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How to Promote and Implement Mobility as a Service? An Italian Survey to Learn About the Propensity of Users

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Abstract

To discourage private vehicle use and promote multimodality, Mobility-as-a-Service (MaaS) has been developed in recent years. The idea is to combine different types of transportation, including active transportation, on-demand cab services, shared vehicles, and emerging micromobility technologies (such as e-bikes and electric scooters), with well-known modes of public transport, such as rail, tram, bus, and ferry. In this way, users can plan and book their trips using a single platform and user account. This study aims to investigate the needs and desires of travelers from a real perspective of Integrated Mobility as a Service. To achieve this goal, a survey was performed in the Italian context to understand the profiles and needs of potential MaaS users. The structure of the survey includes 33 questions divided into seven sections: i) Introduction and Language, ii) Daily Travel and Transportation, iii) MaaS and Sharing Mobility, iv) Travel Behavior and Technology, v) MaaS Platform, vi) MaaS Platform Travel Functions, and vii) Socio-demographic Information. A total of 301 responses were collected. Analysis of the results allows us to: i) understand whether there is a correlation between user profiling and the daily transportation mode chosen by travelers, ii) identify representative clusters that include the characteristics of travelers that are most closely related to transportation modal choice. Three clusters of users were identified by considering the following criteria: a) occupation, b) residence, and c) reason for travel. Finally, iii) the interest in MaaS was evaluated. The results can be used to implement representative mobility scenarios that reflect user needs and provide valuable insights for designing MaaS products in different spatial areas.

Keywords: Mobility as a Service; Transportation management; Transportation planning; Sustainable Mobility; Mobility survey; Mobility bundles; User behavior

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1. Introduction

Different smart, integrated, and sustainable mobility solutions are becoming increasingly popular to address the important and ambitious goals of decarbonizing and reducing externalities in the transportation sector. Mobility-as-a-Service (MaaS) represents one such solution as it is an integrated system that allows people to plan, book, pay, and manage trips using different service providers in a single platform. MaaS thus represents a potential alternative to private vehicle ownership, especially in an urban context. Moreover, MaaS could provide an addition to public transport also in the case a good transit network design and quality of service are provided (Barabino, 2009, 2018). The goal of this paper is to present the results of a preliminary analysis performed as a result of a survey to (i) understand whether there is a correlation between user profiling and the daily mode of transportation chosen by travelers, (ii) identify representative clusters that include the characteristics of travelers most closely related to the mode of transportation used, and (ii) assess the interest the propensity of users for MaaS. Although preliminary, the results of this work can be used to define mobility scenarios that different mobility operators can implement. The paper is organized as follows: section 2 gives the background on the topic of MaaS; section 3 describes the structure of the survey, the sample (3.1), the correlation and cluster analysis (3.2), and the analysis of the responses to the MaaS-focused questionnaire (3.3). Section 4 presents the conclusions and further development of the work.

2. Background

Increasing demand for mobility in urban areas has gradually led to the development of on-demand modes of transport. The wide range of travel options, on the one hand, increases modal choices and accessibility; on the other hand, it increases the complexity for travelers to juggle multiple transport modes (Alonso-González et al. 2020). Mobility as a Service (MaaS) is rapidly emerging to manage this complexity. To better structure and explore the MaaS context, four macro-groups were identified to track the development of MaaS: Business, Governance, Technology, and Social. These topics may serve as the foundation pillars of MaaS worldwide. The main takeaway of the analysis has brought some final resuming considerations related to each of the pillars investigated. As for Business, it has been found that although competition and liberalization benefit the MaaS industry, they are insufficient (Wonga et al., 2006). Additionally, while various business models may be used, the ideal one is still unclear (Aapaoja et al., 2017). Integrated fares are the cornerstone of success, yet there is still considerable inconsistency in the price and make-up of transit options offered (Abrate et al., 2009). As for Governance, the studies claim that building a level playing field requires public planning and interventions, and the appropriate number of interventions might be disputed. In the meantime, some nations have already implemented the legislative framework and are far ahead of others (Mantelero, 2015). In the Technological fields, the main takeaways are related to the fact that MaaS can drive technical advancement and is strongly dependent on it (Szmelter-Jarosz, 2018). Moreover, the MaaS ecosystem needs standards set and adhered to by all businesses to grow quickly and effectively (Polydoropoulou et al., 2020). Overall, a mobile app is the obvious example of MaaS, and the caliber of the app may have an indirect impact on user decisions that influence the overall transportation ecosystem (Stopka, 2014). Concerning the social context, it has emerged that people's strong habits are hard to break, but by combining the MaaS Pay-per-Use and mobility package systems, this challenge may be lessened (Durand and Harms, 2018). In any case, the main goal of MaaS must be to meet each user's specific mobility demands with tailored offerings (Johansson, 2017). Furthermore, rewards and incentives may impact users' mobility decisions (Pratelli et al., 2019). Regarding surveys, there are some international experiences to study users' travel behavior and preferences (Arias-Molinares and García-Palomares, 2020; Maas, 2022; Caballini et al., 2023). For example, a survey was performed involving 6,000 commuters in England, Germany, the Czech Republic, and Poland to know their willingness to use MaaS (Matowicki et al., 2022). An additional survey was conducted in Greater Manchester, UK, to study the demand and willingness to pay for MaaS and consider different services offered (Tsouros et al., 2021). It is then necessary to consider possible barriers related to the implantation of MaaS, including, for example, the lack of attractiveness to older generations, public transport users, and private vehicle users, from the attractiveness of the digital platform and users' willingness to pay (Butler et al., 2022). This paper is in the last area of MaaS (Social) to investigate (i) the relationships between socio-demographic information, (ii) users' behavior and desires, (iii) willingness to pay, and (iv) service forms and functions. By deepening this field of research, this work aims to enrich knowledge regarding user profiling in the Italian context, where the motorization rate is among the

