distribution. The following factors should therefore accompany the interpretation of the income trajectories:

- Affordable fares and subscription models.
- Coverage in lower-density and lower-income areas.
- Accessible vehicles and interfaces.
- Alternatives for users without smartphones, bank accounts or advanced digital skills.
- Assistance for people requiring physical or personal support.
- Transparent pricing and protection against discriminatory service provision.

CCAM may improve mobility for groups currently facing transport disadvantages, but only if their needs are incorporated into deployment decisions. Aggregate economic growth cannot substitute for inclusive design or targeted affordability measures.

4.5 Safety Effects

Road safety is one of the most frequently anticipated benefits of automated mobility. The model results show declining road-traffic fatalities in both Helmond and Düsseldorf, although the rate and scale of change differ.

4.5.1 Helmond

The Helmond trajectory decreases from approximately 4.2 units in 2025 to around 3.2 units in 2050. The reduction is gradual and consistent across the forecast period. This pathway represents a moderate long-term improvement rather than a rapid transformation. It is consistent with phased deployment, during which automated vehicles progressively become more common but continue to interact with conventional vehicles and other road users.

The result also implies that safety challenges remain even under increasing automation. Infrastructure quality, system performance, maintenance, user behavior and mixed-traffic conditions continue to influence fatalities. Automation can reduce some human-error-related incidents but may introduce new risks related to system limitations, handover, cybersecurity or interaction with vulnerable road users.

4.5.2 Dusseldorf

The Düsseldorf trajectory shows a considerably steeper decline, from approximately 1.0 in 2025 to a value close to zero by 2050. Under the model assumptions, this represents a strong cumulative safety improvement. The scale of the decline suggests a pathway involving effective deployment, substantial technology penetration and supportive infrastructure and policy. The result illustrates the potential safety benefit of a mature and well-integrated CCAM system. However, the trajectory should be interpreted as a conditional upper pathway rather than a guarantee that fatalities will be eliminated. Residual risks remain even in highly automated systems, and the precise result depends on the definition and unit of the indicator.

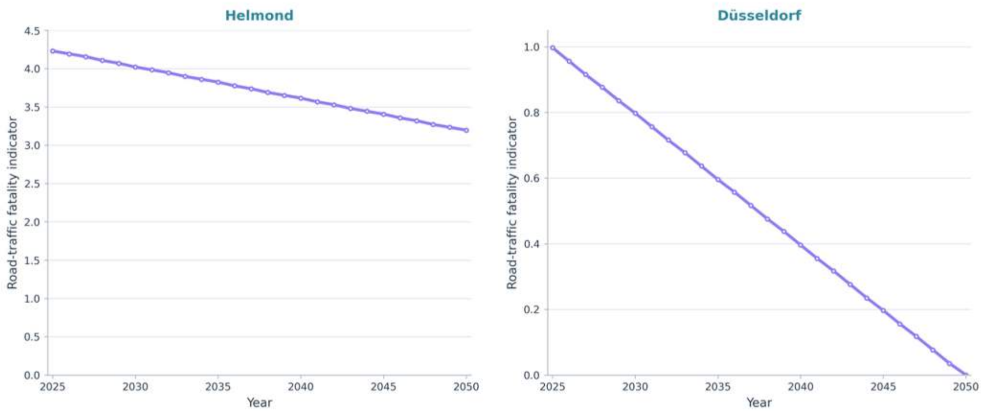

Figure 4: Projected road-traffic fatality indicators in Helmond and Düsseldorf, 2025–2050

4.5.3 Validated Interpretation of Environmental Effects

The validation supported the direction of the safety results while reinforcing their conditional nature. Safety improvements depend on:

- The proportion of automated vehicles within the fleet.
- The operational design domains in which automated systems can function safely.
- The management of interactions between automated and conventional vehicles.
- Infrastructure quality and digital connectivity.
- Vehicle and software maintenance.
- Regulatory monitoring and incident reporting.
- Safe interaction with pedestrians, cyclists and people with disabilities.

The final assessment therefore concludes that CCAM offers considerable safety potential, but that the benefit will emerge through a combination of automation, infrastructure, regulation and responsible deployment.

4.6 Economic Development and Infrastructure Readiness

Economic and infrastructure indicators describe the capacity of regional systems to support CCAM deployment. They also illustrate how CCAM may interact with wider investment and development processes.

4.6.1 Regional GDP

Helmond's projected GDP increases from approximately €5,000–€5,500 million in 2025 to over €9,000 million by 2050. The growth is steady and indicates a gradually expanding regional economy. Düsseldorf's GDP increases from approximately €80,000 million to almost €160,000 million. The much larger absolute values reflect the scale of the regional economy rather than a proportionally superior CCAM outcome.

The GDP trajectories are relevant because stronger economies may have greater capacity to finance infrastructure, support innovation and generate demand for new mobility services. CCAM may also contribute to productivity, logistics efficiency and new business activity. Nevertheless, the modeled GDP growth cannot be attributed exclusively to CCAM.

