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## Exploring Cultural Diversity in Mobility Behaviour and CCAM Acceptance

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### Abstract

The uptake of Connected, Cooperative, and Automated Mobility (CCAM) in Europe remains slow, primarily due to a lack of understanding of CCAM's societal and business benefits. To address this research gap, the EU project *Diversify-CCAM* aims to tackle the lack of inclusivity in shared mobility systems, which hinders equitable access and adoption, especially for diverse societal groups. The goal of this paper is to explore the cultural factors within the framework of this project, identify the cultural categories that influence population diversification, and predict mobility behaviour and CCAM acceptance. This analysis is conducted with a focus on the unique cultural characteristics of different countries, using case studies from four cities: Frankfurt and Monheim in Germany, and Rhodes and Thessaloniki in Greece. These cultural categories are developed using several established theories and a prior state-of-the-art study, which included a literature review and stakeholder interviews conducted across twelve pilot sites. Unlike theoretical models, which provide a more general perspective on culture, the interviews allow for a more nuanced understanding of cultural aspects in relation to future mobility. The main cultural categories identified include CCAM acceptance, governance culture, values and norms, mobility culture, innovation culture, and social equity. The diversification characteristics of Germany and Greece were revealed through quantitative and qualitative analyses of the local stakeholder interviews. This paper contributes to the literature by offering valuable tools to assess cultural influences and their potential impact on the adoption of future mobility technologies across diverse contexts.

**Keywords:** CCAM (Connected, Cooperative, and Automated Mobility), shared CCAM acceptance, shared CCAM uptake, culture, diversity aspects

### Objectives

The adoption of CCAM (Connected, Cooperative, and Automated Mobility) in Europe remains slow despite optimistic projections. The CCAM Strategic Research and Innovation Agenda [1] states that CCAM's acceptance is hindered by a lack of understanding of its societal and business benefits. Furthermore, the challenge of achieving "mobility for all," as outlined in UN Sustainable Development Goal 11.2 [2], is driven by issues such as outdated transportation system designs, technology-centric approaches, and societal disparities related to income, geography, ethnicity, disability, migration, language, accessibility, cultural practices, and infrastructure. [3, 4, 5]. The EU-funded *Diversify-CCAM* project aims to overcome these barriers by adopting a user-centric approach for the development of an all-inclusive CCAM. In particular, this project seeks to understand how diversification factors

like culture, geography, and policy influence user trust, adoption, and acceptance of CCAM technologies, and ultimately develop a tool (i.e., CCAM Diversification Tool or CCAM D-Tool) that would potentially lead to a fair deployment of the particular service.

Researchers are set to gather information on the above factors from twelve cities across six European countries: Czech Republic: Brno, Přerov; Greece: Thessaloniki, Rhodes; Italy: Modena, Carpi; Germany: Frankfurt, Monheim; Spain: Barcelona, Tarragona; Sweden: Linköping, Nykil. Additionally, multiple stakeholders from public authorities, transport manufacturers, service providers and researchers/academics were interviewed and consulted to discuss the mobility 'life' of their cities providing preliminary information.

The objective of the current study is to contribute to the broader goals of the Diversify-CCAM project, by focusing on the cultural factor - and the exploration of its aspects - that contribute to population diversification. Specifically, this study focuses on the two German and Greek cities and aims to describe their various cultural characteristics that shape their general mobility behaviour and potential CCAM acceptance and willingness to use. To achieve this, we will draw upon several established theories, as well state-of-the-art results already conducted in the earlier stages of the project, which included preliminary literature review and stakeholder's interviews.

Before delving into the cultural theories, we found it important to first attempt to define the term culture. Although many definitions have been given to culture by different disciplines, such as anthropology, sociology and psychology [6], almost all of them focus on the common mind-sets and behaviours among people. For example, Steenland [7] referred to culture as “the beliefs that people hold about reality, the norms that guide their behaviour, the values that orient their moral commitments, or the symbols through which these beliefs, norms, and values are communicated” while Klinger and his colleagues [8] as the “commonly shared knowledge which facilitates the organization of day-to-day life by suggesting particular practices as feasible and signifying others as not feasible”. Notably, in the Diversify-CCAM project, the cultural diversification factor is defined as the “the heterogeneity between different local and context-specific cultures.” [9].

Next, despite the limited knowledge regarding the specific cultural factors that can influence mobility behaviour, several theories have been proposed that can offer a valuable foundation for examining these influences. One of the most popular cultural theories is Hofstede's Cultural Dimensions Theory (HCD) [10] which provides a framework for understanding cultural norms and behaviours across societies through six dimensions. Specifically, power distance describes how societies perceive power inequalities, with high power distance cultures accepting hierarchies and low power distance cultures favouring equality. Individualism versus collectivism highlights whether individuals prioritize personal goals or the community's well-being. Masculinity versus femininity refers to a preference for competition and achievement (masculine) or nurturing and cooperation (feminine). Uncertainty avoidance measures comfort with ambiguity; high uncertainty avoidance cultures prefer stability, while low uncertainty avoidance cultures supports change. Long-term versus short-term orientation focuses on whether a culture values future planning versus traditions. Finally, indulgence versus restraint examines whether people prioritize fulfilling desires versus exercising self-control and following societal norms.

Interestingly, a relatively recent research by Dingil and his colleagues [11], which studied urban travel patterns in 87 urban areas and 41 countries based on HCD, showed that three out of the six dimensions (i.e., collectivism, uncertainty, and masculinity) were linked to higher usage of public transport.

