Fleet and traffic management systems
for conducting future cooperative mobility

Report on stakeholders' requirements, user needs and social innovations

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1. EXECUTIVE SUMMARY

This report presents the results of Task 1.1 and T1.2 of the CONDUCTOR project, which aims to design, integrate, and demonstrate advanced traffic and fleet management for efficient and optimal transport of passengers and goods. The report includes a careful analysis of the use cases covered by CONDUCTOR, a set of general regulatory and social requirements, and stakeholders' and users' needs collected from a State-of-the-Art Review and a dedicated survey.

To achieve these results, the CONDUCTOR Consortium elicited an integrated methodology, represented by a double-funnel graph. A top-down analysis collects formalized and general inputs from regulatory bodies and public authorities. A bottom-up approach facilitates the collection of service-specific inputs derived from the needs of the users and the interests of other stakeholders.

More specifically, the scope of the top-down analysis covers the EU policy programme directly and indirectly related to CCAM. Beyond the insights provided by the DG-MOVE about CCAM in mobility and transport policy, the attention also focuses on the priorities highlighted by the EU Green Deal, Digital Decade, and EESC guidelines for a more sustainable mobility. The inquiry revolves around five main principles: Safety, Environment, Wellbeing, Accessibility, and Inclusiveness. These latter are then furtherly specified in more precise requirements and sub-requirements that should inform and lead the design process of the single pilots.

The bottom-up approach used a methodology to identify and prioritise stakeholders' and users' needs and requirements of each use case. The analysis covered five pilots framed in three use-cases, respectively related to integrated traffic management with intermodality (UC1), demand-response transport (UC2) and urban logistics (UC3). The survey collected data from stakeholders and users, including regulatory needs, requirements, benefits, expected bottlenecks/challenges, and primary and secondary stakeholders. The survey identified a total of 58 stakeholders, with the most well-represented groups being Mobility & logistic services (N=19) and Public authorities & road operators (N=17). The gathering and prioritization of users' needs and stakeholders' requirements remarked and specified how intuitive safety issues are intertwined with social and user-based concerns about accessibility and the expectations in terms of reduction of emissions.

In the final section of the report, the CONDUCTOR Consortium jointly considered the results obtained by the bottom-up and the top-down analysis, also including the inputs collected in a workshop participated by the project partners. The in-deep study of the use cases led to more insightful results, highlighting the primacy of certain conditions for the specific purposes of CONDUCTOR. By mapping the requirements to the specific needs of stakeholders in each use case, the report identifies the most important ones in practice. The insights shared by users and stakeholders also helped to improve the understanding and specification of the general requisites previously considered.

In the conclusion the readers will find insights and suggestions for a profitable use of the findings for the design process of the use cases and pilots. The criteria here outlined will be furtherly used as part of the KPIs for the assessment and validation of the proposed CCAM solution in WP5.

Keywords: CCAM; Acceptability; Social impacts of innovation; CCAM stakeholders' and users' needs; CCAM regulatory requirements.

2. INTRODUCTION

2.1 Scope of the document

The main goal of CONDUCTOR is to design, integrate and demonstrate advanced, high-level traffic and fleet management that will allow efficient and optimal transport of passengers and goods, ensuring multimodality and interoperability in the dynamic management of vehicles[1].

This deliverable presents the results of Task 1.1 – "Recommendations of stakeholders" and T1.2 – "Users' needs from the social perspective", as produced in the first 6 months of the CONDUCTOR project. In line with the complementary objectives of the two tasks, it presents the stakeholders' recommendations and users' requirements for the purposes of the research activities foreseen by the project. The scope of the analysis is limited to the European Union (EU) policy guidelines for Collaborative, Connected, and Automated Mobility (CCAM).

The two tasks were programmed at the very beginning of the research activities for a series of consequential reasons. In line with the European Commission (EC) guidance for Horizon funded projects, innovative technological solutions should be developed and tested also in light of the social impacts they may have on the involved users and communities – and this interdisciplinary approach should be embraced since the early stages of the design process. According to these directives, the analysis of the social needs and requirements is located at the very beginning of CONDUCTOR project plan. As specified by the WP1 description, the analysis of the users' and stakeholders' requirements (T1.1 and T1.2) is intended as a complementary activity to the specifications setting of the future mobility systems architecture and data sources (T1.3 and T1.4) and the definition of the project KPIs (T1.5). These tasks should be thus read within a unitary framework and their findings should be used according to a holistic approach, giving equal importance both to technical and social requirements.

The results obtained will be used in different phases of the project and for diversified purposes. More specifically, regulatory and social requirements and the users' needs and stakeholders' requirements will be used in:

- **T1.3 – "Future mobility systems architecture"** for the definition of the future mobility systems considered in CONDUCTOR.
- **T5.1, 5.2, 5.3 – "Use cases"** for the design and validation of the use cases covered CONDUCTOR.
- **T5.4 – "Validation plan and results"** for the definition of the Key Performance Indicators (KPIs) and the overall qualitative and quantitative criteria adopted by the validation strategy.

[1] https://conductor-project.eu/

2.2 Contents of the document

In general terms, D1.1 includes a comprehensive analysis of the different categories involved in the implementation of CCAM and a State-of-the-Art Review (SOAR) of their acceptance. Embracing a double-funnel methodology, from a top-down perspective, the report presents the social and regulatory requirements for CCAM in the EU law and EC programmes. The bottom-up approach, once having carefully analysed the use cases covered by CONDUCTOR, presents the results obtained by the survey administrated to the stakeholders directly involved in the project pilots.

More specifically, the document is structured in 8 sections, articulated as follows:

1. **Executive summary**, which reports a brief operative reading of the overall results contained in this deliverable;
2. **Introduction,** which provides functional information about the scope and the contents of the document;
3. **Background**, with the identification of the CCAM stakeholders and a SOAR of literature on CCAM acceptance;
4. **Approach and methodology,** which introduces and explains the double-funnel methods elaborated for the identification and collection of users' and stakeholders' requirements for the purposes of this project;
5. **Top-down approach for CCAM social and regulatory requirements identification**, which presents the inspiring methodologies for the public policy and regulatory analysis and the principles and requirements that should lead the development and implementation of CCAM in Europe;
6. **Bottom-up approach for CCAM users' and stakeholders' requirements identification** which presents the methodology applied for stakeholder and users' identification and data collection, in order to derive the main needs and requirements of each actor involved in the use cases;
7. **Merge between the top-down and bottom-up approach**, which reports a systematic overview of the results obtained mapping the social and regulatory requirements on the use cases and the users' needs and requirements suggested by the stakeholders and project partners;
8. **Conclusions and way forward,** reporting insights and suggestions for the design of the use cases and pilots. The criteria here outlined will be furtherly used as part of the KPIs for the assessment and validation of the proposed CCAM solution in WP5.

3. BACKGROUND

3.1 Stakeholders' and users' needs in CCAM domain

The Strategic Research and Innovation Agenda (SRIA) for CCAM (CCAM Partnership, 2021) recognises that **the successful deployment of CCAM services depends largely on the societal benefits it can generate and on uptake by individual users**. To achieve the desired benefits, CCAM development, deployment and regulation shall be based on a well-founded and genuine understanding of specific needs, impacts (positive as well as negative) and costs. Taking into account user and societal aspects is a prerequisite for CCAM offers to be acceptable, appreciated and appropriate for serving social, economic, and environmental needs and objectives.

Figure 1 - CCAM SRIA Cluster Structure

Based on these considerations the CCAM SRIA cluster structure [Figure 1] dedicates one of its clusters (i.e., Cluster 6) to understanding the user needs and societal aspects of mobility. This cluster provides inputs to the other clusters, aiming in particular at delivering user needs with a focus on HMI and user-centric technologies (to Cluster 2), the user perspective and societal needs to develop and guide overall transport system integration (to Cluster 4) and the user needs and concerns to be addressed while developing and adapting Key Enabling Technologies for CCAM (to Cluster 5).

The cluster strives for a better understanding of the needs, expectations and desires of future users, citizens, and society at large. This will be essential to the design and development of CCAM solutions that can best serve these needs, without increasing or introducing equity gaps.

Besides highlighting the importance of design and development of CCAM solutions on users' and societal needs, the SRIA also points out another interesting aspect, concerning the multi-stakeholder nature of this specific domain. In particular it highlights that **advancing CCAM is a multi-stakeholder effort involving public and private stakeholders across industries and value chains**. Such multiple stakeholders involved in the design and deployment process bring their different perspectives, needs and requirements – not necessarily convergent – that shall also be taken into account while designing and developing CCAM solutions in order to ensure their acceptability.

The CCAM Partnership offers an interesting taxonomy of the multiple stakeholders involved in the process of CCAM design, development and deployment. In it, the overall CCAM stakeholder community is presented as articulated in 6 main categories based on the sector they belong to and on the type of activity they carry out. The 6 categories include respectively: national, European and international regulatory bodies – national and regional public authorities and road operators - industrial providers – public and private mobility and logistics services – public and private research institutes and universities - and representative bodies, including road users and passengers (Figure 2).

The multiple and multifaceted needs of these categories of stakeholders were taken into account in the co-creation of the CCAM SRIA, where their different perspectives were integrated into a common ecosystem in order to develop synergetic effects for their investment plans to advance vehicle and infrastructure technologies.

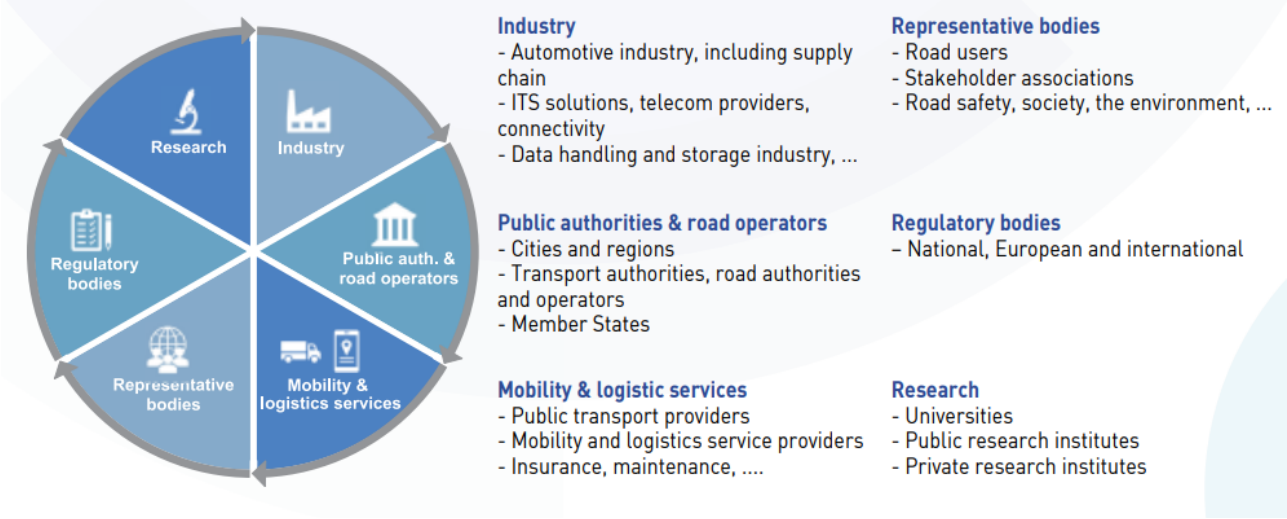

Figure 2 - Sectors and types of stakeholders contributing to CCAM Partnership and SRIA

In the CONDUCTOR project we envisaged that adopting the same approach and transposing it to the design of new CCAM solutions may be a valid and relevant guideline to identify the users and the stakeholders potentially interested by the new solutions and map their needs (§ 4) .

3.2 State of the art review on CCAM acceptance factors

One of the problem drivers that the CCAM SRIA aims to address concerns the insufficient demand for CCAM, that is considered largely determined by the fact that society does not have a clear knowledge and understanding of the potential benefits of CCAM-enabled mobility yet. In consideration of this limitation, some effort is deemed necessary to examine the long-term implications, benefits and impacts of integrating CCAM solutions into the mobility system and to increase the public awareness, acceptance and adoption of CCAM solutions with a clear understanding of its benefits and limits, as well as rebound effects. This is one of the specific objectives of the SRIA for 2030, and dedicated actions have been already defined and implemented in order to meet the target.

In the meantime, many studies have addressed the topic, in the attempt of exploring the factors that potentially affect the acceptance of CCAM. Although such studies are not exhaustive and often focused on specific solutions or on specific aspects of CCAM, their results can be analysed within a unitary framework, taking into account some common insights, patterns and directions already emerged.

In order to ground the stakeholder and user study of the CONDUCTOR project on a sound and clear theoretical framework on CCAM acceptance factors, a SOAR on this topic was carried out by the Consortium. The literature review had a twofold objective.

The first objective covered the **identification of the intrinsic factors and needs that may influence the different mobility patterns observed in CONDUCTOR**. Both sociodemographic criteria (including but not limited to age and gender), and economic, social and cultural aspects were taken into account, extracting information from the literature for CCAM acceptance.

The second objective of the literature review was to find **existing travel surveys and associated mobility data available** from open data portals and other geolocated big data sources (e.g., mobile network data) that contain the identified indicators to enrich the data available for the project developments. This way, those features considered as most relevant for the CCAM acceptance are included in the models developed.

From the methodological perspective, the literature review was restricted to journal papers. The main tool for the search was Google Scholar. As there are already many literature review papers on CCAM, the primary focus was on those works. Additionally, the papers cited in these reviews that were also considered as relevant were selected. The date of publication of the studies ranged from 2018 to 2022, while the keywords selected in the search included 'CCAM', 'shared autonomous vehicles', 'shared autonomous mobility', 'survey', 'acceptance', 'perception', 'adoption'.

From those identified, a list of papers was selected, having at least 10 citations per year in average since the year of publication. Beyond the number of references, a softer criterion was considered for the selection of the papers, this was to have a sample of studies from different regions or cultural backgrounds to capture intercultural differences. From a reading of the abstract, it was determined which articles were relevant for the review.

In light of the above, 12 articles were selected and reviewed. All of them analysed the relation between the different factors taken into account in the selected papers (e.g., socio-demographic, psychological, cultural, mobility behavioural) and the CCAM acceptance.

As anticipated, the focus of the literature review was on the identification of a set of objective and measurable characteristics that can be obtained from different data sources (existing travel surveys and mobility data) and that can be considered as CCAM acceptance factors. . This is the reason why the attention converged on sociodemographic criteria (including but not limited to age and gender), and economic, social and cultural aspects. Although many articles also consider psychological factors such as extroversion, perceived safety, perceived usefulness, or trust (Charness et al., 2018; Golbabaei et al., 2020; Narayanan et al., 2020; Nikitas et al., 2020; Xu et al., 2018; Zhu et al., 2020) or social factors such as environmental benefits awareness (Liu et al., 2019; Nemoto et al., 2021) as relevant for the CCAM acceptance, these factors were not considered during the analysis, as they are subjective factors, hard to measure or characterise with data sources. The insights collected, however, may be used for future research on more mature technological solutions.

The remaining factors identified as relevant were distinguished in two groups: socio-demographic factors and mobility behaviour characteristics.

Most of the articles reviewed (Charness et al., 2018; Golbabaei et al., 2020; Narayanan et al., 2020; Golbabaei et al., 2021; Suet Theng & Susilawati, 2021; Othman, 2021; Rezaei & Caulfield, 2020) relate **socio-demographic factors** with the CCAM acceptance. Among these factors, the more relevant are age, gender, educational level, household structure (presence of children), household location, and household income. In particular, as stated in (Charness et al., 2018; Golbabaei et al., 2020; Narayanan et al., 2020; Othman, 2021; Rezaei & Caulfield, 2020), males are more likely to use or be interested in autonomous mobility and, additionally, young people are more open to this new type of mobility. Regarding the educational level, as stated in (Golbabaei et al., 2020; Narayanan et al., 2020; Othman, 2021), students and more educated people may be more willing to adopt CCAM. The presence of children in the household may be also related with a higher interest in autonomous mobility (Golbabaei et al., 2020). Finally, wealthier households and those located in

urban areas may have more interest in autonomous mobility (Golbabaei et al., 2020; Narayanan et al., 2020). As highlighted in Othman (2021), many studies assume that CCAM can potentially increase accessibility for elder people, and hence, that this group would be one of the most benefited. However, surveys show that they are more reluctant to this type of mobility in opposition to young people, who are considered as early adopters.

Relevant **factors related to mobility behaviour** are driving license, car ownership, environmental conditions, daily travel time and commute mode choice (Golbabaei et al., 2020; Narayanan et al., 2020; Golbabaei et al., 2021; Suet Theng & Susilawati, 2021; Othman, 2021). Those individuals who have a driving license and own a car are less willing to adopt Shared Autonomous Vehicles SAVs (Golbabaei et al., 2020; Narayanan et al., 2020). Moreover, as the driving experience increase, people become more discouraged about autonomous vehicles (Othman, 2021). Regarding the environmental conditions, people may be more interested in using CAVs in bad weather conditions, closed areas (university campuses, airports, hospitals, etc.), areas with worse public transport services, urban touristic/unfamiliar regions, for the transport of goods, or for one-way travel (Golbabaei et al., 2020). People who have long daily travel times may be more willing to use CCAM, as travel time can be used for more productive activities and it is likely to be reduced, as connected vehicles could potentially predict and scape from congestion and bottlenecks (Golbabaei et al., 2020; 2021). Additionally, as mentioned in Suet Theng & Susilawati (2021), people seem to prefer waiting rather than walking, so reducing walking time may be more crucial for CCAM adoption than reducing waiting time and in-vehicle travel time.

Lastly, the CCAM adoption may be influenced by the commute mode choice (Golbabaei et al., 2020; Narayanan et al., 2020). As already mentioned, private car users would be more reluctant to adopt shared autonomous mobility services than users of other transit modes. Conversely, multi-modal users are more likely to adopt it, in particular, those individuals that already use ride-hailing services.

Finally, regarding the second objective of the literature review (i.e., the identification of existing travel surveys and associated mobility data available from open data portals), most of the articles reviewed based their analysis on surveys they themselves conducted. Nevertheless, as far as we have found out, the results of the surveys and the data collected are not public.

To conclude, the results obtained from the SOAR suggest to take into account the permeability of the social fabric to CCAM, especially in light of the relevant socio-demographic factors like age, gender, educational level and households social and economic conditions. These criteria should be also considered to tailor the solutions on contextual needs, fostering the ones that better meet the factors related to the mobility behaviours of the different categories of stakeholders involved.

4. APPROACH AND METHODOLOGY

From the previous section it is evident that the successful deployment of CCAM services depends on the benefits it can generate for the large and diverse range of stakeholders and users involved, whose interests, needs and acceptance factors do not necessarily coincide or are consistent. Consider, for example, how different the interests of regulatory bodies and public authorities may be from those of industry, or from the needs of the users. For the latter, we saw that the factors influencing the acceptance of CCAM services by users are multiple and can be related to both sociodemographic aspects as well as lifestyles and mobility needs. A similarly fragmented situation can be envisaged for the other stakeholders involved in deployment and management of these solutions.

Within this framework, **the challenge for the successful design and implementation of CCAM services lies in finding a way to intercept the multiple needs and interests of this wide range of stakeholders and users and bring them together in a holistic design process**.

This is evident in many of the ongoing multiannual research frameworks funded by the EU that stress the importance of a holistic approach to innovative mobility solutions, while pointing out that one of the main open issues approaching innovative sectors is precisely the correct and fair alignment of technological innovation and individual and social expectations about these pioneering solutions.

Against this background, the CONDUCTOR Consortium embraced the holistic approach suggested by the EU institutions and elaborated a dedicated **methodology for stakeholders' and users' needs and requirements elicitation,** that aims to keep together formalized and general inputs provided by institutional stakeholders - such as regulatory bodies and public authorities, and spontaneous and more service-specific inputs derived from considering the needs of the users and the interests of other stakeholders, such as industry and service operators.

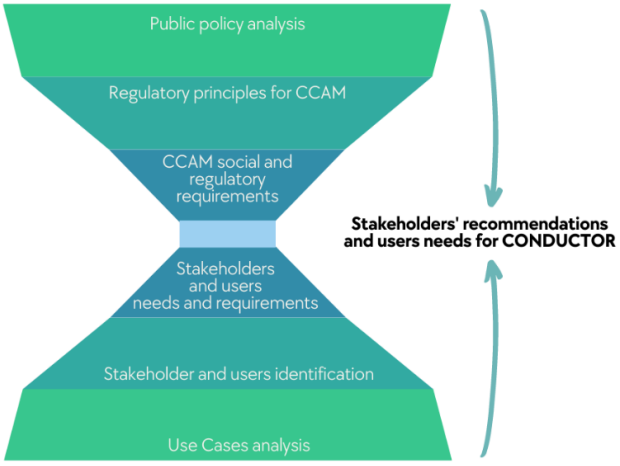

Figure 3 – CONDUCTOR methodology for stakeholders' and users' needs and requirements elicitation

The methodology proposed is twofold and combines top-down and bottom-up approach, as represented in the double funnel graph illustrated in Figure 3.