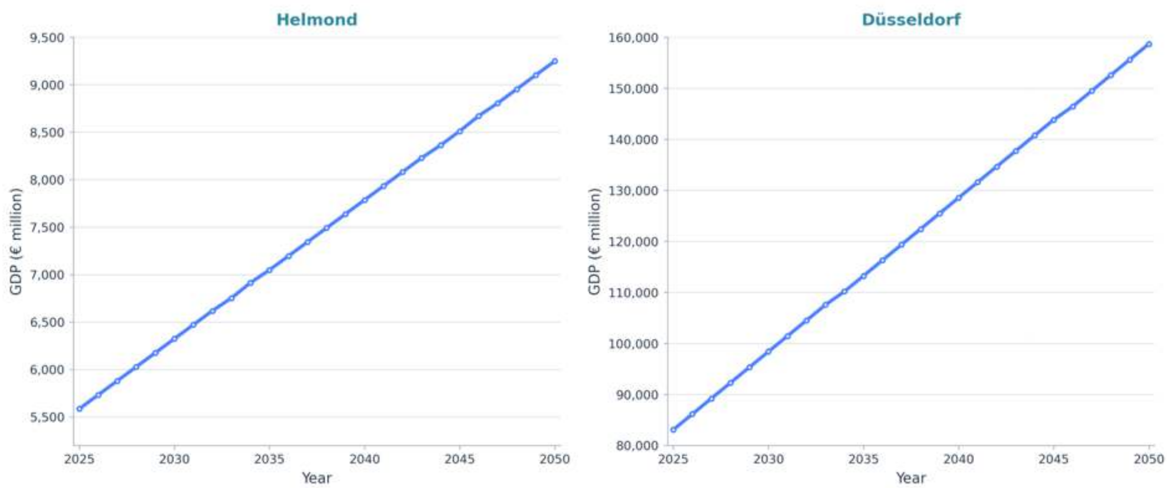

Figure 5: Projected GDP in Helmond and Düsseldorf, 2025–2050

4.6.2 Transport Infrastructure

The Limassol infrastructure trajectory increases from approximately 72 km in 2025 to nearly 100 km by 2050. The development is gradual and indicates progressive expansion of the transport network. The Düsseldorf trajectory increases from approximately 275 km to more than 500 km over the same period. The result suggests a substantially larger scale of infrastructure development and a stronger increase in network capacity.

Infrastructure expansion can support CCAM through improved coverage, routing flexibility, maintenance capacity and operational reliability. However, the quantity of infrastructure alone does not determine readiness. Digital connectivity, road quality, mapping, signage and the suitability of infrastructure for automated operation are also relevant.

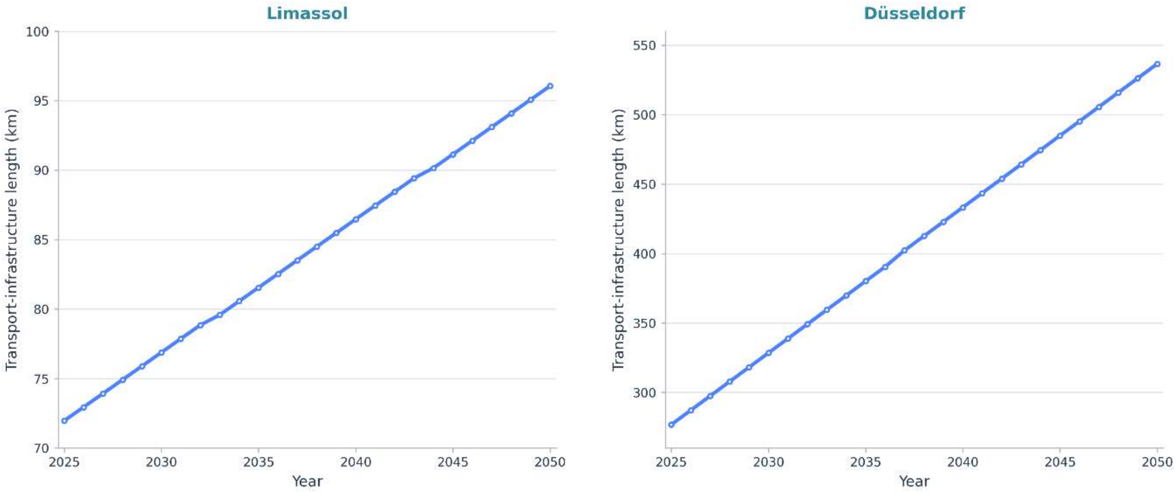

Figure 6: Projected transport-infrastructure development in Limassol and Düsseldorf, 2025–2050

4.6.3 Charging Infrastructure

The number of charging stations in Helmond increases from approximately 200–230 in 2025 to more than 600 by 2050. The trajectory represents substantial and sustained expansion. In Düsseldorf, the number increases from approximately 40 to around 125–130. The absolute difference between the regional examples may reflect the model assumptions, geographical definition, charging-station classification or baseline data and should not be interpreted without reference to these factors.

