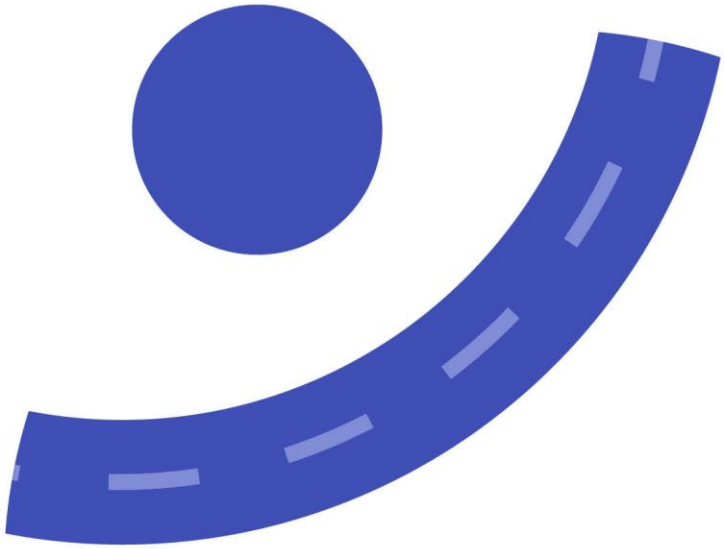
CulturalRoad

Cocreate, Embrace

Project deliverable D1.1

Report on CCAM Readiness



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EXECUTIVE SUMMARY

D1.1 Report on CCAM Readiness provides an overview of the development and deployment of Cooperative, Connected and Automated Mobility (CCAM) pilots and projects across Europe, with emphasis on how said projects have adapted to local culture and environment. This report is written in the context of the project CulturalRoad (EU grant 101147397) and will be used as a starting point to develop a holistic approach to inclusivity for the project's pilots and final evaluation.

The primary goal of this report is to present a summary of the result of previous CCAM projects with comparable goals to CulturalRoad and see how their recommendations can be applied to the pilots. CCAM projects from all over Europe have been researched and compared. Projects considered included those connecting rural areas to the city centres, those bringing AVs (Automated Vehicles) close to local communities were at the core of this research, as well as projects that aimed to develop new cross-country standards and those which operated large-scale deployment of automated shuttles.

The impact of cultural, geographical, and exogenous diversity on CCAM operations is also analysed, serving as a stepping stone for the subsequent evaluation model that will be developed as a part of CulturalRoad.

Recommendations and lessons learned from the projects considered are collected and analysed to present a unified conclusion and to provide takeaways both for CulturalRoad and for upcoming CCAM projects that deal with similar topics of inclusivity and accessibility.

The results of our preliminary analysis showed that, while the current generation of European projects has tackled geographical factors, the effect of cultural and societal aspects on the development of CCAM solutions is still largely unexplored. In this context, CulturalRoad can help close an existing research gap, with the potential of becoming a tool for future endeavours in this direction.

Key words

Standards, Literature review, CCAM, Diversity

List of abbreviations and acronyms

Acronym	Meaning
AI	Artificial Intelligence
AV	Automated Vehicle
BMDV	Bundesministerium für Digitales und Verkehr (German Federal Ministry of Transport and Digital Infrastructure)
C-ITS	Cooperative Intelligent Transport Systems
CAD	Connected, Cooperative, and Automated Driving
CAM	Connected and Automated Mobility
CAV	Connected and Automated Vehicle
CCAM	Cooperative, Connected and Automated Mobility
CCAV	Connected Cooperative and Automated Vehicle
CEM	Common Evaluation Methodology
EC	European Commission
EU	European Union
MEC	Multi-Access Edge Computing
NTUA	National Technical University of Athens
PDI	Physical and Digital Infrastructure
RAN	Radio Access Network
SRIA	Strategic Research and Innovation Agenda
SUMP	Sustainable Urban Mobility Plan
TDS	Test Data Space
UTATU	Unified Acceptance and Use of Technology
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
V2X	Vehicle-to-Everything

VDV	Verband der Deutschen Verkehrsunternehmen (Association of German Transport Companies)

1 INTRODUCTION

1.1 A Brief History of CCAM

As of 2024, automated vehicles (AV) and automated mobility (AM) in general are not a new concept. Already in 2014, SAE International published a standard which identified six levels of driving automation, ranging from no automation at all (level 0) to no human interaction required (level 5) [SAE, 2014]. US companies such as Waymo are fielding fleets of robotaxis, while others like Tesla are planning their own robotaxi offers in the coming years. While full-self-driving operations are still under active research, level 3 automated driving systems are now routinely deployed in consumer vehicles both in the US [Wilhelm, 2023] and in Europe [Gries, 2023; Beutnagel, 2024], while level 4 autonomous shuttles are currently in use in a number of projects [Anund, 2022]. A careful integration of this new reality in the scope of public transport could lead to a better quality of mobility but also be the source of significant challenges. These include both technical barriers, such as building reliable navigation systems and refining obstacle recognition, and legal barriers, especially regarding who is responsible in case of incidents. Furthermore, acceptance of this driverless medium of transportation by the general populace is not a given and must be carefully considered as a major contribution to the success or failure of this inclusion.

Starting in 2016, the European Commission elected to adopt a European Strategy on Cooperative Intelligent Transport Systems (C-ITS) to foster the development and application of connected mobility solutions, aimed to straighten the legal framework and publish guidelines for the development of connected mobility pilots. These efforts resulted in the drafting of the *Final report of the Single Platform for Open Road Testing and Pre-deployment of Cooperative, Connected and Automated and Autonomous Mobility Platform (CCAM platform)*, published by the European Commission in 2021 [European Commission, 2021]. This resolution stemmed from the previous communication "On the road to automated mobility: An EU strategy for mobility of the future" [European Commission, 2018] with the goal of building a common platform for deployment and testing of Connected and Automated Mobility (CAM) projects. Despite a strong push in the direction of better standardization, the European framework is still lacking homogeneous, cross-country regulations for the deployment of autonomous vehicles. Nevertheless, there have been several studies and projects in this direction in the past decade, covering many different use cases and key questions.

In the past decade, a wealth of CCAM projects have developed across the European Union, including but not limited to France, Greece, Spain, Finland, Italy, Germany and the Baltic Countries According to [Staelens, 2020], Germany, Greece and France also benefit from internal legal frameworks for the deployment of CCAM solutions, which is not the case in most other countries of the Union. In particular, the German federal government has directly funded research efforts in this direction: there are now over 60 pilot projects, some of which have been completed and some of which are still being actively run [VDV, 2024]. The projects deal with various topics, such as business models for the operation of autonomous vehicles, the technical further development of the driving function and the acceptance and involvement of future users. Acceptance and fairness of automated solutions is still under scrutiny and, aside from surveys and polls, has taken a back seat compared with analyses of technical challenges and regulatory frameworks.

CulturalRoad – Cocreate Embrace – aims to close this gap, by focusing on inclusivity as its main goal, learning from previous projects and studies to bring a new perspective into play.

1.2 Definitions of Diversity

In the scope of this project and at the heart of CulturalRoad, lie three different aspects of diversity – **cultural diversity**, **geographical diversit**y and **exogenous diversity**. As described in our Project Proposal [CulturalRoad 2023]:

- **Cultural diversity** refers to the presence of distinct cultural backgrounds, traditions, customs, activities, languages and social norms within a specific community, as well as their coexistence.
- **Geographical diversity** refers to the variety and range of physical landscapes, environments, and features between specific areas. This diversity encompasses differences in spatial characteristics, including distinctions between urban and non-urban areas and their form, location of activities, as well as variations between geographical features like mountains and plains.
- **Exogenous diversity** refers to the differences between two areas in aspects that are neither cultural nor geographical. It encompasses variations in factors like economic conditions, technological advancements, environmental influences (including climate change effects), political systems, policies and other external factors.

1.3 Objectives of the Task

This document aggregates results from existing studies and pilots investigating the cultural, geographical, and exogenous diversity aspects relevant to the planning, design, development, and implementation of CCAM. Current CCAM regulations are discussed and supplemented by a review of existing standards regarding integrating CCAM solutions into the existing ecosystem.

To this purpose, key European pilots and projects were analysed, thanks to access to project deliverables and direct expertise of institutions that took part in them, making them able to share knowledge accrued during the project's lifetime. This includes a first-hand experience with key concepts and takeaways that are crucial for shaping the direction of the CulturalRoad collaboration, particularly to inform CulutralRoad's five pillars of inclusivity, acceptability, network optimization, safety and psychological factors which will be used to develop a Five-Pointed Star Rating System.

This document is structured as follows:

- **Section 1** includes a short introduction of the purpose and direction of the project and the goal of this deliverable.
- **Section 2** presents a detailed analysis of previous CCAM pilots and projects to ascertain which aspects are not covered by current research.
- **Section 3** summarizes and categorizes the results of the pilots discussed in Section 2.
- Finally, **Section 4** reports the key takeaways and suggested actions in regard to a common European policy.