From a top-down perspective, the analysis aims at eliciting a set of CCAM social and regulatory requirements, extracting them from the regulatory principles and requirements that are orienting the evolution of CCAM in the EU. The process is articulated in three sub-steps and starts from the careful analysis of the EU public policies that concern CCAM, from which the identification of the policy issues related to CCAM and of the main social goals related to these innovations are derived. The second sub-step focuses on the analysis of the rationale of these policy objectives in context, looking for the regulatory principles that lead the ongoing research strategies for CCAM in Europe. Eventually, the third and last sub-step provides the regulatory requirements that should orient the design and development of these new solutions.

From the bottom-up approach, the methodology intends to identify the stakeholders' and users' needs that are specifically associated to the CCAM solutions being proposed by the project. Also, this activity is structured in three sub-steps and follows the explorative approach typical of social sciences and humanities. The process starts from the analysis of the use cases of the CCAM services specifically addressed by CONDUCTOR, to then identify the stakeholders and categories of users involved in the related scenarios. In light of this, all the operative partners taking part in the project were actively involved in the process of stakeholders' and users' identification (second sub-step of the process) and in the collection of their needs and requirements (third sub-step of the process) by means of a dedicated survey aimed at collecting and mapping the specific needs and requirements of the use cases considered within CONDUCTOR. According to the results obtained, we formulated the related stakeholders' and users' needs and requirements.

The two approaches, top-down and bottom-up, run almost in parallel and **the two sets of results are eventually merged to map the needs and requirements specific of the CCAM services considered by the project collected by means of the bottom-up approach, into the wider framework of the social and regulatory requirements obtained from the top-down approach.**

In light of the above, the double funnel methodology allows considering the stakeholders' recommendations and user needs specific to CONDUCTOR in a broader and comprehensive framework. Indeed, this approach promotes a consistent reading of the context-based results obtained by the surveys, mapping the specific results obtained from the use cases on general CCAM social and regulatory requirements.

More methodological insights are available at the beginning of the following sections, respectively devoted to the top-down approach for CCAM social and regulatory requirements identification (§ 5) and the bottom-up approach for stakeholders' and users' needs and requirements identification (§ 6) and to the results respectively obtained (§ 7).

5. TOP-DOWN APPROACH FOR CCAM SOCIAL AND REGULATORY REQUIREMENTS IDENTIFICATION

5.1 Methodology

Approaching the social issues concerning CCAM, some preliminary clarifications are needed about the subject and the scope of this analysis, as well as about the meaning of some keywords.

First, the acronym CCAM (i.e., Connected, Cooperative and Automated Mobility) refers to mobility solutions. Since the opening lines of this document, the concept was immediately coupled with another lemma: transport. These two usually pair. However, for the sake of clarity, it is essential to define the scope of these notions.

> **Mobility** is intended as a direct result of social activities such as living, working, relaxing and production, trade and consumption (for goods). Due to the spatial separation of activities, mobility demand for transport services arises (ELTIS).
>
> **Transport**, instead, refers to various structural and infrastructural aspects (including vehicles, infrastructure and traffic rules) and is intended as an instrument required for the concrete realisation of mobility (ELTIS).

Evidently, there is an intrinsic correlation between these two policy areas. However, **CONDUCTOR will mainly address mobility policy issues** and, more specifically, the requirements that can facilitate the satisfaction of user needs and the improvement of mobility experience, as well as the connected social expectations.

Secondly, the top-down part of the double funnel methodology respectively refers to principles and requirements. These two words usually may be intended as synonyms but in this document, and for the purposes of CONDUCTOR, they have different meanings.

> **Principles** are envisaged as optimization commands that indicate **objectives** that should be achieved in the highest degree that is actually and legally possible (Alexy, 1994)
>
> **Requirements** are context-specific rules that embed **definitive commands** and describe what exactly demand, nothing more and nothing less (Alexy, 1994)

Thirdly, there are issues concerning the level and the scope of prescriptiveness of the principles and the requirements here outlined. Intuitively, mobility issues simultaneously involve different policy and regulatory levels (EU, national, regional and local authorities) pushing for a multi-level, integrated governance approach. However, the use of such an approach in a project like CONDUCTOR may present some serious shortcomings.

At this stage of research, a structured and comprehensive analysis of the various sets of requirements applicable to each use case (*e.g.*, legal and regulatory requirements applicable at the national, regional and/or local level) may lead to twofold adverse consequences. On the one hand, from a general standpoint, strict and context-based requirements might have a chilling effect on the design and validation of the research hypothesis underlying the project. On the other hand, the distinctions imposed by the different legal and regulatory contexts might eventually lead to fragmented and unusable normative scenarios, frustrating any attempt at systematization.

Therefore, in accordance with the method agreed upon by the EC and the Member States in the Declaration of Amsterdam of 2016 (see: § II(a)) the Consortium opted for a staged approach. In this phase of research, **the regulatory analysis will focus on the insights and directives provided by the EU and its authorities.** As a consequence, the applicable requirements will have a general value, working towards the removal of barriers and the promotion of legal consistency. Possible issues emerging from the differences and specificities of national legislation will be taken into consideration only if relevant for the research purposes of CONDUCTOR, considered as a whole.

Once clarified these aspects, the methodologies that inspired the analysis of the CCAM regulatory principles and requirements basically include legal and public policy analysis, with particular attention to the normative attitude of the sources considered (Kreis & Christensen, 2013) (Kammerer & Estrella-Luna, 2020).

The table below provides a brief introduction to the methodologies that inspired our research on CCAM regulatory requirements. Further details about their application will be provided in the following paragraphs.

Steps	Outcomes	References
Positioning	Mobility and Transport	Principle of conferral and legal basis
Perspective	Social science	Law and Public policy analysis
Mapping	CCAM	Principle of relevance (analogical reasoning)
Scope	EU institutions (EC-DG&As)	Principles of competence and relevance
Analysis	Principles (thematic)	EC Better regulation
Process	High-level requirements	Policy mapping
Elaboration	Recommendations	Deductive reasoning, legal-policy drafting

Table 1 - Regulatory requirements - Methodological framework

Setting the research process, we follow a logic-deductive approach. We first focused on the linear steps required for a systematic analysis of CCAM regulatory requirements and, in parallel, we outlined the outcome obtained by these progressive scoping operations. We also traced the references that guided our activities, drawing from the principles of EU law and policymaking. Further details about the results obtained will be available in the following paragraphs.

5.2 CCAM social and regulatory requirements

5.2.1 CCAM in Europe: competences and legal basis

In accordance with the Single European Act (1986), the EU is founded on four fundamental and legally guaranteed freedoms. They state that **goods, services, capital and persons can move without restriction within the EU**.

This assumption sheds lights on the role of transport and mobility policy within the EU, as well as in the other correlated sectors. Indeed, a **common strategy on vehicles, infrastructures and service is an essential pillar to ensure and promote this freedom in practice**. Legal and regulatory considerations about CCAM, therefore, rely on this background, and need to be contextualised within the EU law- and policy-making process.

In this regard, it has to be noted that the EU can act and legislate only within the limits of the competences that EU Member States have conferred upon it in the treaties, as per Articles 5 of the Treaty on the European Union (TEU) and 2 of the Treaty on Functioning of the European Union (TFEU). Competences not conferred on the EU by the treaties thus remain fully with the Member States.

These provisions are inspired by three funding principles of EU law, namely:

- **Principle of conferral**, which governs the limits to EU competences, the use of those competences is governed by the principles of subsidiarity and proportionality;
- **Principle of subsidiarity**, which aims to ensure that decisions are taken at the closest possible level to the citizen and that constant checks are made to verify that action at the EU level is justified in light of the possibilities available at the national, regional or local level. More specifically, it is the principle whereby the EU does not take action (except in the areas that fall within its exclusive jurisdiction), unless it is more effective than action taken at the national, regional or local level.
- **Principle of proportionality,** which seeks to set actions taken by EU institutions within specified bounds. Under this principle, EU measures: must be suitable to achieve the desired end; must be necessary to achieve the desired end; and must not impose a burden on the individual that is excessive in relation to the objective sought to be achieved (proportionality in the narrow sense).

The Treaty of Lisbon further clarifies the division of competences between the EU and its Member States. These competences are divided into three main categories:

- **exclusive competences of the EU**, namely areas in which the EU alone is able to legislate and adopt binding acts. Member States are able to do so themselves only if given the powers by the EU to implement these acts.
- **shared competences between the EU and the Member States**, including all the cases when the EU and its Member States are able to legislate and adopt legally binding acts. Member States exercise their own competence where the EU does not exercise, or has decided not to exercise, its own competence.
- **supporting competences**, i.e., when the EU can only intervene to support, coordinate or complement the action of its Member States. Legally binding EU acts must not require the harmonisation of the laws or regulations of the Member States.

For the purposes of CONDUCTOR, it is essential to note how **CCAM may implicitly entangle many different areas, frequently falling within the scope of vary EU shared competences**, likewise:

- internal market
- economic, social and territorial cohesion (regional policy)
- **environment**

- **consumer protection**
- **transport**
- energy
- research, **technological development** and space

We took into consideration all these elements to define the cornerstones of our policy and regulatory framework. The guiding reasons of this scoping operation concern the nature of the project, the stage of research, and the scenarios and the contexts envisioned in the use cases.

In this regard, CONDUCTOR is an EU funded project that aims at developing innovative technological solutions for the fleet and management traffic within CCAM initiatives and involves three use cases anchored on five locally based pilots. On the one hand, the expected policy outcomes from this project go beyond the national dimension of their current applications. On the other, a detailed analysis of the contextual regulatory requirements could lead to an uncertain and fragmented scenario, making impossible a systematic overview of the main policy guidance.

Against this background, since transport falls within the EU shared competences and mobility entangles many other policy areas connected with CCAM, we opted for a high-level analysis of the regulatory requirements, converging our efforts to EU policy strategies related to this sector.

Considering the stage of research of CCAM in Europe (CCAM Partnership, 2021) this approach is consistent with the EU guidelines. This ensures the primacy of EU law for the proactive definition of the regulatory milestones of innovative technologies, preventing the future fragmentation of the normative framework due to national divergences. This high-level perspective also provides a flexible and comprehensive regulatory framework, potentially applicable to the different context-based use cases covered by CONDUCTOR. Not least, this approach fosters and respects the principles of subsidiarity and proportionality and leaves an adequate margin of autonomy to the regulatory stakeholders involved according to their competences and needs.

5.2.2 CCAM in the EU policy: from transport to mobility

The following figure (Figure 4) provides a summary positioning of this topic within the EU transport and mobility policy.

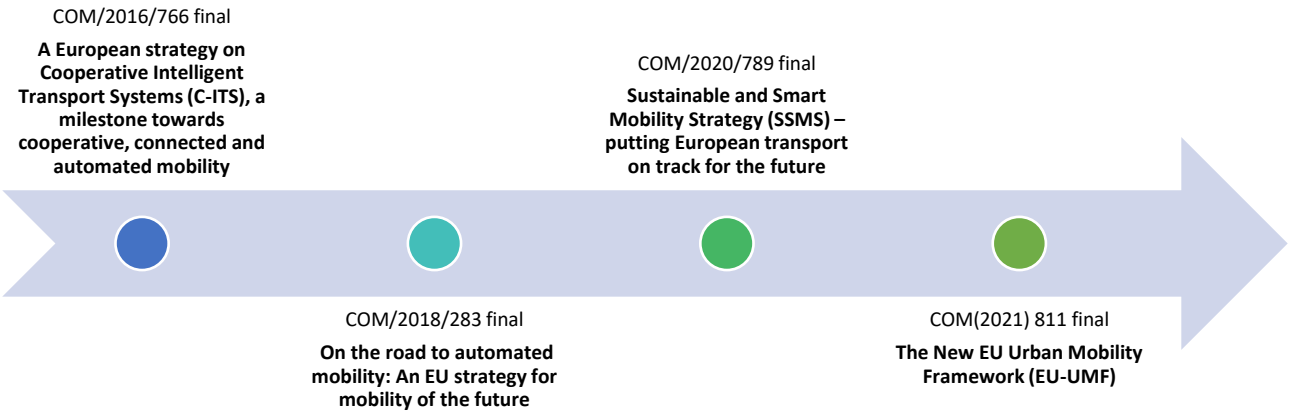

Figure 4 - CCAM in the evolution of EU mobility and transport policy

From the public policy perspective, CCAM represents the ideal and technical continuum of the **Cooperative Intelligent Transport Systems (C-ITS) Strategy**, launched by the EC in 2016, when the attention mainly converged on the technical aspects related to infrastructural and structural innovations of roads, vehicles, and traffic management (C-ROAD and C-ITS platforms).

Against this background, the **Sustainable and Smart Mobility Strategy (SSMS)** (2020) identifies the deployment of Intelligent Transport Systems (ITS) as a key action in achieving connected and automated multimodal mobility. Multimodality combines new developments such as Mobility as a Service (MaaS) and CCAM. This latter aims to transform a driver into a user of a shared fleet of vehicles, fully integrated in a multi-modal transport system, made seamless by Multimodal Digital Mobility (MDM) services such as MaaS.

In this perspective, in 2021, **the new EU Urban Mobility Framework** (EU-UMF), highlighted this socio-technical wide-angle. If mobility is framed as a critical aspect of social inclusion and an important determinant of human wellbeing (especially for disadvantaged groups), transport is recognised as an essential service in the European Pillar of Social Rights.

This explains why the EU, pursuing its ambitious climate, environmental, digital, health and societal objectives, is taking a more decisive action on urban mobility, pushing for a cultural and concrete shift from the current reactive approach based on traffic flows to a more proactive approach based on moving people and goods more sustainably (EC, 2021).

Therefore, as stressed by the EC, «multimodality shall be the guiding principles for future urban mobility, zero-emission and connected and automated mobility will be a key component of the transition to a climate-neutral urban future that also enables suburban and rural areas to connect sustainably with cities. Better management of transport and mobility using multimodal hubs and digital solutions is needed to increase system-wide efficiency» (EC, 2021).

5.2.3 CCAM into a broader perspective, beyond mobility

Once framed the main policy issue plainly related to CCAM, it is essential to consider the additional dimensions entangled by these innovative solutions. Indeed, as above explained**, mobility directly and indirectly affects other policy areas, like climate, environment, economic growth and social inclusion and cohesion.**

Having in mind the methodological inputs provided by CINEA (EC, 2021), CONDUCTOR takes into account all these dimensions. The analysis of the regulatory principles and requirements from CCAM is not limited to the guidance provided by the EC and the Directorate-General (DG) for Mobility and Transport (DG MOVE). The inquiry, instead, includes also the inputs coming from other several EU policy makers.

In parallel with the general guidance provided by the EC, the Consortium also takes into account the insights coming from the **European Economic and Social Committee** (EESC) and the **Committee of Regions** (CoR). These two institutions were included to have a more comprehensive understanding of the social inclusiveness and territorial cohesions policy issues related to CCAM development and deployment.

Moreover, the inquiry also considers the corollary policy inputs coming from the DGs for Climate Action (DG CLIMA), Environment (DG ENV), Internal Market, Industry, Entrepreneurship and SME (DG GROWTH) and Employment, Social Affairs and Inclusion (DG EMPL).

Considering the scope and aims of the analysis of the regulatory requirements, we decided to not include the possible guidance coming from the DG for Communications Networks, Content and Technology (DG CONNECT). The inquiry of these documents indeed would have fallen outside the scope of the document. The reason of this choice is twofold. On the one hand, this part of the D1.1 is intrinsically complementary to the user needs analysis, and therefore the two aim to cover the same scope (users' needs and social expectations). On the other hand, the technical features of the solutions considered in the various use cases are pretty different. A comprehensive analysis of the technical requirements of each of them would have led to fragmented final outcomes.

5.2.4 Sustainable Development Goals related to CCAM solutions

Sustainable development is a core principle of the Treaty on the European Union and a priority objective for the Union's internal and external policies. The EU was instrumental in shaping the global Agenda 2030 (A2030) (UN-GA, 2015) that has become the world blueprint for global sustainable development.

In light of the competences of EU in mobility and transport, as well as in some related areas, CCAM may implicitly contribute to several of these objectives. Approached from a proactive perspective, these innovative solutions promise to have positive impacts on the sustainable wellbeing of cities and communities, improving the quality of services and infrastructures. Moreover, worth to be noted the direct and undirect effects of CCAM on people health and wellbeing, as well as on the mitigation of the environmental impacts of transport.

The *Strategic Research and Innovation Agenda 2021-2027* (CCAM Partnership, 2021) published by CCAM Partnership in 2021 has tried to map more in the detail the contribution of CCAM solutions to the achievement of SDGs. As explained by the figure below [Figure 5], combining connectivity, cooperative systems and automation will enable automated and fully orchestrated manoeuvres, improving the safety of mobility experiences for drivers and other transport users. Moreover, CCAM enables more user-centred, all-inclusive mobility, while increasing individual and public health and wellbeing, reducing congestion and contributing to decarbonisation. Eventually, CCAM will also enable the provision of new mobility services for passengers and goods, fostering benefits for urban and rural communities, as well as for the economic fabric and for the mobility system as a whole.

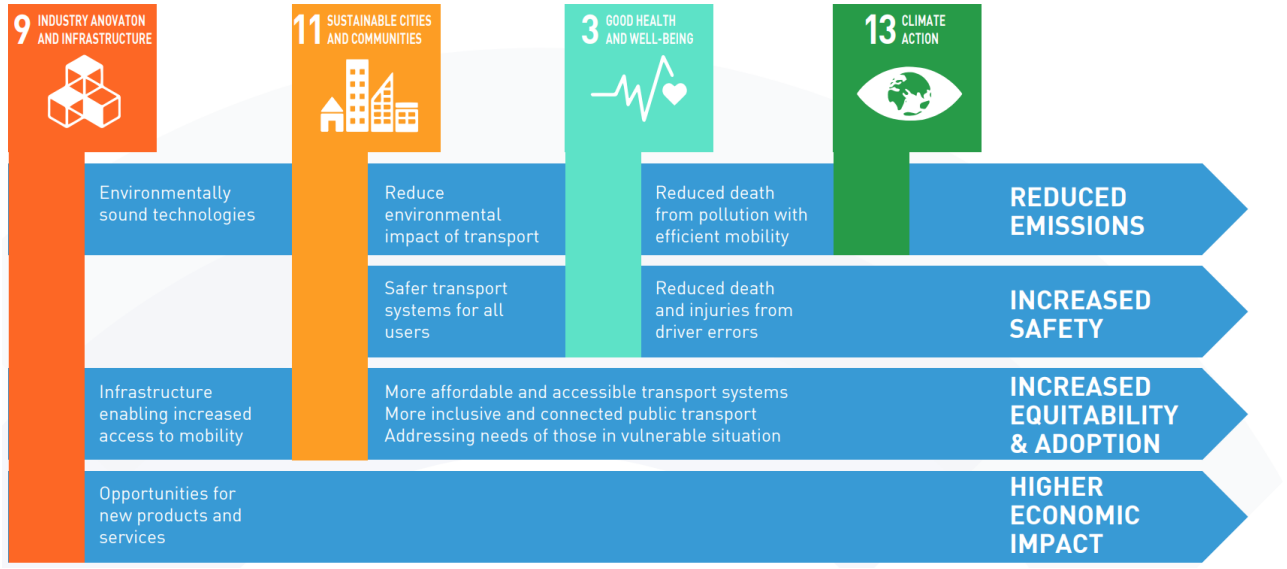

Figure 5 - CCAM related SDGs (CCAM Partnership, 2021)

In light of these findings, the analysis considers what the EU institutions (more specifically, the EC and the involved DGs, as well as the interested Agencies) prescribe or recommend for the development and use of these solutions in practice. Considering the scope of the mentioned issues and the specificities of each use case, the document here reports only high-level insights.

5.2.5 The place of CCAM in the EU priorities towards 2030

The A2030 became a referral inspiring framework for the EU policy, officially embedded into the EC priorities (EC, 2019). What is more, the EC opted for a Whole-of-Government Approach ("WGA") in pursuing these goals, asking for the transversal collaboration of many different actors[2]. Generally, the A2030 includes 17 Sustainable Development Goals (SDGs) intended to apply universally to all countries. More specifically, the EC opted for a comprehensive and ramified approach to the Agenda, launching and monitoring several different initiatives.

The figure below [Figure 6] generally represents the intersections between the EC priorities and the Agenda, showing the matching point among the leading programmes of the EU and the SDGs.

Figure 6 - EC 2019-2024 priorities, mapped on the A2030 SDGs

[2] The "Whole-of-the-Government Approach" involves collaboration between the different public bodies that extends beyond their respective fields of competence with a view to providing the public with a combined response from a single body (EC, 2021).

This figure shows how the EU made its Green Deal the cornerstone of its mission, and how mobility issues are intertwined with many of its goals. Just mapping the main SDGs related to CCAM with this plan, we see how the reduction of the emission, enhancement of safety, increase of equitability and adoption and the purchase of higher economic impacts are located at the top of the EC priorities, intersecting economic, social and environmental goals. More specifically, we see how CCAM has an intersectoral nature, primarily entangled with the two main programmes, namely the EU Green Deal and Digital Decade.

The **European Green Deal** is a package of policy initiatives launched by the Commission in December 2019. This programme aims to set the EU on the path to a green transition, with the ultimate goal of reaching climate neutrality by 2050. Approaching this challenge, the programme also fosters a socially and economically sustainable transition, ensuring this transformation will lead the EU into a fair and prosperous society with a modern and competitive economy. It is noteworthy how the EU Green Deal underlines the need for a holistic and cross-sectoral approach in which all relevant policy areas contribute to the ultimate climate-related goal. This is the reason why the package includes initiatives covering the climate, the environment, energy, transport, industry, agriculture and sustainable finance – all of which are strongly interlinked.