The charging-station results demonstrate the interdependence between automation and electrification. Where automated fleets are electric, insufficient charging capacity may constrain adoption or reduce operational efficiency. Conversely, expanded charging infrastructure can support both CCAM and the broader transition to electric mobility.

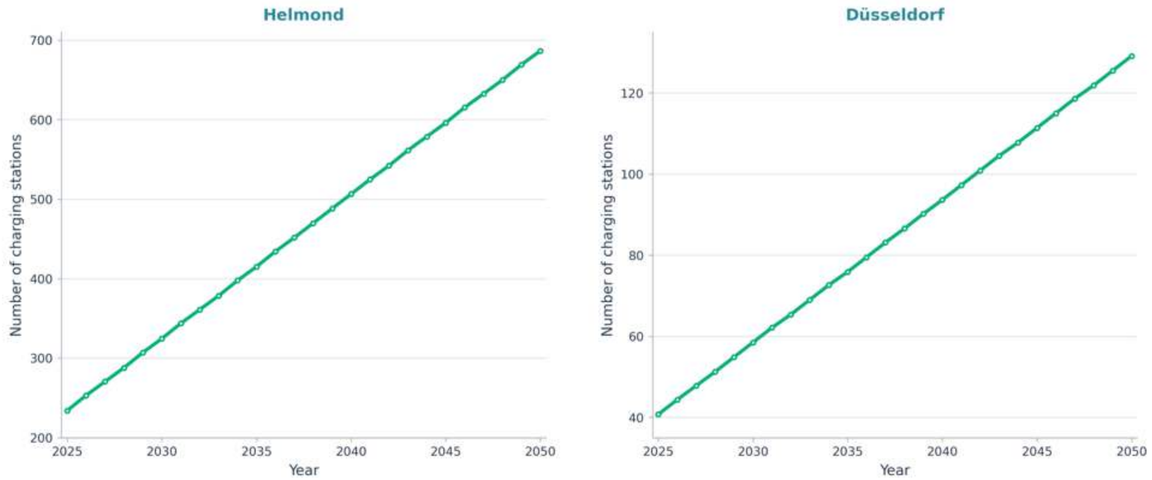

Figure 7: Projected number of charging stations in Helmond and Düsseldorf, 2025–2050

4.6.4 Validated Interpretation of Economic and Infrastructure Conditions

The combined results demonstrate that CCAM readiness is shaped by the interaction of economic capacity, physical infrastructure and electrification. Regions with stronger investment capacity and supportive infrastructure may be better positioned to deploy CCAM at scale. However, the relationship operates in both directions. Economic development enables CCAM investment, while CCAM may support productivity and new services. Infrastructure supports deployment, while expectations of future deployment can stimulate infrastructure investment. The final assessment therefore avoids attributing the complete projected growth of these indicators to CCAM.

4.7 Self-driving Taxi Adoption and Use

Self-driving taxis provide a passenger-transport example for examining both proportional adoption and absolute service activity. The distinction is important because a region can record a high adoption rate but a comparatively low number of trips due to its smaller population and market size.

4.7.1 Adoption Rates

The Helmond trajectory reaches approximately 40% adoption around the middle of the 2030s and exceeds 70% by 2050. The curve follows a diffusion pattern in which early adoption is limited, growth accelerates during the 2030s and the rate gradually approaches a more mature level. Düsseldorf reaches approximately 35% during the middle of the 2030s and around 60% by 2050. Its proportional uptake is lower than Helmond's, although its absolute service market is considerably larger.

Limassol follows the most gradual pathway. Adoption remains below approximately 30% in the middle of the 2030s and reaches around 50% by 2050. The slower trajectory reflects more cautious diffusion under the regional assumptions. The differences demonstrate how regulation, infrastructure, market size, spatial structure and public acceptance may affect the timing of adoption. They should not be interpreted as fixed forecasts of technological leadership.