2 LITERATURE REVIEW

This section presents a review of existing CCAM EU projects with focus on the topics that were addressed by each of them and, more importantly for CulturalRoad, on the topics which were not addressed yet, detecting potential research gaps. This section is structured as follows:

- **Section 2.1** contains a literature review of a selected number of European CCAM projects, many of which shared a consortium partner with CulturalRoad – which allowed for gathering first-hand experience.
- **Section 2.2** focuses on the role of diversity in existing projects and how it was or it was not put at the forefront of the experimentation
- **Section 2.3** reviews existing standards and frameworks for the integration of CCAM in a transport network and other guidelines.
- **Section 2.4** discusses potential guidelines for stakeholder engagement and collaboration with the end users of the CCAM services.

2.1 Overview of Existing Studies and Pilots on CCAM

While active experimentation on CCAM is still relatively young, in the past five years there have been a considerable number of projects on the topic in different geosocial scenarios. In this section, we analyse a key projects that have investigated different aspects of CCAM deployments inside the EU. The projects considered are summarised in Table 1. Each project is shortly discussed separately in the following.

Table 1 - List of CCAM projects analysed in this literature review

Project	Pilots / Countries of Focus	Year	Topics and goals
Digibus Austria	Austria	2017-2021	• Connecting rural and mobility-poor areas by means of CCAM
ENA	France	2019-2022	• Connecting rural and mobility-poor areas by means of CCAM • Investigating user acceptance of CCAM
SINFONICA	Germany UK Greece Netherlands	2022-2025	• Guidelines for inclusive CCAM deployment
IN2CCAM	Finland Greece Spain Italy	2022-2025	• Improving CCAM inclusivity • Improving CCAM safety • Reducing human-caused incidents involving CCAM

Project	Pilots / Countries of Focus	Year	Topics and goals
RIMA	France	2021-2025	• Connecting rural and mobility-poor areas by means of CCAM
AVINT	Greece	2018-2021	• Integration of CCAM in public transport system
SHOW	Austria Sweden France Germany Spain Czech Republic Greece Finland	2020-2023	• Integration of CCAM in public transport system • Investigating user acceptance of CCAM • Investigating the impact of CCAM on sustainable urban mobility planning
ÈRICA	Spain	2018	• Deployment of CCAM to gauge interest and showcase their viability to larger sections of the local population
Sohjoa Last Mile	Norway Estonia Latvia Finland Poland	2020-2022	• Integration of CCAM for last mile mobility • Investigation of legal framework for CCAM deployment
ARCADE	No pilots	2018-2022	• Moving towards a unified EU framework for CCAM deployment
FAME	No pilots	2022-2025	• Successor to ARCADE • Moving towards a unified EU framework for CCAM deployment
metaCCAZE	Netherlands Germany Finland Cyprus	2024-2027	• Integration of CCAM in logistic infrastructure • Integration of CCAM in electric charge network infrastructure

Project	Pilots / Countries of Focus	Year	Topics and goals
5G-MOBIX	Greece-Turkey Spain-Portugal France Germany Netherlands Finland China South Korea	2018-2022	• Cross-border CCAM development • Harmonization of cross-border legal and technical frameworks, both intra-EU and outside of the Union
AUGMENTED CCAM	France Latvia Spain	2022-2025	• Improvement on digital, communication and digital infrastructure for CCAM

2.1.1 Digibus Austria

Connecting rural areas has been the focus of the project Digibus Austria, running from 2017 to 2021 in Koppl, Salzburg. The tests were performed with a NAVYA Arma DL4 autonomous shuttle on a test track and accepted passengers, but the vehicles weren't bound to a regular schedule [Rehrl, 2017; Digibus Austria, 2021]. A successor project, Digibus 2.0, has been operated in summer 2023 with regular trips every half an hour, covering a 1.4km route in around six minutes, with the goal of supplementing local public transport buses [Digibus 2.0, 2023].

2.1.2 ENA

The French project ENA (Expérimentations Navettes Autonomes) also focused on rural and sparse areas. Run from 2019 to 2022 in the territories of Coeur de Brenne, Sophia Antipolis and the open-air laboratory of Transpolis, ENA studied acceptance among users of public transport for an automated solution and how to tackle safety-critical scenarios, such as emergency braking. This project was deeply rooted in the territory and aimed to supply mobility options for people that only had cars as the only viable alternative to move around the areas in question. The final report of the project [ENA, 2023] investigated the topic of acceptance of automatic mobility bound to specific demographic indicators. One of the studies published in the final acts of the project closure conference indicated how, for example, retired or elderly people showed limited interest in using autonomous shuttles, especially compared to students and workers up to forty-five years old. Inhabitants of cities of more than 100,000 residents were also more likely to be favourable to using autonomous shuttle compared to people residing in rural areas and smaller settlements.

2.1.3 SINFONICA

The divide between the older and younger generations highlighted by the ENA report is even more relevant in light of recent developments and results from other CCAM projects. As an important example, according

to a thorough analysis carried out by the SINFONICA project (Social INnovation to FOster INclusIve cooperative, Connected and Automated mobility, 2022-2025) on a sample of 40 pre-existing CCAM projects [Enei, 2023], most existing literature and pilots focus on serving elderly people and people with disabilities, but mostly ignore younger segments of the population, people at risk of poverty and digitally vulnerable people. Furthermore, only a small fraction of the projects tackles the issues of affordability. SINFONICA itself aims to close part of the gap: the main objective of the project is to foster inclusive CCAM operations. It is the first project of its kind that focuses more on Human Rights in a wider sense regarding CCAM instead of the technical deployment of a CCAM service. CulturalRoad could use this kind of zero level investigation regarding inclusivity in CCAM services to build onto the humanity aspect of CCAM besides the technicalities of services.

SINFONICA includes citizens to think about the future of inclusiveness in these services. As a result, the project has assessed the current CCAM deployments combined with interviews, focus groups and questionnaires to research what citizens think about CCAM and what they need in future deployment. All this data feeds into a work package that drafts preliminary recommendations for policy makers, service providers and manufacturers. The project is not finished yet, but there are some first recommendations to consider already. One of the outstanding points is the need for human connection. People feel more secure when they have the chance of connecting with the bus driver to ask questions or another staff member to help them to use the CCAM service or ask questions about the route. This could be provided with, for example, a video call screen within the vehicle. Other recommendations will be finalized and published in the first part of 2025.

2.1.4 IN2CCAM

The topic of inclusivity and access to autonomous mobility is also a stated goal of the project IN2CCAM (Enhancing Integration and Interoperability of CCAM eco-system, 2022-2025), which has a distinct focus on improving safety and reducing the number of human-caused incidents affecting automated shared mobility solutions. IN2CCAM is planning to carry out several pilots in the living labs of Tampere (Finland), Trikala (Greece), Vigo (Spain), and Turin (Italy), with two follower living labs in Bari, Italy, and in the Quadrilátero Urbano city network in Portugal. According to [Ruffin, 2023], each city explores different themes and specific topics, but there is a common line between the field tests. Integrating CCAM into traffic management systems and setting up efficient real-time communication channels with the existing infrastructure is the underlying goal behind the Tampere, Trikala, and Vigo pilots. Trikala and Tampere also focus on modelling safety measures for vulnerable road users, while the Turin and Vigo pilots are more geared towards dynamic traffic management strategies.

2.1.5 RIMA

On a similar topic as ENA, the project RIMA (Réseau Inclusif de Mobilité Automatisée), started in 2021 and planned to run up to 2025, aims to deploy seven automated vehicles to cover a 50km^2 surface near the towns of Crest and Val de Drôme. The RIMA project was motivated by the fact that 85% of the rural population of France does not have direct access to public transportation. The consortium, made up of beti, Macif, NAVYA and VINCI Construction, aims to provide a concrete solution to the challenges involved in providing inclusive mobility to people and goods in rural areas [Navya, 2023]. One of the aspects that made the project possible in France is that regulations are ahead in terms of autonomous shuttles, facilitating the setup of experimental systems on the road [Thierry-Aymé, 2023], which was also a factor pointed out by Ref. [Staelens, 2020] as a French advantage when it comes to deploy CCAM projects.

2.1.6 AVINT

In a similar vein, the AVINT project (Autonomous vehicles integrated within the urban context, 2018-2021) [AVINT, 2019] aimed to advance urban mobility in Trikala, Greece, through the implementation of automated shuttles. Building upon experience gained during the CityMobil2 (CM2) initiative, AVINT sought to

demonstrate the feasibility of integrating autonomous buses into a city's transport ecosystem. This project, led by e-Trikala, ICCS/NTUA, and Space Hellas, introduced a driverless shuttle service connecting Trikala's city centre to the TEFAA university campus. Greece has been a pioneer in automated mobility, establishing a legal framework in 2014 that allowed for the operation of autonomous shuttles under specific conditions. This regulatory groundwork was essential to pilots like CM2, which laid the foundation for AVINT, under the Transport Research and Innovation Monitoring and Information System initiative [TRIMIS, 2018]. Notably, Greece's efforts included hosting a European workshop under the 2014 Greek presidency of the European Union to discuss CCAM policy and regulations. Ministerial decisions subsequently enabled CM2's pilot phase in Trikala, which tested automated vehicles in a real-world urban environment, accommodating over 11,000 passengers in a phased deployment. AVINT adopted three automated buses, each capable of carrying ten passengers, and implemented a dedicated route connecting Trikala's city centre to the TEFAA university campus. This initiative involved multiple preparatory steps, including feasibility studies, infrastructure adaptation, and the integration of automated buses into the existing transport network. The technology, which benefitted from the maturation of small, low-speed automated vehicles, leveraged lessons learned from CM2, further enhancing operational reliability and safety.