On the other hand, the **Digital Decade** is a policy programme that will guide Europe's digital transformation towards 2030. Continuing the initiatives launched in February 2020, with the approval of Shaping Europe's Digital Future, this programme aims to improve digital infrastructures, skills, governance and business in a transversal and holistic way. Proposing a declaration of digital rights and principles for the digital decade, the EC particularly stressed the importance of human-centred design, safety and security, solidarity and inclusion and – not least, sustainability. Specific highlights concern the social role of digital technologies that should unite, not divide, people, supporting sustainability and the green transition.

This picture should also take into consideration the further efforts done by the EU approving the Union budget 2021-2027 and the so-called **Recovery Fund** (Council, 2020). This latter, in particular, is intended as a supportive long-term measure to mitigate and recover the negative effect of the COVID-19 pandemic and relaunch the investments in the green and digital transition.

In this regard, beyond the supplements to EU Multiannual Financial Framework (MFF)[3], the EC has also supported the **Just Transition Mechanism** (JTM): a key tool to ensure that the transition towards a climate-neutral economy happens in a fair way, leaving no one behind. In other words, the JTM will address the social and economic effects of the transition, focusing on the regions, industries and workers who will face the greatest challenges. This is to say that the social component should have adequate consideration within the holistic approach to many goals that CCAM shall pursue.

[3] On 21 July 2020, EU leaders agreed on a comprehensive package of €1 824.3 billion (in 2018 prices), which combines the €1 074.3 billion long-term budget for 2021-2027, known as the multiannual financial framework (MFF), and an extraordinary €750 billion recovery effort, Next Generation EU (NGEU).

5.2.6 CCAM social regulatory principles and requirements

In light of the above, evidently **CCAM entangles different areas of the EU agenda**, going far beyond the mere domain of transport and mobility. According to the approach adopted by the EC, we thus opted for a transversal and holistic approach, including several branches of the EU policy strategy.

Worth to be noted that, when we consider the social expectations about CCAM, our attention primarily focuses on the final users. This category of subject basically includes people that will experience the new CCAM solutions at issues. On the one hand, there are the users that directly use these innovative concepts, such as passengers or onboard/remote drivers (direct beneficiaries). On the other, instead, there are those using “traditional” solutions, that indirectly have to interact with these novel ones (indirect beneficiaries).

Recalling the SDGs related to CCAM, the analysis of the regulatory requirements gravitates around the following principles, as outlined by the Green Deal, the Digital Decade and the guidelines of the European Economic and Social Committee:

1. **Safety**
2. **Environment**
3. **Wellbeing**
4. **Accessibility**
5. **Inclusiveness**

For the sake of comprehension, the following table presents a graphical illustration of the research structure. As the image shows, the main areas represent the five leading principles, while the respective subsections report the primary requirements considered in each of them. This may be a useful support to navigate the following sections, where the reader will find more specific sub-requirements reporting the acceptability conditions that should lead the design of the use cases.

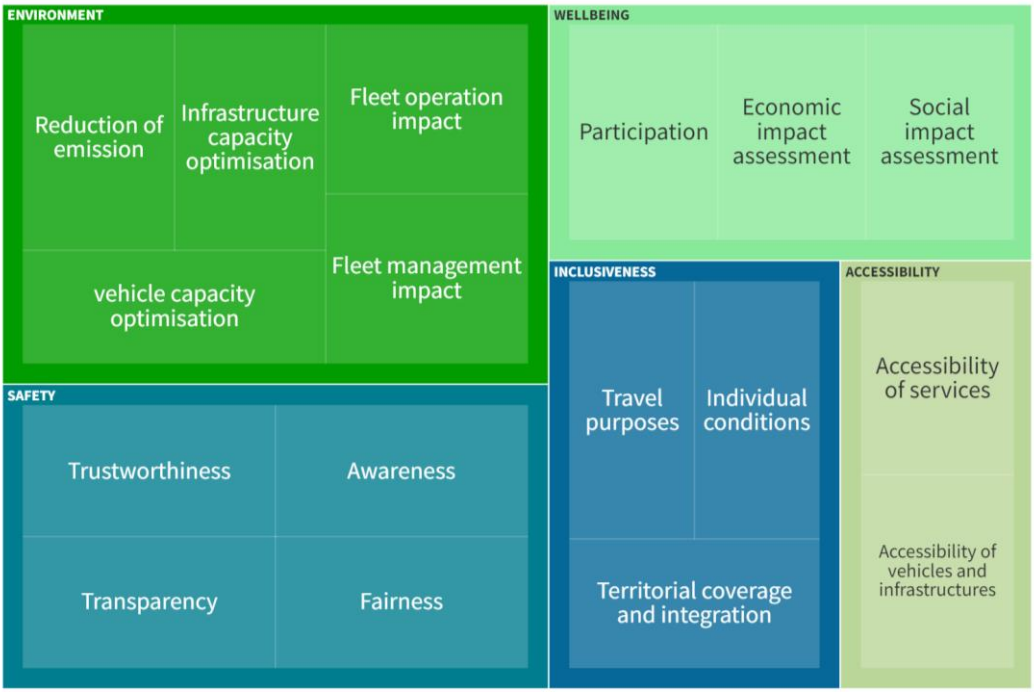

Table 2 - Regulatory requirements

5.2.6.1 Safety

Safety may be considered a primary implicit goal of innovation in transport and mobility. However, here we collected the technical requirements that contribute to assure the social expectations about CCAM. These two categories of conditions, indeed, are supplementary to one another.

The bullet points below summarise the main requirements related to individual and social safety expectations and the leading requirements to fulfil them.

- **Trustworthiness**
  - The activation of the automated driving mode should only be possible when the conditions of the operational domain (OD) are met
  - Means should be provided to humans (driver or if no driver, passenger or operation control centre) to deactivate or override immediately the automated mode in an easy manner
  - The system may however momentarily delay deactivation when an immediate human deactivation could compromise safety
- **Transparency**
  - The vehicle should always inform the driver (or person responsible for operation) or passengers about the operational status (operational, failure, etc.) of the system in an unambiguous manner
  - Vehicles and mobility infrastructures should also share relevant information about their behaviour and functioning with the users/passengers that opted for traditional (non-CCAM) mobility solutions (at least at a general level)
- **Awareness**
  - The driver (both onboard and/or remote) should be made aware of the use and the limits of the automated driving mode, as well as which tasks other than driving may be enabled by the system for the driver
  - Adequate information about functioning and limits of the automated driving mode should be also shared with the users/passengers that opted for traditional (non-CCAM) mobility solutions (at least at a general level)
- **Fairness**
  - CCAM solutions should be integrated and compatible with the safe circulation of non-automated vehicles, especially taking into consideration the specific needs of vulnerable users
  - CCAM solutions should be integrated and compatible with the safe circulation of non-automated vehicles, especially taking into consideration the specific needs for the delivering of emergency services
  - CCAM solutions should be integrated and compatible with the safe circulation of non-automated vehicles, especially taking into the safe handling of extremely dangerous behaviour, both CCAM and non-CCAM users

5.2.6.2 Environment

The environmental impact of mobility is a core issue of the EU agenda, especially in light of the recommendations and the legislative initiatives promoted within the framework of the EU Green Deal.

In this regard, the bullet points below summarise the main requirements related to individual and social expectations about the environmental impact of CCAM and the leading requirements to fulfil them.

- **Reduction of emission**
  - The introduction and use of CCAM solutions should reduce/minimise transport emissions, and infrastructure will support new sustainable mobility services that can reduce congestion and pollution, especially in urban areas
  - The introduction and use of CCAM solutions should be based on the energy efficiency of vehicles, assessed since the early stage of the concepts design and updated over time if needed
  - The introduction and use of CCAM solutions should be considered carbon content of energy sources, while also considering air pollution impacts. Options available are using cleaner and lower-carbon fuels, such as biofuels, blended fuels, hydrogen, and electrification that ideally uses renewable energy
- **Infrastructure capacity optimization**
  - The introduction and use of CCAM solutions should contribute to the smoothening of traffic flow while guaranteeing safety
  - The introduction and use of CCAM solutions should facilitate the use of different and complementary transport modes avoiding/minimising unnecessary trips
  - The introduction and use of CCAM solutions should facilitate the use of different and complementary transport modes, favouring the accessible, smart and combined use of the various alternatives available
  - The introduction and use of CCAM solutions should facilitate the access and use of shared services and vehicles, assuring fleets and assets are shared and used to their maximum capacity
- **Vehicles capacity optimization**
  - The introduction and use of CCAM solutions should be based on routinary vehicles capacity assessment, taking into consideration the users' needs in a broad sense (direct and indirect users)
- **Fleet operations impact**
  - The introduction and use of CCAM solutions should be based on a holistic approach to fleet energy efficiency, looking at the management of fleet, and not merely at the deployment of technologies
  - Management options include improving driving behaviour, and better fleet operations, improved and dynamic planning skills (human factor), and maintenance and monitoring that increasingly makes use of information and communications technology (ICT)
- **Fleet management impact**
  - The introduction and use of CCAM solutions should be based on the increase in load factors, as well as the capacity of individual vehicle combinations, and at the same time reduce empty runs in road, rail and maritime freight transport
  - The introduction and use of CCAM solutions should rely on combined solutions such as load optimisation and consolidation, sharing of assets, and better management of logistics centres, warehouses and transport infrastructure. Transport predictability and flexibility are important enablers for this solutions area. An important side benefit may be reduced congestion and the need for storage space.

5.2.6.3 Inclusiveness

Transport and mobility are essential services in the European Pillar of Social Rights and fulfil a basic need in enabling citizens to integrate into society and the labour market, but also constitutes a significant part of household expenditure. Moreover, as emphasised by the *New EU Urban Mobility Framework* (2021), mobility is a critical aspect of social inclusion and an important determinant of human wellbeing, especially for disadvantaged groups.

This is the reason why inclusiveness, as a principle, should be taken into account in the design of innovative mobility solutions. This principle, indeed, aims at including and considering the many needs of the different categories of users of mobility services, paying attention to the specificities of each one. In other words, this means being aware that good quality public transport serves different categories of people: commuters and travellers, high- and low-income households, older and young people, and women and men alike.

Over time, the coverage of public transport within cities has improved. However, more needs to be done to increase its quality and accessibility. To include and benefit as many people as possible, EU policymakers highlight the importance to ensure better integration between public transport with shared mobility services and active mobility, including micro-mobility services to cover the last mile where access points are far, or the frequency of public transport is low.

Against this background, the bullet points below summarise the main requirements related to individual and social expectations about the inclusiveness of CCAM and the leading requirements to fulfil them.

- **Travel purposes**
  - The introduction and use of CCAM solutions should be designed in light of the specific local and regional users' needs, facilitating the combined use of the different alternatives
- **Individual conditions (gender, age, income, literacy)**
  - The introduction and use of CCAM solutions should provide affordable and inclusive mobility options, enabling social cohesion and local economic development.
  - The introduction and use of CCAM solutions should contribute to the spread of shared and on-demand mobility as part of public transport, in particular in rural areas, integrated under the mobility-as-a-service model.
  - The introduction and use of CCAM solutions should include an adequate delivery of transport service information including real-time travel information through websites, mobile device-based services, interactive information screens and interactive self-service terminals, required by passengers with disabilities to travel.
  - The introduction and use of CCAM solutions should include an adequate delivery of information about the real transport conditions, including information about the service provider's passenger transport products and services, pre-journey information, information during the journey and information provided when a service is cancelled or its departure is delayed. Other elements of information could also include information on prices and promotions.
- **Territorial coverage**
  - The introduction and use of CCAM solutions should contribute to a more effective integration of public transport and shared mobility services, complementing each other.

- The introduction and use of CCAM solutions should take into account the need for efficient and inclusive connectivity between rural, peri-urban and urban areas via sustainable mobility options
- The introduction and use of CCAM solutions, when developed and implemented on a large scale, should take into account the need for integrated links between rural, suburban and urban areas and connections between these areas and cities.

5.2.6.4 Accessibility

For the purposes of CONDUCTOR, accessibility includes a set of requirements aimed at making services and products easily usable by everyone, with particular attention to people with disabilities and elderly people.

Generally, the EU Accessibility Act (Dir. EU 2019/822) provides a detailed list of accessibility requirements, including those related to the use of transport and mobility services. However, for the sake of conciseness, the bullet points below summarise the main requirements related to CCAM and the leading requirements to fulfil them.

- **Accessibility of services**
  - The introduction and use of CCAM solutions should include an accurate strategy for the easy planning and purchasing of tickets for multimodal journeys
  - The introduction and use of CCAM solutions should ensure the provision of information about smart ticketing (electronic reservation, booking of tickets, etc.)
  - The introduction and use of CCAM solutions should ensure the provision of information about real-time travel information (timetables, information about traffic disruptions, connecting services, onward travel with other transport modes, etc.)
  - The introduction and use of CCAM solutions should ensure the provision of information about additional service information (e.g., staffing of stations, lifts that are out of order or services that are temporarily unavailable).
  - The introduction and use of CCAM solutions should ensure the accessibility of self-service terminals used in the provision of the service
- **Accessibility of vehicles and/or infrastructures**
  - The introduction and use of CCAM solutions should ensure the provision of information on the accessibility of vehicles, the surrounding infrastructure and the built environment and on assistance for persons with disabilities
  - The introduction and use of CCAM solutions should ensure the provision of information on the use of vehicles and/or infrastructures will be made available via more than one sensory channel, always presented in an understandable way, ensuring users can perceive them
  - The introduction and use of CCAM solutions should ensure that vehicles and infrastructure design, including their user interface that should contain features, elements and functions that allow persons with disabilities to access, perceive, operate, understand and control the surrounding situation

5.2.6.5 Wellbeing

Eventually, wellbeing has to be intended as closure and comprehensive principles, able to take into consideration the community expectations related to innovation in transport and mobility. For the purposes of CONDUCTOR this lemma aims to include all the possible issues related to the just transitions goals and social and economic sustainability objectives.

In this regard, the requirements related to the wellbeing of people and communities addressed the challenges concerning more sustainable urban nodes with a higher quality of life and better connectivity, affordability and accessibility of mobility services for urban and their surrounding rural areas. To achieve the major transition in urban mobility, swift and significant action and investment is needed at EU, national, regional and particularly local level.

In light of this, the bullet points below summarise the main requirements related to CCAM and the leading requirements to fulfil them.

- **Participation**
  - The introduction and use of CCAM solutions should be based on collaboration between local authorities and private stakeholders, regular dialogues among all parties, networking and exchanges among city planners
- **Economic impact assessment**
  - The introduction and use of CCAM solutions should take into consideration the mobility-correlated economic needs, having regard to the economic and social fabric of the territories and the communities involved
- **Social impact assessment**
  - The introduction and use of CCAM solutions should take into consideration the changes linked to automation and digitalisation and the challenges for public and shared transport sectors, including for its workers
  - The introduction and use of CCAM solutions should include reskilling and upskilling programs, and other measures have to be worked out in a dialogue with social partners

6. BOTTOM-UP APPROACH FOR STAKEHOLDERS' AND USERS' NEEDS AND REQUIREMENTS IDENTIFICATION

6.1 Methodology

For the bottom-up approach, a stakeholder and user needs and requirements methodology was used to identify and prioritize the requirements and needs of the stakeholders and users involved in the use cases.

The first step in this methodology is to identify the stakeholders and users of the service. Stakeholders are individuals or groups who have a vested interest in the success of the project. Users are the people who will be using the product or service.

Once the stakeholders and users have been identified, the next step is to gather their requirements and needs. This is typically done through various methods such as interviews, surveys, focus groups, and user testing. The goal is to understand what the stakeholders and users want and need from the service, and to prioritize these requirements based on their importance and feasibility.

6.2 Analysis of the Use Cases

As anticipated above, the first step taken within the bottom-up approach of the methodology was to solicit an overview of the context within which the use cases would be deployed from the responsible parties. This was done to achieve shared knowledge and a comprehensive understanding of the various contextual and operational factors involved in each use case to establish common ground before moving on to any further stages of the project.

During this process the use cases proposed by CONDUCTOR were explored and detailed using dedicated participatory design and evaluation methods and involving both the members of the Consortium and the external stakeholders identified as relevant. The results emerging from this process are presented in the form of scenarios that graphically depict the key actors of each use case and their interactions with the other actors and systems in the overall organisational context.

Overall, CONDUCTOR intends to address three uses cases, referring to three different areas of CCAM application.

The first use case (UC1) refers to **integrated traffic management with intermodality**. It takes into consideration CCAM solutions intended to provide recommendations to balance demand and supply, optimize performance of the overall transport network, and support transport network recovery from accidents and planned and unplanned events. The solutions envisaged in this area of application take into account the traffic conditions (both real-time and predicted) to respond to a specific transport network scenario. In this light the concept addressed can be ascribed in the overall framework of those CCAM applications related to multimodal traffic management ecosystems and traffic orchestrators.

The second use case (UC2) refers to **demand-response transport** and is more related to the research area of MaaS. In this case in fact CONDUCTOR explores the possibility of using CCAM applications to plan and implement social and cooperative routing strategies and customised travel services for passengers, based on their needs and requests.

The third and last use case (UC3) refers to **urban logistics** and intends to investigate and propose solutions for last-mile delivery based on the integration of urban distribution of goods in the to identify and prioritize. In the framework of the project, these three use cases will develop into five different solutions specifically designed to address known problems of urban mobility and logistics by means of dedicated CCAM applications according to the areas above. The association is one to one for UC2 and UC3, as the project will design, develop and test one solution for each use case. Different is the case of UC1, for which 3 different solutions are proposed.

For the purposes of this document, namely the identification of user and stakeholder needs associated to the solutions proposed, each solution was considered individually.

6.2.1 UC1 integrated traffic management with intermodality in Athens

The UC1 Athens (Figure 7) solution will optimize the synchronization of buses and on-demand services with metro and tram by means of adjusting their schedules to reduce the door-to-door travel times of passengers, while using traffic management centres (Attica TMC, Attica Tollway TMC), and MaaS platforms. The solutions to be offered by CONDUCTOR will make use of novel traffic management strategies for CCAM including AI assisted traffic signal control for multimodal traffic; road space allocation strategies; transit fleet integration to traffic management; rescheduling and rebalancing strategies.

These strategies will consider the needs and objectives of different stakeholders and users in the CCAM eco-system and enable optimized mobility of people through diversion/transfers to shared mobility fleets (including on-demand services), urban rail and use of Park&Ride Hubs as well as encouraging modal shifts towards public transport.

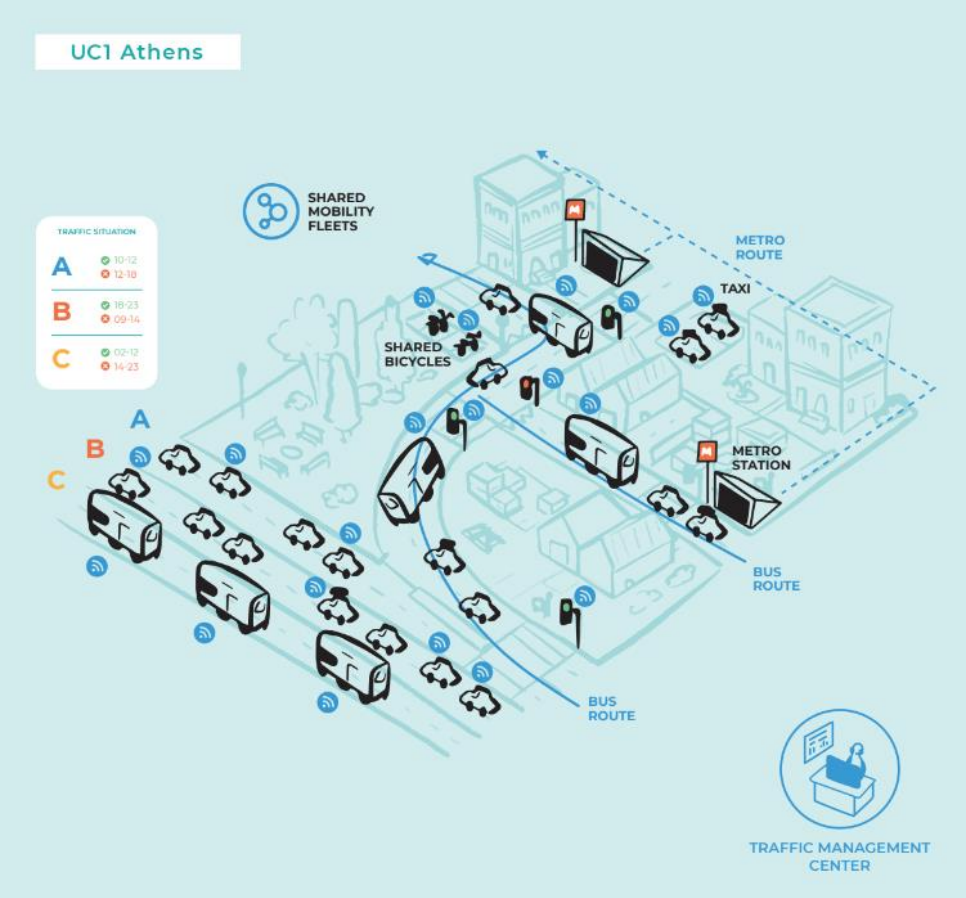

Figure 7. UC1 Athens

6.2.2 UC1 integrated traffic management with intermodality in Almelo

The focus of the Almelo Use Case (Figure 8) is on improving traffic flow along a major logistics corridor and reduce the number of vehicles stops at traffic signals.