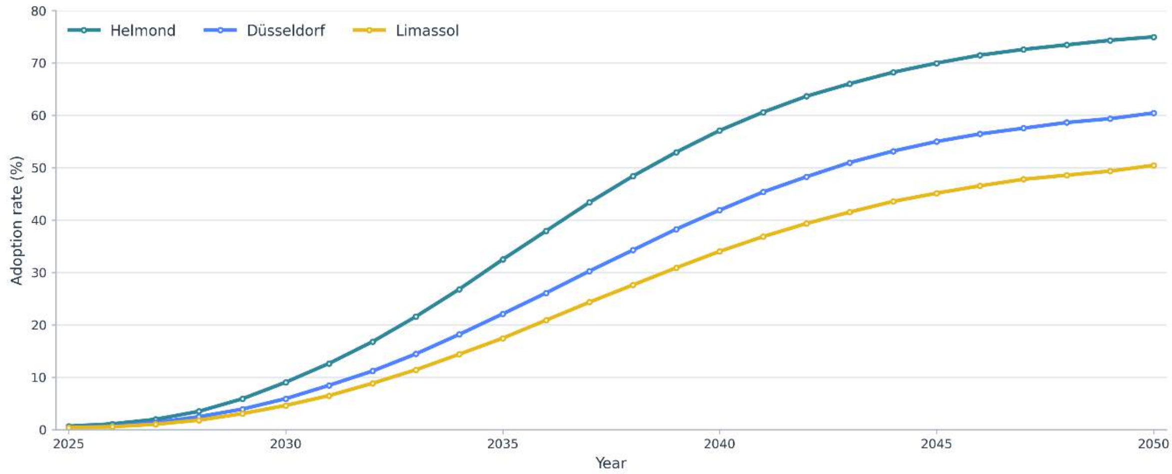

Figure 8: Projected adoption rate of self-driving taxis in Helmond, Düsseldorf and Limassol, 2025–2050

4.7.2 Number of Trips

Self-driving taxi trips in Helmond increase from a low initial base to more than 50,000 annually by 2050. The pathway shows sustained growth as the service becomes more widely available and accepted. Düsseldorf records the largest absolute increase, with annual trips exceeding one million by 2050. The substantial volume reflects the larger population and urban transport market. It does not contradict Düsseldorf's lower proportional adoption rate compared with Helmond. Limassol reaches approximately 35,000 annual trips by 2050. The result suggests a smaller but progressively developing market in which automated taxis may fulfil specific rather than mass-market mobility functions.

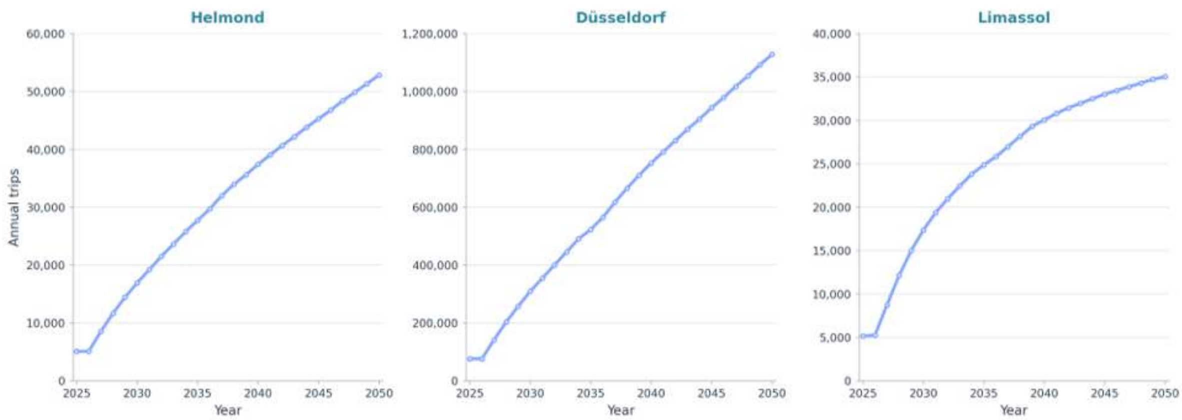

Figure 9: Projected number of self-driving taxi trips in Helmond, Düsseldorf and Limassol, 2025–2050

4.7.3 Validated Interpretation of Passenger CCAM Adoption

The adoption results support four conclusions. First, CCAM diffusion is expected to be gradual and to follow different regional timelines. Early uptake does not immediately translate into widespread use. Second, proportional adoption and absolute demand describe different aspects of market development. Both should be considered when assessing infrastructure requirements and social relevance.

Third, high trip volumes are not inherently beneficial. Automated taxis may improve accessibility and reduce the need for private-car ownership, but they may also increase vehicle kilometers, empty running and congestion.

Fourth, the social outcome depends on integration with the wider transport system. Self-driving taxis are more likely to generate positive effects where they provide connections to public transport, serve people with limited mobility and operate through shared or higher-occupancy models.

4.8 Automated Last-mile Delivery

The last-mile delivery results illustrate the prospective diffusion of automated freight services. Depending on the technology represented in the model, these services may include ground-based automated delivery vehicles or another defined form of automated delivery. The final terminology should be aligned with the underlying model variable and used consistently.

Helmond shows the faster adoption pathway, reaching approximately 40% by 2050. Growth is initially limited, accelerates from the 2030s and continues during the 2040s. Düsseldorf reaches approximately 28–30% by 2050. The trajectory remains positive but indicates more cautious adoption. Differences may reflect the regulatory environment, urban complexity, operational conditions, market structure or public acceptance. Both trajectories include periods in which growth slows temporarily. These variations should not be interpreted as precise predictions of individual market events. They illustrate that technology diffusion may not proceed at a uniform annual rate and may be affected by regulatory, commercial or implementation constraints.