Furthermore, the Technology Acceptance Model (TAM) [12] explains the adoption of new technology based on two main factors: perceived usefulness (how helpful a technology is) and perceived ease of use (how easy it is to use). TAM was later expanded to include other factors influencing usage intention. TAM 2 [13] added social influence (subjective norms, voluntariness, image) and cognitive instrumental processes (job relevance, output quality, result demonstrability, perceived ease of use). Subjective norm refers to beliefs about whether significant others think they should perform a behaviour, while voluntariness is the perception of technology adoption as a voluntary choice. Image relates to how innovation usage boosts social status. Job relevance and output quality relate

to the fit of the technology for a particular job and its capability to perform tasks, respectively and result demonstrability is linked to the tangible outcomes of the system which enhance its perceived usefulness. Venkatesh [14] also emphasized the role of emotion in technology adoption, noting that emotional responses like enjoyment or anxiety can affect willingness to use new technologies. In 2003, Venkatesh [15] developed the unified technology acceptance model, highlighting four key factors in technology adoption: 1) performance expectancy, 2) effort expectancy, 3) social influence, and 4) facilitating conditions. TAM 3 [16] included trust and perceived risk of technology usage.

Notably, various researchers have incorporated TAM in their studies and the analysis of automated vehicles' acceptance [e.g. 17, 18, 19]. For instance, a study comparing the acceptance of automated vehicles and car-sharing in countries across Europe, China, and North America showed that societal norms and individual experiences, such as perceived enjoyment of electric driving, influenced the acceptance of this particular technology [18].

Also, we decided to include the mobility justice concept by Cook and Butz [20] as it provides a comprehensive framework to understand inequalities in mobility access. Specifically, it describes that mobility is not simply about physical movement but also about who has access to mobility, under what conditions, and with what consequences. Certain critical factors are social equity, spatial justice, and environmental justice. The former refers to the impact of race, class, gender, and ability on access to mobility. The second deals with the unequal distribution of transportation infrastructure across regions and the latter with the environmental impacts of transportation systems on marginalized communities.

While the above theories and frameworks were not specifically created for mobility behaviour – except for the latter - they offer valuable insights into how cultural norms, values, and perceptions can shape attitudes towards transit systems and services. By using them as a theoretical basis, we attempt to categorise culture into various aspects and explore those that influence mobility behaviours in diverse contexts and specifically in the four cities in Germany and Greece.

Lastly, the previous state-of-the-art work which collected and analysed raw data including a review of literature, CCAM focused projects and stakeholder interviews, has resulted in a list of various potential diversity aspects, providing terminologies that correspond to the already existing literature, and a tabular list with the most essential components of this work that will assist in the further bifurcation of the main aspect of culture based on the project's needs and goals, creating hierarchies and identifying lower-level subcategories.

## **Methodology**

According to the higher methodological level of the project, which focuses on three diversity aspects - culture, geography and policy – culture represents diversity aspect level (L) 1, while all the different subcategories start from L2 and lower, providing deeper aspects of the former. To identify and define the different hierarchies of culture, we followed a combination of top-down and bottom-up processes. In the top-down approach, we utilised the three theoretical frameworks that were discussed earlier, along with the list of the different diversity aspects produced by the state-of-the-art work. This process mainly led to L2 and L3 subcategories, serving as a foundation for the more in-depth hierarchization. On the other hand, in the bottom-up approach, we analysed the raw data to refine and more explicitly identify the cultural diversity aspects, which provided the L3-L5 subcategories.

Firstly, we chose to closely align with the state-of-the-art work, completed in the previous stage of the project, while incorporating updates and potential modifications based on the three theoretical frameworks. In addition, we kept in mind one of the project's goal, which was to observe the diversity factors at both the individual and societal levels. After the identification of the L2 and L3 aspects, qualitative analysis of the raw data led us in the further definition of L3-L5 aspects. No additional level was deemed necessary to include in the overall categorization process. An example of this procedure can be seen in Table 1.

**Table 1. Categorization process of the culture factor**

| Diversity aspect L1 | Diversity aspect L2 | Diversity aspect L3       | Diversity aspect L4 | Diversity aspect L5 | Measurement factor    | Definition / Raw data                                         |
|---------------------|---------------------|---------------------------|---------------------|---------------------|-----------------------|---------------------------------------------------------------|
| Culture             | Mobility culture    | Conviviality              |                     |                     | Mobility_Participatio | population participates (in Monheim)                          |
| Culture             | Innovation culture  | Attitude towards new tech | Societal level      |                     | Innov_Preference for  | modern: e. g. digital trip information indicator at bus stops |
| Culture             | Mobility culture    | Car culture               | Use preference      | Societal level      | Mobility_Preference   | Germany is very car oriented                                  |
| Culture             | Innovation culture  | Attitude towards new tech | Societal level      |                     | Innov_Preference for  | Germany is less open to innovation                            |

Next, out of the twelve pilot sites being studied overall in the project, this paper focuses on the four cities in Germany and Greece, serving as case studies in this preliminary stage. Regarding the German cities, Monheim am Rhein, a city in North Rhine-Westphalia, Germany, has a population of 43,000, with 17% foreign nationals. Christianity (Roman Catholicism and Protestantism) is the largest faith, making up 50% of the population. Frankfurt, Germany's fifth-largest city with 770,000 residents, is a multicultural hub with 30% foreign nationals and a history of immigration. Christianity makes up 40% of the population, with significant Jewish and Muslim communities. Frankfurt also has experience with CCAM, having operated in a district for 11 months in 2023. In Greece, Rhodes, a medium-sized island with 125,000 residents (which doubles in summer due to tourism), has a Greek Orthodox majority, with small percentages of Muslims, Catholics, and Jews. Thessaloniki, Greece's second-largest city with 1.1 million residents, is home to various minority groups and has a strong student presence, with two major universities attracting a diverse international student population.