It will bring considerable benefits to the sector because every time a truck stops at a traffic light it results in major costs, both monetarily and in terms of emissions. A total amount of 27 intelligent traffic control systems (iTLCs) will be implemented to communicate with vehicles and road users in an effective, safe and platform-independent way. This will bring information from the traffic controllers to the road users and vice versa. Specific emphasis will be placed on freight traffic, where truck drivers will receive information to adjust their speeds and form platoons in order to receive green lights at signalized intersections. A network-wide prioritisation of vehicles at signalised intersections will be introduced in order to guarantee a seamless trip and help governmental bodies in their transition towards net-zero emissions in transport and improved community wellbeing.

Figure 8. UC1 Almelo

6.2.3 UC1 integrated traffic management with intermodality in Madrid

The Madrid Use Case (Figure 9) will be focussed on the management of events/incidents for recovering the transport network operations, considering connected and autonomous vehicles (CAVs). Planned events (e.g., roadworks) and unplanned events (e.g., accidents) will be considered. The M-30 ring road section of Madrid has been selected as the network for the Use Case. The vehicles in the simulated environment will have an on-board unit or smart device that will enable communication with the surroundings. Different scenarios will be tested including routes/lanes for evacuation, prioritization of emergency vehicles, control of access on the ring highway, lane management, alternative routes for avoiding specific road stretches in the M-30. With the results obtained in the simulation environment, CONDUCTOR will boost the integration of CAVs in traffic management systems, leveraging its benefits, such as the direct communication between traffic managers and CAVs, individual route guidance (e.g., instructions of alternative routes depending on the type of event considered and its location), cooperative cruise control, among others.

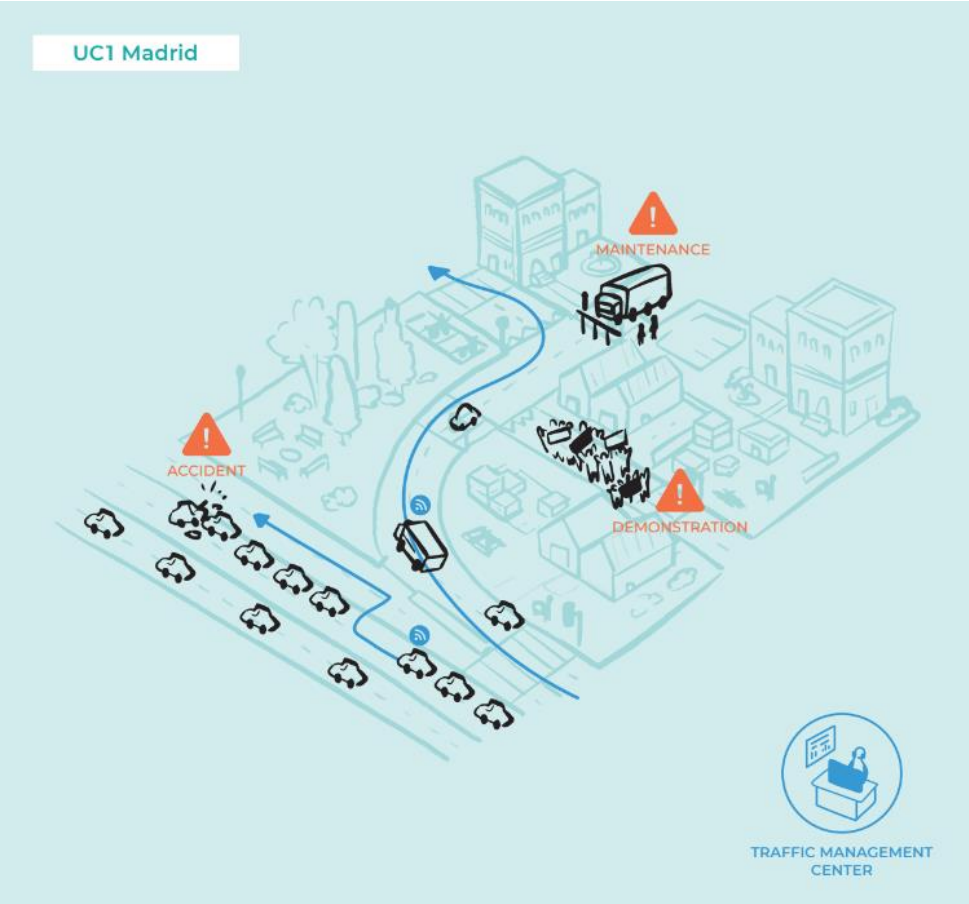

Figure 9. UC1 Madrid

6.2.4 UC2 demand-respond traffic in Slovenia

The Use Case in the Slovenian-Italian region (Figure 10) is planning to implement social routing strategies, also known as cooperative routing, for their large scale CCAM vehicle fleets. This will involve providing a reservation-based shuttle service that offers an efficient and cost-effective transportation solution for customers traveling long distances.

The service will use data optimization techniques to optimize routes and services, while also accommodating customers with diverse needs and promoting economic benefits. The system will offer a variety of pick-up options, such as predefined points or the customer's residence, to cater to different users and arrange shared travel and services. This will result in economic benefits for customers, who will have transparency into the cost implications of their choices, including the number of people they choose to travel with, their preference for a direct or deviated route, and their willingness to adjust departure times to accommodate others.

The UC2 system will include intermediate stops for loading and unloading passengers, as well as route deviations, without compromising the system's ability to deliver customers to their destination on time. Moreover, the service will be flexible in accommodating customers with varying start and endpoints.

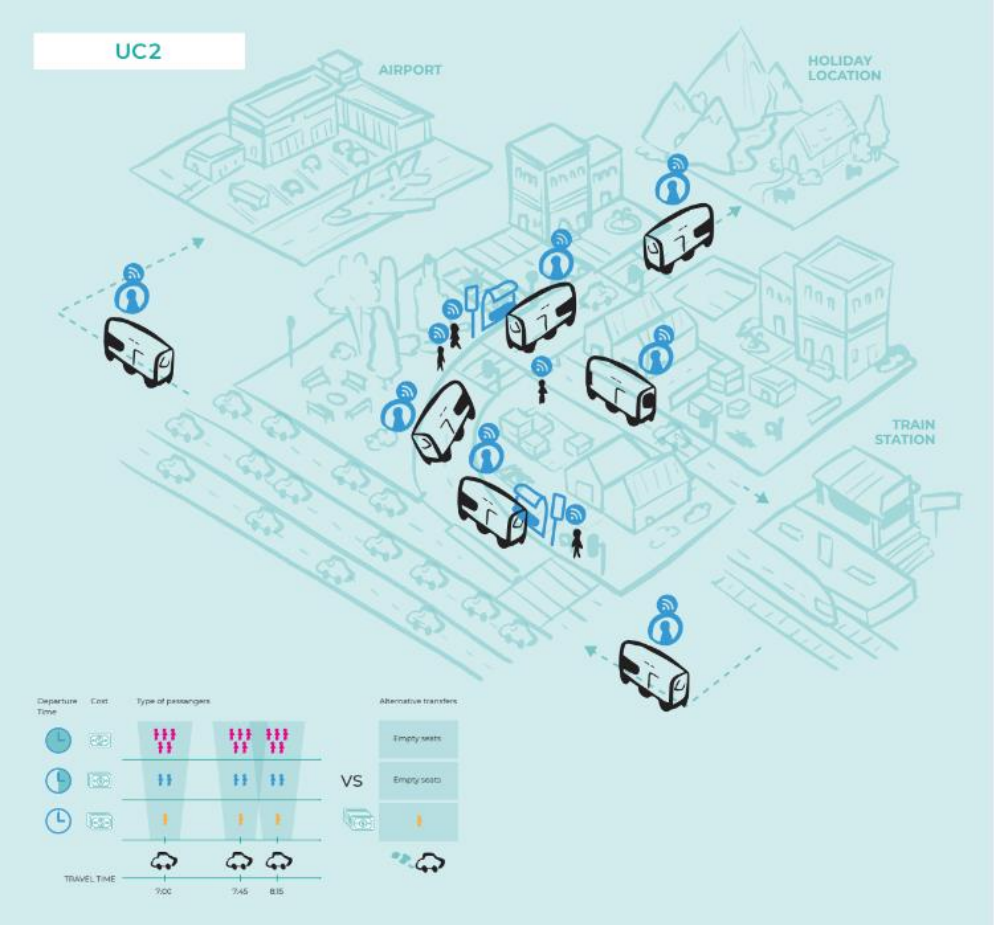

Figure 10. UC2 Slovenia

6.2.5 UC3 Urban logistics in Madrid

The urban logistics use case 3 Madrid (Figure 11) will investigate and propose solutions for last-mile delivery based on the integration of urban distribution of goods in the existing on-demand passengers' transport services . The demand of urban goods delivery has increased in the last ten years. The adoption of e-commerce, now boosted with the COVID-19 crisis, is responsible for this shift and in particular of traffic due to last-mile delivery. The use case will propose and simulate different passenger and goods coordination strategies that reduce last-mile parcel delivery-related traffic, taking advantage of the synergies with on-demand passenger transport services.

For that, on demand transport services and demand data will be used to identify time windows in which on-demand services have low demand for specific routes, which may be used by logistics operators to deliver certain types of goods compatible with the transport of people.

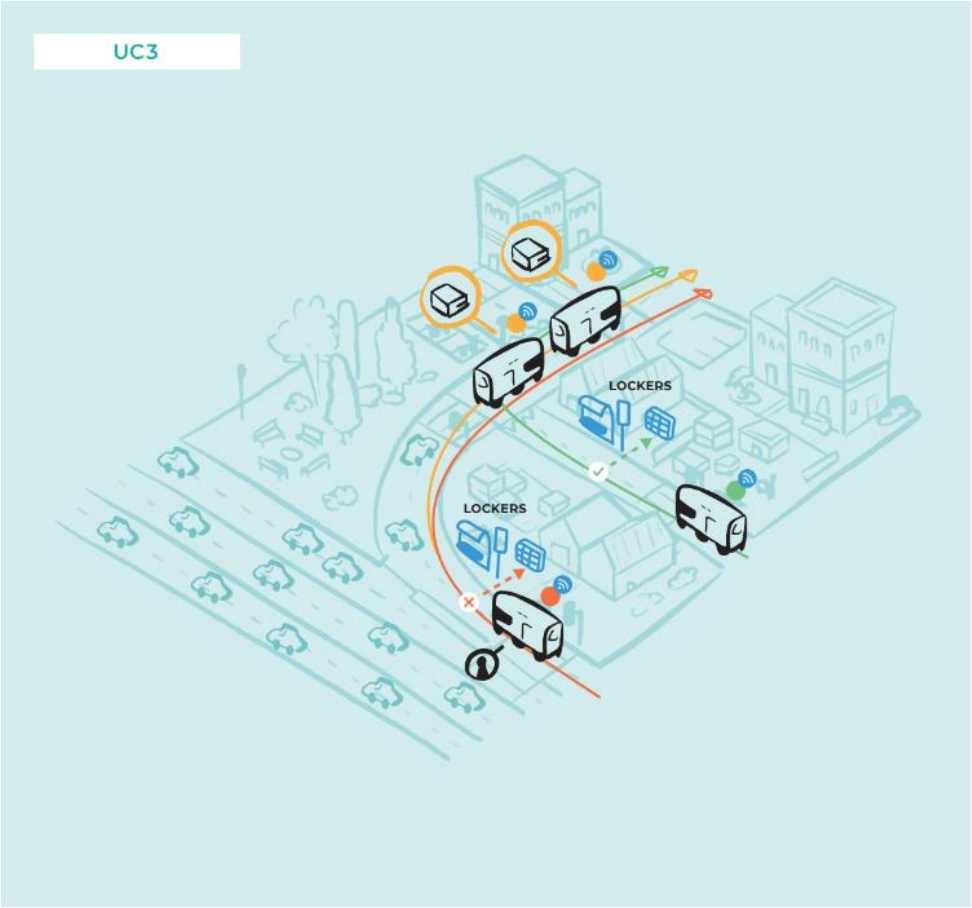

Figure 11. UC3 Madrid

6.3 Stakeholders and users identification

Based on the analysis of the use cases presented in previous section and partially in parallel with it, the second step of the bottom-up approach of the needs and requirements elicitation methodology proposed by CONDUCTOR focused on the identification of relevant users and stakeholders directly and indirectly involved by each of the use cases.

The sectors and types of stakeholders contributing to CCAM Partnership and SRIA (§ 3.1) were used to guide the process towards the identification of the relevant stakeholders and users. In particular, a comprehensive stakeholder and user matrix was created with selected categories (i.e. industry, public authorities & road operators, mobility & logistic services, representative bodies, research, plus users as a further category added by the consortium) to provide a structured framework for the systematic and collaborative identification of the stakeholders and users associated with the project. This matrix was distributed to the partners for completion, ensuring that all relevant stakeholders and users were identified and documented accurately. It is to be noticed that regulatory bodies were not included in the matrix, as in the overall methodological framework adopted by CONDUCTOR, their requirements are expected to emerge from the results of the top-down approach.

The stakeholders and users' matrix was an essential tool for ensuring that all project stakeholders and users were accounted for and their respective needs and requirements were documented. By establishing a structured approach to stakeholder and user identification, the matrix provided a clear and comprehensive understanding of the project's stakeholder landscape.

The following diagram presents the results of the identification process.

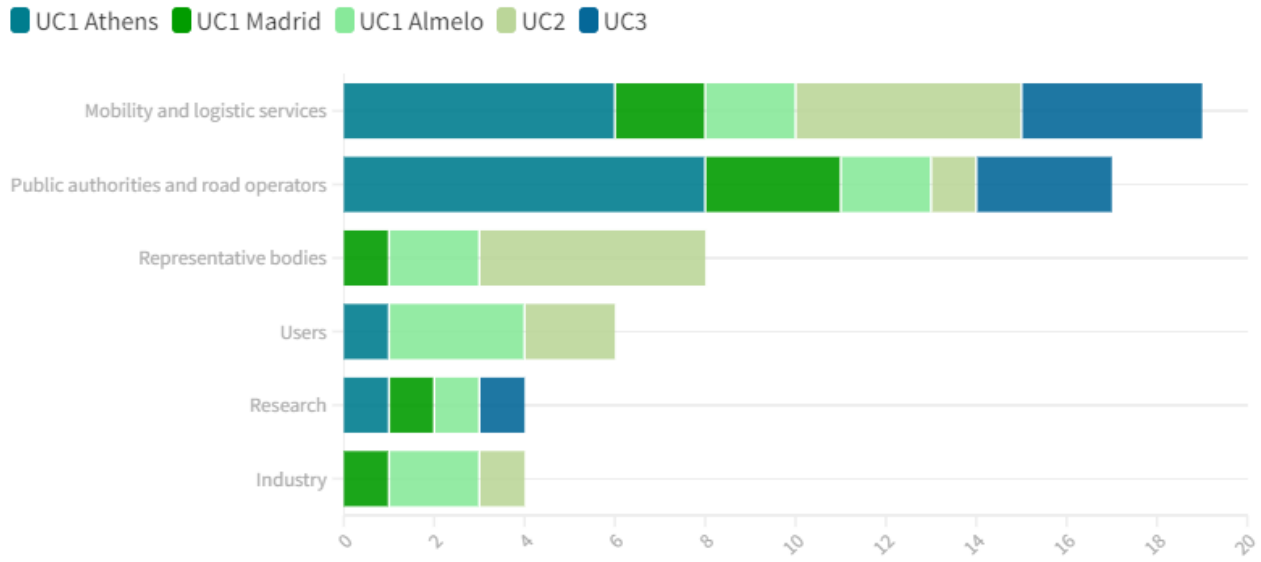

Figure 12 Stakeholders and users identified as relevant

A total of 58 stakeholders were identified, with the most well-represented groups being mobility & logistic services (N=19) and public authorities & road operators (N=17). Survey for stakeholders and users.

Following the identification of stakeholders and users for each use case, the project team proceeded with the third and last step of the process, which consisted in collecting stakeholders and users' needs and requirements by means of a dedicated survey. The survey was designed to capture detailed information on the approach, regulatory needs, requirements, main and secondary stakeholders, (end)users, benefits, and expected bottlenecks/challenges associated with each use case.

The survey was thoroughly tested, reviewed, and administered to all relevant stakeholders and users to solicit their input and feedback.

The survey process was an essential part of the project's data collection efforts and helped to ensure that stakeholder and user needs and requirements were thoroughly understood and documented. The insights gathered through the survey process were carefully analysed and incorporated into the project's design and development, ensuring that the final product would meet the needs and requirements of all stakeholders and users.

6.3.1 General intro to the survey

The main objectives of this survey were to gain a thorough understanding of the needs and requirements of both stakeholders and users in relation to the use cases being considered. By identifying these needs and requirements, the CONDUCTOR project can take them into account when developing and implementing the Use Cases, increasing the likelihood of social acceptance of the CCAM solutions proposed and thereby assure sustained impact.

In addition, the survey aimed to determine the factors that could either facilitate or obstruct the implementation of these use cases with regards to national, European, and international regulations. By identifying these factors, the project team could ensure that the use cases complied with all relevant regulations and standards.

To achieve these objectives, the survey was designed to include 33 questions and took approximately 20 minutes to complete. Participants were informed that their participation in the study was completely voluntary, and that all data collected would be anonymized and treated confidentially. The research results were only included as aggregated data, with no possibility of identifying individual responses. The survey did not require respondents to provide any personally identifiable information, such as their name or email, except for their company name (to be able to identify the stakeholder company). These measures helped to ensure that participants felt comfortable providing honest and accurate feedback, which was critical for the success of the survey.

6.3.2 Selection criteria for questions and matrixes

CONDUCTOR derived significant benefits from adopting the well-developed INDIMO methodology (INDIMO, [n° 875533]), which had already demonstrated successful in previous applications. Our work leveraged the INDIMO project as a crucial point of reference, utilizing its established framework and approaches to guide our own research and analysis. This process facilitated the identification and utilization of the strengths and insights of the referenced project, while also allowing for the necessary adaptations and customizations to align with our specific research objectives and limitations. This comprehensive approach facilitated the realization of robust and meaningful outcomes, building upon the original methodology's successes to advance our own research objectives.

To address our goals and meet the demands of our research, we identified the following user requirements from the INDIMO project. **Usability** was a key consideration, with a focus on intuitive interfaces, whether digital or physical, that use local language and easy-to-understand terminology. **Privacy and security** were also key requirements, with a need to adhere to data privacy legislation, while also acknowledging that some user groups may not be overly concerned with privacy beyond safeguarding their bank details, particularly older persons. **Trust and reliability** were also central requirements, with trust primarily depending on the operator running the service, while service agent ratings could help increase trust. Finally, reliability was deemed critical, with a dependable service being of utmost importance.

This led us to define the final survey structure as follows:

- Goal and purposes: this section collects the individual perception on the goals and purposes of the service proposed in each use case.
- Needs & impact: to develop solutions that are tailored to the specific requirements of each location, while also addressing the broader societal and environmental impacts of CCAM technologies.
- Requirements: to develop solutions that are not only effective but also scalable, adaptable, and interoperable, facilitating the integration of CCAM technologies into the wider mobility system.
- Skills and capabilities: it is possible to identify the gaps in knowledge and skills required to operate/use the service proposed in the use cases and to, eventually, develop training and educational programs that support the development and deployment of CCAM solutions.

- Trust, privacy, and security: it is possible to identify the concerns and expectations of citizens and stakeholders regarding the use of CCAM solutions and to develop services that address these concerns while ensuring the necessary privacy and security measures are in place.
- Individual and social benefits & risks: it is possible to develop solutions that maximize the benefits while minimizing the risks and negative impacts of CCAM technologies on individuals and society.
- Attitude: it is possible to develop solutions that are socially and culturally acceptable, promoting the wider adoption of CCAM technologies.
- Regulation and positive actions: By understanding the regulatory framework and positive actions required, it is possible to ensure that CCAM solutions are developed and implemented in a responsible and sustainable way.
- Sociodemographic: this section collects information on the respondent: name, company, and email. These were optional questions except for the company.

6.3.3 Survey administration

The survey was administered by the project partners, who had received a preliminary training to ensure that they were familiar with the survey's administration process. The decision to have local partners administer the survey was intentional, as it was expected to foster stronger relationships with the stakeholders and users and create a greater territorial bond. By having local partners administer the survey, the project team aimed to improve the quality and relevance of the data collected, and to better understand the unique challenges and opportunities that existed within different regions. Overall, the decision to have local partners administer the survey was a key strategy for ensuring that the project was relevant and responsive to the needs of the local communities it aimed to serve.

6.3.4 Stakeholders' and users' needs and requirements

Out of the 58 identified stakeholders and users, a total of 24 answers were collected among all the different use cases. Descriptives statistics were performed for the overall answers of the respondents and for each use case. The survey pdf template is available in Appendix A ~~Appendix A~~.

Type of respondent.