highest in Europe. Knowing travelers' habits, needs, and propensity to use MaaS can be useful in defining a suitable, convenient, and integrated transport offer instead of using private cars.

3. Methodology implementation and preliminary results of the survey

The survey was organized into seven sections and 33 questions in Italian and English to ensure greater dissemination and participation, as shown in Table 1. The total number of questions was evaluated considering an average response time of 15 minutes; this represents a compromise between the speed of the survey and the need to acquire specific responses from people.

Table 1. Survey structure and organization.

N. section	Title	Focus and Goals	N. Questions
1	Introduction and language	Research work description	1
2	Daily Trips and Means of transport	Current mobility habits	7
3	MaaS and Sharing Mobility	Knowledge of topics	1
4	Travel Behavior and Technology	Technology confidence and use	3
5	MaaS Platform	Mobility services and Ancillaries	13
6	MaaS platform travel functions	Functionalities for trip phases	3
7	Socio-Demographic info	Sample characteristics	5

The responses are anonymous; some are mandatory, while others are optional. Regarding dissemination, the Microsoft Forms tool used social networks (Facebook, Linkedin, Twitter) and research sites (Research Gate). From August 2022 until the end of April 2024, 301 responses were provided. This article focuses only on a few points touched upon by the survey, as there is not enough space to analyze all respondents' answers comprehensively. Fig. 1 shows the structure of the preliminary analysis performed in this paper, and it is organized into three levels: i) the first level concerns the description of the sample of respondents; ii) the second level makes a cluster analysis to assess possible correlations among the responses; iii) the third level analyzes some responses related to interest and propensity towards MaaS. The following sections describe the three levels of analysis.

Fig. 1. (a) Levels of analysis of obtained responses.

3.1. Level 1 - Sample description

The first level of analysis concerns the sample of responses received; in particular, three questions were considered: 2a) *How old are you?* 2b) *What's your gender?* and 2c) *Do you know the terms MaaS and Shared Mobility?* as illustrated in Fig. 2. Specifically, these questions may have been deemed necessary to gather relevant information for segmentation purposes. Addressing characteristics like age, gender, and familiarity with technical terms such as MaaS and shared mobility can provide valuable insights for research or tailored recommendations. Regarding question 2a), it is observed that most people are between 20 and 70 years old, with a peak of responses for the 36-55 age range. Response 2b) shows a reasonably balanced gender distribution with a prevalence of men (165) compared to women (128). Finally, question 2c) shows that 44% of the respondents are unfamiliar with the terms MaaS and Shared Mobility. The next step was to analyze the sample of responses by considering two additional questions related to people's journeys: 3a) *How many trips do you make on average in a day? (Trip means a journey from starting point A to ending point B for a given reason)* and 3b) *What is the reason for the main or most frequent trip of your typical day?* as illustrated in Fig. 3.