To further explore the diversity characteristics of each city, we conducted both quantitative and qualitative analyses on the interview data. Firstly, we began by dividing the data by city. Monheim had eight interviewed stakeholder participants (five from public authorities and three from non-governmental organizations (NGO) related to mobility). Frankfurt had four participants (two from the transport service provider, one from research and academia and one from the technical development sector related to CCAM), Rhodes had five participants (two from the transport service provider two from public authorities and one from an NGO) and, Thessaloniki had also five participants (two from transport authority, one from the transport service provider, one from the technical development sector related to CCAM and one from research and academia). To quantify the appearance of each cultural category, we systematically coded the interview transcripts, by assigning a measurement factor, and counted via the Excel Function [COUNTIF], the number of times each theme emerged. Then, we conducted a supplementary qualitative analysis of the data, which was deemed necessary due to the fact that the measurement factors often did not fully capture the data, as each component could reflect multiple cultural aspects simultaneously.

## Results

### *Categorization*

As shown in Table 2 and 3, we identified six L2 aspects (i.e., CCAM acceptance, governance culture, values and norms, mobility culture, innovation culture and social equity) with various subcategories and we calculated the occurrence of their assigned measurement factor. Particularly, CCAM acceptance aspect is defined as the public's opinions about the positive and negative aspects [perceived benefits (time efficiency, cost, usability, trust-safety, sustainability and social equity), perceived risks (cybersecurity and trust-safety)] of the particular technology that influence the level of trust and acceptance/willingness to use it. Governance culture deals with people's trust in authorities (government and transport system) regarding the effectiveness of the transport system and the perceived ability of the government to promote public interest. Values and norms refer to the fundamental beliefs/principles and social rules/expectations that shape transport choice and include individualism (need for privacy and comfort), collectivism (social influence and preference for social interactions) and general acceptance of diverse people during commuting. Mobility culture refers to the societal and individual preferences and behaviours associated with transport choice (i.e., car, public-transportation, walking, cycling, shared-mobility, intermodalities), including also conviviality (how participation in social life is associated with mobility behaviour), safety culture (need for personal and transport safety and tendency to follow traffic regulations), and work culture (telecommuting or commuting). Innovation culture refers to the societal and individual encouragement of creativity, experimentation, risk-taking along with the existence of innovative infrastructure which encompass both the practical aspects of adopting new technologies (tech-savviness), including green initiatives (sustainable culture) and the internal dimensions, such as

the general attitudes towards innovation. Lastly, social equity refers to fair access and inclusivity within transportation systems based on the demographic and financial characteristics of the population, its geographical location and the facilitating conditions (existing infrastructure) to commute.

Due to the requirement to have six main aspects, as in the previous state-of-the-art work, we decided to include work culture within mobility culture, as it reflects how employment influences an individual's travel behaviour. In addition, we included sustainability culture within innovation culture, as it portrays another aspect of the latter, describing tendencies to support new green initiatives and solutions in the transport system. It should be noted that only mobility and innovation cultures were deemed necessary to have both societal and individual levels as they are found one of the most important factors to investigate the overall CCAM attitudes, while dividing every aspect in two levels would further increase the data, making the analysis more complicated.

Notably, HCD, and particularly the dimensions of masculinity vs femininity, uncertainty avoidance, long-term vs short-term avoidance and individualism vs collectivism, contributed to the creation of the innovation culture and values and norms L2 aspects. TAM contributed to CCAM acceptance, social equity, innovation culture, values and norms and mobility culture L2 aspects and in several of their subcategories. Lastly, the social equity L2 aspect and its subcategories were mostly based on the mobility justice concept.