The higher share of respondents was from UC2 (N=10), followed by UC1 Athens (N=6), UC1 Madrid (N=4) and UC3 (N=4). No answers were collected for UC1 Almelo due to some difficulties in contacting the stakeholders. Of all the respondents (figure 13, left), end users of the service were the most represented (N=11), followed by "other" (N=7), and service providers (N=4). The "other" respondents were transport authority (N=5), infrastructure provider (N=1), and mobility institute (N=1). When respondents are divided by use case (figure 13, right), it is possible to observe that almost all individual end users of the service come from use case 2 (N=9), where a service is already existing.

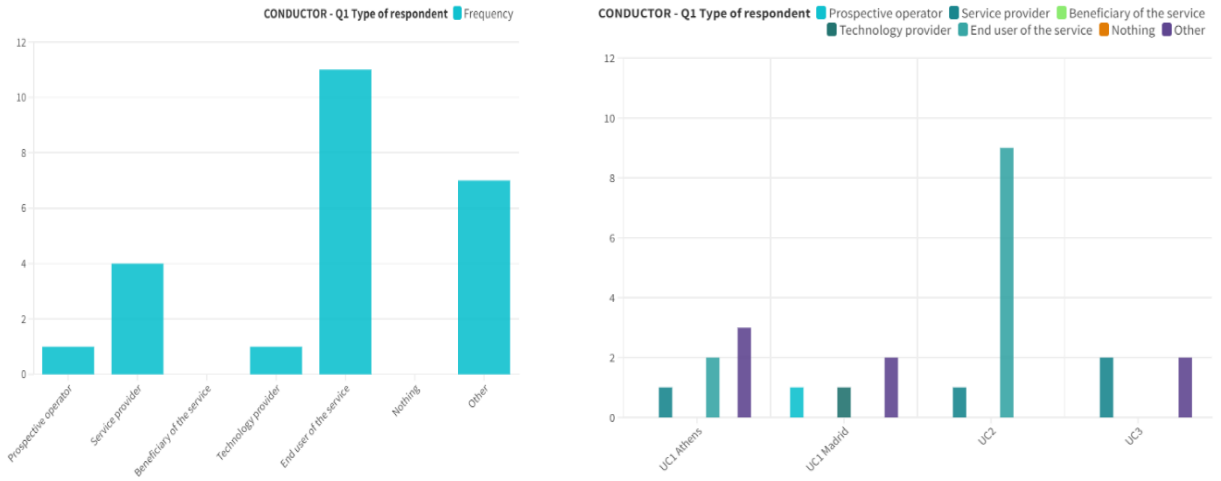

Figure 13 - Type of respondent, overall and per use case

Respondents were presented with short descriptions of their respective use case and were asked to identify the main benefits, needs, challenges, barriers, and requirements.

Expected benefits

Overall, the most reported benefits are environment (75%) (intended as concerns for environmental conditions), lower emissions (75%), technological advancement (58%), and interoperability (58%).

Specifically, for each use case: UC1 Athens respondents identified interoperability (100%), environment (83%), and lower emissions (83%) as the expected benefits of these UC; In UC1 Madrid, environment (100%) and safety (100%) were identified as the main expected benefits; for UC2, economy (70%), lower emissions (70%), and technological advancement (60%); and for UC3, environment (100%), economy (100%), lower emissions (100%), and safety (75%).

The results suggest that the most commonly reported benefits of these use cases are related to the environment and reducing emissions. This is not surprising given the growing concern for the environment and the way that CCAM research can help achieving this goal, and that this result is aligned with previous findings, as environmental conditions have been found to relate to mobility behaviours (Golbabaei et al., 2020; Narayanan et al., 2020; Golbabaei et al., 2021; Suet Theng & Susilawati, 2021; Othman, 2021). In addition, technological advancement and interoperability were also mentioned as expected benefits, indicating the potential for new innovations and collaborations in the realm of CCAM.

Interestingly, UC1 Athens and UC1 Madrid, although they share the same UC umbrella (UC1), have different expected benefits. This result may suggest the need to address these use cases independently.

Stakeholders and Users' Needs

Respondents were asked to identify the most relevant needs for their respective use cases on a 1-7 Likert scale. Overall, as it can be seen from Figure 14, the most frequently identified needs are safety (m=5.78); lower emissions (m=5.39); and accessibility (m=5.35). Generally, all the items presented had a mean score above average (4) indicating their relative perceived need. The least important need identified by the respondents was the need for competitiveness (m=4.13).

The results indicate that the most relevant needs for the use cases identified were safety, lower emissions, and accessibility. These findings are consistent with the broader goals of CCAM research, which is focused on reducing the environmental impact of transportation and making mobility more accessible and equitable for all users. For instance, previous findings have highlighted that CCAM can potentially increase accessibility for elder people, and hence, that this group would be one of the most benefited (Othman, 2021)

The relatively low score for competitiveness suggests that respondents do not see the need for competition as a top priority in the context of CCAM. This is not surprising, given that shared mobility is often seen as a collaborative effort among various stakeholders, including government agencies, transportation providers, and other organizations.

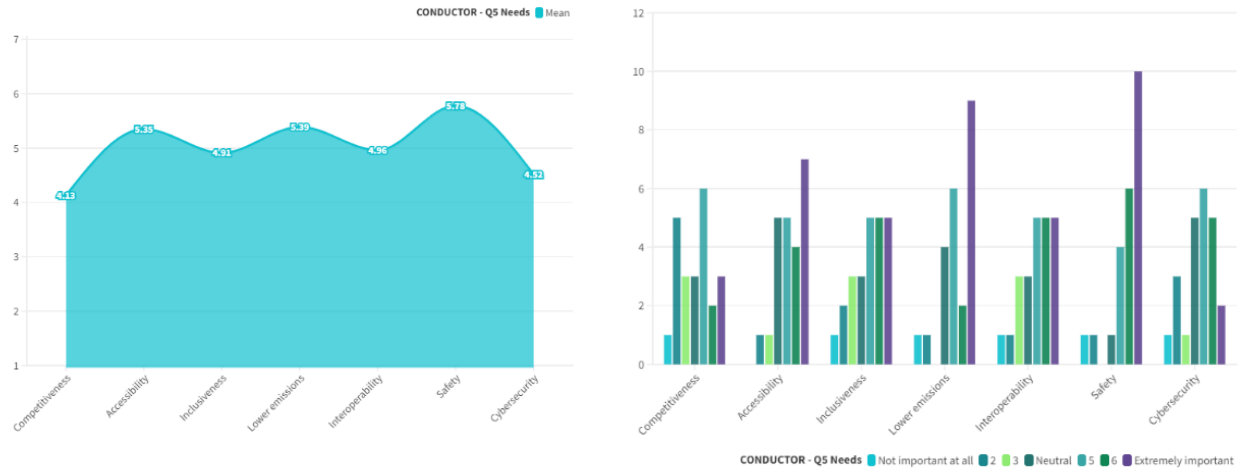

Figure 14 - Stakeholders and users' needs

When it comes to get insights between use cases (Figure 15), it is possible to observe small differences in the overall means. In particular, UC2 has scored m=7 for the lower emissions need compared to the other use cases. Generally, accessibility and Inclusiveness seem to be less relevant for the use cases based in Madrid (UC1 Madrid and UC3).

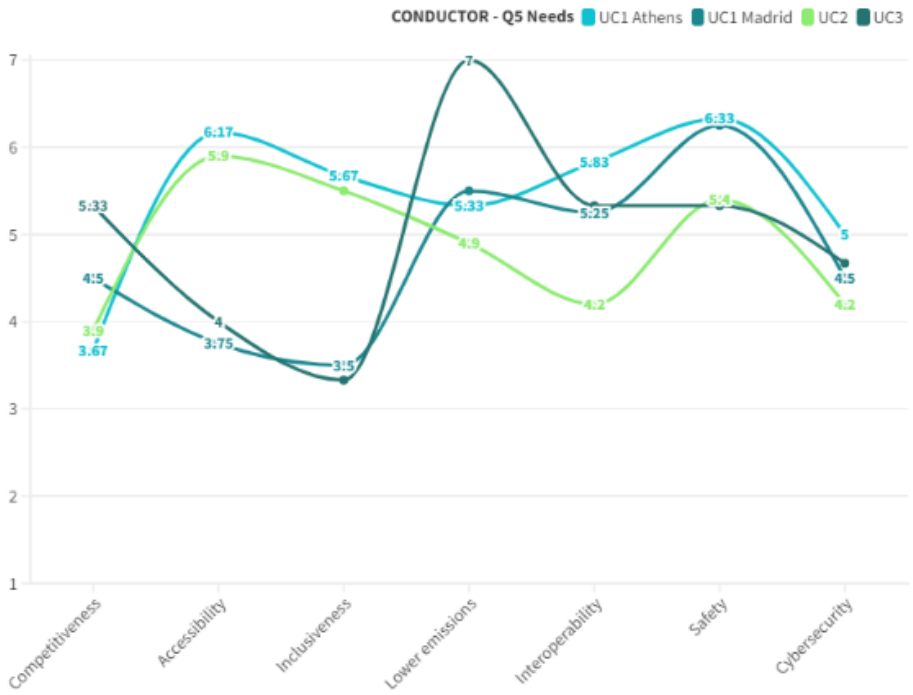

Figure 15 - Stakeholders and users' needs per use case

Service challenges

Concerning the challenges associated with the services offered by the use cases (Figure 16, left), the respondents reported several difficulties: response to system failure (N=14), followed by understanding emergency situations (N=13), and lack of independence (N=10).

Response to system failure is an important challenge that affects the reliability and availability of the services. Understanding emergency situations is another challenge that is especially relevant to CCAM services, as they involve multiple users. Lack of independence is another challenge that can affect the user experience of CCAM services, particularly for users who require assistance or have mobility impairments. Service providers need to consider the needs of all users and ensure that their services are accessible and inclusive, given that CCAM can potentially increase accessibility of elders (Othman, 2021), and that presence of children in the household may be also related with a higher interest in autonomous mobility (Golbabaei et al., 2020).

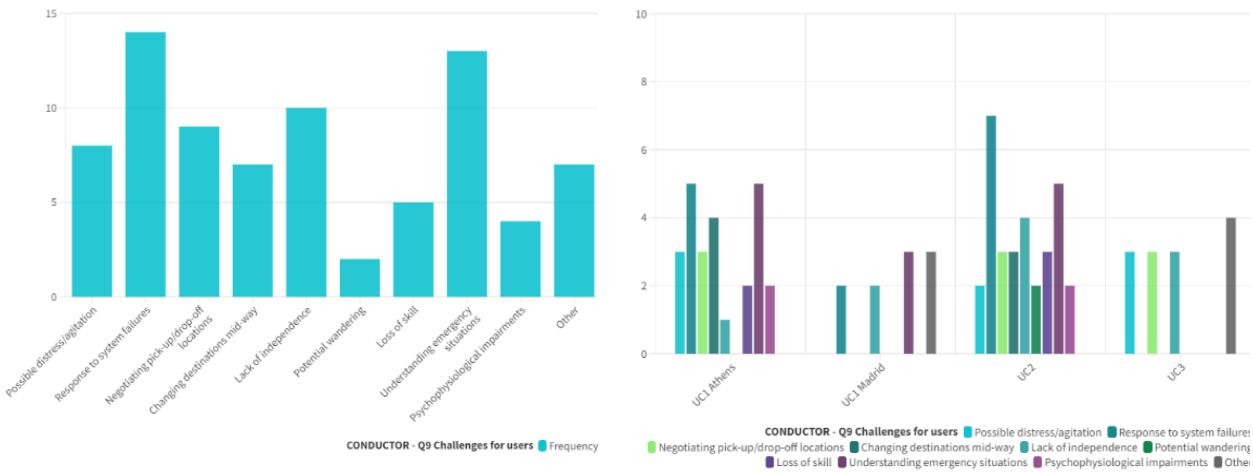

Figure 16 - Main challenges for users while using the service, overall and per use case

When it comes to consider use cases individually (Figure 16, right) , for UC1 Athens, the primary challenges were response to system failure (75%), understanding emergency situations (75%), and changing destination mid-way (67%). In UC1 Madrid, users faced challenges in understanding emergency situations (75%), a lack of independence (50%), and other difficulties (75%). In UC2, the most relevant challenges for users were understanding emergency situations (50%) and a lack of independence (40%). Finally, for UC3, users reported possible distress/agitation (75%), response to system failure (75%), and a lack of independence (75%) as the most significant challenges.

Sharing personal data

Regarding the sharing of personal data with the services (Figure 17), more than half of the participants (N=13) expressed a concrete concern. Specifically, the reasons for this apprehension were attributed to data privacy issues (N=5), compliance with the General Data Protection Regulation (GDPR) (N=3), and potential manipulation or abuse of data (N=1), as stated by some respondents.

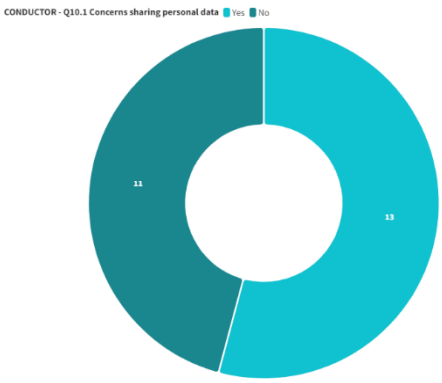

Figure 17 - Concerns sharing personal data to the service

Service reliability

According to the respondents (Figure 18), the most relevant concerns related to the reliability of the services are: The speed of execution (N=17), performance (N=14), and accuracy (N=14).

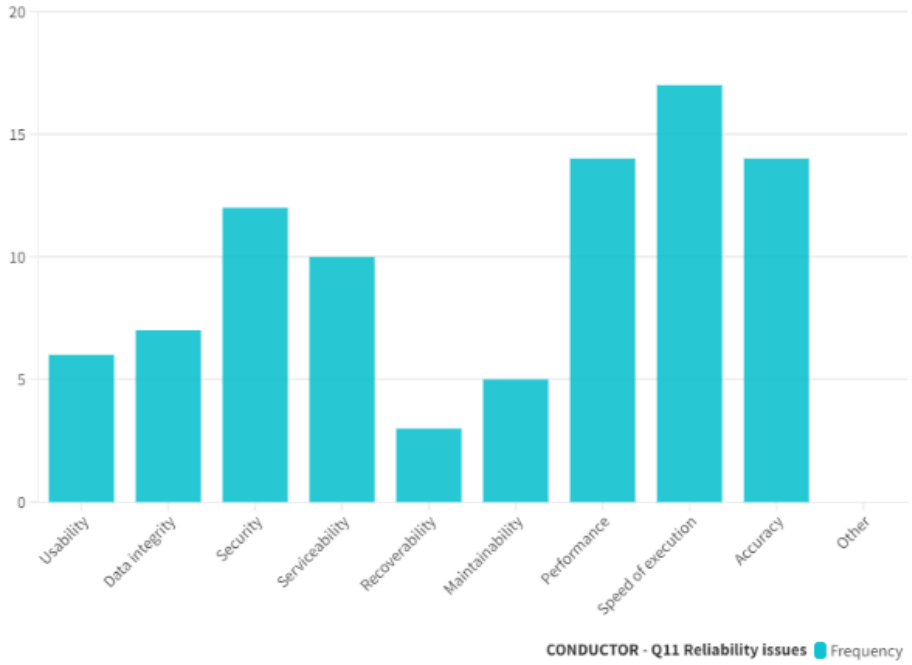

Figure 18 - Concerns related to the reliability of the service

Furthermore, the reliability concerns vary for each use case (Figure 19). For UC1 Athens, the most relevant reliability issues are accuracy (100%) and speed of execution (83%). For UC1 Madrid, the most significant reliability concerns are speed of execution (75%), security (50%), and accuracy (50%). For UC2, the most relevant reliability issues are speed of execution (60%), accuracy (60%), and performance (60%). Finally, for UC3, the most significant reliability concerns are speed of execution (75%), performance (75%), and security (50%).

Figure 19 - Concerns related to the reliability of the service per use case

Service trustworthiness

The respondents have highlighted three significant factors that impact trustworthiness (Figure 20, left), namely security (N=17), data integrity (N=13), and proposed solutions (N=10).

These findings align with previous research on trust in CCAM services. For example, studies have shown that concerns about data privacy and security are among the main reasons why some people are hesitant to use these services (Kanak et al., 2022). Therefore, service providers should prioritize the implementation of robust security measures and transparent data handling practices to build trust with their users. Additionally, service providers should be responsive to user feedback and take proactive measures to address any issues that arise, which can help to further enhance trustworthiness.

Figure 20 - Issues related to the trustworthiness of the service, overall and per use case

Moreover, the findings reveal that trustworthiness issues vary for each use case (Figure 20, right). For UC1 Athens, data integrity (83%) is the most relevant trustworthiness issue, followed by security, proposed solutions, and ethics of the service (all at 67%). In contrast, for UC1 Madrid, security (75%) and proposed solutions (50%) are the most significant trustworthiness concerns. For UC2, security (70%) and data integrity (60%) are the most relevant trustworthiness issues, while for UC3, security (75%) is the most significant trustworthiness concern.

Improve trustworthiness

When asked what could be done to improve the trustworthiness of the services (Figure 21, left), respondents identified in transparency (71%), explainability (67%), and conformance (67%) the actions to mitigate the trustworthiness issues perceived.

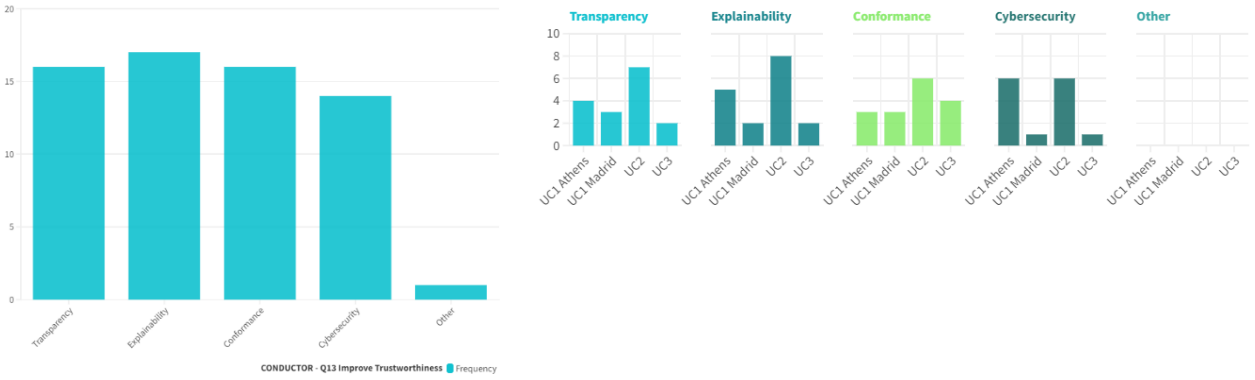

Figure 21 - Actions to improve trust in the service

When it comes to the use cases, some differences are observable (Figure 21, right). For UC1 Athens, cybersecurity (100%) and explainability (83%) are the most identified way to mitigate the trustworthiness issues. For UC1 Madrid, transparency (75%) and conformance (75%). For UC2, explainability (80%) and transparency (70%). For UC3, conformance (100%), transparency (50%), and explainability (50%).

The results for trustworthiness issues and trustworthiness improvements in UC1 Athens and UC1 Madrid corroborate the results in identifying differences in addressing these two pilot sites, despite being categorised under the same use case.

Risks and adverse effects of the use case

The analysis of open-ended questions revealed that respondents expressed concerns about risks and potential adverse effects related to the use cases. Specifically, the complexity of the use cases (N=3) and safety issues (N=3) were identified as the primary factors contributing to these concerns.

Regarding complexity, it is possible that respondents are concerned that the use cases may be too complicated or difficult to understand, which could result in errors or unintended consequences. This could be particularly relevant in the context of new or emerging technologies, which may not be well-understood by users or stakeholders.

Regarding safety, respondents may be concerned about the potential risks associated with using the technologies or services in question. This could include risks related to physical safety, such as accidents or injuries, as well as risks related to data privacy and security.

In particular, UC1 respondents mentioned complexity of the use case (N=2), safety issues (N=2) and cyber threats (N=2) as the main risks associated to the UC. On the other hand, UC1 Madrid was associated with the risks of lower mobility performance (N=2) and perception of injustice (N=2). UC2 respondents mentioned safety issues (N=1), complexity (N=1) and perception of injustice (N=1). UC3 respondents were more concerned about accessibility (N=1), and malfunctioning (N=1).

Barriers to the implementation

Three significant barriers were identified (Figure 22, left) to impede the implementation of the use cases services. These barriers are conflicts with other stakeholders (N=20), social acceptance (N=16), and existing regulations (N=14).

Conflicts with other stakeholders could arise if there are disagreements or competing interests between different groups involved in the implementation of the use cases, such as service providers, policymakers, and community organizations. If the public is not supportive of the use cases, it may be difficult to gain the necessary engagement from key stakeholders, including potential users, policymakers, and service providers. Existing regulations may also pose a significant barrier to the implementation of the use cases, particularly if the technologies or services in question are subject to complex or restrictive regulations.