2.1.7 SHOW

SHOW, running from 2020 to 2024, deployed small fleets of connected vehicles in controlled test environments around several European cities. SHOW aimed to support the development of Shared CCAMs through different use cases, including demand-responsive transport, mobility as a service, and integration with logistic services. The goal of the project was to move beyond the theory and test the feasibility of CCAMs in terms of business models, integration within the public transport eco-system, scalability and transferability of CCAM solutions. One of the special aspects of SHOW was the identification of guidelines and concrete processes to integrate CCAV in Sustainable Urban Mobility Plans (SUMPs), in the scope of the Bremen and Tampere pilots [de Cerjat, 2024]. Similarly to CulturalRoad, SHOW analysed acceptance using the widely accepted framework of the Unified Acceptance and Use of Technology (UTATU) [Venkatesh, 2003]. Given the availability of a fleet of autonomous vehicles, the focus was on analysing acceptance before and after the experience.

2.1.8 ÈRICA

Deploying automated vehicles close to citizens to let them have a first-hand experience on them was the main highlight of the Èrica Project, started in 2018 and known as the Autonomous Bus Catalan Tour [ÈRICA, 2018; Reus.cat, 2018]. Èrica was a large-scale deployment initiative that brought Catalonia's first autonomous bus to eight municipalities, including Sant Cugat, Terrassa, and Girona. Organized by the Association of Municipalities for Mobility and Urban Transport (AMTU) with the Generalitat's support, the tour showcased the viability and benefits of autonomous buses to the citizens, emphasizing their fully electric systems, their eco-friendliness, and accessibility. The vehicles in use through the Èrica project were designed for up to 12 passengers and incorporated advanced technologies like GPS and LIDAR sensors, allowing it to map and navigate routes safely and flexibly. Besides enhancing safety through continuous learning, Èrica also aimed to provide improved sustainability and widespread access to public transport by offering flexible and personalized mobility services. The project toured through Catalonia from 7 September to 28 October 2018, involving eight different municipalities.

2.1.9 Sohjoa Last Mile

Applications of CCAM vehicles to last mile transport in municipal areas were the focus of the project Sohjoa Last Mile, a collaboration between Norway, Estonia, Latvia, Finland and Poland [Sohjoa Last Mile, 2022] and successor to the previous project Sohjoa Baltic [Sohjoa Baltic, 2020]. In 2021, the project deployed three automated electric shuttles in test pilots in Gdańsk, Tallinn and Kongsberg. This project stood out for the

absence of a safety driver travelling with the vehicle. Further emphasis was given to the legal implications of CCAM mobility in the Baltic countries, concluding that the current framework for CCAM integration is lacking and does not allow for a seamless integration [Mäkinen, 2020].

2.1.10 ARCADE

Streamlining and coordinating the deployment of Connected, Cooperative, and Automated Driving (CAD) systems across Europe and internationally was one of the main goals of the ARCADE project (Aligning Research & Innovation for Connected and Automated Driving in Europe), running from 2018 to 2022 [ARCADE, 2018]. Backed by the European Commission and EU Member States, ARCADE gathered 23 core partners and 43 associated organizations, creating a broad coalition of industry, public sector, and research experts. ARCADE's goal was to foster a unified approach to the development, testing, and implementation of CAD technologies by tackling barriers and encouraging collaboration among stakeholders. Described as “clearing obstacles, preparing the path, and leading toward a common goal”, ARCADE also offered an accessible online repository of CAD regulations, policies, and standards, acting as a comprehensive resource. Through annual workshops, the project facilitated stakeholder collaboration, producing aligned strategies, recommendations, and roadmaps that benefited CAD advancement across Europe, the US, Japan, and beyond.

2.1.11 FAME

Even limiting cooperation to European countries, the variance of intra-EU legal frameworks for the deployment of CCAM vehicles is one area where more research is required to define a clear, unified legal landscape for the development of automated mobility. To this goal, the FAME initiative (Framework for Coordination of Automated Mobility in Europe, 2022-2025) [FAME 2022], coordinated by the National Technical University of Athens (NTUA) and funded under the EU’s Horizon Europe program, aims to advance CCAM across Europe. It focuses on fostering collaboration among CCAM stakeholders, sharing best practices, and developing tools and methodologies to standardize and harmonize CCAM deployment and testing. The project builds on previous European initiatives, such as ARCADE, CARTRE, VRA, and FOT-Net, to ensure alignment with ongoing advancements in the field. One of FAME’s primary objectives is to establish a European framework for CCAM testing on public roads. To achieve this, the project is developing a Common Evaluation Methodology (CEM) to guide the assessment of CCAM solutions' direct and indirect impacts. The methodology is designed for various user groups, ensuring broad applicability and consistency in evaluating CCAM technologies. Complementing the CEM, FAME is also creating a CCAM Test Data Space (TDS), a trusted data-sharing platform aimed to enhance cooperation and data exchange among stakeholders. This platform will facilitate comparability and complementarity in testing outcomes across Europe. Another crucial aspect of the project is engaging and enriching the CCAM stakeholder network. FAME emphasizes collaboration by broadening the existing CCAM partnership to include a wider European and international community. Through this collaborative approach, the project seeks to align stakeholder contributions with the content of the EU CCAM Knowledge Base and support the Strategic Research and Innovation Agenda (SRIA). Additionally, FAME is implementing an efficient governance mechanism to ensure continuous stakeholder input and the relevance of the Knowledge Base. FAME’s focus on harmonizing methodologies and fostering stakeholder collaboration is expected to have a significant impact on the deployment and evaluation of CCAM solutions across Europe. By standardizing legal, ethical, and operational guidelines, the project provides a robust framework for CCAM integration, contributing to a safer, more efficient, and sustainable transport network in Europe.

2.1.12 metaCCAZE

The topic of interoperability is also a tenet of the recent metaCCAZE project (Flexibly adapted MetaInnovations, use cases, collaborative business and governance models to accelerate deployment of

smart and shared Zero Emission mobility for passengers and freight, 2024-2027), which has, among its goals, the objective to promote interoperability and standardization to overcome cross-border mobility challenges. At its core, the metaCCAZE project plans to offer a comprehensive framework for exploring and addressing the diverse use cases of CCAM technologies. By deploying pilots that target specific transportation externalities, such as urban congestion, carbon emissions, and infrastructure inefficiencies, metaCCAZE focuses on understanding how AV systems can transform mobility landscapes. Its efforts highlight distinct aspects of AV integration, including shared electric transport, infrastructure optimization, and urban logistics solutions, providing valuable insights into the social, environmental, and operational dimensions of CCAM. There are four main pilots planned, three of which make use of automated vehicles. These include: an on-demand mini-bus service for students in Limassol (Cyprus); the deployment of an automatic charging system for autonomous vehicles in Tampere for a reduced-downtime continuous service (Finland); automated freight transport on water and ground using autonomous vehicles in Amsterdam (Netherlands). In a broader sense, the Amsterdam autonomous barge system's modular communication framework ensures seamless integration with urban freight management systems, while the automatic charging infrastructure in Tampere aligns with broader European standards for electric mobility. These efforts contribute to harmonized regulatory and technical frameworks, a critical factor in achieving the scalability of CCAM solutions across diverse European contexts.

2.1.13 5G-MOBIX

On the front of improving the communication between automated vehicles and the existing infrastructure, there have been efforts like the 5G-MOBIX project [5G-MOBIX, 2018]. 5G-MOBIX was an EU-funded initiative from 2018 to 2022, aimed to explore the potential of 5G technology in advancing Connected and Automated Mobility (CAM). Bringing together 60 partners from 13 countries, including the EU, Turkey, China, and Korea, the project focused on demonstrating how 5G could address key technical and regulatory challenges in CAM applications. Leveraging the low latency, high bandwidth, and network slicing capabilities of 5G, 5G-MOBIX sought to improve vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication, which is essential for the smooth operation of autonomous vehicles in real-world environments. While earlier studies had explored 5G's theoretical benefits, 5G-MOBIX shifted the focus to large-scale field trials that tested 5G functionalities across diverse cross-border corridors and urban locations. The project's trials included a variety of advanced CAM applications, such as cooperative overtaking, lane merging, and truck platooning, under challenging real-world traffic and network conditions. These trials were crucial in evaluating the technical feasibility of 5G for CAM and addressing cross-border issues, such as maintaining seamless connectivity and interoperability across different national networks. Previous research had largely been confined to controlled settings, but 5G-MOBIX aimed to bridge this gap by testing the technology in practical, dynamic environments.