**Table 2. Cultural diversity aspects (L2-L5)**

| Aspect L2          | Aspect L3                | Aspect L4                 | Aspect L5        | Measurement Factor                                           | Summary |
|--------------------|--------------------------|---------------------------|------------------|--------------------------------------------------------------|---------|
| CCAM acceptance    | Perceived benefits       | Time efficiency           |                  | CCAM_Preference for fast CCAM                                | 10      |
|                    |                          | Cost                      |                  | CCAM_Preference for the most economical transport            | 5       |
|                    |                          | Usability                 |                  | CCAM_Preference for ease of use                              | 9       |
|                    |                          | Trust-Safety              |                  | CCAM_Preference for safe and secure transportation (benefit) | 7       |
|                    |                          | Sustainability            |                  | CCAM_Preference for environmentally friendly transport       | 3       |
|                    |                          | Social Equity             |                  | CCAM_Preference for transit inclusivity                      | 8       |
|                    | Perceived risks          | Cybersecurity             |                  | CCAM_Preference for data privacy                             | 5       |
|                    |                          | Trust-Safety              |                  | CCAM_Preference for safe and secure transportation (risk)    | 3       |
| Governance culture | Trust                    | Governmental Institutions |                  | Governance_Trust in institutions                             | 12      |
|                    |                          | Transport system          |                  | Governance_Trust in transport system                         | 19      |
| Values and norms   | Individualism            | Privacy                   |                  | ValNor_Prioritization of individuality (privacy)             | 4       |
|                    |                          | Comfort                   |                  | ValNor_Prioritization of individuality (comfort)             | 8       |
|                    | Collectivism             | Social interactions       |                  | ValNor_Preference for collectivism (social influence)        | 7       |
|                    |                          | Social influence          |                  | ValNor_Preference for collectivism (social interactions)     | 6       |
|                    | Diversity acceptance     |                           |                  | ValNor_Acceptance of diversity                               | 5       |
| Mobility culture   | Car culture              | Ownership preference      | Societal level   | Mobility_Preference for car ownership (societal)             | 16      |
|                    |                          |                           | Individual level | Mobility_Preference for car ownership (individual)           | 0       |
|                    |                          | Use preference            | Societal level   | Mobility_Preference for car use (societal)                   | 16      |
|                    |                          |                           | Individual level | Mobility_Preference for car use (individual)                 | 0       |
|                    |                          | Dependency                | Societal level   | Mobility_Car dependency (societal)                           | 17      |
|                    |                          |                           | Individual level | Mobility_Car dependency (individual)                         | 0       |
|                    |                          | Car identity              | Societal level   | Mobility_Car identity (societal)                             | 10      |
|                    |                          |                           | Individual level | Mobility_Car identity (individual)                           | 0       |
|                    | Public-transport culture | Use preference            | Societal level   | Mobility_Preference for public transit (societal)            | 15      |
|                    |                          |                           | Individual level | Mobility_Preference for public transit (individual)          | 0       |
|                    |                          | Satisfaction              | Societal level   | Mobility_Satisfaction with transport system (societal)       | 9       |
|                    |                          |                           | Individual level | Mobility_Satisfaction with transport system (individual)     | 0       |
|                    |                          | Public-transport identity | Societal level   | Mobility_Public-transport identity (societal)                | 1       |
|                    |                          |                           | Individual level | Mobility_Public-transport identity (individual)              | 0       |
|                    | Walking culture          | Societal level            |                  | Mobility_Preference for walking (societal)                   | 6       |
|                    |                          |                           | Individual level | Mobility_Preference for walking (individual)                 | 0       |

**Table 3. Cultural diversity aspects (L2-L5) (continuation)**

| Aspect L2          | Aspect L3                 | Aspect L4                   | Aspect L5           | Measurement Factor                                                   | Summary |
|--------------------|---------------------------|-----------------------------|---------------------|----------------------------------------------------------------------|---------|
| Mobility culture   | Cycling culture           | Societal level              |                     | Mobility_Preference for cycling (societal)                           | 12      |
|                    |                           | Individual level            |                     | Mobility_Preference for cycling (individual)                         | 0       |
|                    | Shared-mobility culture   | Societal level              |                     | Mobility_Preference for shared mobility alternatives (societal)      | 10      |
|                    |                           | Individual level            |                     | Mobility_Preference for shared mobility alternatives (individual)    | 0       |
|                    | Intermodalities           | Societal level              |                     | Mobility_Preference for intermodalities (societal)                   | 1       |
|                    |                           | Individual level            |                     | Mobility_Preference for intermodalities (individual)                 | 0       |
|                    | Conviviality              |                             |                     | Mobility_Participation in societal habits                            | 10      |
|                    | Safety culture            | Traffic rule compliance     | Societal level      | Mobility_Preference to follow traffic rules (societal)               | 1       |
|                    |                           |                             | Individual level    | Mobility_Preference to follow traffic rules (individual)             | 0       |
|                    |                           | Trust-Safety                | Societal level      | Mobility_Preference for a safe and secure transportation system      | 6       |
|                    |                           |                             | Individual level    | Mobility_Preference for a safe and secure transportation system      | 0       |
|                    |                           | Petty Crime-Safety          | Societal level      | Mobility_Preference to avoid petty crimes (societal)                 | 1       |
|                    |                           |                             | Individual level    | Mobility_Preference to avoid petty crimes (individual)               | 0       |
|                    | Work culture              | Telecommuting               | Societal level      | Mobility_Preference to telecommute (societal)                        | 8       |
|                    |                           |                             | Individual level    | Mobility_Preference to telecommute (individual)                      | 0       |
|                    |                           | Commuting                   | Societal level      | Mobility_Preference to commute (societal)                            | 8       |
|                    |                           |                             | Individual level    | Mobility_Preference to commute (individual)                          | 0       |
| Innovation culture | Innovative Infrastructure |                             |                     | Innov_Existence of innovative infrastructure                         | 9       |
|                    | Attitude towards advance  | New technologies            | Societal level      | Innov_Preference for new technologies (societal)                     | 23      |
|                    |                           |                             | Individual level    | Innov_Preference for new technologies (individual)                   | 0       |
|                    |                           | New mobility options        | Societal level      | Innov_Preference for new mobility options (societal)                 | 26      |
|                    |                           |                             | Individual level    | Innov_Preference for new mobility options (individual)               | 0       |
|                    |                           | Perceived value of innova   | Societal level      | Innov_Level of perceived innovation value (societal)                 | 21      |
|                    |                           |                             | Individual level    | Innov_Level of perceived innovation value (individual)               | 0       |
|                    | Tech-savviness            | Societal level              |                     | Innov_Preference to use technologies (societal)                      | 12      |
|                    |                           |                             | Individual level    | Innov_Preference to use technologies (individual)                    | 0       |
|                    | Sustainability culture    | Support of green initiative | Societal level      | Innov_Preference for environmentally friendly transport (societal)   | 17      |
|                    |                           |                             | Individual level    | Innov_Preference for environmentally friendly transport (individual) | 0       |
|                    |                           | Green awareness             | Societal level      | Innov_Level of environmental sensitization (societal)                | 13      |
|                    |                           |                             | Individual level    | Innov_Level of environmental sensitization (individual)              | 0       |
| Social Equity      | Transit accessibility     | Geography                   | Rural areas         | SocialEq_Transit accessibility (rural areas)                         | 5       |
|                    |                           |                             | Islands             | SocialEq_Transit accessibility (islands)                             | 0       |
|                    |                           | Infrastructure              |                     | SocialEq_Transit accessibility (infrastructure)                      | 5       |
|                    | Transit inclusivity       | Demographics                | Gender              | SocialEq_Transit inclusivity (gender)                                | 3       |
|                    |                           |                             | Vulnerable to exclu | SocialEq_Transit inclusivity (vulnerable to exclusion groups)        | 7       |
|                    |                           |                             | Language            | SocialEq_Transit inclusivity (language)                              | 6       |
|                    |                           |                             | Economic status     | SocialEq_Transit inclusivity (economic status)                       | 1       |