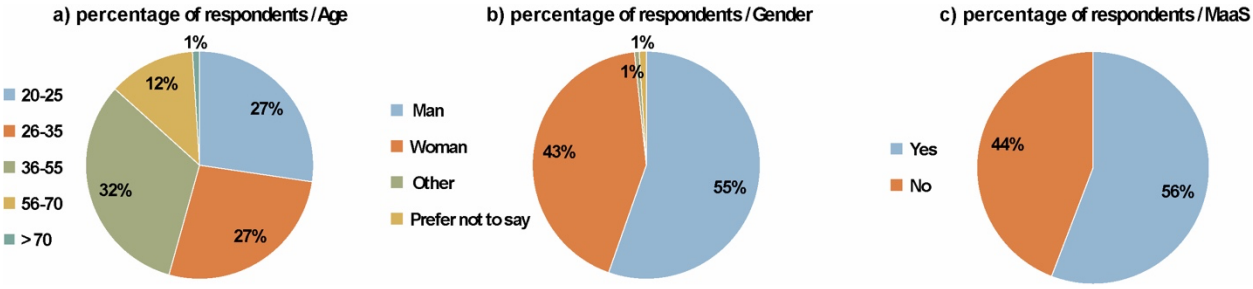

Fig. 2. (a) How old are you? b) What's your gender? and c) Do you know the terms MaaS and Shared Mobility?

Fig. 3. (a) How many trips do you make on average in a day? b) What is the reason for the main or most frequent trip of your typical day?

Specifically, understanding the average number of trips a person makes in a day provides critical data on travel behavior and patterns. This information mainly helps assess the demand for services and identify the extent of mobility and transport needs of the population. In addition, identifying the primary reason for travel sheds light on the purpose behind most trips, which is crucial for determining the types of services and facilities that should be prioritized (e.g., work commutes, shopping, leisure) and tailoring transport solutions to meet the specific needs of different user groups. Therefore, these questions provide a comprehensive view of travel habits and needs, enabling more effective and user-centered transportation planning and development. The last analysis of level 1 concerns occupation and income: *4a) What's your occupation? and 4b) What's your income bracket?* as shown in Fig. 4. Understanding a respondent's occupation helps identify travel patterns, transport needs, and socioeconomic. Thus, occupation can indicate socioeconomic status, influencing travel behavior and transportation preferences. In addition, knowing a respondent's income bracket is crucial for affordability and accessibility, transportation choices, policy, and planning. Hence, both questions comprehensively understand the socioeconomic factors influencing transport needs and preferences, enabling more effective and equitable planning.

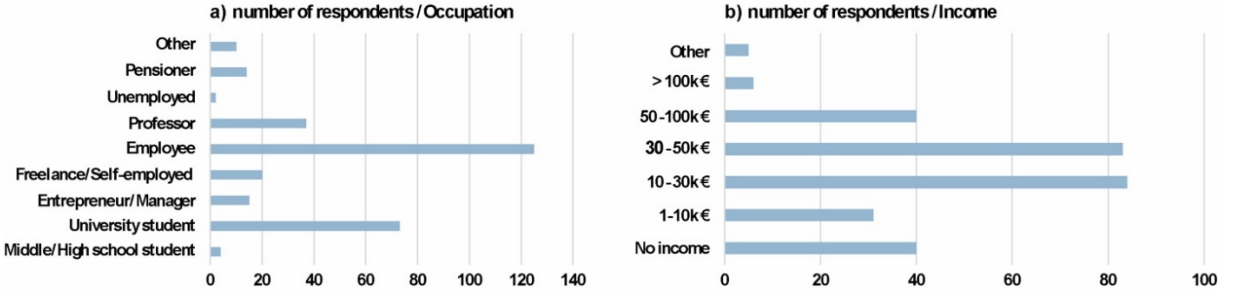

Fig. 4. (a) What's your occupation? b) What's your income bracket?

Most of the people who answered question 4a) are employed, while in second place are university students (about half of the employed). Regarding question 4b) on income bracket, it is observed that there are two income brackets

characterized by the same number of responses: the 10-30k€ and 30-50k€ brackets. The other income brackets have fewer responses (about half).

3.2. Level 2 - Results of correlation and clustering analysis

The second level of analysis aims to understand whether there is a correlation between the user profile and daily transport modal choice of travelers; secondly, it aims to identify clusters based on the correlation found among the different variables considered. The chi-square test of independence was conducted with R software to answer the first research objective. This test compares a pair of categorical variables, testing their association. Survey responses related to the question "*Which mode of transport do you use most frequently?*" were compared through the chi-square test with questions related to user profile: age, occupation, residence, income, number of daily journeys, and reason for the journey. Table 2 shows the statistical test results, defining the variables correlated with the choice of transport mode.