The social effects of last-mile automation extend beyond adoption itself. Potential benefits include improved delivery efficiency, reduced costs, flexible service and support for people unable to travel easily to shops or collection points. Possible risks include displacement or transformation of existing delivery work, increased use of public space, conflicts with pedestrians and cyclists, surveillance or data concerns and unequal service coverage. The final assessment therefore treats adoption as an indicator of market diffusion rather than as a direct measure of social benefit. Positive outcomes depend on operational design, regulation, safety, accessibility and the distribution of efficiency gains.

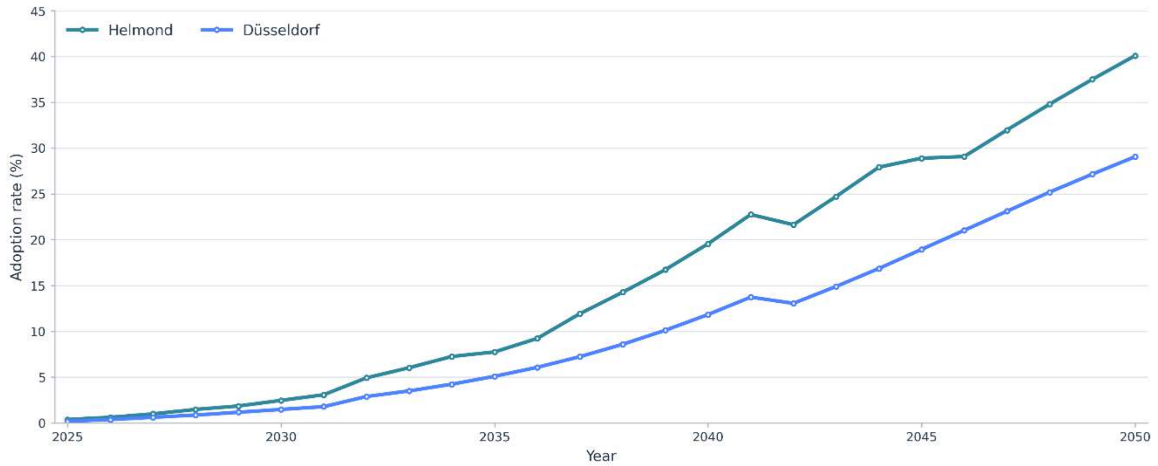

Figure 10: Projected adoption of automated last-mile delivery in Helmond and Düsseldorf, 2025–2050

4.9 Cross-regional Synthesis of the Validated Results

The regional examples demonstrate that the social effects of CCAM emerge through the interaction of technology with local economic, spatial, behavioral and institutional conditions. Table 4-2 summarizes the principal characteristics of the three pathways.

Table 6: Cross-regional synthesis of the final validated results

Region	Main characteristics of the projected pathway	Principal interpretation
Helmond	Strong renewable-energy and charging-infrastructure growth; highest proportional self-driving taxi adoption; moderate taxi-trip volume; gradual improvement in safety and household economic capacity	Favourable conditions for comparatively early uptake, although the smaller regional scale limits absolute service volumes
Düsseldorf	Gradual shift from private vehicles towards public transport; substantial GDP and infrastructure growth; strongest decline in the safety indicator; largest self-driving taxi trip volume; moderate proportional adoption	Large urban and economic scale supports high service activity, while successful outcomes depend on integration with public transport and management of additional demand
Limassol	Relatively stable modal structure with an important role for active modes; gradual household-income and infrastructure growth; slowest taxi-adoption pathway and lowest absolute trip volume	CCAM is more likely to develop gradually and serve targeted mobility needs, requiring context-specific infrastructure and service design

Across the three regions, five common findings emerge. First, most effects develop cumulatively. CCAM adoption, infrastructure expansion and social outcomes require time and are unlikely to change simultaneously. Second, infrastructure and socioeconomic conditions influence adoption. Regions with stronger enabling conditions can support earlier or larger-scale deployment, although a large economy does not automatically produce the highest proportional uptake.

Third, the benefits of CCAM are conditional on service design. Automated mobility can improve accessibility, convenience and safety, but may also increase travel demand or reinforce existing inequalities if introduced primarily through individual and commercially selective services. Fourth, contextual indicators should not be interpreted as direct CCAM effects. GDP, income, renewable-energy use and infrastructure development interact with CCAM but are shaped by wider economic and policy processes.

Finally, no regional pathway is universally applicable. The results support differentiated strategies that reflect local transport needs, population characteristics, infrastructure, regulatory capacity and public preferences. The final validated assessment therefore presents CCAM as an enabling technological development whose societal effects will be determined by the conditions governing its deployment. Positive outcomes are plausible, but their scale and distribution depend on long-term planning, inclusive design, public trust, infrastructure readiness and continuous monitoring.