Based on the above results, the aspects with the most frequent occurrences were innovation culture, car culture, public transport culture and governance culture. Those with zero occurrences did not appear on the raw data.

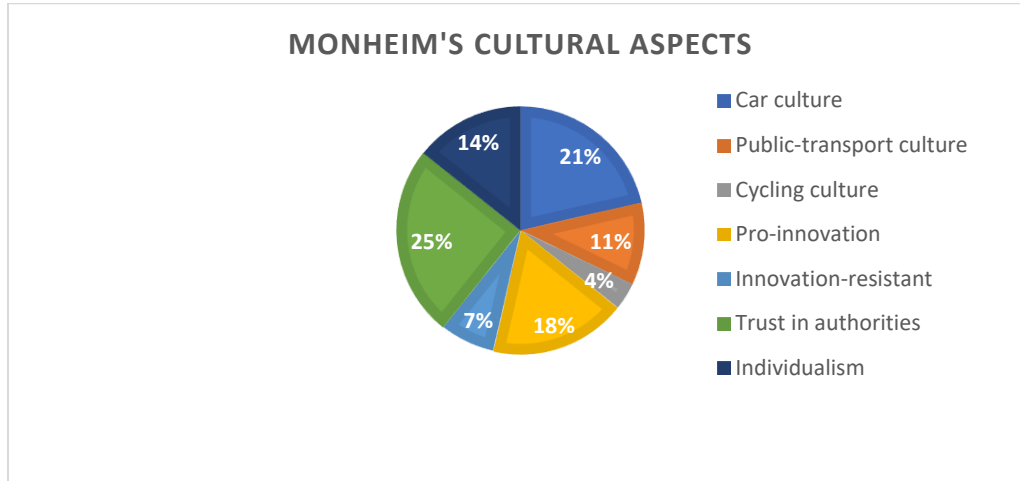
#### *Population diversification across the four case study cities*

##### Monheim

The quantitative results for Monheim from largest to smallest were mobility culture [car culture (9), public transport culture (1), conviviality (3), safety culture (1)], innovation culture [innovative infrastructure (2), attitude towards advancement (5), tech-savviness (1)], governance culture [trust in governmental institutions (4) and transport system (3)], CCAM acceptance [time efficiency (1) and safety (1) as perceived benefits, and safety (1) as perceived risk], values and norms [individualism (1) and diversity acceptance (1)], and social equity [transit inclusivity-vulnerable to exclusion groups (1)].

The qualitative analysis (Figure 1) revealed a strong car culture (6) in Monheim, with the need for high status (3) partially driving it, adding to the evident individualism (4). In fact, one interviewee made the following statement: “Status can be expressed by having your own vehicle, if I use a vehicle that I don't own (e.g. a bus), then I have to use something else to show off.” Nevertheless, a medium level (3) of public transport culture is also reported. This is matched with the fair amount of trust in authorities (7) and specifically in the transport system (3) with one interviewee stating that “trust in mobility system and government is high in Monheim.”. Even-though there are two mentions about people's hesitance towards innovation and technology, the Monheim in general seems to be

characterized by a strong innovation culture with openness towards advancement (1), tech-savviness (1), and existent innovative infrastructure (3). Finally, stakeholders mentioned that CCAM could potential be accepted by the public need for fast commuting and road safety during the night. However, there was one mention of a safety concern regarding the driverless operation of CCAM.