Table 2. Results of the Chi-square test on the correlation between the variable "mode of transport".

Variable 1	Variable 2	$\chi 2$	Degrees of freedom (df)	p-value
Mode of transport	Age	82.55	70	0.1447
	Occupation*	170.01	126	0.0054
	Residence*	42.99	28	0.0348
	Income	102.31	84	0.0850
	Number of daily trips	33.16	42	0.8333
	Reason for the trip*	117.11	84	0.0099

* Statistically significant factors

When the p-value is> 0.05, the two variables are not correlated; thus, occupation, residence, and reason for journey correlate with the transport mode. In contrast, there is no correlation between age, income, and number of daily journeys. Once the correlated variables were identified, the K_{modes} test was performed to create clusters, excluding the age, income, and number of daily journeys. Clustering makes it possible to identify distinct regions into which "similar" data can be grouped. In this case, three clusters represent the main components of travelers (see Fig. 5). In Fig. 5, the colored graphs show the main user categories for each cluster, i.e., those with the highest percentage. Cluster 1, for example, is mainly represented by university students (84%) who live in cities (79%) and travel for study reasons (74%). The users of this cluster mostly travel with transport modes that fall under the concept of active mobility (bicycle, moped, by foot) (21%) and Local Public Transport (LPT) (13%), while a smaller percentage use owned motorized vehicles in association with LPT (11%) and extra-urban/long distances PT (10%). Cluster 2 is mainly represented by workers (57%) who live in villages (81%) and move for work reasons (74%). Unlike cluster 1, users of this cluster mostly travel with owned motorized vehicles (25%), associated with both active mobility (38%) and extra-urban public transport (13%). Finally, cluster 3 is mainly represented by workers (74%) who live in cities (95%) and travel for work reasons (89%). The users of this cluster still mostly travel with owned motorized vehicles (34%), but less than cluster 3. A good percentage uses active mobility modes (10%) and LPT (10%). When users answered the question "*What means of transport do you use every day?*" with three or more modes, a single voice was created, without making specific distinctions but considering all the modes equally. This choice is because these modes are probably alternated on different days and not used during the same trip. These three clusters representing the survey sample can help define strategies to support MaaS development, reducing the number of travelers who use private cars. Cluster 1 is already characterized by a good propensity for more sustainable modes of transportation, including active mobility and public transport. However, multimodality mainly integrates public transport services and the private car. A possible MaaS package for this cluster could focus on improving integration between LPT and sharing mobility (bike-sharing, electric bike-sharing, moped sharing), which are not currently used. Indeed, travelers come from the city and have their destination places of study, mainly in the city where sharing services are normally more available. Cluster 2 is characterized by the elevated use of private cars, probably because it includes travelers coming from villages. While a good portion already integrates the use of private cars with extra-urban public transport and active mobility, it emerges that LPT is used by only 4% of the sample. The need to raise this percentage is clear, lowering that of travelers who use private cars (25%). A possible MaaS package for this

cluster should focus on improving services that better integrate LPT with extra-urban public transport, which connects the origin of this sample's journey with the city, where most of the work activities are concentrated. Cluster 3 appears less virtuous than Cluster 1, as it is characterized by high car use, even though travelers live in the city, which usually offers many more sustainable transportation alternatives and shorter travel distances than the village. Therefore, a possible MaaS package for this cluster could focus on incentivizing local public transportation, currently used by only 10% of the sample, and sharing options. Providing services that integrate LPT with forms of active mobility and sharing could reduce the share of travelers who use private cars, currently equal to 34% of the sample.