5 Refinements and Implications of the Validated Assessment

5.1 Refinements Introduced Following Stakeholder Validation

The stakeholder-validation process broadly confirmed the direction and internal coherence of the projected social effects. It did not identify a need to alter the overall logic of the social impact assessment. The principal refinements concerned the interpretation, visual presentation and communication of the results. These refinements were important because long-term forecasting can easily be presented with a level of precision or causal certainty that is not supported by the underlying evidence. The revised assessment consequently places greater emphasis on the conditional nature of the projected pathways and on the distinction between CCAM adoption, wider enabling conditions and system-level social outcomes.

5.1.1 Interpretation of the Forecast Trajectories

The first refinement concerns the status of the model outputs. The annual values presented for 2025–2050 should be understood as conditional trajectories rather than deterministic forecasts. The validation supported the direction and approximate scale of change but did not imply that each value will be realized in the corresponding year.

The final assessment therefore places greater emphasis on:

- The direction of change over the complete forecasting period.
- The approximate scale of the projected development.
- Differences among regional pathways.
- The conditions that may accelerate, delay or alter the results.
- The interdependence between technological, social, economic and institutional factors.

This approach reduces the risk of interpreting smoothed annual trajectories as precise predictions. Actual CCAM development may include periods of faster growth, regulatory delay, technological disruption or temporary market adjustment.

5.1.2 Distinction Between Contextual Conditions and CCAM Effects

The validation also reinforced the need to distinguish between indicators directly associated with CCAM diffusion and indicators representing the wider environment in which deployment occurs. Self-driving taxi adoption, self-driving taxi trips and automated last-mile delivery uptake are closely connected to the diffusion and use of specific CCAM services. Modal split and safety outcomes are system-level effects that may be influenced by CCAM alongside other transport and policy developments.

By contrast, GDP, disposable household income, renewable-energy use and infrastructure development are influenced by broader economic and policy processes. They may enable CCAM deployment and may also be affected indirectly by improved transport performance, but their complete projected growth cannot be attributed to CCAM. The final interpretation consequently avoids statements suggesting that CCAM alone produces the projected increase in these contextual indicators. Instead, the assessment describes them as enabling, constraining or interacting conditions.

5.1.3 Regional Comparisons

The regional examples were refined to avoid treating Helmond, Düsseldorf and Limassol as a performance ranking. Differences in absolute values reflect differences in geographical definition, population, economic scale, infrastructure and market size.

The validation highlighted the importance of distinguishing proportional adoption from absolute activity. Helmond, for example, records a comparatively high projected self-driving taxi adoption rate, while Düsseldorf generates a much larger number of trips. Both results are internally consistent because Düsseldorf represents a larger transport market.

The final assessment therefore:

- Reports adoption rates and trip volumes separately.
- Uses full regional names rather than abbreviations where possible.
- Avoids describing one regional pathway as universally preferable.
- Interprets each result in relation to its local baseline and context.
- Uses separate panel scales where differences in regional magnitude would otherwise conceal relevant trajectories.

5.1.4 Terminology and Indicator Definitions

Terminology was also reviewed to avoid ambiguity. The final assessment uses "self-driving taxis" consistently for the automated passenger-service example. For the freight application, the term "automated last-mile delivery" is used as the general description. Where the underlying model represents a more specific technology, such as ground-based delivery vehicles, that technology should be identified consistently in the figure title, legend and accompanying text. The transport-infrastructure result is described according to the unit represented in the model rather than interchangeably as infrastructure investment and infrastructure length. Similarly, the safety result is referred to as a road-traffic fatality indicator unless the underlying metadata establishes a more specific unit, such as fatalities per population, percentage change or an indexed value.

Table 7: Refinements introduced following validation

Area	Issue identified	Refinement
Forecast interpretation	Risk of treating annual projections as precise predictions	Emphasis placed on long-term direction, scale and conditionality
Causal interpretation	Contextual socioeconomic changes could be attributed entirely to CCAM	Contextual, adoption and system-outcome indicators explicitly distinguished
Regional comparison	Absolute values could be interpreted as regional performance rankings	Results interpreted relative to regional scale and baseline conditions
Adoption reporting	Adoption rate and trip volume could be treated as equivalent	Proportional uptake and absolute service activity reported separately
Figure scales	Zero-based axes concealed gradual changes	Focused, disclosed non-zero axes used for selected line charts
Chart type	Truncated bar charts could exaggerate differences	Line charts used for time series with non-zero baselines
Units	Some indicators were insufficiently defined	Indicator names and units standardised and clarified

Service terminology	Last-mile technology described inconsistently	Consistent use of the model’s defined automated delivery application
Regional naming	Abbreviations reduced clarity	Full regional names used wherever possible
Traceability	Relationship between feedback and revisions needed to be visible	Validation-and-revision matrix included in the deliverable

5.2 Cross-cutting Social Implications

The validated results demonstrate that the social effects of CCAM cannot be determined solely by the performance of automated vehicles. They emerge through interactions among technology, users, service design, infrastructure, governance and wider socioeconomic conditions.