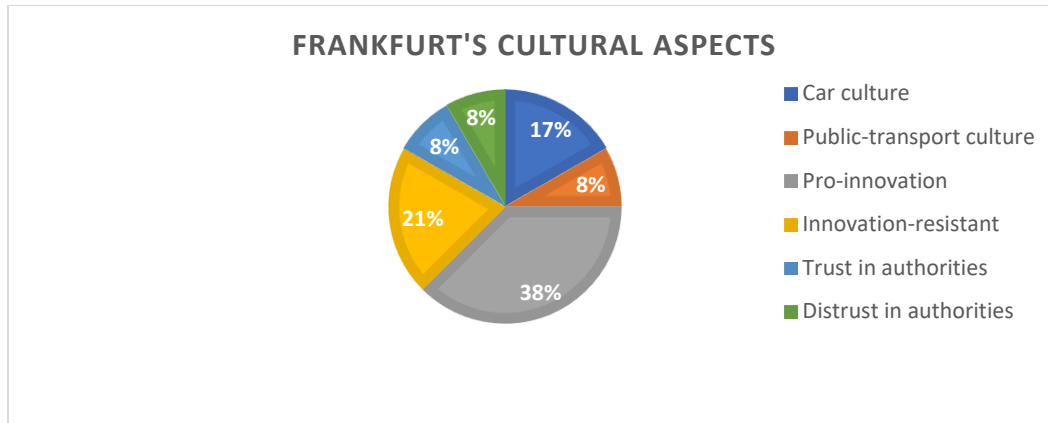


**Figure 1. Monheim's cultural aspects**

### Frankfurt

For the German city of Frankfurt, the quantitative results from largest to smallest were innovation culture [attitude towards advancement (10), sustainable culture (2)], mobility culture [car culture (4), public transport culture (1), safety culture (1), telecommuting (1)], values and norms [diversity acceptance (2)], and social equity [transit inclusivity-gender (1)].

Then, qualitative analysis (Figure 2) revealed both high levels of innovation openness (9) and innovation scepticism (5), with the former one being mostly associated with the urban areas and younger generation, while the latter by the authorities ("Authorities (as opposed to general public) are more traditional and do not want to break new ground") and migrant people ("People with a migration background, in particular, tend to reject certain initiatives [...]"). Furthermore, the preference for cars (4) was, to a degree, based on a certain traditionalism (2) in the country, with one interviewee stating that "Germany is traditionally a 'nation of car drivers' [...]" and could be also stemmed by the average trust towards the public transport system. Despite this, some preference for public transportation (2) is present. Moreover, the public trust towards authorities was average, partially driven by the Frankfurt's multicultural characteristics with one respondent mentioning. Finally, stakeholders mentioned that CCAM could potential be accepted by the public need for "[...] flexibility and availability of mobility solutions", although their lack of CCAM knowledge may lead inappropriate commuting behaviour "Pedestrians might 'test' autonomous vehicles by crossing the street, knowing the vehicle must stop. [...] Complicates CCAM operation/effectiveness".

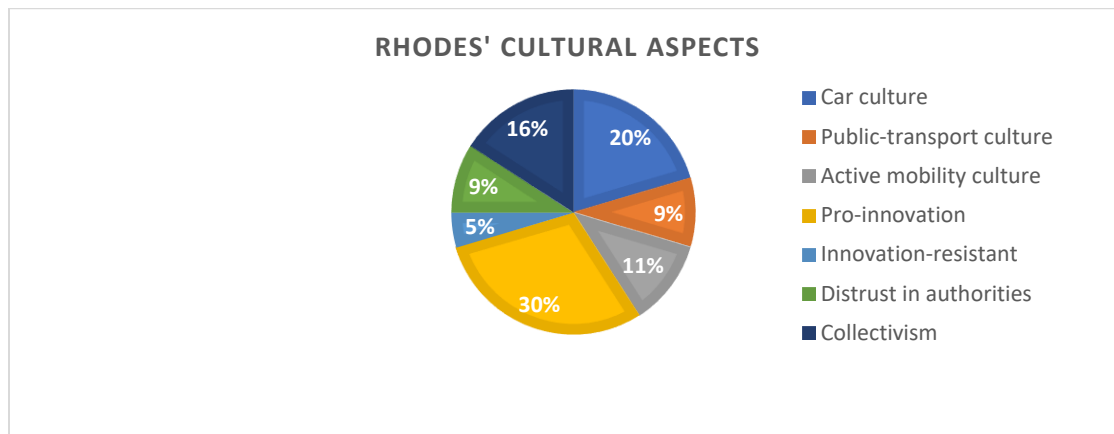


**Figure 2. Frankfurt's cultural aspects**

### Rhodes

Firstly, quantitative analysis of Rhodes showed characteristics from mobility culture [car culture (8), public-transport culture (3), walking culture (2), shared mobility culture (2), telecommuting (1) commuting (3)], innovation culture [sustainability (8), attitude towards advancement (7), tech-savviness (1)], value and norms [collectivism (5)], governance culture (3), CCAM acceptance [sustainability as perceived benefit (2), safety as a perceived risk (1)] and social equity [transport accessibility-geography (2) and infrastructure (1)].

The qualitative analysis (Figure 3) showed that Rhodian people and tourists have a strong car orientation (9) with one respondent reporting that “tourists tend to highly use rental cars and taxis, local tend to prefer using their private cars”. However, we observed a growing interest towards public-transportation (4) and active mobility [cycling (3) and walking (2)]. Next, it was reported a strong innovation culture (13), including sustainability culture (9) which stemmed by both locals, mainly young generation, and tourists. Interestingly, qualitative analysis suggested an even higher degree of collectivism (7) among the people in Rhodes, with community seemingly influencing mode choice. For instance, one said “The deep family and community bonds that exist in Rhodes society, lead its inhabitants to trust more service providers [...]”. Also, we found a low trust in authorities (4) and a perceived limited public-transport infrastructure (6), especially in its rural sites. It is also worth noting that, although limited, some individualistic needs (2) emerged, with one participant stating “[...] people might be reluctant to embrace automated or shared mobility options, over their trusted vehicles which offer them a sense of control and comfort”. Finally, stakeholders mentioned that CCAM could potential be accepted by the increased public environmental sensitization. However, it could also be hindered by the strong car culture, lack of CCAM knowledge and safety concerns, such as road safety issues due to driverless commuting and cybersecurity risks.