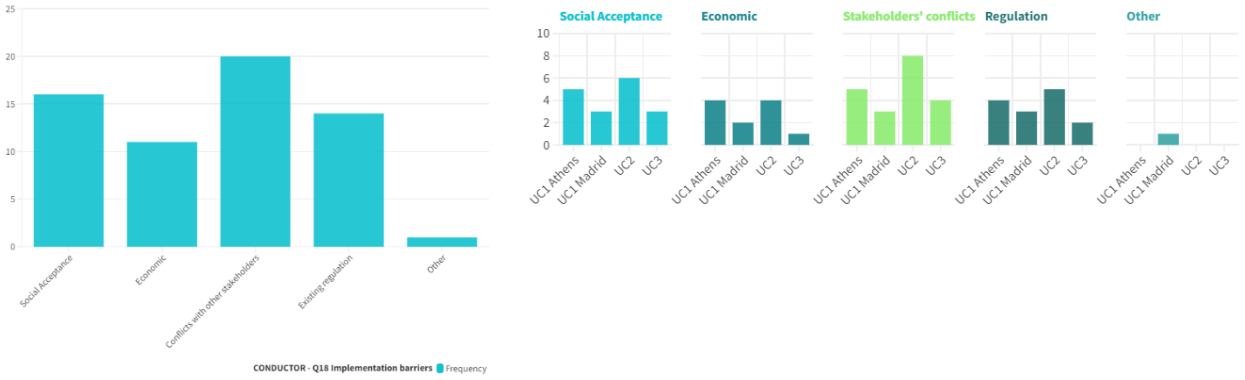

Figure 22 - Main barriers to the implementation in the real operational context of the service

Specifically, per use case (Figure 22, right), conflicts with other stakeholders and social acceptance were the most significant barriers to the implementation of UC1 Athens and UC1 Madrid, with 83% and 75% of the respondents identifying these issues as significant challenges, respectively. Furthermore, existing regulation was also considered a major obstacle in UC1 Madrid, with 75% of the respondents indicating it as a significant impediment.

For UC2, the most relevant barriers to implementation were conflicts with other stakeholders (80%), social acceptance (60%), and existing regulation (50%). Similarly, the study found that conflicts with other stakeholders were the most significant barrier to the implementation of UC3, with 100% of the respondents identifying this issue as a significant challenge. Social acceptance and existing regulation were also found to be barriers in UC3, with 50% of the respondents indicating these issues as significant impediments.

Normative framework

Respondents were asked to express on a 1-7 Likert scale their level of agreement with the following sentence: "The service is regulated by a clear and stable normative framework" (Figure 23, left). It emerges that 4 respondents are not aware of normative frameworks and that 6 respondents (summing scores from 1 to 3) disagree with this sentence, indicating an unclear normative framework. 4 respondents remain neutral, and 10 agree (summing scores from 5 to 7). This result shows the uncertainty and possible variety of normative frameworks among pilot sites.

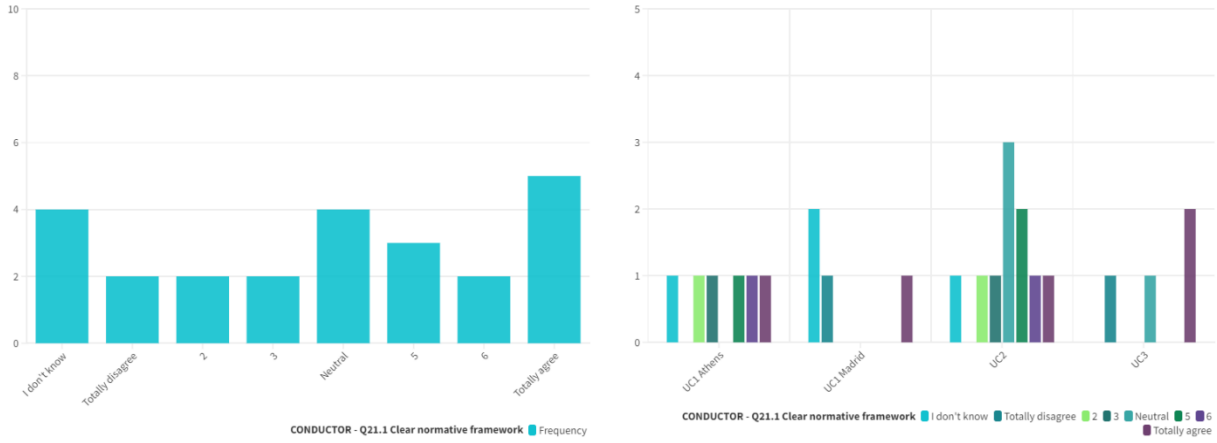

Figure 23 - Awareness of a clear and stable normative framework, overall and per use case

To get a better insight of the pilots, responses were divided per use case (Figure 23, right).

It emerges that in UC1 Athens, respondents distributed along the Likert, while in UC1 Madrid, 2 respondents were not aware of any framework, while the 2 other respondents scored at the two extremes: 1 completely disagreed, while the other completely agreed.

For UC2, a similar trend distribution over the Likert scale is observable. Respondents' scores are mainly neutral (N=3), with individuals that agree, disagree, or are not aware of normative frameworks. Finally, UC3 seems to be the use case where stakeholders and users may be aware of a clear normative framework since 2 respondents out of 4 answered "totally agree", while 1 remained neutral, and 1 answered "totally disagree", but none selected the "I don't know" option. This result for UC3 is similar to UC1 Madrid probably since these two use cases share the same city and socio-cultural context.

Compliance standards

Respondents were asked to express on a 1-7 Likert scale their level of agreement with the following sentence: "Compliance standards about technological safety, security and interoperability are clear" (Figure 24, left). Similarly, to the previous question, 6 respondents out of 24 (33%) are not aware of compliance standards. 4 respondents disagreed, suggesting that compliance standards are not clear, 3 subjects remained neutral and 11 (46%, summing scores from 5 to 7) agreed or completely agreed with the affirmation.

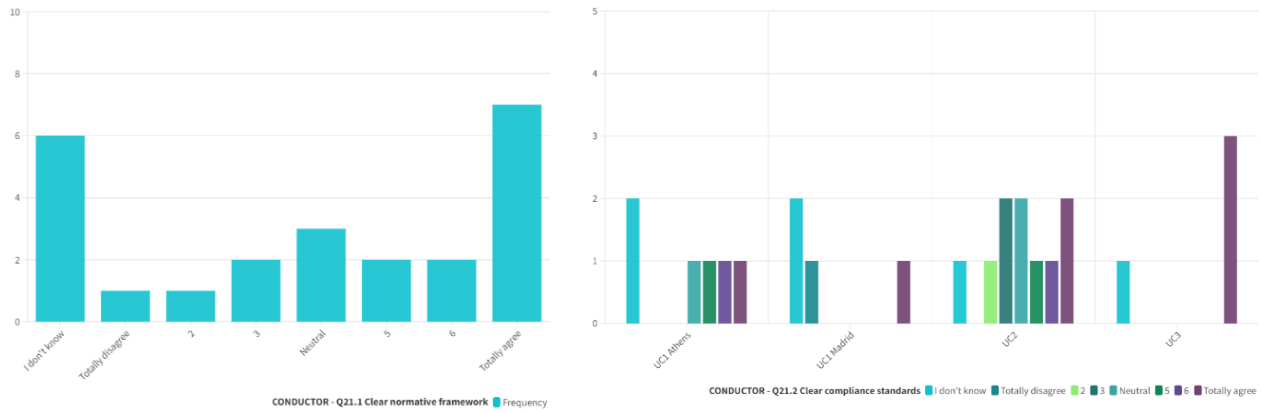

Figure 24 - Awareness of clear compliance standards about technological safety, security and interoperability, overall and per use case

To get a more precise insight, responses were divided by use cases (Figure 24, right) and it emerges that: In UC1 Athens, 33% of the respondents are not aware of any compliance standards. The same applies for UC1 Madrid where 50% of the respondents are not aware. Similarly, to UC2, where only 40% of subjects agreed or completely agreed; conversely to UC3 where respondents seemed to have more awareness with 75% of them completely agreeing.

From these results it is safe to assume that normative frameworks and compliance standards are not well known by all the stakeholders that may be affected by these use cases, and that awareness shall be created. In this sense, this activity may help in the diffusion of normative and standards knowledge.

Stakeholders and Users' Requirements

To conclude the analysis of the Use Cases, open-ended questions regarding the Requirements were asked, and the main answers were collected in the following table (Figure 25):

Competitiveness	Accessibility	Inclusiveness	Lower Emissions	Interoperability	Safety	Cybersecurity	Other
Cheaper service (N=5); Reduced travel time (N=3); More companies involved (N=3); Recognition (N=2); User satisfaction (N=1); Increase of PT shares (N=1); Company as the main player (N=1); Successful management of incidents (N=1); Comfort (N=1); More transfers (N=1); Feasibility (N=1).	Tailored for passengers with disabilities (N=3); More frequent routing (N=3); Practicality (N=3); Accessible price (N=2); Improved service options (N=2); Physical accessibility (N=1); Daily usability (N=1); Service at all times (N=1); CAVs SAE 5 (N=1).	Consider special needs (N=5); Greater coverage (N=5); No social group distinctions (N=4); Services sharing the same platform (N=2); Greater connectivity (N=1); Economic integration (N=1); New modalities (N=1).	Reduce emission (N=13); Shorter journeys (N=6); Increase electric buses (N=2); Shift away from car use (N=1); Car-sharing scenarios (N=1); High demand of public transport (N=1); Increase electric vehicles (N=2)	Cooperation among players (N=4); Shared mobility (N=4); Single platform (N=3); Use of CAVs (N=2); Seamless connectivity among transport systems (N=1); Compatible solutions for stakeholders (N=1); Decrease travel time (N=1); Accessible data (N=1); Adequate infrastructures (N=1); Efficiency (N=1), Transparency (N=1), Neutrality (N=1), Traceability (N=1), Optimisation (N=1) of the system; Accessible public networks (N=1).	Less accidents (N=14); Safety awareness (N=3); Feeling of safety (N=2); Improved prediction (N=2); Improved uncertainty (N=1); Maintenance (N=1); Use of public transport (N=1); Physical security for goods (N=1).	Reduce exposure to cyber threats (N=5); Secured data (N=3); Meet EU/ISO standards (N=3). No use of personal data (N=1)	Reliability (N=1) Satisfaction (N=1)

Figure 25 - Stakeholders and users' requirements

To achieve the competitiveness need, the main requirements provided by stakeholders and users were to reach a cheaper service (N=5), a reduction of travel time (N=3) and a greater involvement of companies (N=3).

Regarding accessibility the respondents pointed out that the UCs should be tailored to passengers with disabilities (N=3), to have higher practicality (N=3) and to have more frequent routing (N=3).

To achieve the inclusiveness requirement the stakeholders and users mentioned to consider special needs (N=5), to have greater coverage (n=5), and to eliminate social distinctions (N=4).

The main criteria mentioned regarding the achievement of lower emissions were to reduce the emissions (N=13) and to shorten the journeys (N=6).

Interoperability was linked to a greater cooperation among players (N=4) and to shared mobility (N=4).

To achieve safety the respondents mainly mentioned the reduction of accidents (N=14) and to increase safety awareness (N=3).

The main criteria mentioned for achieving cybersecurity was related to the reduction of exposure to cyber threats (N=5) and increase the security of data (N=3). Other criteria mentioned by the respondents referred to reliability (N=1) and satisfaction (N=1).

Stakeholder and user requirements were also divided as a function of the use case

As it can be observed (Figure 26) in UC1 Athens the most frequent requirements identified were: less accidents (N=5) (for the need of safety), reduce exposure to cyber threats (N=4) (for the need of cybersecurity), reduce emissions (N=3) (for the need of lower emissions), and greater coverage (N=3) and consider special needs (N=2) (for the need of inclusiveness).

Competitiveness	Accessibility	Inclusiveness	Lower Emissions	Interoperability	Safety	Cybersecurity	Other
Cheaper service (N=1); User satisfaction (N=1); Increase of PT shares (N=1); Company as the main player (N=1);	Tailored for passengers with disabilities (N=1); Improved service options (N=2); Daily usability (N=1); Service at all times (N=1);	Consider special needs (N=2); Greater coverage (N=3); No social group distinctions (N=1);	Reduce emission (N=3); Increase electric buses (N=2); Shift away from car use (N=1);	Cooperation among players (N=1); Shared mobility (N=1); Seamless connectivity among transport systems (N=1); Compatible solutions for stakeholders (N=1); Decrease travel time (N=1);	Less accidents (N=5); Feeling of safety (N=2); Maintenance (N=1);	Reduce exposure to cyber threats (N=4); Secured data (N=1);	

Figure 26 - Stakeholders and users' requirements - UC1 Athens

For UC1 Madrid (Figure 27), the most frequent requirements identified were: reduce emissions (N=2) (for the need of lower emissions), reduce accidents (N=2) (for the need of safety), improve prediction (N=2) (for the need of safety), and reduce trave time (N=2) (for the need of competitiveness).

Competitiveness	Accessibility	Inclusiveness	Lower Emissions	Interoperability	Safety	Cybersecurity	Other
Cheaper service (N=1); Reduced travel time (N=2);	CAVs SAE 5 (N=1).	Consider special needs (N=1); Greater connectivity (N=1);	Reduce emission (N=2); Shorter journeys (N=1); Car-sharing scenarios (N=1);	Shared mobility (N=1); Use of CAVs (N=2);	Less accidents (N=2); Safety awareness (N=1); Improved prediction (N=2); Improved uncertainty (N=1);	Meet EU/ISO standards (N=1).	

Figure 27 - Stakeholders and users' requirements - UC1 Madrid

For UC2 (Figure 28), the most frequent requirements identified were: cheaper service (N=5), more companies involved (N=3) (for the need of competitiveness); greater coverage (N=4) (for the need of inclusiveness); reduce emissions (N=5) and shorter journeys (N=5) (for the need of lower emissions); cooperation among players (N=3) and common single platform (N=3) (for the need of interoperability); and less accidents (N=4) (for the need of safety).

Competitiveness	Accessibility	Inclusiveness	Lower Emissions	Interoperability	Safety	Cybersecurity	Other
Cheaper service (N=5); More companies involved (N=3); Recognition (N=2); Comfort (N=1); More transfers (N=1);	Tailored for passengers with disabilities (N=2); More frequent routing (N=3); Practicality (N=3); Accessible price (N=2);	Consider special needs (N=2); Greater coverage (N=4); No social group distinctions (N=1); Services sharing the same platform (N=2); New modalities (N=1).	Reduce emission (N=5); Shorter journeys (N=5); Increase electric vehicles (N=2) High demand of public transport (N=1);	Cooperation among players (N=3); Single platform (N=3); Accessible data (N=1); Adequate infrastructures (N=1);	Less accidents (N=4); Safety awareness (N=2); Feeling of safety (N=1); Use of public transport (N=1);	Secured data (N=2); No use of personal data (N=1)	Reliability (N=1)

Figure 28 - Stakeholders and users' requirements - UC2

For UC3 (Figure 29), the most frequent requirements identified were: cheaper service (N=2) (for the need of competitiveness); less accidents (N=3) (for the need of safety).

Competitiveness	Accessibility	Inclusiveness	Lower Emissions	Interoperability	Safety	Cybersecurity	Other
Cheaper service (N=2); Reduced travel time (N=1); Feasibility (N=1)	Physical accessibility (N=1);	Economic integration (N=1);	Reduce emission (N=3);	Efficiency (N=1), Transparency (N=1), Neutrality (N=1), Traceability (N=1), Optimisation (N=1) of the system. Accessible public networks (N=1).	Less accidents (N=3); Physical security for goods (N=1).	Reduce exposure to cyber threats (N=1); Meet EU/ISO standards (N=2).	Satisfaction (N=1)

Figure 29 - Stakeholders and users' requirements - UC3

Conclusion

In conclusion, the most expressed needs by stakeholders and users involved in CONDUCTOR are safety (mean=5.78); reduced emissions (mean=5.39); and accessibility (mean=5.35).

Specifically, to attain safety, the participants emphasized the need to reduce accidents (N=14) and increase safety awareness (N=3). The primary criteria identified for reducing emissions were the reduction of emissions (N=13) and shorter travel distances (N=6). Concerning accessibility, the respondents suggested that UCs should be customized to meet the needs of passengers with disabilities (N=3), have greater practicality (N=3), and offer more frequent routing (N=3).

Detailed conclusions and requirements per each use case that shall be considered in the further development stages of the project are reported in the below tables.

Table 3 - UC1 Athens takeaways

UC1 Athens	
Needs	UC1 Athens most cited needs from stakeholders and users are *Accessibility*, *Safety*, and *Interoperability*.
Service challenges	UC1 Athens shall consider *Response to system failure*, *Understanding emergency situations*, and *Changing destination mid-way for passengers*, as the main reported challenges of the service.
Service data	UC1 Athens shall consider *Data privacy* and *GDPR compliance*, as the main reported issues of sharing personal data.
Service reliability	UC1 Athens shall consider *Accuracy* and *Speed of execution*, as the main reported reliability issues.
Service trustworthiness	UC1 Athens shall consider *Data integrity*, *Security*, *Proposed solutions*, and *Ethics of the service*, as the main reported issues in the trustworthiness of the service.
Risks and adverse effects	UC1 Athens shall consider the *Complexity of the Use Case*, the *Safety issues*, and the *Cyber threats*, as the main reported risks and adverse effects of the service.

Implementation barriers	UC1 Athens shall consider the possible *Conflicts with other Stakeholders* and *Social Acceptance*, as the main implementation barriers reported for the service.
Normative framework and compliance standards	UC1 Athens shall consider improving the *Awareness levels* of Stakeholders and Users, as many were not aware of a clear normative framework and clear compliance standards.
Requirements	UC1 Athens shall consider *reducing accidents* (for the need of safety), *reducing exposure to cyber threats* (for the need of cybersecurity), *reducing emissions* (for the need of lower emissions), *increasing the service coverage,* and *considering special needs* (for the need of inclusiveness).

Table 4 - UC1 Madrid takeaways

UC1 Madrid	
Needs	UC1 Madrid most cited needs from stakeholders and users are *Safety*, *Lower emissions*, and *Interoperability*.
Service challenges	UC1 Madrid shall consider *Understanding emergency situations* and *Lack of independence* as the main reported challenges of the service.
Service data	UC1 Madrid shall consider *Data privacy* and *GDPR compliance*, as the main reported issues of sharing personal data.
Service reliability	UC1 Madrid shall consider *Speed of execution*, *Security*, and *Accuracy*, as the main reported reliability issues.
Service trustworthiness	UC1 Madrid shall consider *Security* and *Proposed solutions*, as the main reported issues in the trustworthiness of the service.
Risks and adverse effects	UC1 Madrid shall consider *Lower mobility performance* and *Perception of injustice*, as the main reported risks and adverse effects of the service.
Implementation barriers	UC1 Madrid shall consider the possible *Conflicts with other Stakeholders*, *Social Acceptance*, and *Existing regulation*, as the main implementation barriers reported for the service.
Normative framework and compliance standards	UC1 Madrid shall consider improving the awareness levels of stakeholders and users, as many were not aware of a clear normative framework and clear compliance standards.

Requirements	UC1 Madrid shall consider aiming at *reducing emissions* (for the need of lower emissions), *reducing accidents* (for the need of safety), *improving prediction* (for the need of safety), and *reducing trave time* (for the need of competitiveness).

Table 5 - UC2 takeaways

UC2	
Needs	UC2 most cited needs from stakeholders and users are *Accessibility*, *Inclusiveness*, and *Safety*.
Service challenges	UC2 shall consider *Understanding emergency situations* and *Lack of independence*, as the main reported challenges of the service.
Service data	UC2 shall consider *Data privacy* and *Manipulation/abuse of data*, as the main reported issues of sharing personal data.
Service reliability	UC2 shall consider *Accuracy*, *Speed of execution* and *Performance*, as the main reported reliability issues.
Service trustworthiness	UC2 shall consider *Security* and *Data integrity*, as the main reported issues in the trustworthiness of the service.
Risks and adverse effects	UC2 shall consider *Safety issues*, *Perception of injustice*, *Unpredictability*, *Dependency on AI*, *Collapse of the system*, and *Frauds*, as the main reported risks and adverse effects of the service.
Implementation barriers	UC2 shall consider the possible *Conflicts with other Stakeholders*, *Social Acceptance*, and *Existing regulation*, as the main implementation barriers reported for the service.
Normative framework and compliance standards	UC2 shall consider improving the awareness levels of stakeholders and users, as many were not aware of a clear normative framework and clear compliance standards.
Requirements	UC2 shall consider a *Cheaper service* and *More companies involved* (for the need of competitiveness); *Greater coverage* (for the need of inclusiveness); *Reduced Emissions* and *Shorter journeys* (for the need of lower emissions); *Cooperation among players* and *Common single platform* (for the need of interoperability); and *Less accidents* (for the need of safety).

Table 6 - UC3 takeaways

UC3	
Needs	UC3 most cited needs from stakeholders and users are *Lower emissions*, *Competitiveness*, *Interoperability*, and *Safety*.
Service challenges	UC3 shall consider *Possible distress/agitation*, *Response to system failure*, and *Lack of independence*, as the main reported challenges of the service.
Service data	UC3 shall consider *GDPR compliance*, as the main reported issues of sharing personal data.
Service reliability	UC3 shall consider *Speed of execution*, *Performance*, and *Security*, as the main reported reliability issues.
Service trustworthiness	UC3 shall consider *Security*, as the main reported issues in the trustworthiness of the service.
Risks and adverse effects	UC3 shall consider *Accessibility* and *Malfunctioning*, as the main reported risks and adverse effects of the service.
Implementation barriers	UC3 shall consider the possible *Conflicts with other Stakeholders*, *Social Acceptance*, and *Existing regulation*, as the main implementation barriers reported for the service.
Normative framework and compliance standards	UC3 shall consider improving the awareness levels of stakeholders and users, even if many were aware of a normative framework and compliance standards.
Requirements	UC3 shall consider a *Cheaper service* (for the need of competitiveness) and *Reducing accidents* (for the need of safety).