5.2.1 Accessibility and Inclusion

Improved accessibility remains one of the strongest potential social benefits of CCAM. Automated passenger services may provide additional mobility options for older people, people with disabilities, individuals unable to drive and people living in areas with limited conventional public transport. The modelled growth in self-driving taxi adoption illustrates the potential expansion of such services. However, availability does not guarantee accessibility. Vehicles, booking systems, payment methods, passenger information and physical boarding arrangements must be designed for diverse user needs.

Digital exclusion is a particular concern. Services dependent exclusively on smartphones, digital payment or advanced user interfaces may create barriers for people with limited digital skills or access. Inclusive deployment should therefore provide accessible interfaces, alternative booking and payment channels, customer assistance and meaningful involvement of users with different mobility requirements.

5.2.2 Affordability and Distribution of Benefits

The disposable-income trajectories indicate a gradual strengthening of household economic capacity, but this does not establish that automated mobility will be affordable to all households. Aggregate income growth may coexist with substantial inequality.

The distribution of benefits will depend on:

- Service pricing and subscription structures.
- Availability of public support or concessionary fares.
- Coverage of lower-income and lower-density areas.
- Whether operators prioritize commercially attractive routes.
- The cost of digital access and payment.
- The extent to which CCAM complements publicly available transport.

Without appropriate safeguards, CCAM may improve mobility for users able to pay while providing limited benefits to groups already experiencing transport disadvantage. Affordability and geographic coverage should therefore be treated as essential social-performance indicators rather than secondary commercial considerations.

5.2.3 Accessibility and Inclusion

The modal-split results show that CCAM may support a gradual shift towards public transport, but this outcome is not automatic. Automated vehicles can reduce the perceived cost and inconvenience of travel, potentially increasing the number and length of trips.

Additional demand may lead to:

- More vehicles on the road.
- Empty repositioning trips.
- Increased congestion.
- Higher energy consumption.
- Substitution of walking, cycling or public transport.

These effects could offset part of the expected environmental or efficiency benefit. Policies should therefore focus on the role that automated services play within the mobility system. Shared, higher-occupancy and public-transport-connected services are more likely to contribute to sustainable outcomes than widespread low-occupancy automated travel.

5.2.4 Safety, Confidence and Public Trust

The projected decline in road-traffic fatalities illustrates the potential safety contribution of CCAM. The validation nevertheless confirmed that this benefit depends on technology performance, infrastructure, regulation and the safe management of mixed traffic. Public confidence will be influenced by both actual and perceived safety. Transparent incident reporting, clear responsibility, understandable system limitations and effective regulatory oversight will be necessary. Highly visible incidents or unclear accountability could affect acceptance even if overall safety performance improves. Safety assessments should consider pedestrians, cyclists and people with disabilities rather than focusing exclusively on vehicle occupants. The transition period, during which automated and conventional vehicles interact, is likely to require particular attention.

5.2.5 Environmental Performance

The renewable-energy and charging-station trajectories indicate increasingly supportive conditions for electric and automated mobility. However, the environmental performance of CCAM depends on more than vehicle propulsion. Environmental benefits may be weakened by induced travel demand, empty running, low occupancy, vehicle production and the construction of additional infrastructure. They are more likely to be realized where electrification is combined with renewable energy, shared mobility and integration with public transport. The environmental assessment of CCAM should consequently monitor both technological efficiency and total transport activity.

5.2.6 Regional and Spatial Differences

The comparison of Helmond, Düsseldorf and Limassol demonstrates that CCAM pathways are highly context-dependent. Differences in population, urban scale, density, infrastructure and institutional capacity affect both the timing and scale of adoption. A policy or business model suitable for a large metropolitan area may not be appropriate for a smaller city or lower-density region. In large urban areas, automated services may generate substantial trip volumes and require careful integration with existing public transport. In smaller regions, they may play a more targeted role, addressing accessibility gaps or providing connections that are difficult to serve through conventional fixed-route transport.

Deployment strategies should therefore be region-specific and based on local needs rather than uniform technology targets.

5.2.7 Economic and Organizational Transition

CCAM may support new services, investment and productivity improvements. At the same time, it may change tasks, occupations and organizational structures within passenger transport, freight and supporting sectors. Although employment is not the central focus of the final forecast figures, fair-transition considerations remain relevant to the distribution of CCAM's social effects. Deployment plans should anticipate changes in work organization, provide sufficient time for adjustment and support appropriate training where existing roles are transformed.

5.3 Implications for Decision-makers

The validated results indicate that the value of the social impact assessment lies not in identifying a single expected future, but in showing which conditions influence different pathways. Decision-makers can use the findings to identify actions capable of strengthening positive effects and reducing adverse outcomes.

Before supporting deployment, public authorities and transport organizations should define the mobility problem that a CCAM service is intended to address. Relevant objectives may include:

- Improving mobility for people unable to drive.
- Extending public-transport coverage.
- Supporting first- and last-mile connections.
- Improving road safety.
- Increasing freight efficiency.
- Reducing private-car ownership or use.

Clear objectives allow the social performance of the service to be evaluated against intended outcomes rather than adoption alone.