2.1.14 AUGMENTED CCAM

Lastly, the AUGMENTED CCAM project, running from 2022 to 2025 [AUGMENTED CCAM, 2022], aims to advance the readiness of Physical, Digital, and Communication (PDI) infrastructures for the large-scale deployment of CCAM solutions. By harmonizing and evaluating PDI support solutions, the project addresses the needs of all CCAM actors across various modes of transport. It focuses on creating and implementing PDI support solutions in diverse environments, including highways, urban and rural areas, and controlled settings. These solutions are designed to enhance safety, efficiency, and reliability while considering the socio-economic impact. The project leverages advanced technologies like AI, Big Data, and HD maps to improve situational awareness and decision-making. Additionally, it develops roadmaps and recommendations to guide policymakers and infrastructure investors, ultimately paving the way for a future with safe and efficient automated transportation.

2.1.15 General takeaways from the project topics

Considering all of the above, there has been a wealth of European projects which tackled different local realities and aspects of CCAM, ranging from technical issues (connectivity, sensorics) to acceptance and accessibility, including cross-border collaborations and large-scale deployments of several AV shuttles. In the following, we put more focus on the topic of diversity (as defined in Sec. 1.2) and how it was addressed by previous CCAM projects.

2.2 Relevance of Cultural, Geographical, and Exogenous Diversity in CCAM

Most of the analysed previous CCAM projects have put emphasis on the technical or regulatory aspects of automated driving and on the topic of user acceptance, with surveys and polls among prospective passengers, but did not put diversity at the forefront.

When it comes to geographic consideration, projects such as Digibus Austria and ENA and RIMA were designed with local rural realities in mind, which reflected in the design and conclusions of the projects. As highlighted in Ref. [Tourniaire, 2023], one of the results of the ENA project was that the citizens involved found the creation of the autonomous shuttle service important to reduce the depopulation in the rural region of Coeur de Brenne, where the project was tested, together with making the small towns easier to reach and making the whole area more attractive. In comparison, the opinions of the passengers in the Sophia Antipolis pilot focused more on the comfort of the service and less on its implications for the connected area. This alone shows a difference in perceived value of CCAM projects depending on the territorial differences: while for many urban centres CCAM can be a reinforcement of an already existing public transport infrastructure, for rural and peripheral areas it might be the difference between a poor or inexistent and an acceptable public transport service.

Aspects of exogenous diversity have been indirectly studied by the project 5G-MOBIX. [Boualouache, 2022] describes how one of the most challenging parts of the project was harmonizing cross-border communication regulations and legal frameworks, whose differences made testing the underlying technology more difficult. Factors such as weather influence on deployment of autonomous shuttles in the scope of the SHOW project [Anund, 2022] demonstrated how the underline sensor technology must be adapted to the surrounding environment. During the pilot phase of the project in three different cities, it was shown that rain and snow can cause the automated system to halt by confusing the lidar sensors of the shuttles. This goes in the direction of having to adapt the vehicles to the use case, taking also into account edge cases that are location dependent.

While there have been projects that tackled geographical – at least in the limited sense of comparing results in urban and non-urban areas – and covered some aspects of exogenous diversity, the impact of different cultures and languages on the deployment of CCAM solutions has, to our knowledge, not been extensively tested. Our review did not find European projects with emphasis on this aspect, thus identifying a research gap where CulturalRoad could provide important insights and results.

More recent projects such as Diversify-CCAM (Diversify CCAM by integrating the European cultural and regional variations in the design and implementation of citizen-friendly systems to foster mobility equity) [Diversify-CCAM, 2024] are slated to cover a similar niche, by considering the contribution of societal aspects on the deployment and usage of CCAM solutions. We can expect more projects in this direction to expand in the coming years, integrating the results of other European initiatives such as TInnGO (Transport Innovation Gender Observatory), which produced methods and frameworks to combat gender disparity issues in public transportation [TInnGO, 2021].

CulturalRoad might serve as a stepping stone in this specific direction, creating a framework that other European projects will be able to expand on.

2.3 Review of Existing Standards and Frameworks

There are ongoing attempts at standardizing the use of CCAM and integrating automated vehicles within traditional transport.

In 2017, the German Ethics Commission has outlined a framework for the ethical development of automated and connected vehicles [BMDV, 2017]. A primary concern is the safety of all road users, with the goal of minimizing accidents and maximizing mobility opportunities. The commission emphasizes human autonomy and the protection of individual rights, while acknowledging the potential benefits of automated systems. Key ethical principles include the need for transparency, accountability, and fairness in the design and deployment of these systems. Additionally, the commission addresses the ethical implications of data privacy and the potential for surveillance. It emphasizes the importance of human-centric design, ensuring that automated systems enhance, rather than hinder, human capabilities. By adhering to these principles, the development and deployment of automated vehicles can contribute to a safer, more efficient, and equitable transportation system.

In November 2024, the German Federal Ministry of Transport and Digital Infrastructure has also published guidelines for the introduction of automated vehicles as a part of public transport, covering topics such as use cases, required infrastructure, authorization processes and evaluation of the pilots from a legal and regulatory perspective (e.g. how public tenders should be structured when publishing a call for automated mobility services and which national standards the deployed vehicles must abide by). The guidelines in Ref. [BMDV, 2024] are however available only in German at the time of writing this document and apply only to Germany.

On a broader European level, in 2020 the EU Ethics Guidelines for Connected and Automated Vehicles provided a framework for the ethical development and deployment of these technologies [EC 2020]. The guidelines emphasize the importance of safety, privacy, fairness, explainability, and responsibility. The report addresses three key areas:

- **Road safety and risk**: The guidelines highlight the need for demonstrable safety improvements and the ethical considerations involved in dilemma scenarios.
- **Data and algorithm ethics**: The report emphasizes the importance of protecting privacy, ensuring fairness, and making algorithmic decisions transparent and understandable.
- **Responsibility**: The guidelines acknowledge the complex issue of liability in accidents involving automated vehicles and call for careful consideration of who should be held accountable.

This guideline also emphasizes the importance of inclusivity and fairness in the development and deployment of these technologies. The guidelines call for the prevention of discriminatory service provision, ensuring that CAVs are designed and operated in a way that does not discriminate against individuals or groups of users. This includes ensuring equal access to CAV services, avoiding discriminatory pricing strategies, and proactively promoting inclusivity in the design and operation of CAV systems. To achieve this, it is crucial to incorporate diversity into all aspects of CAV development, including the design teams. By considering factors like gender, ethnicity, and other relevant social dimensions, developers can create systems that are more equitable and inclusive.

The EU AI Act does not directly address CCAM or autonomous vehicles, nor does it classify them under high-risk AI systems or essential public infrastructure. However, the risks associated with autonomous vehicle technologies – such as safety, fairness, and accountability – should still align with the Act's standards

for AI systems. It is essential to design AI algorithms for CCAM in compliance with these policies, ensuring responsible, non-discriminatory, and transparent AI operations within the autonomous vehicle sector. We can consider these guidelines, as summarized in Ref. [Holland & Knight, 2024], reported verbatim in the following:

“AI practices that pose "unacceptable risk" are expressly prohibited under the Act. These prohibited practices include marketing, providing or using AI-based systems that:

- use manipulative, deceptive and/or subliminal techniques to influence a person to make a decision that they otherwise would not have made in a way that causes or may cause that person or other persons significant harm
- exploit vulnerabilities of person(s) due to their age, disability or specific social/economic situation in order to influence the behavior of that person in a way that causes or may cause that person or other persons significant harm
- use biometric data to categorize individuals based on their race, political opinions, trade union membership, religious or philosophical beliefs, sex life or sexual orientation
- create or expand facial recognition databases through untargeted scraping of facial images from the internet or closed-circuit television (CCTV) footage”

Some national pilot projects were used as a testing ground to update or propose new standards that could help with the integration of CCAM vehicles in public transport operations. As a recent example, the German project ÖV-LeitmotiF-KI (Öffentlicher Verkehr: Standards für die Leitsystemanbindung von automatisierten Fahrzeugen mittels Künstlicher Intelligenz, 2022-2024) resulted in the extension of an existing German public transport standard, namely VDV 435, to include automated vehicles in the mobility loop. This framework is also going to be implemented in another German project called ABSOLUT II (Automatic bus shuttle self-organizing between Leipzig and the BMW terminal, 2023-2026), aimed to facilitate the integration of CCAM control centres. The VDV 435 standard focuses on interoperability between systems built by different manufacturers and puts together a selection of common data transfer structures, effectively regulating the communications between the vehicle and the control room.

While not specifically building a new standard, FAME (2022-2025) aims to create a common European framework for CCAM testing and developing a common evaluation method for CCAM pilots, together with methods for trusted data sharing between international partners. Further information on this project has been provided in a previous section.

2.4 Collaboration and Stakeholder Engagement

Stakeholder engagement and collaboration integrate participatory processes to reflect the diverse cultural and geographical contexts of the CCAM systems. The approach emphasizes inclusivity by systematically involving policymakers, technical experts, industry representatives, and end-users throughout the design and deployment process. This participatory framework aligns with established planning research principles that advocate aligning technical solutions with societal needs to ensure legitimacy and broad acceptance [Hassenforder, 2015]. Workshops are a critical part of the engagement process, enabling stakeholders to identify deployment challenges and propose context-sensitive solutions collaboratively. For example, in rural regions, participants often highlight connectivity gaps that limit access to essential services. Workshops could incorporate GIS to visualize spatial disparities, providing stakeholders with an evidence-based tool to identify and prioritize underserved areas. Using GIS as a data mapping visualization tool could communicate significant inequities in first and last-mile transport coverage in suburban zones, leading stakeholders to propose solutions such as automated shuttles to bridge these gaps. This approach would ensure that planning decisions are data-driven and responsive to the specific needs of different regions. The use of GIS enhances not only decision-making but also trust among stakeholders by demonstrating a commitment to

data-driven planning [Cascetta, 2015]. Scenario planning further enriches these workshops, allowing stakeholders to evaluate the trade-offs of various deployment models. Urban scenarios might focus on integrating autonomous vehicles with existing public transit systems to alleviate congestion and reduce emissions.