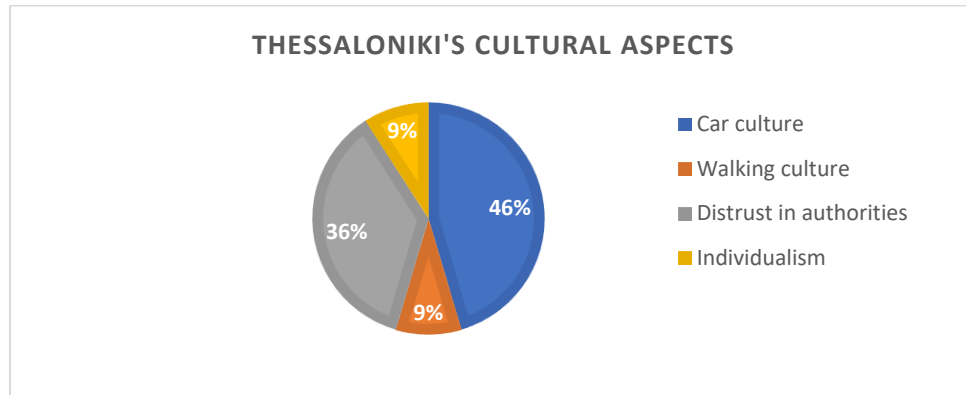


**Figure 3. Rhodes' cultural aspects**

### Thessaloniki

Secondly, stakeholder's interviews from Thessaloniki provided with less information about the mobility "life" of the city. The quantitative results showed characteristics from mobility culture [car culture (4), , public-transport culture (1), walking (1)], governance culture (3), innovation culture (innovative preference (2)), CCAM acceptance [safety as perceived risk (2)], values and norms [diversity acceptance (1)] and social equity [infrastructure accessibility (1), inclusivity based on economic status (1)]. Finally, stakeholders mentioned that CCAM could potential be hindered by the public concern of driverless commuting, lack of familiarization and increased car culture.

Then, the qualitative analysis (Figure 4) supported the strong car orientation (5) of people there, with one participant stating, making individualism also evident, "The feeling of control and the love of driving may have a negative impact on the acceptance of systems [CCAM]". We also found low trust in the public-transport system with four mentions such as "The level of confidence in the transport system is not strong", two mentions of perceived concern about CCAM's safety and security, one of the limited infrastructure on transport system, and one of existing positive innovative attitudes. Additionally, we found low CCAM awareness with three mentions: "Users should [...] have been given appropriate information, training and familiarisation to increase their confidence in the systems"), a factor which was not included as a distinct diversity aspect but was mainly included in the innovation culture.

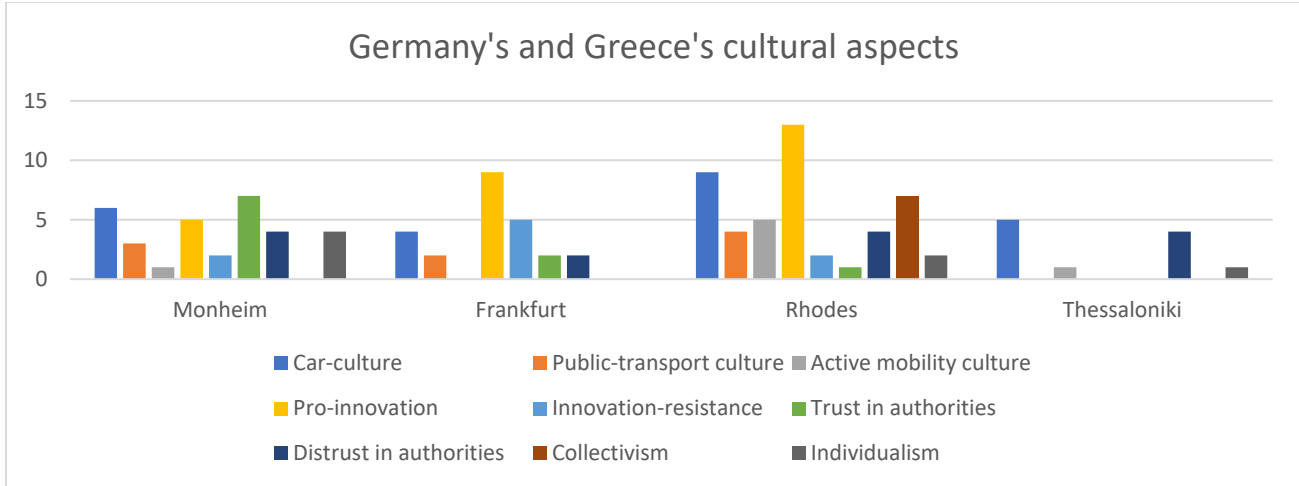


**Figure 4. Thessaloniki's cultural aspects**

### **Discussion**

This study, conducted within the framework of the Diversify-CCAM project, aimed to explore cultural aspects that are crucial for understanding the diversification characteristics and overall readiness of populations for CCAM, with a focus on the German and Greek pilot sites. Through a combination of data stemming from a previous literature review and stakeholder interviews, with the former providing the general orientation and the latter the more nuanced aspects, key cultural categories and subcategories were identified. These main six cultural categories were CCAM acceptance, governance culture, values and norms, mobility culture, innovation culture and social equity. Mobility culture also included work and safety cultures, while sustainability culture was added as a subcategory of innovation culture.