The gradual adoption trajectories support a phased approach. Pilot and early-deployment activities should be used to assess user response, operational performance, accessibility and unintended effects before large-scale expansion. Adaptive deployment should include predefined review points at which service design, pricing, coverage or regulation can be changed. This is especially important because long-term outcomes depend on behavioral responses that may differ from initial expectations.

The mobility results demonstrate that the relationship between CCAM and existing modes is critical. Automated services should be designed to complement public transport and support active travel rather than replace them unnecessarily. Relevant measures include:

- Integrated booking, information and payment.
- Connections to major public-transport stops.
- Pricing that favors shared and connecting trips.
- Management of empty vehicle movements.
- Protection of pedestrian and cycling space.
- Restrictions or charges where automated services increase congestion.

Accessibility should be incorporated into procurement, licensing and service contracts. Minimum requirements could address vehicle accessibility, geographic coverage, non-digital booking, customer support and affordable service options. The involvement of older people, people with disabilities, lower-income users and digitally excluded groups should continue beyond initial consultation. Their experience should be included in service monitoring and redesign.

The infrastructure and charging-station results show that CCAM deployment must be coordinated with physical, digital and energy planning. Investments should be considered:

- Charging demand and grid capacity.
- Digital connectivity and data infrastructure.
- Road quality and maintenance.
- Pick-up, drop-off and transfer locations.
- Infrastructure required for mixed traffic.
- Compatibility with broader decarbonization objectives.

Infrastructure should be based on realistic service-development pathways rather than technology adoption targets in isolation.

Clear governance is necessary to define liability, data responsibilities, safety requirements and operational boundaries. Coordination among national, regional and local authorities will be important because many deployment effects occur locally while regulation may be established at higher levels. Public communication should distinguish clearly between modelled scenarios, policy targets and observed outcomes. Transparency regarding uncertainty and system limitations is likely to support trust more effectively than presenting CCAM as risk-free or inevitable.

6 Conclusions

D4.8 completes the WP4C analytical sequence from stakeholder and population engagement to forecasting, stakeholder validation and final reporting. D4.6 established the empirical foundation by mapping the anticipated social effects of CCAM. D4.7 developed the social impact assessment model and presented its preliminary forecasts. D4.8 has documented the validation of those findings and consolidated their final interpretation. The stakeholder-validation workshop held in Brussels on 19 November 2025 broadly confirmed the plausibility and internal coherence of the projected pathways. The results illustrate gradual rather than immediate transformation, reflecting the time required for technology diffusion, infrastructure development, regulatory adjustment and public acceptance.

The regional examples also demonstrate that CCAM does not follow a uniform development pathway. Helmond presents favorable conditions for comparatively early proportional adoption, Düsseldorf generates the greatest absolute service activity due to its larger urban and economic scale, and Limassol follows a more gradual pathway in which automated services may initially address targeted mobility needs. These differences confirm the importance of interpreting results in relation to regional baselines rather than treating them as performance rankings. The validated mobility results indicate that CCAM can support a gradual shift towards public and shared transport, but this outcome depends on service design and policy. Automation may also stimulate additional travel or replace public and active modes. The environmental results similarly demonstrate that automation does not automatically reduce environmental impacts.

The assessment identifies substantial road-safety potential, although the scale of the benefit depends on technology penetration, infrastructure quality, regulation and the management of mixed traffic. Accessibility may also improve, particularly for people unable to drive, but inclusive outcomes require accessible design, affordable prices, adequate geographic coverage and alternatives to digital-only access. The economic and infrastructure results provide important context for CCAM readiness. Growth in GDP, household income, transport infrastructure and charging facilities may support deployment, while CCAM may contribute indirectly to productivity and investment. These trajectories should not, however, be interpreted as changes caused exclusively by CCAM.

Self-driving taxi and automated last-mile delivery results illustrate the gradual diffusion of passenger and freight services. Adoption rates and absolute activity levels differ substantially among regions, reinforcing the need to assess both proportional uptake and service scale. High adoption or trip volume is not itself a measure of social benefit; the outcome depends on the needs served, the relationship with existing transport and the distribution of benefits and costs. The validation led to several improvements in the final assessment. Contextual indicators are more clearly distinguished from direct CCAM adoption variables, causal language has been moderated, regional differences are interpreted more carefully, and the forecast values are presented as conditional trajectories. The figures were also redesigned using consistent formats and more informative vertical-axis ranges.

The principal conclusion is that CCAM can generate significant societal benefits, but those benefits are not inherent in automation. They depend on decisions concerning governance, service design, affordability, infrastructure, public trust and inclusion. The same technology can support accessibility, safety and sustainable mobility in one implementation context while increasing congestion or inequality in another. CCAM deployment should therefore be treated as a managed social and institutional transition rather than solely as a technological rollout. Region-specific planning, phased implementation, transparent monitoring and continuing stakeholder involvement will be necessary to ensure that the potential benefits are realized and shared widely.