In contrast, rural scenarios could explore the feasibility of shared shuttle services to connect isolated communities and transit deserts. This structured exploration fosters consensus on regionally relevant strategies, reinforcing the adaptability and inclusivity of CCAM solutions. Focus groups complement workshops by engaging end-users directly to gather qualitative insights into inclusivity and user acceptance. Discussions frequently uncover psychological barriers, such as mistrust in automation and concerns about data privacy. Stakeholder engagement provides a valuable opportunity to generate actionable insights that inform the design and deployment of CCAM systems. One way of looking at this is that focus group discussions could reveal the importance of real-time human interaction within automated systems to address user concerns about safety and trust. Based on this feedback, developers might integrate features such as video-call capabilities, allowing passengers to connect with remote operators when needed. This approach demonstrates how incorporating stakeholder input can directly shape system features, ensuring that the solutions address real-world user needs and fostering broader acceptance of automated mobility. By addressing such concerns early, CulturalRoad ensures that CCAM systems are functional and user-centric, fostering greater public trust.

Lessons from prior projects such as SINFONICA and ARCADE further inform the CulturalRoad approach. SINFONICA demonstrated the importance of addressing accessibility barriers through targeted co-creation sessions with marginalized groups. This approach emphasized the need for simplified user interfaces tailored to older adults and individuals with disabilities, a finding that CulturalRoad applies by incorporating intuitive design elements into CCAM systems. Similarly, ARCADE emphasized the importance of harmonized governance structures across municipalities to resolve regulatory inconsistencies that could hinder implementation. Building on these insights, CulturalRoad facilitates multi-level stakeholder collaboration, ensuring that policies and operational frameworks align across local, regional, and national levels [CulturalRoad, 2024a]. Inclusivity is systematically embedded in the planning process through the Five-Pointed Star Rating System, which evaluates deployment strategies based on accessibility, safety, and equity metrics. Feedback gathered during workshops and focus groups informs these evaluations directly, ensuring that inclusivity is a measurable and actionable outcome. From feedback, recommendations are thus created, in this case, for automated wheelchair ramps in shared vehicles that emerged from stakeholder discussions, leading to practical design modifications that enhance mobility options for individuals with disabilities.

Ethical considerations are a critical focus in stakeholder engagement processes. Workshops designed to engage diverse stakeholders could provide a platform for addressing concerns related to data protection and workforce displacement. These discussions would allow participants to collaboratively propose solutions, such as enhanced data security protocols or retraining programs for workers affected by automation, ensuring that these issues are proactively considered in the planning and deployment phases. Stakeholders could collaboratively propose solutions such as enhanced data security protocols and workforce upskilling programs to address these issues. In order to have a baseline for cultural risk perception generated from ethical concerns, key performance Indicators are used as a baseline to assess the effectiveness of these engagement strategies, measuring factors such as the diversity of stakeholder representation and the degree to which feedback shapes deployment strategies. KPI analysis may reveal changes in community satisfaction, whether an increase or decrease, following implementing stakeholder-recommended features such as dynamic scheduling and real-time tracking. By comparing these results against baseline measurements, we can effectively evaluate the impact of these features and understand the outcomes of stakeholder engagement. These iterative evaluations ensure that engagement processes remain responsive to stakeholder needs, fostering a robust foundation for equitable and culturally sensitive CCAM systems.

3 RESULTS AND FINDINGS

The goal of this section is to summarise the results of the projects analysed in Sec. 2 in order to extract lessons learned and insights that could be useful for CulturalRoad. This section is structured as follows:

- **Section 3.1** summarises the results from the pilot projects considered so far.
- **Section 3.2** focuses on the challenges that hindered or made the deployment of CCAM solutions more difficult.
- **Section 3.3** extracts insights from the existing projects to define guidelines for user-centric design that can be applied to CulturalRoad.

3.1 Insights from the Pilot Projects

The pilot projects analysed in Section 2 can be broadly split into four broad categories:

- Projects that study the feasibility of using CCAM vehicles to connect underserved and mobility-poor areas to the rest of their surrounding region;
- Projects that promote accessibility and studying acceptance of CCAM with small-scale to relatively large-scale deployment of autonomous shuttles in urban or peri-urban environments;
- Projects that test new technologies for the improvement of CCAM services, such as cross-border transmission on the 5G spectrum, and consolidating accepted practices, such as platooning;
- Projects that review and expand the legal framework around CCAM deployment

The first class of projects underlined how CCAM can support existing public transport networks with some levels of efficacy, especially in rural areas. The second class of projects focused more on citizen participation and stakeholders' engagement. The third and fourth class of projects focused on the current challenges that a CCAM solution faces in today's regulatory framework. CulturalRoad roughly belongs to the second category, except with a bigger focus on acceptance and fairness and a smaller focus on an active deployment of vehicles. It is important to note how, according to the SINFONICA and AVINT findings, young parts of the population are more engaged in the usage of new means of transportation compared to the older segments, but only a small number of projects seem to cater to this demographic.

Going more into the detail of the projects analysed in Sec. 2:

The ARCADE project delivered a comprehensive knowledge base on CAD regulations, policies, and standards, providing valuable insights to stakeholders. The project also produced detailed analyses and recommendations for 12 key CAD areas, fostering a shared understanding and promoting aligned approaches. Additionally, ARCADE contributed to the updating of CAD roadmaps, facilitated international collaboration, and raised awareness through its online platform and news updates, ultimately advancing the development and deployment of CAD technologies.

The 5G-MOBIX project yielded valuable insights into the technical and operational requirements for leveraging 5G technology and networks in CCAM applications. Through extensive trials across diverse geographical and traffic conditions, the project provided a realistic assessment of 5G's capabilities and limitations, particularly in enabling advanced CAM use cases such as cooperative overtaking, lane merging, and truck platooning. The key findings emphasized the critical importance of seamless cross-border connectivity and the need for robust network infrastructure to support reliable Vehicle-to-Everything (V2X) communications. The trials also highlighted the potential of 5G to enhance CAM applications, but revealed challenges related to network interoperability, especially in multi-operator environments, where issues like

device compatibility and roaming delays were observed. In addition to technical insights, the project underscored the significance of addressing non-technical aspects, including regulatory frameworks and standardization efforts, which are crucial for the successful roll-out of 5G in CAM. The project provided a comprehensive analysis of policy gaps, including roaming charges, data privacy, and security concerns, which must be addressed to ensure a smooth deployment. Moreover, 5G-MOBIX identified best practices for cross-border deployments, such as the fine-tuning of radio access network (RAN) parameters, the use of dual-modem technology, and the deployment of Multi-Access Edge Computing (MEC) infrastructure. These findings offer practical guidance for future 5G-enabled CAM systems and will play a key role in shaping the development of a more connected and automated transportation future.

The Èrica project's autonomous bus tour across Catalonia aimed to achieve both public engagement and practical insights for urban adaptation. By enabling citizens to interact directly with an autonomous vehicle, the project fostered a deeper understanding of how autonomous transport integrates within urban settings and previewed the broader cultural shift toward smart mobility. Local councils were given a chance to observe Èrica's operations, noting potential urban planning adjustments necessary to accommodate autonomous vehicles. The University of Barcelona (UB) contributed by conducting a survey to gauge public perceptions of this new technology, adding valuable data to assess readiness and acceptance among citizens. Additionally, the tour included informational sessions through a dedicated tent, where attendees could learn about the economic, cultural, and infrastructural impacts anticipated with autonomous public transport. The project extended its outreach by offering rides to schools, educating young students about the future of transportation and inspiring early awareness of smart mobility's role in urban life.

The project AVINT implemented a structured testing methodology in three steps:

- Initial trials without passengers to validate the system's technical reliability.
- Trials with passengers and an onboard operator to manage emergency interventions.
- Fully autonomous trials without an operator onboard, marking a significant milestone in automated driving technology.

This approach mirrored that of CM2 but extended its scope by fully integrating the service into the city's public transport system. The pilot assessed its impact on traffic patterns, public perception, and urban mobility. Findings indicated that automated shuttles could effectively supplement traditional public transport, particularly on short routes underserved by conventional buses. Public acceptance, although generally positive, varied across demographics, with younger residents and students being more receptive to the innovation. Beyond the pilot, AVINT produced a roadmap for expanding automated mobility solutions across Greece. This roadmap addressed legal barriers, infrastructure requirements, and operational challenges, providing practical examples for other cities to emulate. Furthermore, it emphasized the importance of public engagement and stakeholder collaboration in ensuring the successful adoption of CCAM technologies. AVINT aligns with broader European efforts to standardize automated mobility, drawing on frameworks like those developed by CM2. By demonstrating a successful urban implementation, AVINT contributed valuable insights into overcoming CCAM deployment barriers, reinforcing the importance of cross-regional collaboration.