7. MERGE BETWEEN TOP-DOWN & BOTTOM-UP APPROACH

7.1 Expected outcomes

As noted, CCAM is intertwined with relevant and different policy ambitions and SDGs, but often this is still not supported by specific and consolidated methods to pursue these goals. On the one hand, the EC and CINEA highly tout a holistic approach to ‘smart mobility’, warming the inclusion of social and human-based approach to technological innovation in transport. On the other hand, researcher and developers have to deal with specific and context-based use cases and, on this background, they aim to develop consistent and well-accepted solutions, usable and marketable on the medium and long term.

This is an issue that goes far beyond mere compliance since much of smart mobility refers to policies and principles which are not necessarily reflected in – or have not yet been transposed into – specific legal rules and technical protocols. Albeit these uncertainties, the acceptance of innovative mobility solutions is the essential condition for further investments and research in this sector, so encouraging the integration and the renewal of previous research and validation methodologies.

Projects like CONDUCTOR thus are spurred to dare something more than the mere technological research on CCAM, promoting a holistic understanding of innovation and testing in practice the acceptability of the solutions that the EU aims to promote on a larger scale. Funded research is aimed to assess the feasibility of policy ambitions in practice, collecting evidence about the consistency and adaptability of general principles and requirements in practice.

This is the reason why the Consortium embraced and sponsored a double funnel method for the analysis of the users' needs and stakeholders' requirements. What was separately presented in the previous sections – the social and regulatory requirements and the users' and stakeholders' needs – here will be merged and jointly analysed. On the one hand, this combined reading aims to facilitate the design process of the use cases, including in the analysis the social based requirements that could better ensure the acceptability of CCAM on a medium- and long-term perspective. On the other hand, this approach also aims to test if and how the field practice experiences provided by the use cases owners and their stakeholders may improve the specification of the here obtained social requirements.

In light of the above, the following paragraphs will provide an overview of the results obtained by the merged reading of the social and regulatory requirements and the users and stakeholders needs and requirements. The added value of this combined approach is the contextualized analysis of the desiderata, mapped on each use case with the help of the use cases owners and the dialogue among the project partners.

7.2 The results obtained

As anticipated, the regulatory analysis highlighted a comprehensive understanding of environmental, social and economic sustainability of the solutions, in line with the holistic approach fostered by the Agenda2030. If from a quantitative standpoint, some safety- and environmental-based requirements are more granularly defined, the scope of the social- and economic-based ones reinforce their relevance of the relative policy ambitions in practice.

The validity of this understanding has been validated by the data collected by the survey and the data collected over the dedicated project workshop. Albeit we can appreciate the qualitative more than the quantitative value of the evidence obtained, we observed how the issues that emerged are generally in line with the policy principles and goals.

More insightful results, however, emerged from the analysis of the use cases in light of the requirements so identified. The combined reading of the results obtained from the bottom-up and top-down approaches allows to point out the primacy of some requirements in practice. In line with the expectations of the double-funnel method, the mapping of the requirements on the specific needs of the stakeholders involved in each use case highlighted the primacy of some requirements for the specific purposes of CONDUCTOR. Moreover, the insights shared by the users and stakeholders involved permits a better understanding and a further specification the general requirements previously considered.

The paragraphs that follow will present the data collected from the individual use cases, highlighting the specificities of each of them in terms of compliance and acceptability. This analysis aims to obtain a holistic understanding of the social expectations, users' needs and stakeholders' requirements in practice, matching the insights produced by the top-down and bottom-up approaches.

7.2.1 UC1 Athens

As explained, in the use case based in Athens, CONDUCTOR will provide a solution for CCAM aimed at optimising the synchronization of buses and on-demand services with metros and trams to reduce the door-to-door travel times of passengers. This will be possible by means of novel traffic management strategies including AI-assisted traffic signal control for multimodal traffic; road space allocation strategies; transit fleet integration to traffic management; rescheduling and rebalancing strategies.

Approaching this scenario, we identified four main categories of stakeholders, namely: **transport operators; travellers and passengers; traffic managers operators and local public administrations**. We analysed their purposes for the proposed solution, assessing the benefit and the drawbacks in light of the social and regulatory requirements suggested by EU policy for CCAM. Their respective points of view and expectations are summarised in the cards that follow (Figure 30).

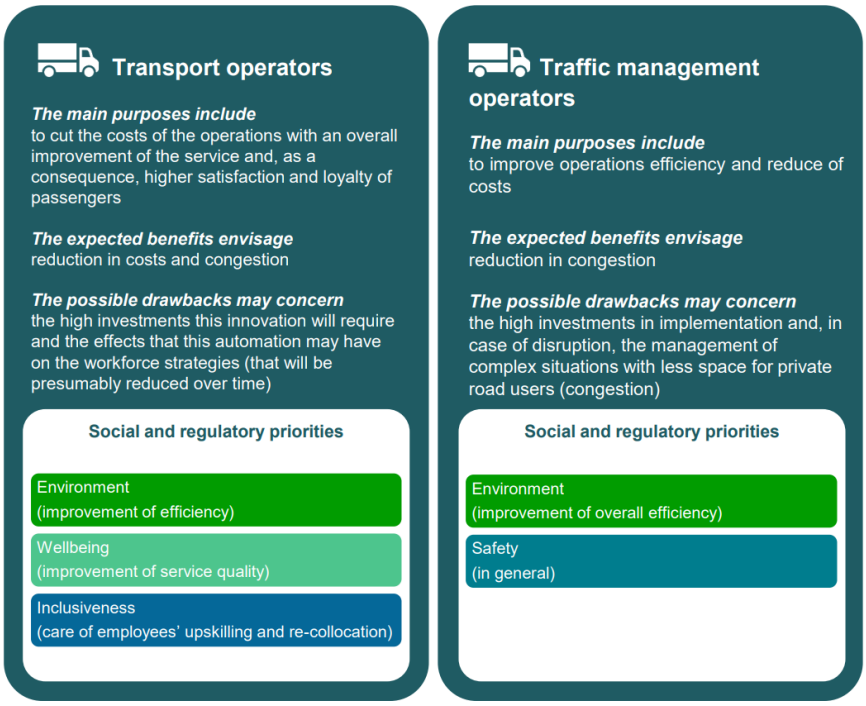

Figure 30 - UC1 Athens merged results

7.2.2 UC1 Almelo

As explained, the city of Almelo aims at using the CCAM solutions analysed in CONDUCTOR for improving traffic flow along a major logistics corridor and reducing the number of vehicles stops at traffic signals. This will be possible by means of intelligent traffic control systems (iVRIs) that will communicate with vehicles and road users in an effective, safe and platform-independent way, bringing information from the traffic controllers to the road users and vice versa.

Approaching this scenario, we identified three main categories of stakeholders, namely: **logistic operators, road authorities and road users**, in general (*e.g.,* emergency services; cyclists; CAVs users; public transports)**.** We thus analysed their purposes for the proposed solution, assessing the benefit and the drawbacks in light of the social and regulatory requirements suggested by EU policy for CCAM. Their respective points of view and expectations are summarised in the cards that follow (Figure 31).

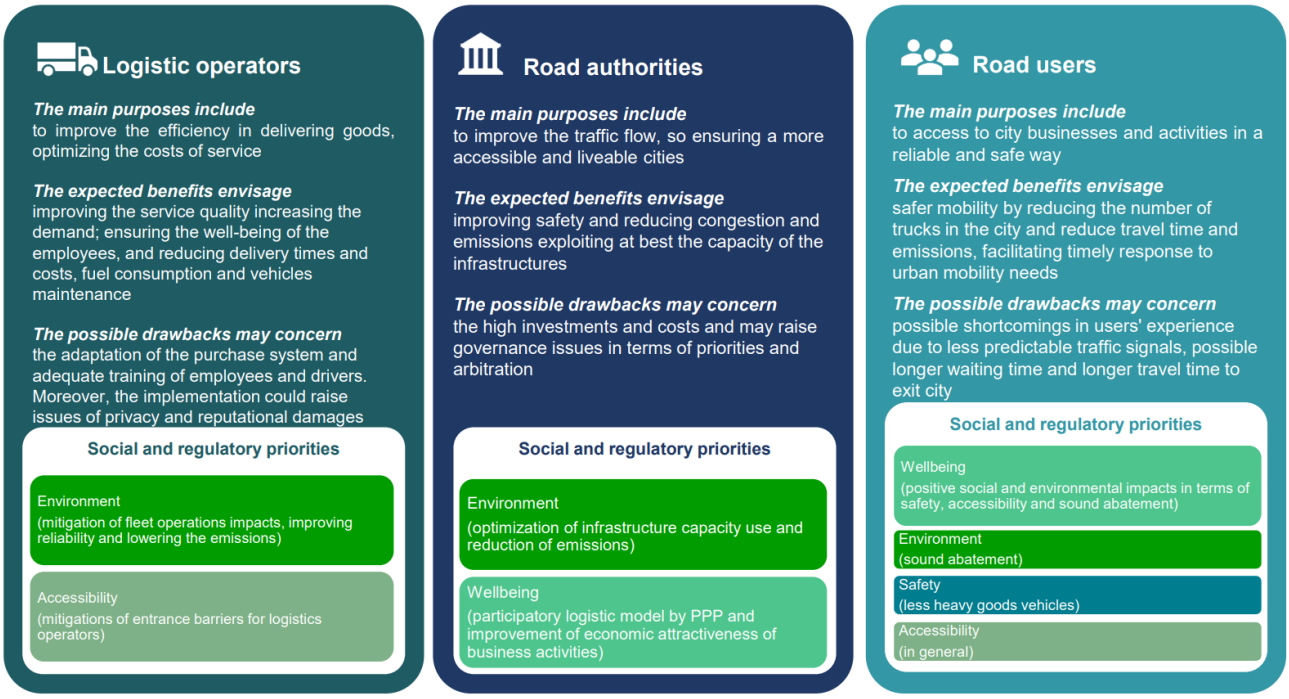

Figure 31 - UC1 Almelo merged results

7.2.3 UC1 Madrid

The use case based in Madrid focuses on the use of the CCAM solutions analysed in CONDUCTOR for the management of events/incidents for recovering the transport network operations in case of adverse planned (e.g., roadworks) and unplanned events (e.g., accidents). This will be possible by means of onboard units or smart devices that will enable communication with the surroundings, prioritizing emergency vehicles and re-routing the others.

Approaching this scenario, we identified five main categories of stakeholders, namely: **passengers of normal cars, passengers of CAVs, network managers, vehicles involved in the disruption, and the other users of the network**. We thus analysed their purposes for the proposed solution, assessing the benefit and the drawbacks in light of the social and regulatory requirements suggested by EU policy for CCAM. Their respective points of view and expectations are summarised in the cards that follow (Figure 32).

Figure 32 - UC1 Madrid merged results

7.2.4 UC2 Slovenia

The Slovenian-Italian use case plans to implement cooperative social routing strategies for large-scale CCAM vehicle fleets. In particular, the service will use data optimization techniques to optimize routes and services, while also accommodating customers with diverse needs and promoting economic benefits, offering a variety of pick-up options.

Approaching this scenario, we identified four main categories of stakeholders, namely: **passengers, drivers, operators.** We thus analysed their purposes for the proposed solution, assessing the benefit and the drawbacks in light of the social and regulatory requirements suggested by EU policy for CCAM. Their respective points of view and expectations are summarised in the cards that follow (Figure 33).

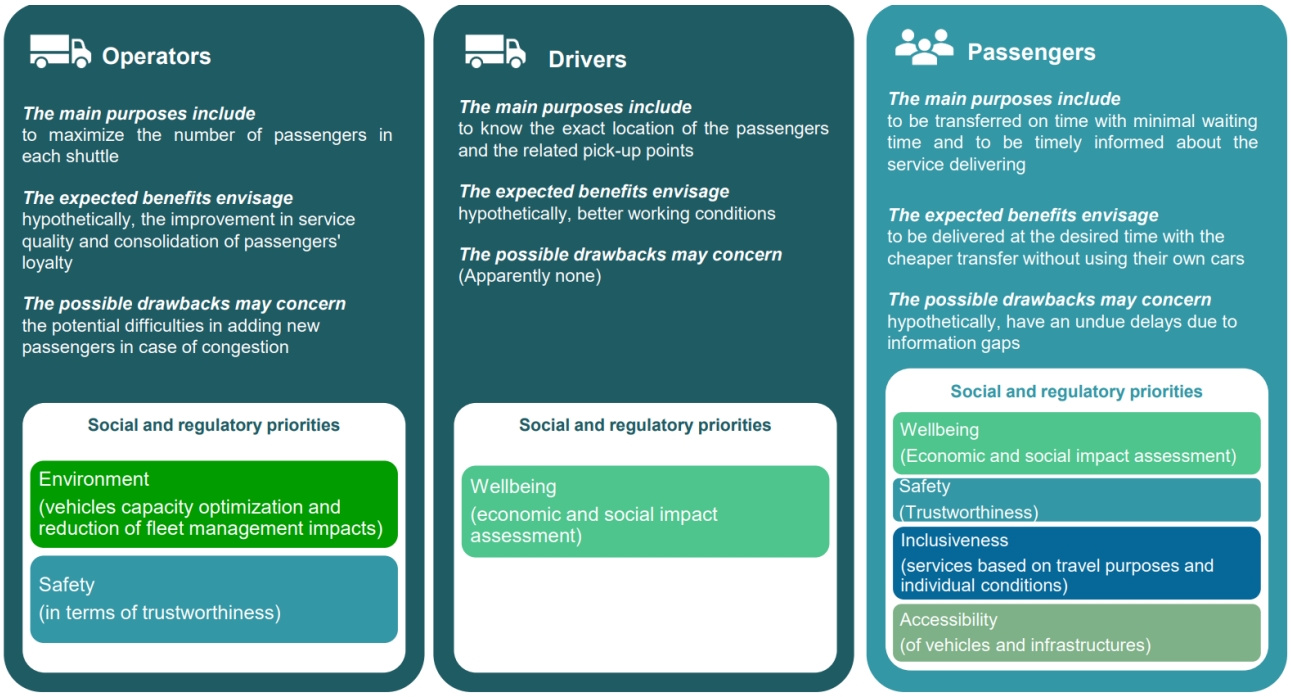

Figure 33 - UC2 merged results

7.2.5 UC3 Madrid

Eventually, the second use case based in Madrid will aim to use CCAM solutions for a last-minute delivery, integrating urban distribution of goods in the existent public transport supply.

Approaching this scenario, we identified five main categories of stakeholders, namely: **passengers, logistic companies, public transport operators, inhabitants and parcel receivers**. We thus analysed their purposes for the proposed solution, assessing the benefit and the drawbacks in light of the social and regulatory requirements suggested by EU policy for CCAM. Their respective points of view and expectations are summarised in the cards that follow (Figure 34).

Figure 34 - UC3 merged results

7.3 Systematic overview

The data collected over the workshop facilitated a realistic reading of the results obtained by the top-down and the bottom-up analysis. On the one hand, the users' journey maps allow a better contextualization of users' and stakeholders needs and requirements, also including categories of actors not clearly emerged before. On the other hand, the mapping of these needs on the respective social and regulatory priorities promoted a reasoned assessment of the general principles and requirements, highlighting the core compliance issues for the better acceptance of CCAM in CONDUCTOR.

Against this background, we are able to formulate the following considerations, respectively referred to the categories of actors included in the stakeholder community, the reasoned assessment of the regulatory requirements and the mutual conditions among these latter for the purposes of the project.

The analysis of the first of these points leads to recall the categories of stakeholders initially considered by the CCAM SRIA. This taxonomy indeed highlighted six main clusters of actors, distinguishing:

- **Industry** – i.e., automotive industry; ITS solutions, telecom providers and connectivity; data handling and storage industries
- **Public authorities and road operators** – i.e., cities and regions, transport authorities, road authorities and operators, Member States
- **Mobility and logistic services** – i.e., public transport providers, mobility and logistic service providers, insurance and maintenance services
- **Representative bodies** – i.e., road users, stakeholder associations
- **Regulatory bodies** – i.e., National, European and international entities
- **Research** – i.e., universities, public and private research institutes

As mentioned, for the purposes of CONDUCTOR, the social and regulatory requirements obtained from the top-down analysis integrate the point of view and directives of regulatory bodies at the EU level. On the other hand, the survey was administrated to a selected set of participants with a high representation of mobility and logistic services (19) and public authorities and road operators (17). Instead, less tangible results were available about industry (4) and representative bodies (8).

The results obtained by the workshop confirmed and integrate this reading. As explained by the figure below (Figure 35), the categories of actors mainly considered in the implementation of CCAM involve mobility and logistic services and public authorities and road operators. However, it is interesting to note how the contextual analysis of the different clusters lets more clearly emerge the position of undirect beneficiaries. This is a special category of subject that includes all those that are not immediately involved in the deployment of CCAM but are somehow affected by the implementation of these innovations. This cluster might consider the interests of local residents as well as the mobility experience of all the users not directly involved in CCAM solutions.

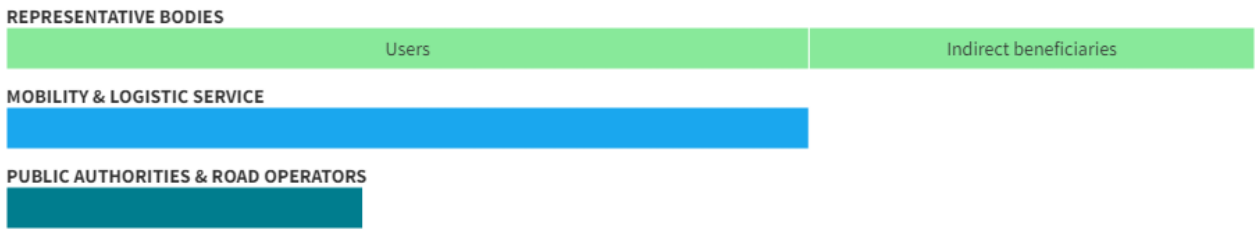

Figure 35 - Users and stakeholders categories in CONDUCTOR

Secondly, the analysis of data allows a reasonable assessment of the regulatory requirements in light of the specific needs of the stakeholders considered. In particular, we were able to consider the relevance of the various needs and requirements collected for each stakeholder in a broader view, merging the results related to a single actor to those referring to the respective categories. What is more, the involvement of the project partners allowed us to take into account additional elements that previously were not clearly emerged, as the requirements and needs of undirect beneficiaries and local communities.

The picture below illustrates the results obtained (Figure 36).

Figure 36 - Relevant requirements per stakeholders' category

Consistently with the more intuitive expectations, the more representative categories include direct beneficiaries and public stakeholders. The two clusters evidently give a genuine voice to the most recognizable policy goals of CCAM: improving safety and accessibility of urban mobility and mitigating the negative impacts on climate and the environment. On the other hand, however, the requirements and needs stressed for private stakeholders and indirect beneficiaries cannot be overlooked. Considering the main concerns of these two categories, indeed, we do note how social wellbeing and environmental effects are top priorities – aligning these results to the ones emerged for the other two groups of actors.

Against this background, the private and public stakeholders – as well as direct beneficiaries – emphasise on the advantages taken by CCAM solutions in terms of improved user experience. They particularly stress the expected benefits related the reduction of travel time; traffic congestion, fuel consumption, maintenance operations, and (where involved) CAV social responsibility.

On the other hand, the insights collected by the users' journeys involving public stakeholders and direct and indirect beneficiaries remarked the overreaching importance of having a comprehensive and networked understanding of the specific solutions implemented. The possible frictions experienceable by users and stakeholders in the transition phase, indeed, could have detrimental effects on the consolidation of these innovations, chilling the upstream investments.

Eventually, in light of the above, a combined reading of the results obtained allowed a better understanding of the weight of the different requirements for the purposes of CONDUCTOR. If from a qualitative point of view, they have the same weight and value, the scenarios specifically considered in the pilots highlighted the priority of some of them for the better acceptance of CCAM on the short and medium term.

The figure below (Figure 37) provides a visual representation of the results obtained.