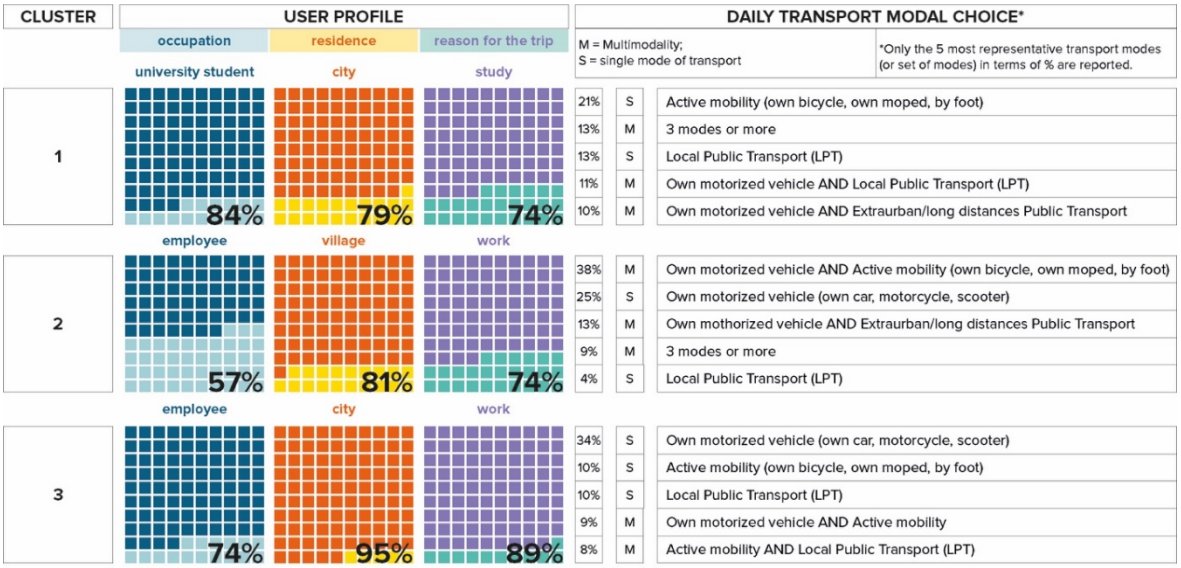

Fig. 5. Summary of the clustering results relating to the profiling of users and transport mode choices.

3.3. Level 3 - Interest on MaaS

The third level analyzes some responses related to interest and propensity for MaaS. The first issue concerns ticketing, and the following questions are asked: 6a) *Regarding the number of tickets, would you prefer to have one integrated ticket or multiple tickets for different means of transport?* 6b) *About the form of your ticket, what is your preference?* as shown in Fig. 6. All these questions provide valuable insights into user preferences, which can inform the design of a more user-friendly, efficient, and integrated ticketing system that meets the needs of diverse passengers.

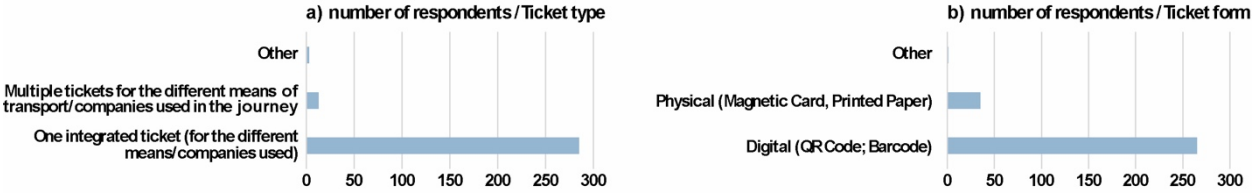

Fig. 6. (a) Regarding the number of tickets, would you prefer to have one integrated ticket or multiple tickets for different means of transport? b) About the form of your ticket, what is your preference?

Most people (285 responses) prefer a single integrated ticket for different modes and transportation companies, as observed in response 6a). Regarding the type of ticket, question 7(b) highlights that 265 people prefer a digital type solution over a physical one. A second issue concerns monthly spending on current and future mobility: 7a) *How much do you spend on average monthly for your weekly most frequent trips? (for the private vehicle: parking, fuel, recharge, motorway; for public transport: subscriptions, travel tickets)* and 7b) *Also based on the real costs of a*

private car seen earlier, how much would you be willing to spend monthly on a MaaS service including various means and transport services to fully meet your main mobility needs during the week and weekend (e.g. City bus + Regional train + Bike sharing + Rental car for the weekend+ Taxi)? as illustrated in Fig. 7. All these questions are critical for understanding user spending on transportation and their potential interest in MaaS solutions.