The SHOW project is unique in the sense that CCAM solutions were tested on the territory. One of the main outputs of the project is to stress the importance of measuring and monitoring social acceptance at a local level, as well as to revision systematically the market conditions and infrastructure This is necessary to ensure both the acceptance and the efficiency of CCAM solutions. An unsurprising result was that demographic shifts and urbanization levels play a crucial role in affecting acceptance. Promoting acceptance also entails understanding the needs of the population, their perception of the new technology, and their inclusivity (e.g., in terms of design). In addition, not using the technology in the correct way can cause the loss of customers/users. Similarly, it was reported that the loss of trust in the system, especially trust in the

technology and the way it interacts with the user, may lead to users leaving the system, revenue loss, and eventually a failure of the CCAM service [Worschech, 2020]. Other results, more related to the operational aspects, pointed out toward the need to properly optimize both vehicle sizes and frequency, monitor the status and quality of the infrastructure, the use of standardized equipment to promote transferability and comparisons across countries, the requirement to monitor environmental impacts and safety concerns, the relevance of co-creation and more specifically to engage the local population through, for example, a public information interface, the requirement for CCAMs to be integrated with the public transport to promote cooperation instead of competition, consider how different traffic participants may require different assessments in term of acceptance, design tools to allow smart routing and system optimization for CCAM services.

3.2 Challenges and Opportunities of Integrating CCAM Solutions in Existing Ecosystems

Infrastructure and legislation come up as the most relevant challenges when it comes to integration of CCAM solutions within the public transport network. The lack of a unified European framework or even of clear state regulations significantly hinders the process of bringing automated vehicles into active service. Projects such as 5G-MOBIX underlined how cross-border operations, even inside the EU, require significant cooperation to connect different standards – both technological and regulatory [Boualouache, 2022]. Projects such as SOHJOA Last Mile pointed out how clear regulations would substantially improve the feasibility of bringing CCAM solutions to everyday life.

However, the results from many of the pilots are encouraging in pointing out niches where CCAM can make a difference. Projects such as ENA, RIMA and Digibus Austria focused on connecting underserved communities and locations with the use of automated vehicles, helping close a service gap that is endemic in public transport operations. In places were running a regular scheduled line is antieconomic or serves a very limited number of people, CCAM has the potential to be a suitable and sustainable solution, freeing resources for routes that require more demand while still offering the inhabitants of the currently underserved areas a reliable mean of transportation to interact with their communities.

The use of CCAM in last mile operations can also help supply longer distance mobility options with a convenient way to connect the stations with urban and peri-urban areas, thus improving the general perception of flexibility and adaptability that traditional public transport does not currently foster.

3.3 User-Centric Design and Development for Inclusivity and Optimization

User-centric design and development prioritize the needs, desires, and limitations of end users throughout the entire development process. This approach fosters the creation of intuitive, user-friendly mobility systems that enhance technology adoption and usage. By aligning CCAM solutions with user expectations, it contributes significantly to improving traffic safety and operational efficiency. Moreover, the iterative nature of user-centric design allows for continuous refinement and optimization, leading to more sustainable, adaptable, and cost-effective solutions over time.

Many projects have integrated these principles, often initiated to address specific passenger needs. A notable example is the Digibus Austria project, designed to connect rural areas with urban centres. Through extensive surveys and real-world trials, it identified and catered to the unique mobility requirements of rural residents. Accessibility features, such as accommodating wheelchairs and strollers, were prioritized, while passenger behaviour in unforeseen situations, such as obstacles halting vehicle operations, was analysed. These measures fostered trust and enhanced usability, as evidenced by the majority of pilot participants

reporting safety and comfort, with 40% indicating a willingness to replace personal or second cars with automated shuttle services.

Similarly, the ENA project tackled the mobility challenges in sparsely populated areas, focusing on complementing existing transportation networks for residents with limited mobility options. It applied iterative design processes involving surveys, requirements analysis, and real-world experiments to ensure safety and user acceptance. Additional tests on test tracks further refined safety and comfort measures before broader deployment.

In urban contexts, the AVINT project addressed traffic usability and performance in Greece, showcasing the feasibility of integrating autonomous shuttles into urban ecosystems. Over six months, it deployed three automated buses in Trikala to evaluate public acceptance and operational efficiency.

Expanding the scope, the RIMA project in France developed a mobility network across a 50 km² rural area using seven autonomous vehicles. This initiative addressed diverse needs, including daily commuting, access to healthcare, tourism, and local logistics, aligning mobility solutions with community-specific requirements. The project not only enhanced transportation accessibility but also contributed to broader regional development goals.

On a larger scale, the Sohjoa Last Mile project explored last-mile connectivity in urban settings across multiple European cities, such as Tallinn and Gdańsk. User acceptance studies revealed high satisfaction levels, with passengers reporting feelings of safety and comfort, even in operator-free scenarios. However, challenges like over-reliance on automation and unpredictable interactions with pedestrians and other road users underscored the need for refined behavioural modelling and system robustness.

The IN2CCAM project also applied participatory methods by involving diverse stakeholders, including end-users, in the design and implementation of CCAM services.

Inclusivity remains a central theme in projects like SINFONICA and SHOW, where stakeholder engagement, particularly with vulnerable groups, shaped accessible and reliable mobility solutions. Structured frameworks guided interactions, such as ideathons and hackathons, fostering collaborative innovation. Pre- and post-demonstration surveys are applied to reveal user priorities for highlighting the importance of reliability, safety, and inclusive features like accessible boarding for elderly passengers and those with reduced mobility. Gender and cultural considerations are also gaining traction.

The TinnGo project pioneered gender-sensitive smart mobility solutions across Europe, establishing Gender Action Plans and addressing safety concerns through an open data repository (see [TinnGO, 2021]). Likewise, the Diversify-CCAM initiative is planning to integrate cultural and geographic diversity into CCAM design and deployment, ensuring equitable solutions across various demographics.

In summary, user-centric design is critical for CCAM systems to meet the diverse needs of end-users effectively. Projects like Digibus and ENA demonstrated the importance of addressing rural mobility needs through surveys, real-world trials, and tailored accessibility features. Similarly, RIMA expanded this focus by creating a mobility network aligned with the multifaceted needs of a community, including daily commutes, healthcare, and tourism.

Urban-focused initiatives such as AVINT for urban mobility and Sohjoa Last Mile highlighted the growing public trust in autonomous systems, while also identifying challenges like unpredictable road user behaviour and over-reliance on automation. Inclusivity played a central role in SINFONICA and SHOW, where co-creation with vulnerable groups and pre- and post-demonstration surveys shaped accessible and reliable mobility solutions.

Additionally, TinnGo extended the scope of inclusivity by addressing gender-specific issues and cultural differences, ensuring that mobility solutions are equitable across various demographics. These examples underscore the critical role of iterative user feedback, stakeholder engagement, and context-specific design in creating optimized, inclusive CCAM solutions that address both practical needs and broader societal goals.

4 RECOMMENDATIONS AND DESIGN GUIDELINES

This section is focused on collecting guidelines and recommendations for the deployment of CCAM identified thanks to the analysis of the projects presented in Sec. 2. It is structured as follows:

- **Section 4.1** addresses recommendations for EU action in order to solve challenges that are delaying the development of EU CCAM solutions
- **Section 4.2** presents a short summary of development guidelines for CulturalRoad based on the findings of this document;

4.1 Policy Recommendations for European Union Initiatives

One common factor that was observed around several of the projects analysed is the requirement for an intra-European legal framework to regulate the deployment of automated mobility. Currently there are national standards and guidelines, but no unified European framework that is valid in the whole territory of the Union, causing intra-EU projects to have to comply with several different national regulations. This was most evident in the conclusions of the project SOHJOA Last Mile, AVINT, ARCADE and FAME, all of which concluded that legal uncertainties were a major barrier to the introduction of CCAM solutions into active service. While FAME is moving in the direction of promoting an EU-wide standard for the deployment of automated vehicles, stronger EU commitments towards unified CCAM guidelines would benefit all projects and experimentations involved.

As also identified by the project 5G-MOBIX, the absence of a common European infrastructure caused regulatory problems in cross-border operations, especially concerning telecommunication standards. Strict regulations around the use of spectrum and licenses, as well as complications with cross-border permissions and documentation, created delays and inefficiencies. For future projects, it is recommended to simplify and standardize these processes to avoid unnecessary hold-ups. Moreover, as the technology for CAM continues to evolve, future efforts should focus on automating certain processes to improve efficiency. Standardizing 5G features for cross-border CAM services will also be important to ensure smoother implementation and faster deployment of new technologies. Furthermore, the project emphasized the importance of addressing non-technical challenges, such as cross-border coordination and data sharing. Streamlining border crossing procedures and defining common data formats can significantly improve the efficiency of future deployments.