Then, by creating measurement factors, we were able to calculate the frequency of occurrence of every main category and subcategory in the raw data. We found that the most significant diversity cultural aspects were innovation culture, car culture, public transport culture and governance culture, suggesting that mobility "life" and the possible CCAM acceptance are mostly associated with mode choice, the level of innovative attitudes and openness towards new things, and trust towards authorities. Next, by applying both quantitative and qualitative analyses (Figure 5), we examined the German and Greek pilot sites and explored their cultural characteristics related to mobility behaviour, attitudes and potential CCAM readiness.



**Figure 5. Germany's and Greece's main cultural aspects**

Initially, as expected, both German areas exhibit strong car culture and a weaker preference for public-transport, which was explained by some interviewees by country's overall car tradition and partly driven by some level of individualism (i.e., need for high status). Moreover, both areas exhibit medium to high levels of innovation openness, particularly in Frankfurt, which is to be expected due to its larger size compared to Monheim. At the same time, innovation resistance is evident, especially in Frankfurt, driven by certain cultural groups and governmental risk-aversion. Interestingly, the lower trust in authorities in Frankfurt, compared to Monheim, could be explained by the stronger cultural diversity in the latter area. The aspects that could potentially lead to CCAM acceptance include the average innovation culture, the average trust in authorities and certain operational characteristics of the German population, that were mentioned in the interviews, such as the need for fast, flexible, safe and night-time commuting. On the other hand, the aspects that could hinder CCAM acceptance are the strong car culture and the part of the population that exhibits distrust towards authorities and innovation-resistance.

Next, both Rhodes and Thessaloniki exhibited strong car preference, possibly due to a lack of public transport infrastructure and some levels of individualism. Interestingly, both regions showed mostly distrust towards authorities and mainly the transport system that could stem from a historical political instability, economic crises, and perceived inefficiencies in public services, aspects that have been discussed in several published articles such as by the OECD [25] and CESifo [26]. In contrast to Thessaloniki, we found stronger innovation culture, and particularly high sustainability culture, in Rhodes which may be explained by the island's strong focus on tourism-driven technological advancements and adaptive mobility solutions. Additionally, a smaller, more agile community and proactive local initiatives may foster a sense of rapid innovation. Thus, in Rhodes, the cultural aspects that are associated with CCAM acceptance are the strong innovation culture and the strong existing sense of collectivism, with people supporting initiatives that bring social and community benefits, as is expected in small, relative homogeneous communities like Rhodes. However, it also has the potential to produce the opposite effect in case community does not perceive CCAM as beneficial. In addition, the increased need for transport availability due to accessibility issues in both Greek regions may also add to the potential CCAM acceptance. On the other hand, the strong car culture, medium to high distrust in authorities, lack of CCAM knowledge and safety/security concerns regarding CCAM in Rhodes and Thessaloniki may impede its adoption.

Interestingly, all four sites showed a strong car culture, possibly reflecting the general demands of modern society for fast and flexible travel to accommodate busy lifestyles while also promoting attachment to cars as status symbols. In addition, this car dependency may be reinforced by dissatisfaction with unreliable public transit, and perceptions of ineffective government planning which can be reflected by the nature of governance culture in most of these areas. Alternative mobility preference was mostly seen in Rhodes, which may stem from its slower pace of life, as it is a smaller island, and high tourism which could decrease the need for fast transportation. The higher trust

towards authorities, including transport system, in Germany compared to Greece could be driven by the former's more stable governance and well-maintained infrastructure. Surprisingly, Rhodes show the strongest innovation culture which, as previously mentioned, could be explained by the island's small size and focus on accommodating tourists. On the other hand, the largest and more economically advanced city of Frankfurt seems to have a more structured and traditional innovation approach, leading to the weaker innovation culture.

While this study provides valuable insights, certain limitations should be acknowledged. Firstly, the reliance on a small number of stakeholder interviews may introduce biases related to sample selection and interpretation as we did not gather information directly from the population. Secondly, the vague nature of some interview components and the simultaneous occurrence of cultural aspects on a single component, inhibited us to include every information to a specific cultural subcategory, thus influencing quantitative analysis. Thirdly, we may have overlooked potential important cultural aspects, due to limited existing research and biased interviews. Also, the interviews in Thessaloniki were performed before the opening of the new subway, which could have led to different responses. In addition, the data collected by the the former region seemed to be limited as interviewers disclosed less information compared to the other areas, leading to insufficient analysis. Despite the above, the results of this study will continue to evolve as the questionnaires are administered directly to the users at pilot sites. The data collected will inform this stage of the study and may lead to adjustments in the developed cultural categories to better reflect the characteristics of the populations.

## Conclusions

Culture is a highly complex concept that requires careful consideration in research and should be clearly defined based on the specific goals of the study. Our work focused on the aspects that differentiate the mobility values and behaviours within diverse population and potentially influence their CCAM acceptance level. In particular, data analysis showed that mobility culture, governance culture and innovation culture were the most frequently mentioned aspects influencing the general mobility 'life' of people in Germany and Greece. These aspects are possibly the most important for researching CCAM acceptance, as they can reveal factors influencing mode choice and resistance or openness to new travel behaviours. Certain operational preferences were also mentioned to influence the willingness to use CCAM. Future research and the integration of these aspects into upcoming surveys, with large population samples from the 12 project pilot sites, can verify their validity and identify any potential improvements and gaps in our work.

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