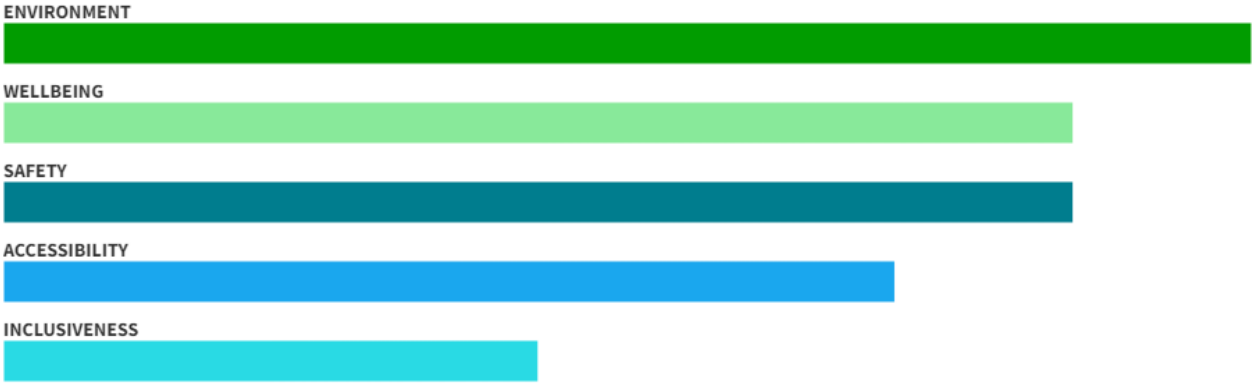

Figure 37 - Relevant requirements for CONDUCTOR

This reading of the social needs and requirements for 'smart mobility' solutions, allowed us to formulate the following considerations. First, the acceptability of these solutions is conditioned by their contribution to the improvement of **environmental sustainability**. This is especially true if we consider the immediately expected benefit in terms of lower emissions and consumptions, which should be a key driver in the design and implementation of CCAM. Secondly come the needs related to the complementary fulfilment of **accessibility** and **social wellbeing** requirements. The impacts of CCAM should be addressed in advance, modulating and mitigating the negative effects since the early stage of projects. Data shows how the specific concerns related to accessibility of services, vehicles and infrastructures and minimal negative impacts for residents and local communities are the core needs, in this regard. Therefore, these should sound as the priorities for the social acceptance of these innovations on a medium-long terms. Not least, **safety** – intended as a holistic and gradual awareness of CCAM direct and indirect effects on urban mobility, at large – should be the cornerstone of any CCAM solution. This principle indeed, to a greater or less extent, embeds the expectations of all the actors involved and fosters an accessible and inclusive approach to the development of these solutions, without leaving anyone behind.

8. CONCLUSIONS AND WAY FORWARD

The research activities undertaken in T1.1 and T1.2 highlighted the many social factors that may affect the acceptance of CCAM in practice. As already pointed out, the innovation process has an impact both on the actors that directly benefit from the novelties introduced (passengers and drivers, operators and mobility and logistic services) and on the surrounding communities and territories, considered as a whole. These two dimensions are inseparable and complementary. This is the reason why a **proactive and holistic approach, since the early stage of the design, can significantly benefit the development and deployment of these solutions and their consolidation over time.**

A contextual reading of CCAM within the A2030 remarks how these solutions are primarily asked for reducing emissions, increasing mobility safety, ensuring equitability and adoption and generating a higher economic impact. In this regard, EU public policy and regulatory directives stress the importance of safety as well as social, economic and environmental sustainability. On the other hand, the gathering and prioritization of users' needs and stakeholders' requirements remarked and specified how safety is inevitably intertwined with accessibility concerns and expectations in terms of the reduction of emissions. Eventually, the analyses carried out on the single use cases and pilots shown how the general social requirements further need to be contextually read in light of the specific needs of the respective operative scenarios.

By prioritizing these needs and requirements and actively engaging with stakeholders and users throughout the development process, the CONDUCTOR project can create solutions that are more likely to be successful and well-received by their intended audience.

The inputs that emerged in this deliverable aim to contribute to the design process of the use cases and the CCAM solutions there implemented. As anticipated, the social needs and requirement will feed the research activities planned in the parallel WP1 tasks, as well as the validation setting scheduled in WP5. Throughout the development process, it's important to continuously engage with stakeholders and users to ensure that their needs and requirements are being met. This will be done involving the identified stakeholders and users in the evaluation process of the use cases solutions (deliverable 5.x).

In light of the above, in the next research stages, the researcher should draw by the requirements presented in D1.1 (§§ 5.2.6 and 6.3.4) and embed their essence into the design of the respective use cases. To facilitate the target reading of this document and support the use of these final recommendations, this section is structured around four main questions (Figure 38).

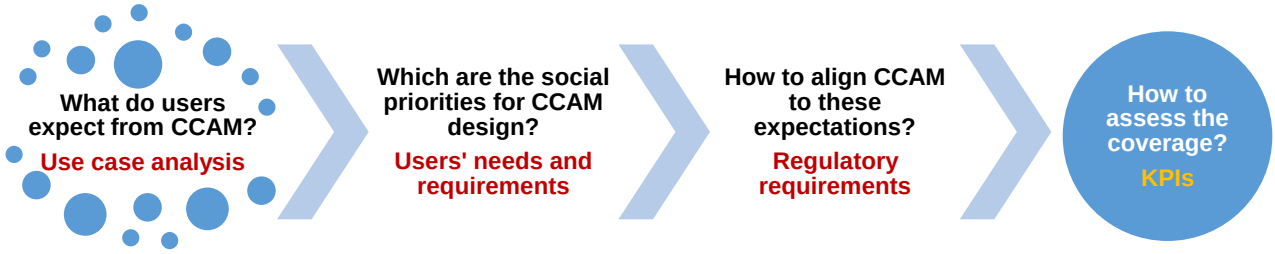

Figure 38 - Operative workflow for embedding social requirements in the use cases

The workflow sketched out by this figure basically aims to be a guide for the use of this document. **Over the design process, each pilot owner is invited to take into account the findings here emerged from the analysis of its use case.** Once contextualized the intended technical solution into the here outline framework, the following research activities should consider and take on board the findings emerged by the survey and the suggestions reported in the dedicated take away massage table. Against this background, they should map the use case on the policy principles and regulatory requirements that inform CCAM in Europe. This operation should be divided into two steps: a preliminary mapping on the CCAM regulatory framework (as represented by the dedicated table) and a careful analysis of the relevant sub-requirements specified for each macro area. In this operation, we recommend to pay the due attention to the less represented categories, especially local inhabitants potentially impacted by the introduction of CCAM. The KPIs defined in D1.3 will support the assessment of the measures undertaken and the effectiveness of the overall coverage of social requirements.

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APPENDIX A - SURVEY STRUCTURE

This section contains the pdf template of the survey administered to stakeholders and users. 5 versions of the survey were realised, one per each use case.

CONDUCTOR

Survey to explore Stakeholders' and Users' Needs and Requirements - UC1 Almelo

About the project
This survey is being conducted as part of the CONDUCTOR project, funded by the European Union's Horizon Europe research and innovation programme (Project 101077049).

The CONDUCTOR project's main goal is to **design, integrate and demonstrate advanced, high-level traffic and fleet management that will allow efficient and globally optimal transport of passengers and goods, while ensuring seamless multi-modality and interoperability.** Using innovative dynamic balancing and priority-based management of vehicles (automated and conventional) CONDUCTOR will build upon state-of-the-art fleet and traffic management solutions in the CCAM ecosystem and develop next generation simulation models and tools enabled by machine learning and data fusion, enhancing the capabilities of transport authorities and operators, allowing them to become "conductors" of future mobility networks. **We will upgrade existing technologies to place autonomous vehicles at the centre of future cities, allowing heightened safety and flexible, responsive, centralized control able to conduct traffic and fleets at a high level.** These innovations will lead to less urban traffic and congestion, lowered pollution, and a higher quality of life. Project innovations will be integrated into a common, open platform, and validated in three use cases, testing the interoperability of traffic management systems and integration of different transportation means for both people and goods. Use case UC1 integrates traffic management with inter-modality, UC2 tests demand-response transport, and UC3 urban logistics. In each use case and its demonstrations, simulations will be validated through real life data.

About the survey
As a starting point of its research activity, the CONDUCTOR project aims to directly engage the potential stakeholders and users of the foreseen solutions in order to identify the specific needs/requirements they have and discuss how the proposed solutions could contribute to satisfying such needs/requirements. In particular, the main objectives of this survey are to:

- Identity needs and requirements from the perspective of Stakeholders and Users
- Determine the factors that obstruct or facilitate the implementation of these Use Cases with regards to the national, European and international regulations

The survey includes 34 questions and will take approximately 20 minutes to complete.

About your participation
The following survey is not public, but is sent to specific individuals expressly identified as stakeholders or users of a specific use case.
If you are receiving this survey, you have been identified as a potential stakeholder or user for the Use Case 1 Almelo.
Your participation in this study is fully voluntary and all the collected data will be anonymized and treated confidentially. The research outputs resulting from this work will only include collated data, without the possibility for anyone to identify individual answers. The survey does not require you to provide any information that could identify you personally (e.g., your name, email) except for the company name. If, whilst completing the survey, you wish to withdraw, please just close the browser without submitting your answers.

3. 3. According to you, what are the main benefits of implementing this Use Case in real life? *

Check all that apply.

- [ ] Competitiveness
- [ ] Environment
- [ ] Health
- [ ] Equality
- [ ] Economy
- [ ] Accessibility
- [ ] Inclusiveness
- [ ] Lower Emissions
- [ ] Safety
- [ ] Cybersecurity
- [ ] Technological advancement
- [ ] Interoperability
- [ ] Other: _____

4. 4.1 When could you expect this Use Case to be operational? *

Mark only one oval.

- ◯ Very soon
- ◯ By 2030
- ◯ By 2040
- ◯ Later than 2040
- ◯ Never

5. 4.2 Why did you identify that time period? *

_____

_____

_____

_____

_____

REQUIREMENTS

What are needs?

Needs are Stakeholders' and Users' goals and inputs the project shall address and cover.

What are requirements?

Requirements are the steps/procedures/actions the project need to do in order to achieve a need.

_____

The description of Use case 1 Almelo is repeated below:

The focus of the Almelo Use Case is on improving traffic flow along a major logistics corridor and **reduce the number of vehicle stops at traffic signals.**

It will bring considerable benefits to the sector because **every time a truck stops at a traffic light it results in major costs, both monetarily and in terms of emissions.**

27 **intelligent traffic control systems** (iVRIs) will be implemented to **communicate with vehicles and road users** in an effective, safe and platform independent way. This will bring information from the traffic controllers to the road users and vice versa. Specific emphasis will be placed on freight traffic, where **truck drivers will receive information to adjust their speeds and form platoons in order to receive green lights at signalized intersections**. A network-wide prioritisation of vehicles at signalised intersections will be introduced in order to guarantee a **seamless trip** and help governmental bodies in their transition towards **net-zero emissions** in transport and improved **community wellbeing**.

8. 7.1 In your opinion, in which conditions would you consider the need for Competitiveness satisfied? *

e.g., the need has been achieved if...; a measure of success would be...

_____

9. 7.2 In your opinion, in which conditions would you consider the need for Accessibility satisfied? *

e.g., the need has been achieved if...; a measure of success would be...

_____

By proceeding with this survey you confirm that you are at least 18 years old, have read and understood the above information, agree to participate in this research study and agree that your data will be included in our analysis and any research publications resulting from it.

If you have any questions or would like to hear about the results of the survey and/or their usage in the CONDUCTOR project, please contact Paola Lanzi at paola.lanzi@dblue.it.

Thank you for your participation in this survey.
The CONDUCTOR Project Team

* Required

USE CASE 1 ALMELO - In brief

The focus of the Almelo Use Case is on improving traffic flow along a major logistics corridor and **reduce the number of vehicle stops at traffic signals.**

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TYPE OF RESPONDENT

1. 1. What type of respondent are you *

Check all that apply.

- [ ] Prospective operator
- [ ] Service provider
- [ ] Beneficiary of the service (i.e. municipality)
- [ ] Technology provider
- [ ] End user of the service
- [ ] Nothing
- [ ] Other: _____

NEEDS AND IMPACT

What are needs?

Needs are Stakeholders' and Users' goals and inputs the project shall address and cover.

_____

The description of Use case 1 Almelo is repeated below:

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6. 5. How much these needs are relevant to you? *

Please answer each Likert scale (from 1 = Not important at all to 7 = Extremely important)

Mark only one oval per row.

	Not important at all	2	3	4	5	6	Extremely important
Competitiveness	◯	◯	◯	◯	◯	◯	◯
Accessibility	◯	◯	◯	◯	◯	◯	◯
Inclusiveness	◯	◯	◯	◯	◯	◯	◯
Lower emissions	◯	◯	◯	◯	◯	◯	◯
Interoperability	◯	◯	◯	◯	◯	◯	◯
Safety	◯	◯	◯	◯	◯	◯	◯
Cybersecurity	◯	◯	◯	◯	◯	◯	◯

10. 7.3 In your opinion, in which conditions would you consider the need for Inclusiveness satisfied? *

e.g., the need has been achieved if...; a measure of success would be...

_____

11. 7.4 In your opinion, in which conditions would you consider the need for Lower emissions satisfied? *

e.g., the need has been achieved if...; a measure of success would be...

_____

12. 7.5 In your opinion, in which conditions would you consider the need for Interoperability satisfied? *

e.g., the need has been achieved if...; a measure of success would be...

_____

13. 7.6 In your opinion, in which conditions would you consider the need for Safety satisfied? *

e.g., the need has been achieved if...; a measure of success would be...

_____

14. 7.7 In your opinion, in which conditions would you consider the need for Cybersecurity satisfied? *

e.g., the need has been achieved if...; a measure of success would be...

_____

15. 7.8 In your opinion, in which conditions would you consider the need for "Other" satisfied? *

e.g., the need has been achieved if...; a measure of success would be...

_____

GOAL AND PURPOSE

The description of Use case 1 Almelo is repeated below:

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2. 2. What is the objective/purpose(s) of this Use Case for you? *

_____

_____

_____

_____

_____

7. 6. How much the Use Case would impact these following needs? *

Please answer each Likert scale (from 1 = no impact to 7 = maximum impact)

Mark only one oval per row.

	No impact	2	3	Medium impact	5	6	Maximum impact
Competitiveness	◯	◯	◯	◯	◯	◯	◯
Accessibility	◯	◯	◯	◯	◯	◯	◯
Inclusiveness	◯	◯	◯	◯	◯	◯	◯
Lower emissions	◯	◯	◯	◯	◯	◯	◯
Interoperability	◯	◯	◯	◯	◯	◯	◯
Safety	◯	◯	◯	◯	◯	◯	◯
Cybersecurity	◯	◯	◯	◯	◯	◯	◯

SKILLS AND CAPABILITIES

The description of Use case 1 Almelo is repeated below:

The focus of the Almelo Use Case is on improving traffic flow along a major logistics corridor and **reduce the number of vehicle stops at traffic signals.**

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16. 8.1 What skills and knowledge should a user (e.g., specific of the use case) have to use the service of this Use Case? *

Check all that apply.

- [ ] Visual attention
- [ ] Situational awareness
- [ ] Executive memory
- [ ] Alertness
- [ ] Preparedness
- [ ] Knowledge of system functioning
- [ ] Other: _____

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17. 8.2 Which skills are harder to achieve? *

Please answer each Likert scale (from 1 = easy to 7 = challenging)

Mark only one oval per row.

	Easy	2	3	Moderate	5	6	Challenging
Visual attention	◯	◯	◯	◯	◯	◯	◯
Situational awareness	◯	◯	◯	◯	◯	◯	◯
Executive memory	◯	◯	◯	◯	◯	◯	◯
Alertness	◯	◯	◯	◯	◯	◯	◯
Preparedness	◯	◯	◯	◯	◯	◯	◯
Knowledge of system functioning	◯	◯	◯	◯	◯	◯	◯

18. 9. What will be the main difficulties and challenges for users (*e.g.*, specific of the use case) while using the service? *

Check all that apply.

- ☐ Possible distress/agitation
- ☐ Response to system failures
- ☐ Negotiating pick-up/drop-off locations
- ☐ Changing destinations mid-way
- ☐ Lack of independence
- ☐ Potential wandering
- ☐ Loss of skill
- ☐ Understanding emergency situations
- ☐ Psychophysiological impairments
- ☐ Other: _____

TRUST, PRIVACY, AND SECURITY

The description of Use case 1 Almelo is repeated below:

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19. 10.1 Would you have specific concerns with sharing personal (*e.g.*, name, address, email address, personal identification number etc.) data with the service? *

Mark only one oval.

- ◯ Yes
- ◯ No

20. 10.2 If yes, what would be the major concerns of sharing personal data?

_____

_____

_____

_____

_____

21. 11. What issues in reliability can you expect from this Use Case? *

Check all that apply.

- ☐ Usability
- ☐ Data integrity
- ☐ Security
- ☐ Serviceability
- ☐ Recoverability
- ☐ Maintainability
- ☐ Performance
- ☐ Speed of execution
- ☐ Accuracy
- ☐ Other: _____

22. 12. What issues in trustworthiness can you expect from this Use Case? *

Check all that apply.

- ☐ Data integrity
- ☐ Security
- ☐ Proposed solutions
- ☐ Ethics of the service
- ☐ Other: _____

23. 13. How much could the following actions contribute to improve the trust in the Use Case solution? *

Check all that apply.

- ☐ Ensure Explainability (e.g., Provide explanation for system decisions)
- ☐ Ensure Transparency (e.g., accessibility of information)
- ☐ Ensure Conformal solutions to your needs
- ☐ Ensure Cybersecurity
- ☐ Other: _____

INDIVIDUAL and SOCIAL BENEFITS & RISKS

The description of Use case 1 Almelo is repeated below:

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24. 14. The service makes urban mobility more accessible (*e.g.*, travel time, cost of service, helpfulness of service) *

Mark only one oval.

Completely disagree

1 ◯
2 ◯
3 ◯
4 ◯
5 ◯
6 ◯
7 ◯

Completely agree

25. 15. The service makes urban mobility more inclusive (*e.g.*, easier travel experience for people with disabilities, minors, vulnerable groups, and minorities) *

Mark only one oval.

Completely disagree

1 ◯
2 ◯
3 ◯
4 ◯
5 ◯
6 ◯
7 ◯

Completely agree

26. 16. The service makes the urban mobility experience more sustainable and environmentally friendly (*e.g.*, use of environmentally sound technologies, reduced emissions) *

Mark only one oval.

Completely disagree

1 ◯
2 ◯
3 ◯
4 ◯
5 ◯
6 ◯
7 ◯

Completely agree

27. 17. In your opinion, what are the potential risks and adverse side effects of the use case? *

_____

_____

_____

_____

_____

CONDUCTOR

28. 18. What do you think are or may be the main barriers to the implementation in the real operational context of the proposed Use Case? *

Check all that apply.

- [ ] Social acceptance
- [ ] Economic (e.g., it requires a high deployment inversion)
- [ ] Conflicts with other stakeholders (e.g., competition between different infrastructures, competition for vias capacity, users, etc.)
- [ ] Existing regulation
- [ ] Other: _____

ATTITUDE

The description of Use case 1 Almelo is repeated below:

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29. 19. I have a positive attitude towards the Use Case solution *

Mark only one oval.

Completely disagree
1
2
3
4
5
6
7
Completely agree

30. 20. I believe that the Use case solution will help me reach my goal *

Mark only one oval.

Completely disagree
1
2
3
4
5
6
7
Completely agree

REGULATION and POSITIVE ACTIONS

The description of Use case 1 Almelo is repeated below:

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31. 21. Regulation *

Please answer each Likert scale (from 1 = completely disagree to 7 = completely agree)

Mark only one oval per row.

	Completely disagree	2	3	4	5	6	Completely agree	I don't know
21.1 The service is regulated by a clear and stable normative framework								
21.2 Compliance standards about technological safety, security and interoperability are clear								

32. 22. The service is aligned with social interests and deserves positive public action (e.g., financial incentives, tax reduction, other benefits) *

Mark only one oval.

Completely disagree
1
2
3
4
5
6
7
Completely agree

33. 23.1 Based on your experience, would you expect the solution of this Use Case to face limitations/inhibitions due to regulatory constraints? *

Mark only one oval.

- Yes
- No

34. 23.2 If yes, please specify why

_____

SOCIO-DEMOGRAPHIC INFORMATION

35. Your name

(First name - Last name)

_____

36. Company *

(the *Stakeholder* company you are part of)

_____

37. Email

Please leave your email here if you wish to be contacted by the CONDUCTOR Project team in the future

_____

THANK YOU!

Thank you for your participation in this survey.
The CONDUCTOR Project Team

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APPENDIX B - ABBREVIATIONS AND DEFINITIONS

Abbreviation	Definition
A2030	Agenda 2030
CAV	Connected Automated Vehicle
CCAM	Cooperative, Connected and Automated Mobility
CINEA	European Climate, Infrastructure and Environment Executive Agency
C-ITA	Cooperative Intelligent Transport System
CoR	Committee of Regions
DG-CLIMA	Directorate-General for Climate Action
DG-CONNECT	Directorate-General for Communication Network
DG-EMPL	Directorate-General for Employment, Social Affairs & Inclusion
DG-ENV	Directorate-General for Environment
DG-GROWTH	Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs
DG-MOVE	Directorate-General for Mobility and Transport
EC	European Commission
EESC	European Economic and Social Committee
EU	European Union
EU-UMF	European Union Urban Mobility Framework
GDPR	General Data Protection Regulation (i.e., Reg. (EU) 2016/679)
ICT	Information and Communication Technologies
ITS	Intelligent Transport System
JTM	Just Transition Mechanism
KPI	Key Performance Indicator
MaaS	Mobility as a Service
MDM	Multimodal Digital Mobility
MFF	Multiannual Financial Framework
OD	Operational Domain
SDG	Sustainable Development Goal
SOAR	State-Of-the-Art Review
SSMS	Sustainable and Smart Mobility Strategy
TEU	Treaty on European Union
TFEU	Treaty on the Functioning of European Union
UC	Use Case
UN-GA	United Nations General Assembly
WGA	Whole Government Approach