Unclear legislation was also at the centre of the key takeaways from the Èrica project, as it was summarized by Pere Calvet, general manager of Catalonian railway company FGC – quoted verbatim from Ref. [AUVSI News, 2018]:

“We still need to overcome hurdles, such as legislation, and carefully deal with moral issues as well as the coexistence of people and machines in the urban environment,” Calvet says. “But the shift to a more sustainable mobility is necessary and unstoppable.”

The topic of infrastructural inadequacy, even if more on a state level, was another key takeaway of Èrica, pushing for electrification and relevant support for automated mobility. Translated from Ref. [Moventia, 2018]:

For the councillor [of Territory and Sustainability of the Generalitat de Catalunya] Damià Calvet, “it is important to start carrying out pilot tests to visualize the mobility of the future”. The councillor has emphasized that the evolution towards the electric vehicle must also be accompanied by the transformation of the

infrastructure: "As a Generalitat we have to be able to digitalize the roads and also offer incentives to facilitate the change towards cleaner mobility".

In Ref. [Staelens, 2020], the SHOW project also put emphasis on the need for shared regulation, emphasizing that, with the exception of countries like France and Germany, which promulgated laws and guidelines for the deployment of automated vehicles in conjunction with traditional traffic, most European countries still have limited legislation and grey areas that make the deployment of CCAM solutions more volatile. According to the same reference, local administrations are still lacking experience and competence for pushing "hard regulations".

A European push for shared legislation, lower barriers and better intra-EU network communication infrastructure would be strongly requested to improve the reach and applicability of CCAM, ensuring a widespread deployment in the near future.

4.2 Design and Development Guidelines for CulturalRoad

CulturalRoad builds upon and expands the results of the EU Project SHOW. As discussed in the introduction, the goals of the two projects are quite aligned. SHOW also included. While SHOW already evaluated the acceptance of CCAMs and – in general – a broad body of research exists that uses the Technology Acceptance Model (TAM) to evaluate the impact of autonomous vehicles, one single solution cannot fit all contexts. Acceptance only makes sense if considered in the context of multiple user groups, the psychological aspects related to fear and trust in automation (being often reported as the most crucial aspect for acceptance), inclusivity, and safety. Therefore, CulturalRoad addresses all these dimensions in its five-pointed star rating system. This system, summarized in the project website [CulturalRoad, 2024b] defines an overall mobility score that aggregates the results for five identified pillars of mobility equity: safety, inclusivity, user acceptance, network readiness, and psychological factors influencing usage. The specifics of the evaluation will be the subject of additional work during the project's lifetime.

For the user acceptance pillar, a model that builds upon the one presented in SHOW (UTATU) will be used. This will be the first time that acceptance, psychological factors, intention of use, inclusivity, and safety are considered into a single framework. In addition, CulturalRoad will also advance the work started in SHOW about the management of CCAM services. Through a dedicated pillar on network optimization, tools to optimize CCAM fleets and their operation next to traditional public transport solutions will be developed and tested.

5 CONCLUSIONS

This report analysed European CCAM projects to draw conclusions on the current state of CCAM experimentation, aiming to identify topics and research directions that are currently underrepresented. Around a dozen European pilots have been reviewed, going through the challenges, results and recommendations produced in their span, in order to identify research gaps that could be filled by CulturalRoad and takeaways that could inform and guide the project's direction.

A number of pilots, such as 5G-MOBIX and Sohjoa Last Mile, encountered legal challenges and vouched for a harmonisation of European regulation on CCAM deployment, with emphasis on simplifying cross-border collaborations and having clear, EU-wide guidelines for carrying out experiments with automated driving systems.

When it comes to cultural, exogenous and geographical diversity, the results of this analysis were mixed:

- Geographical factors, such as the difference in acceptance between rural and urban areas, were the subject of pilot projects in Austria and France (Digibus Austria, ENA, RIMA), which concluded that CCAM could be a valuable support for underserved and mobility-poor regions, fighting depopulation and improving connections between small towns.
- Exogenous diversity factors have been partly considered, mostly from a technological perspective and less from a user-centric perspective, by projects such as 5G-MOBIX and SHOW.
- Cultural diversity has, as far as our review of existing pilots went, seemingly not have been tackled as a major factor by previous CCAM projects.

CulturalRoad's focus could help collect evidence in directions that have been traditionally not followed, with emphasis on societal factors in CCAM acceptance that were not the subject of previous studies. Other projects such as Diversify-CCAM are moving in a similar direction, and we can foresee a comparison of the results further in the lifetime of the pilots in both projects.

6 REFERENCES

- **5G-MOBIX (2018)**, 5G-MOBIX, https://www.5g-mobix.com/about, accessed 21 November 2024
- **Anund (2022)**, A. Anund, R. Ludovic, B. Caroleo, H. Hardestam, A. Dahlman, I. Skogsmo, M. Nicaise, M. Arnone, "Lessons learned from setting up a demonstration site with autonomous shuttle operation – based on experience from three cities in Europe", Journal of Urban Mobility 2022, vol. 2, 100021, https://doi.org/10.1016/j.urbmob.2022.100021
- **ARCADE (2018)**, TRIMIS, "ARCADE - Aligning Research & Innovation for Connected and Automated Driving in Europe", 2018, https://trimis.ec.europa.eu/project/aligning-research-innovation-connected-and-automated-driving-europe
- **AUGMENTED CCAM (2022)**, AUGMENTED CCAM, https://augmentedccam.com/whatisaugmentedccam, accessed 21 November 2024
- **AVINT (2019)**, TRIMIS, "AVINT - Autonomous vehicles integrated within the urban context", 2019, https://trimis.ec.europa.eu/project/autonomous-vehicles-integrated-within-urban-context, accessed 6 December 2024
- **AUVSI News (2018)**, AUVSI News, "Autonomous bus named Erica being tested in Spain to help familiarize citizens with driverless technology", 4 October 2018, https://www.auvsi.org/industry-news/autonomous-bus-named-erica-being-tested-spain-help-familiarize-citizens-driverless, accessed 27 November 2024
- **Beutnagel (2024)**, W. Beutnagel, automotiveIT,"BMW vereint Level 2+ und 3 beim autonomen Fahren", 25 June 2024, https://www.automotiveit.eu/technology/bmw-bringt-level-2-und-3-in-einem-fahrzeug-zusammen-531.html, accessed 6 December 2024
- **BMDV (2017),** German Federal Ministry of Transport and Digital Infrastructure, "Ethic Commission Automated and Connected Driving – Report (Extract) June 2017", https://bmdv.bund.de/SharedDocs/EN/publications/report-ethics-commission-automated-and-connected-driving.pdf, 2017
- **BMDV (2024)**, German Federal Ministry of Transport and Digital Infrastructure, "Autonomes Fahren im öffentlichen Verkehr Ein Handbuch mit Vorschlägen für die Umsetzung in der kommunalen Praxis", https://fops.de/wp-content/uploads/2024/11/BMDV_Handbuch_Autonomes_Fahren_Im_Oeffentlichen_Verkehr.pdf, 2024
- **Boualouache (2022)**, A. Boualouache, A. Buscemi, I. Turcanu, L. Ladid, 5G-MOBIX, „Deliverable 7.6 Report on the international cooperation and results", version 2.0, 6 June 2023, https://www.5g-mobix.com/assets/files/5G-MOBIX-D7.6-Report-on-the-international-cooperation-and-results_v2.0_final.pdf, accessed 2 December 2024
- **Bouzoina (2020)**, L. Bouzouina, M. Dauvergne, N. Kotelnikova-Weiler, O. Klein, R. Djeridi, D. Blaustein, M. Soury, B. Lecureux, C. Morhain, ENA, "Livrable 5.3.2 - 5.4.2: Evaluations Socio-économique et Environnementale des Expérimentations", 2020
- **Cascetta (2015)**, E. Cascetta, A. Cartenì, F. Pagliara, and M. Montanino. "A new look at planning and designing transportation systems: A decision-making model based on cognitive rationality, stakeholder engagement, and quantitative methods". Transport Policy, 38, 27-39, 2015,https://doi.org/10.1016/j.tranpol.2014.11.005
- **de Cerjat (2024)**, C. de Cerjat, V. Ferran, A. Ziakopoulos, M. Glotz-Richter, SHOW, "Deliverable 17.4: CCAV integration in SUMP", 2024, https://show-project.eu/wp-content/uploads/2024/11/D17.4-CCAV-integration-in-SUMP.pdf
- **CityMobil2 (2012)**, https://cordis.europa.eu/project/id/314190/reporting, 2012-2016, accessed 15 November 2024