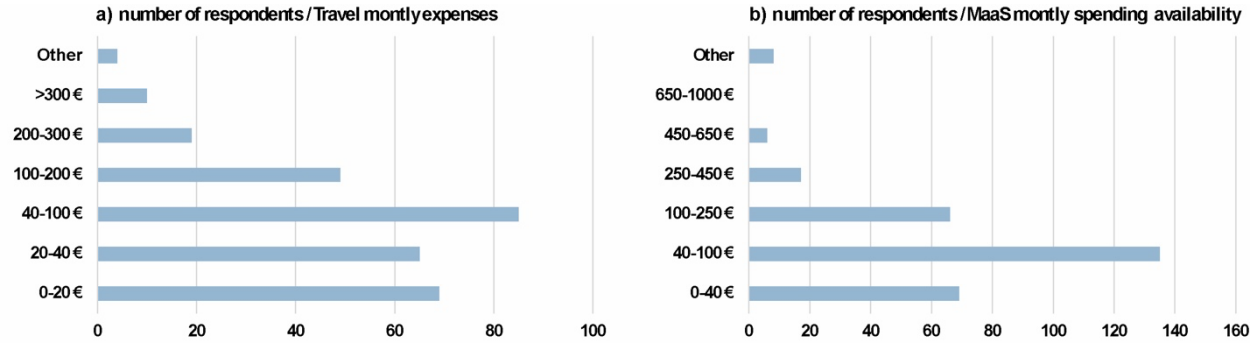

Fig. 7. (a) How much do you spend on average monthly for your weekly most frequent trips? (b) Also based on the real costs of a private car seen earlier, how much would you be willing to spend monthly on a MaaS service including various means and transport services to fully meet your main mobility needs during the week and weekend?

The responses to question 7(a) indicate that the most frequent range of monthly commuting expenditures is between 40-100€ (85 responses). The two ranges, between 0-20€ and 20-40€, have similar and lower values than the previous one (69 and 65). The introduction of MaaS indicates a monthly spending availability for weekly and weekend travel between 40-100€ (135 responses). It is observed that the two ranges between 0-40€ and 100-250€ present substantially similar values. The third issue concerns the potential expected benefits associated with MaaS related to private vehicle use: 8a) *With MaaS, would you decrease the number of journeys you make with your private motorized vehicle (e.g., car, motorcycle)?* and 8b) *Would the possibility of a MaaS service discourage you from buying a car?* as illustrated in Fig. 8. These questions provide valuable insights into how MaaS can influence travel behavior and vehicle ownership, helping stakeholders design and promote effective, sustainable transportation systems.

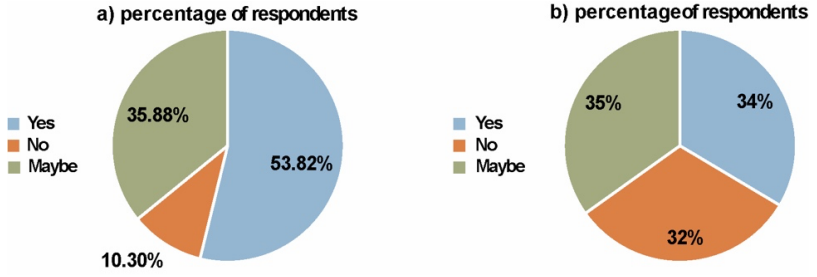

Fig. 8. (a) With MaaS, would you decrease the number of journeys you make with your private motorized vehicle (e.g., car, motorcycle)? b) Would the possibility of a MaaS service discourage you from buying a car?

Responses to question 8a) show that more than half of the responses (54%) confirm that MaaS adoption could reduce private vehicle use; 36% of the participants, however, would not reduce private vehicle use. The responses to question 8(b) show a uniform situation with a slight prevalence of uncertainty (35%). From responses, about one-third of people (34%) would be willing to renounce car acquisition due to the introduction of MaaS.

4. Conclusions

The study surveys people's propensity to use MaaS, including a preliminary sample analysis, cluster analysis for response correlations, and an overview of MaaS usage inclination. The 301 responses are representative across age, gender, journey purpose, daily trips, employment, and income. The analysis of the survey responses on MaaS provides

an interesting basis for defining future sustainable mobility scenarios oriented toward the interconnection of transportation services, thus supporting policymakers, technicians, and practitioners in defining MaaS packages that meet the needs of travelers. The definition of mobility packages is highly variable in the literature (Kriswardhana et al., 2023) and is a topic of growing interest with ample room for further investigation. Similar outcomes to other studies were found related to the diffused propensity for the use of mobile applications for MaaS and its, at least, potential ability to reduce the use and ownership of a car (Johansson, 2017). Another similar outcome was found in the proportion of undecided people evolving from potential to actual MaaS users, mainly due to the novelty and small knowledge of the concept (Matowicki et al., 2022). This paper sheds light on possible end users, travel behaviors, and fare options, providing useful hints to decision-makers. Currently, there are very few surveys and proposals like the ones investigated in the Italian context. The work can be developed by expanding the sample and performing further cluster analysis to assess possible correlations between different responses, defining scenarios and mobility packages related to the MaaS application.

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