- **CulturalRoad (2023)**, CulturalRoad, “Proposal template Part B: technical description CulturalRoad: Cultural, Regional and societal factors to Overcome barriers to connected, cooperative and Automated mobility Deployment”, 6 September 2023, Ref. Ares(2023)6044826 - not publicly available
- **CulturalRoad (2024a),** CulturalRoad, “Co-creating equitable CCAM deployment strategies that consider cultural diversity”, 2024. https://www.culturalroad.eu/co-creating-equitable-ccam-deployment-strategies-that-consider-cultural-diversity/, accessed 10 December 2024
- **CulturalRoad (2024b)**, CulturalRoad, 2024, “Overview of the project”, https://www.culturalroad.eu/about/, accessed 18 December 2024
- **Digibus 2.0 (2023)**, Digibus 2.0, 2023, https://www.digibus.at/en/, accessed 6 December 2024
- **Digibus Austria (2021)**, Digibus Austria, “Results and experiences”, 2021, https://www.digibus.at/en/results-and-experiences/, accessed 6 December 2024
- **Diversify-CCAM (2024)**, Diversify-CCAM, https://diversify-ccam.eu/, accessed 5 December 2024
- **ENA (2023)**, ENA, “Actes de la conférence finale”, 28 March 2023, https://collections.univ-gustave-eiffel.fr/Livrables/Conference_finale-ENA-Actes.pdf
- **Enei (2023)**, R. Enei, S. Gaggi et al., SINFONICA, “Deliverable 5.1: Equity practices and social indicators”, 2023, https://sinfonica.eu/wp-content/uploads/2024/03/D5.1_Equity-practices-and-social-indicators_v2.0.pdf
- **ÈRICA (2018)**, https://www.erica.cat/, accessed 15 November 2024
- **European Commission (2018)**, European Commission, “Communication from the Commission to the European Parliament, the council, the European Economic and Social Committee, the Committee of the Regions on the road to automated mobility: An EU strategy for mobility of the future”, 2018 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52018DC0283
- **European Commission (2020),** European Commission: Directorate-General for Research and Innovation, “Ethics of connected and automated vehicles – Recommendations on road safety, privacy, fairness, explainability and responsibility”, Publications Office, 2020, https://data.europa.eu/doi/10.2777/035239
- **European Commission (2021),** European Commission: Directorate-General for Mobility and Transport, “Final report of the Single Platform for Open Road Testing and Pre-deployment of Cooperative, Connected and Automated and Autonomous Mobility Platform (CCAM platform)”, 2021, https://transport.ec.europa.eu/document/download/15d0f5a7-73cd-48f0-83d3-1c7a160d5854_en?filename=Final%20Report-CCAM%20Platform.pdf, accessed 28 November 2024
- **European Commission (2024)**, European Commission, https://digital-strategy.ec.europa.eu/en/policies/regulatory-framework-ai, accessed 26 November 2024
- **European Parliament (2024),** European Parliament, “Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence and amending Regulations (EC) No 300/2008, (EU) No 167/2013, (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1139 and (EU) 2019/2144 and Directives 2014/90/EU, (EU) 2016/797 and (EU) 2020/1828 (Artificial Intelligence Act) (Text with EEA relevance), PE/24/2024/REV/1 OJ L, 2024/1689, 12.7.2024”, 2024, http://data.europa.eu/eli/reg/2024/1689/oj
- **FAME (2022)** https://www.connectedautomateddriving.eu/about/fame/, accessed 15 November 2024
- **Grandsart (2020)**, D. Grandsart, K. Bulanowski, et al., SHOW, “Deliverable 9.4: Users engagement and co-creation initiatives”, 2020, https://show-project.eu/wp-content/uploads/2024/11/SHOW_D9.4_Users_engagement_Final_combined1.pdf

- **Greis (2023)**, F. Greis, golem.de, “BMW erhält Zulassung für hochautomatisiertes Fahren”, 26 September 2023, https://www.golem.de/news/level-3-im-stau-bmw-erhaelt-zulassung-fuer-hochautomatisiertes-fahren-2309-177982.html, accessed 6 December 2024
- **Holland & Knight (2024),** Holland & Knight Law Firm, “The European Union's AI Act: What You Need to Know”, 15 March 2024, https://www.hklaw.com/en/insights/publications/2024/03/the-european-unions-ai-act-what-you-need-to-know, accessed 26 November 2024
- **Hassenforder (2015)**, E. Hassenforder, A. Smajgl, J. Ward, “Towards understanding participatory processes: Framework, application, and results. Journal of Environmental Management”, 2015, 157, 84-95. https://doi.org/10.1016/j.jenvman.2015.04.012
- **Mäkinen (2020)**, S. Mäkinen, T. Kantala, T. Haapamäki, J. Olin, M. Å. Kyyrö, SOHJOA Last Mile, “User Experience and Impact on Public Transport”, 2020, https://www.sohjoabaltic.eu/wp-content/uploads/2020/10/Sohjoa-Baltic-User-experience-and-impact-on-public-transport-30-09-2020_18.pdf
- **Moventia (2018)**, Moventia, “La gira del bus autónomo ÉRICA, organizada por AMTU y la Generalitat, empieza en Sant Cugat del Vallès”, 19 September 2018, https://moventia.es/news/la-gira-del-bus-autonomo-erica-organizada-por-amtu-y-la-generalitat-empieza-en-sant-cugat-del-valles/, accessed 27 November 2024
- **Navya (2023)**, Navya, “beti, Macif, NAVYA and VINCI Construction, win government investment tender to jointly develop an Inclusive Automated Mobility Network in Crest Val de Drôme, France”, 21 November 2022, https://www.navya.tech/en/beti-macif-navya-and-vinci-construction-win-government-investment-tender-to-jointly-develop-an-inclusive-automated-mobility-network-in-crest-val-de-drome-france/, accessed 30 October 2024
- **Rehrl (2017)**, K. Rehrl, C. Zankl, “Digibus©: results from the first self-driving shuttle trial on a public road in Austria”. Eur. Transp. Res. Rev. 10, 51, 2018, https://doi.org/10.1186/s12544-018-0326-4
- **Reus.cat (2018)**, Reus.cat, https://www.reus.cat/en/noticia/Reus-is-one-of-the-8-cities-chosen-to-test-the-first-autonomous-bus-in-Catalonia, accessed 21 November 2024
- **Ruffin, (2023)**, C. Ruffin, A. Perpey, M.-L. Watrinet, et al., IN2CCAM, “Deliverable 2.3: Use Cases Definition”, 2023, https://in2ccam.eu/wp-content/uploads/2023/10/IN2CCAM-D2.3-Use-cases-definition_v1.0.pdf
- **SAE (2014)**, SAE International, “Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles”, 16 January 2014, https://www.sae.org/standards/content/j3016_201401/, accessed 27 November 2024
- **Sohjoa Baltic (2020)**, Sohjoa, “Sohjoa Baltic Project”, https://www.sohjoabaltic.eu/, accessed 6 December 2024
- **Sohjoa Last Mile (2022),** Sohjoa, "Sohjoa Last Mile: the Future of Autonomous Transport”, https://www.sohjoalastmile.eu/, accessed 6 December 2024
- **Staelens (2020)**, P. Staelens, D. Schallauer, P. Rodriguez, et al., SHOW “Deliverable 3.3: Recommendations for Adapting Regulatory and Operational Strategies for CCAV deployment at Local and Regional Level”, 2020, https://show-project.eu/wp-content/uploads/2023/03/SHOW-WP03-D-UIP-005-01_-_SHOW_D3.3__Recommendations_for_Adapting_Regulatory_and_Operational_Strategies_for_CCAV_Deployment_at.pdf
- **Thierry-Aymé (2023)**, E. Thierry-Aymé, “Rural et périurbain, ces autres laboratoires des nouvelles mobilités”, https://www.lesechos.fr/thema/articles/rural-et-periurbain-ces-autres-laboratoires-des-nouvelles-mobilites-1975222, 5 September 2023, accessed 30 October 2024
- **TInnGO (2021)**, TInnGO, http://www.tinngo.eu/, accessed 5 December 2024

- **Tourniaire (2023)**, A. Tourniaire, V. Despinoy Nurain, L. Fraboulet, et al. ENA, “Livrable 4.5.2: Synthèse des Entretiens Acteurs locaux”, 8 March 2023, https://experimentations-navettes-autonomes.univ-gustave-eiffel.fr/fileadmin/contributeurs/Ena/livrables/Livrable_4.5.2.pdf
- **TRIMIS (2018)**, Transport Research and Innovation Monitoring and Information System (TRIMIS) https://transport.ec.europa.eu/transport-themes/research-and-innovation/strategic-transport-technology-plan-sttp/transport-research-and-innovation-monitoring-and-information-system-trimis_en, accessed 2 December 2024
- **Venkatesh (2003)**, V. Venkatesh, M. G. Morris, G. B. Davis, F. D. Davis, "User acceptance of information technology: Toward a unified view" MIS quarterly (2003): 425-478, https://doi.org/10.2307/30036540
- **Wilhelm (2023)**, K. Wilhelm, tagesschau.de, “Auf dem Highway ohne Hände am Lenkrad”, 1 October 2023, https://www.tagesschau.de/wirtschaft/autonomes-fahren-kalifornien-tesla-mercedes-100.html, accessed 6 December 2024
- **Worschech (2020)**, J. Worschech, J. Weidenauer, T. Mourey, et al., SHOW, “Deliverable 17.1: First issue of best practices and decision-making mechanisms for different stakeholder groups”, 2020, https://show-project.eu/wp-content/uploads/2023/03/SHOW-WP17-D-UIP-001-01_-_SHOW_D17_1_Best_practices___decision_making_mechanisms.pdf
- **VDV (2024)**, Verband Deutscher Verkehrsunternehmen, “Autonome Shuttle-Bus-Projekte in Deutschland”, https://www.vdv.de/liste-autonome-shuttle-bus-projekte.aspx, accessed 3 December 2024